Seek

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Seek

RESEARCH MAGAZINE FOR KANSAS STATE UNIVERSITY

SPRING • 2021

Research that ticks

Seeking answers to tick-borne diseases

The grid

Making our electric grid smarter, safer

Redefining the classroom

Bringing research, robots together

Under the microscope

This photo — taken through a microscope — offers a close-up look of the mouthparts of an adult female lone star tick, *Amblyomma americanum*.

This tick is part of the National Equine Tick Survey, which is housed at Kansas State University and is the first large-scale tick collection study from horses.

The lone star tick can cause multiple human and animal diseases, including ehrlichiosis, tularemia, Heartland virus disease, Bourbon virus disease and Southern tick-associated rash illness. See page 12 to read more about tick-borne disease research at K-State.

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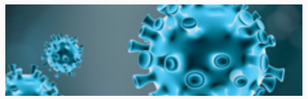
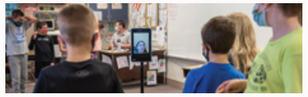
Features





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Find Seek online at *k-state.edu/seek* or at Kansas State University's New Prairie Press, *newprairiepress.org*.

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Editor's note:

Some of the photos in this issue were taken before the COVID-19 global pandemic and before face coverings and physical distancing became common practices. In the photos that have been taken during the pandemic, people are wearing face coverings and practicing physical distancing and other safety measures.

About Seek

Seek is Kansas State University's flagship research magazine and invites readers to "See" "K"-State's research, scholarly and creative activities, and discoveries. Seek is produced by the Office of the Vice President for Research and the Division of Communications and Marketing.

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KANSAS STATE UNIVERSITY

Welcome to the spring 2021 issue of Seek! I am honored to be in a position to greet you during your visit to our research highlights, as I am serving as interim vice president for research, following the departure of our former vice president for research, Peter K. Dorhout.

I'll tell you just a little about myself. I have been at Kansas State University since 1988 and am a professor of biology. I have had a variety of administrative roles, including associate dean for research in the College of Arts and Sciences, interim research director of the Biosecurity Research Institute, and most recently, senior associate vice president for research. The Office of the Vice President for Research continues to move the university research mission forward in conjunction with our faculty researchers. We will tell you some of their stories in this issue.

February 2021 provided a climate shock to most of the continental United States in the form of a huge southward dip in the jet stream that caused the displacement of the polar vortex. This resulted in far below-normal temperatures in a lot of the country, with many record lows set during the second and third weeks of the month. The impacts on our electric grid were particularly striking. Our cover story on "The grid" highlights K-State research that focuses on power electronics and improving the nation's power grid. Becoming an international leader in power and energy systems is a key priority area of the Carl R. Ice College of Engineering.

Two of our feature stories in this issue focus on our infectious disease research: One provides updates on various coronavirus research projects across multiple disciplines as we continue to struggle under the SARS-CoV-2 pandemic; the other highlights work by researchers of the Center of Excellence for Vector-Borne Diseases on combatting diseases carried by ticks.

Another feature story highlights work of the College of Education designed to help teachers and families overcome the intrinsic challenges posed by remote learning, including the robotic learning program of the Rural Education Center.

Our final feature describes several recent research achievements related to Kansas' signature crop, wheat, including the International Wheat Yield Partnership, the recent genome sequencing of 15 wheat varieties and work on the continuing threat of wheat blast.

Our shorter features highlight the research of University Distinguished Professor Christine Aikens of the chemistry department; K-State Polytechnic researcher Tom Haritos, geology graduate student Sarah Lamm; and undergraduate scholar Anna Welsh, a senior in psychological sciences, art and modern languages. Anna's project is highly interdisciplinary, involving art, history and Spanish, and is supported by an Office of Undergraduate Research and Creative Inquiry undergraduate research scholarship.

K-State's commitment to engagement is demonstrated by our story on the Shelter Medicine Mobile Surgery Unit of the College of Veterinary Medicine, which recently completed its 27,000th spay/neuter procedure in the six years it has been in existence. The unit has traveled statewide and has helped dozens of animal shelters, community organizations and the citizens of the communities they serve, save on veterinary care costs.

I hope you enjoy your tour of just a few of K-State's recent research, scholarly and creative activities. I encourage you to read this issue of Seek and learn more.

Beth A. Montelone, vice president for research

An eye for cattle facial recognition technology

If you've stared one cow in the face, you've seen them all … right?

New technology being developed at Kansas State University is debunking that thought and capitalizing on the power of artificial intelligence to build a database of facial recognition technology for the cattle industry.

Just like humans, each cow has a set of unique facial features that modern technology can scan and later use to track the animal throughout its life. Several K-State researchers from the College of Agriculture, the College of Veterinary Medicine and the Carl R. Ice College of Engineering are developing an artificial intelligence network for cattle that is based on human facial recognition technology.

"Our thinking is, 'Why can't we have something like that for beef cattle, which could then be used to create a national animal disease traceability system?'" said KC Olson, beef cattle scientist with K-State Research and Extension, who has helped to develop the idea. "The need for such a system has never been greater. We need this extra layer of protection for our industry against a foreign animal disease or possible malfeasance by somebody who's an enemy of this nation."

K-State has worked with Kansas City-based company Black Hereford Holdings Inc. to build a smartphone app called CattleTracs, which allows producers to submit pictures of their cattle.

Seek more

Watch a video that explains how the cattle facial recognition technology works.
k-state.edu/seek

Engaging the nonprofit workforce

Leadership development can help engage employees of nonprofit organizations, according to Kansas State University collaborative research.

Third Floor Research — the research partnership between the Kansas Leadership Center and K-State's Staley School of Leadership Studies — recently released a report that investigated the influence a leadership development program has on employee leadership behaviors and organizational outcomes in a nonprofit organization.

The result: Widespread leadership development up and down the organizational chart contributes to a more engaged workforce in the nonprofit sector.

"From the front desk to the C-suite, it's encouraging to see the difference leadership training can have on employees and the nonprofits where they work," said Tim Steffensmeier, K-State professor and director of the leadership communication doctoral program at the Staley School and director of research at the Kansas Leadership Center. "With organizational missions expanding and workloads increasing throughout the sector, employees at all levels are taking on more, often with less support. These findings and recommendations can really make a difference on burnout across the board."

See *Shorts*

Students and faculty members in the interior architecture & industrial design program meet with Sloan executives to review their commercial restroom product designs. (Photo credit: Mekin Elcioglu)

Designing a new studio experience

Interior architecture & industrial design students are building backgrounds in research, design and development, thanks to a new partnership with Sloan.

Sloan Valve Co., based in Chicago, is sponsoring two College of Architecture, Planning & Design classes: an undergraduate class for third-year students and a masters-level class for fifth-year students. Mekin Elcioglu, assistant professor of interior architecture & industrial design, is teaching both courses, which help students learn and innovate the future of interior restroom design as they enter the workforce.

"Benefiting from both academia and industry experiences, the research and resources can give the young designers and engineers an upper hand in the development of new concepts and solutions, and generate added value in tackling the issues brought up by global challenges," Elcioglu said.

In the courses, students delve into topics such as design research, idea conceptualization, human-centered design, market research trend analysis and innovation in the plumbing industry.

"We have found this partnership to be mutually beneficial in combining our 100 years of expertise in the plumbing industry with K-State's amazing creativity in design," said Jim Allen, Sloan co-president and CEO.

Konza Prairie continues decades of research success

The National Science Foundation has awarded a $7.12 million grant renewal to Kansas State University's Konza Prairie Biological Station to support the next six years of long-term ecological research. The grant is the eighth consecutive NSF grant renewal for Konza Prairie and marks more than 40 years of the Konza Prairie Long-Term Ecological Research, or LTER, program.

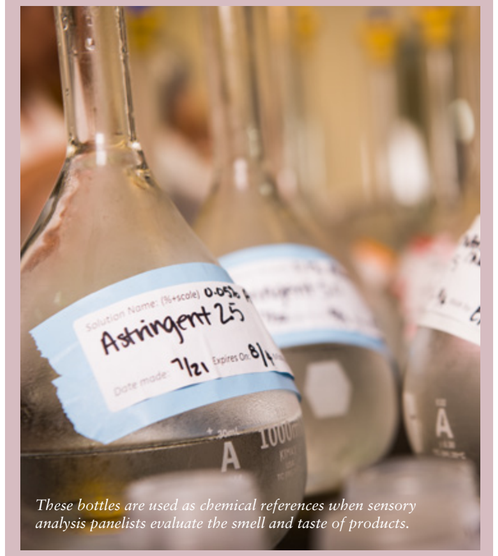
Since 1980, the Konza Prairie LTER program has supported a comprehensive ecological research, education and outreach program. The program centers on one of the most productive, yet endangered grasslands in North America: the tallgrass prairie.

With the recent NSF grant renewal, Konza Prairie has received a total of nearly $40 million in LTER funding and leveraged an additional $60 million of federally funded research.

Konza Prairie, an 8,600-acre native tallgrass prairie research station, is co-owned by the Kansas State University Foundation and The Nature Conservancy. Faculty in the K-State Division of Biology in the College of Arts and Sciences manage Konza Prairie as a world-class platform for education and scientific investigation of grassland ecology.

"The Konza Prairie Biological Station is an amazing and critical resource for K-State," said Chris Culbertson, associate dean for research in the College of Arts and Sciences. "The recent renewal of the NSF LTER grant for an unprecedented eighth time will allow the critical long-term research underway there to continue and will allow for several new research directions to be pursued."

The Konza Prairie Biological Station is an 8,600-acre native tallgrass prairie where researchers conduct long-term ecological research.



These bottles are used as chemical references when sensory analysis panelists evaluate the smell and taste of products.

The nose knows

Odor can be complicated. It is a key component in the flavor of food, the smell of nature and perfumes, and products such as shampoos and deodorants.

But the problem with understanding smell is that small changes in chemical structure can cause large changes to odors. Even further, food products with multiple chemical compounds may taste nothing like any single chemical compound.

Researchers with the Kansas State University Center for Sensory Analysis and Consumer Behavior want to know why.

Two researchers in the food, nutrition, dietetics and health department in the College of Health and Human Sciences — Kadri Koppel, associate professor and co-director of the Center for Sensory Analysis and Consumer Behavior, and Edgar Chambers IV, university distinguished professor — are using machine learning to better understand and predict smells.

The machine learning involves a mathematical and statistical tool to understand and predict how changes can affect smell.

The K-State work is supported by a five-year $550,000 grant from the National Institutes of Health. The project is a collaboration with Monell Chemical Senses Center at the University of Pennsylvania.

See Shorts

Researchers Bret Flanders, left, and Paul Smith have received a prestigious W.M. Keck Foundation award.

Big support for a big idea

A Kansas State University-led collaboration has received a $1 million grant from the William M. Keck Foundation for research on stochastic heating and how it can accelerate chemical reaction rates. It is the first W.M. Keck Foundation award to a K-State-led research initiative.

The collaboration involves College of Arts and Sciences researchers Bret Flanders, professor of physics, and Paul Smith, professor of chemistry, as well as research partner Christine Orme, senior staff physicist from Lawrence Livermore National Laboratory.

The research focuses on understanding electrochemical, biomineralization and biochemical reactions. It aligns with the Rules of Life — part of the 10 Big Ideas that the National Science Foundation uses as a road map for future funding.

The W.M. Keck Foundation limits awards to a few projects each year and focuses on distinctive and novel approaches to medical research, science and engineering.

"The physics of living systems is a physics frontier," said Flanders, the project lead investigator. "This award will initiate a new avenue of biophysical research in the physics and chemistry departments at K-State and through the collaboration at Lawrence Livermore National Laboratory. The W.M. Keck award and the research it will fund are significant steps forward."

Based in Los Angeles, the W.M. Keck Foundation was established in 1954 by the late W.M. Keck, founder of the Superior Oil Company. The foundation's grant making is focused primarily on pioneering efforts in the areas of medical research, science and engineering. The foundation also maintains a Southern California Grant Program that provides support for the Los Angeles community, with a special emphasis on children and youth.

Seek more

Learn more about the project and the W.M. Keck Foundation.

k-state.edu/seek

CONTINUING THE FIGHT

Researchers work across disciplines to end COVID-19 pandemic

By Erin Pennington and Jennifer Tidball

When the world paused during the COVID-19 pandemic, many Kansas State University researchers did the opposite.

K-State researchers increased their efforts or pivoted focus to join the battle against the novel coronavirus. By February 2021 — nearly a year after the World Health Organization declared the COVID-19 pandemic — K-State had more than $35 million in coronavirus-related grant proposals, more than $12 million in contracts for COVID-19 research and several new technologies licensed to corporate partners to combat the disease.

Research across the university has ranged from treatment and vaccine development to understanding the pandemic's effects on early learners. Read more about the variety of K-State projects during the pandemic.

Candidate compound

A series of protease inhibitors developed, patented and licensed by K-State continues to help the fight against coronaviruses, including SARS-CoV-2, the virus that causes COVID-19. Cocrystal Pharma Inc., a clinical-stage biotechnology company, has selected the protease inhibitors as a preclinical lead compound for further development.

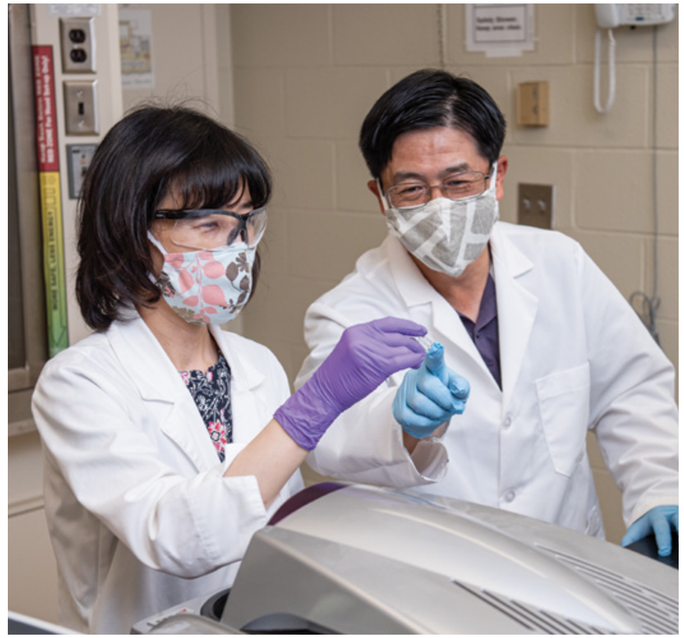
Kyeong-Ok "KC" Chang and Yunjeong Kim, virologists in the K-State College of Veterinary Medicine, developed the protease inhibitors in collaboration with William Groutas at Wichita State University and Stanley Perlman at the University of Iowa. K-State Innovation Partners licensed the protease inhibitors, which could lead to a possible COVID-19 drug or treatment.

"Further studies are required to reveal the therapeutic potency of our protease inhibitor compared to other approved drugs," Kim said. "Drugs targeting different virus proteins are often combined to maximize their efficacy, so it is always nice to have a repertoire of drugs that work in different ways."

Preclinical animal studies of these K-State coronavirus compounds published in the prestigious medical journal Science Translational Medicine showed efficacy against Middle East respiratory syndrome, or MERS, a related deadly human coronavirus infection, in a mouse model.

Further testing allowed Cocrystal to identify this promising candidate for preclinical lead development for COVID-19. According to the company, the compound potentially could be delivered through injection or inhalation and could be used as both a therapeutic and prophylactic, which protects uninfected individuals who may become exposed.

With the selection of this candidate, Cocrystal will initiate studies to evaluate potential toxicity risks and conduct safety pharmacology studies before the phase 1 clinical trial.



Virologists Yunjeong Kim, left, and Kyeong-Ok "KC" Chang have developed a series of protease inhibitors.

Developing the research space

K-State recently received a $1.2 million University SARS-CoV-2/COVID Research and Diagnostic Capacity Support Grant from the Kansas Department of Commerce as part of the Coronavirus Aid, Relief and Economic Security Act — known as the CARES Act — distribution. These funds will launch a Biotechnology Development Module, or BDM, at the K-State Biosecurity Research Institute, or BRI.

The National Bio and Agro-Defense Facility, or NBAF — nearing completion adjacent to K-State's Manhattan campus — will house a BDM for companies to increase manufacturing for a limited number of select agent countermeasures. The K-State BDM at the BRI will be a complementary pilot-scale facility for research that does not focus only on NBAF-priority diseases.

The K-State BDM will allow researchers and corporate partners to develop diagnostic, therapeutic and preventive countermeasures for a broad range of emerging zoonotic diseases, including SARS-CoV-2 and African swine fever virus. The facility will be located in unique close proximity to containment and non-containment animal facilities as well as the Kansas State Veterinary Diagnostic Laboratory.

"K-State's strengths in addressing threats to plant, animal and human health are more important than ever before," said Beth Montelone, interim vice president for research. "This grant will enable K-State to continue to grow its vaccine and other countermeasure development strategy to address new and emerging diseases."

A Biotechnology Development Module at the Biosecurity Research Institute will allow research on emerging pathogens.

A K-State study focuses on how long the SARS-CoV-2 virus survives in different climates and on different surfaces, such as gloves, masks, glass and cardboard.

Environmental stability

K-State researchers are helping understand how long SARS-CoV-2 can survive on different types of surfaces and in various temperatures.

A Center of Excellence for Emerging and Zoonotic Animal Diseases, or CEEZAD, team recently completed a BRI study on the topic. The researchers, also from the College of Veterinary Medicine, included Taeyong Kwon, doctoral student in pathobiology; Natasha Gaudreault, research assistant professor of diagnostic medicine and pathobiology; and Jürgen A. Richt, Regents distinguished professor and CEEZAD director.

The study resulted in several important insights into SARS-CoV-2 survival, including:

- The virus survived the longest — 21 days after contamination — on surfaces under winter conditions.
- In spring and fall conditions, the virus survived up to seven days.
- No infectious virus was found three days after contamination under summer conditions.
- Under indoor conditions, infectious virus was recovered from cloth up to one day after contamination; for up to three days from concrete, polypropylene, stainless steel and galvanized steel; and for up to four days from nitrile gloves, Tyvek, N95 masks, Styrofoam, cardboard, rubber and glass.

"These findings clarify a major concern among scientists, and also among members of the general public, namely the ability of the SARS-CoV-2 to survive on various surfaces under varying climatic conditions," Richt said. "It shows that the virus's ability to remain a threat is greatest in winter and less in summer. But it also shows that even in indoor conditions, SARS-CoV-2 remains viable for several days depending on the surface."

Understanding quarantine

Kyle Goerl, medical director of K-State's Lafene Health Center, is part of a collaborative team providing research-based guidance during the COVID-19 pandemic. The Centers for Disease Control and Prevention has used the team's research to update and shorten quarantine guidance.

Goerl is a co-author of a quarantine-related publication that recently appeared in the CDC Morbidity and Mortality Weekly Report and involved multiple organizations and universities.

The publication describes a sample of COVID-19-exposed collegiate athletes in 17 states from June to October 2020. Twenty-five percent of the athletes tested positive during quarantine and the positive test occurred an average of 3.8 days after quarantine started. As quarantine progressed, the probability of testing positive dropped from 27% after day five to less than 5% after day 10.

"These findings show that after 10 days of quarantine, the risk of COVID-19 is relatively low," said Goerl, also a team physician for Kansas State University Athletics. "This helps to support a quarantine period that is shorter than 14 days. If the quarantine period is shortened, it is more likely that people will follow important quarantine measures."

Kyle Goerl, K-State medical director, is helping provide research-based quarantine guidance.

Effect on early learners

Adelaide Klutse, master's student in applied family science in the College of Health and Human Sciences, is studying how teachers are facilitating the social-emotional development of children ages 0 through 5 during the COVID-19 pandemic.

Her research is providing knowledge on the availability and kinds of support targeted at empowering early educators during the pandemic.

Klutse is working with adviser Bradford Wiles, associate professor of applied human sciences, to understand how teachers facilitate social-emotional development in children when close contact and touch are major risks for disease transmission. She is researching how teachers' perceived levels of stress affect their classroom qualities and their abilities to help children with social-emotional development.

According to Klutse, this study is significant because current research does not include early childhood education teachers who are facilitating development in the early years.

"Research suggests children spend a considerable number of hours with their teachers and these teachers' abilities to facilitate socioemotional development in children goes a long way toward influencing family outcomes in current and future families," Klutse said.

Adelaide Klutse, master's student in applied family science, is studying how children are adapting during the pandemic.

Analyzing contact tracing

K-State engineers are investigating some of the hidden mechanisms behind the spread of COVID-19.

In their latest work, the researchers in the Carl R. Ice College of Engineering are modeling the spread of COVID-19 and evaluating the effectiveness of disease mitigation measures. Specifically, they have studied the benefits and costs of contact tracing and how effective it is in containing the spread of COVID-19.

"Contact tracing plays a vital role as a critical mitigation strategy for COVID-19," said Sifat Afroj Moon, doctoral student in electrical and computer engineering. "Our investigation indicates that a sufficient amount of contact tracing can reduce the impact of COVID-19 spreading in the reopening process of a location."

Moon works with Caterina Scoglio, the LeRoy and Aileen Paslay professor and Steve Hsu Keystone research scholar in the Mike Wiegers Department of Electrical and Computer Engineering. They recently published their findings on contact tracing in Nature Scientific Reports.

The researchers are continuing their modeling research and also are studying and simulating the effectiveness of multiple COVID-19 vaccination strategies. k

By the numbers

K-State COVID-19 research

$35 million+
In grant proposals.

$12 million+
In grant awards.

3
Technology option or license agreements.

20+
Studies at the Biosecurity Research Institute conducted during 2020 and 2021.

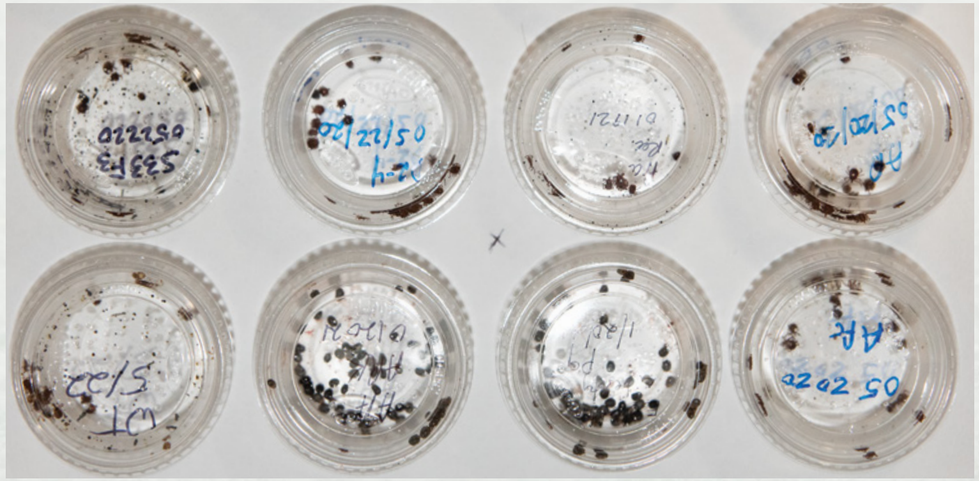
25+
Researchers and staff involved in COVID-19 research at the Biosecurity Research Institute.

Seek more

Read more and find K-State research publications related to COVID-19.
k-state.edu/seek

Research that ticks

Seeking answers to tick-borne diseases
By Beth Bohn



Lone star ticks are anchored in wax plates for research at the Center of Excellence for Vector-Borne Diseases.

Kansas State University researchers are taking on a problem that is on the uptick: tick-borne diseases.

According to the Centers for Disease Control and Prevention, tick-borne disease cases increased from 48,610 in 2016 to 59,349 in 2017 alone, but actual cases are estimated to be much higher. Eighteen tick-borne diseases that affect humans have been identified in the United States, with the most common being Lyme disease, as well as anaplasmosis, ehrlichiosis and Rocky Mountain spotted fever. Tick-borne diseases also affect animals.

Tick-borne diseases are spread through the bite of a tick infected with a pathogen. Some of these diseases can be fatal to both humans and animals if not properly treated.

To deal with the increasing number of tick-borne disease cases, the National Institutes of Health launched a strategic research plan in October 2019 that prioritizes funding and support for tools to fight tick-borne diseases, including rapid diagnostic tests, research for new treatments and vaccines, and more.

Tick-borne diseases have long been the focus of K-State researchers. Their efforts continue to garner support from the NIH, the U.S. Department of Agriculture and other public and private entities to take on these diseases in many ways.

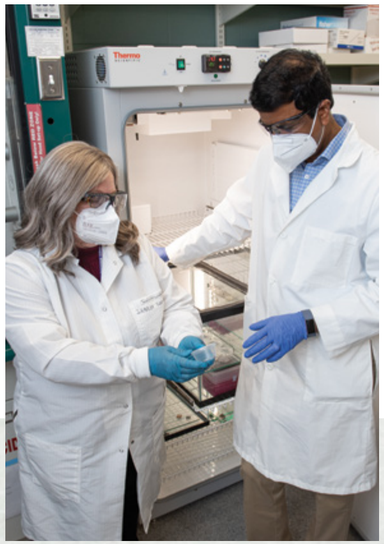
ALL THINGS TICKS

At the K-State Center of Excellence for Vector-Borne Diseases in the College of Veterinary Medicine, Roman Ganta, center director and professor of diagnostic medicine and pathobiology, his team and affiliated scientists are on a mission to build an internationally recognized program that combats diseases from vectors, which are living organisms like ticks and mosquitoes that can transmit infectious pathogens.

Since the center was founded in 2015, Ganta has generated $9.56 million in competitive research grant support, with the majority — $8 million — coming from the NIH. The funding supports basic and applied research to develop vaccines for several tick-borne diseases that affect people, dogs and cattle, including anaplasmosis, ehrlichiosis and Rocky Mountain spotted fever.

“We work on all priorities of the NIH when it comes to tick-borne diseases,” Ganta said. “Indeed, our most recent NIH-funded grant is the result of our success in securing funding from NIH as part of its special funding initiative.”

Ganta’s most recent NIH grant seeks a vaccine for ehrlichiosis and anaplasmosis. Ehrlichiosis in people and domestic animals is caused primarily by the lone star tick. The blacklegged deer tick and brown dog tick also can spread the disease.



Above left and right: At the Center of Excellence for Vector-Borne Diseases, Deborah Jaworksi, left, research assistant professor, and Roman Ganta, center director and professor, examine some of the different tick species maintained in storage containers in the center's incubator.

The disease affects domestic animals and humans and causes fever, chills and muscle aches. Anaplasmosis is caused by the blacklegged deer tick and involves many of the same symptoms as ehrlichiosis in humans, along with nausea, vomiting, diarrhea and loss of appetite. Bovine anaplasmosis is a major tick-borne disease of cattle that can be fatal and costs the cattle industry hundreds of millions of dollars annually.

Another NIH grant focuses on human monocytic ehrlichiosis, which is caused by the lone star tick-transmitted pathogen *Ehrlichia chaffeensis*. The grant seeks to help vaccine development to control infections in humans and animals.

"We are investigating how *Ehrlichia chaffeensis* regulates its gene expression in response to host cell environmental signals and how it develops strategies to evade host response for its continued survival in vertebrate hosts and ticks," Ganta said.

One of the center's newest tick-borne disease studies is on heartwater disease, which the USDA has labeled a high-consequence foreign animal disease. It is an infectious disease of domestic and wild ruminants transmitted by a number of species of ticks in the genus *Amblyomma*. It has not been reported in the U.S. but is a threat for likely introduction.

"The introduction of heartwater in the U.S. could cause high morbidities and mortalities — possibly up to 80% — in domestic and wild ruminants, such as cattle, sheep, goats and deer," Ganta said.

The center received a $400,000 grant from the state of Kansas' National Bio and Agro-Defense Facility, or NBAF, Transition Fund to launch its initial heartwater study. Ganta expects to extend collaborations on the heartwater project with scientists at the USDA Agricultural Research Service and NBAF to develop ways to reduce the disease risk in the U.S. ruminant population. NBAF will be the nation's foremost animal disease research facility and is nearing completion adjacent to the K-State campus.

Other center tick-borne disease research projects include disease surveillance, ehrlichiosis vaccine evaluation and a bovine anaplasmosis vaccine development study.

TICKING OFF RESEARCH BOXES

In the lab of Kathryn Reif, work is dedicated to identifying innovative solutions to combat ticks and tick-borne pathogens of medical, veterinary and agricultural importance. The collaborative research spans from basic to translational and involves several K-State researchers and graduate students.

Reif, assistant professor of diagnostic medicine and pathobiology in the College of Veterinary Medicine, is using several grants from the USDA, Food and Drug Administration and various foundations and organizations to study bovine anaplasmosis.

"We are evaluating the prevalence and genetic diversity of the agent of bovine anaplasmosis, *Anaplasma marginale*, in the U.S., as well as evaluating and developing anaplasmosis control strategies, including use of antimicrobials and vaccination," Reif said.

Another Reif lab project focuses on feline cytauxzoonosis, a tick-borne disease of cats caused by the parasite *Cytauxzoon felis*. Although feline cytauxzoonosis is frequently fatal in domestic cats, some cats do survive and become pathogen hosts.

"We are looking at the prevalence of acute and chronic cytauxzoonosis among domestic cats and identifying immunodominant antigens that can be used to develop diagnostic assays and vaccines," Reif said.

Understanding what makes ticks tick also is a research focus. One project is adapting the technique of electropenetrography, or electrical penetration graph monitoring, to monitor the feeding behavior of ticks on their hosts. A second project is studying molecular mechanisms of tick-borne pathogens for clues on pathogen persistence and transmission.

TICKS, SALIVA AND DISEASE

Berlin Londoño, assistant professor of entomology in the College of Agriculture, mixes her primary research on mosquito-borne diseases with studies on tick salivary proteins. Londoño wants to develop tools to measure intensity of exposure to arthropod bites.

"Currently, there are no tools to directly measure human or animal exposure to arthropod bites that can give us a better approximation of the risk for suffering a disease transmitted by them," Londoño said. "We are trying to develop a protocol to establish risk of infection measuring level and type of antibodies against arthropod saliva. With this protocol, we will try to track pathogen transmission and block epidemics before they get out of proportion."

The Londoño lab has identified several mosquito and tick salivary proteins from *Aedes* and *Anopheles* mosquitoes and lone star ticks that induce significant antibody levels in humans. She and her team are measuring those antibodies to learn more about the risk of suffering a disease.

Entomology researchers Berlin Londoño, assistant professor, right, and Olayinka Olajiga, master's student, prepare artificial feeders for mosquitoes.

This image shows an adult female lone star tick, Amblyomma americanum, *that is part of the National Equine Tick Survey.*

THE TICK COLLECTOR

Tick-borne disease transmission in companion animals, wildlife and equine is the focus of Brian Herrin, assistant professor of diagnostic medicine and pathobiology in the College of Veterinary Medicine.

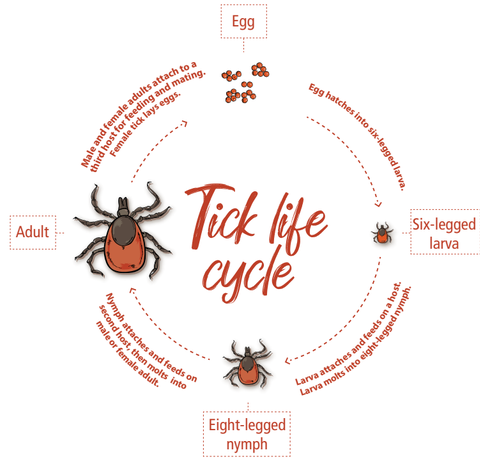
One of the projects Herrin leads is the National Equine Tick Survey of the United States, the first large-scale tick collection study from horses. Launched in 2018, the survey asks equine veterinarians and horse owners across the nation to send the ticks they find on their horses to Herrin's lab for identification. So far, he has received more than 1,500 ticks.

"We identify the tick and report our results back to the submitter along with a short informational sheet describing the tick species and the associated pathogens that could be transmitted by it," Herrin said. "A big portion of this study is also about horse owner education on ticks and tick-borne diseases, so we felt it was really important to engage with the community that is sending us ticks."

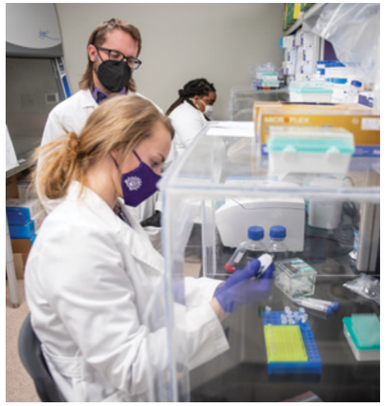
Common tick-borne disease in horses include Lyme disease and anaplasmosis.

Herrin plans to collect the survey information about the various ticks infesting horses and the types of pathogens ticks they carry for future publications.

"This survey will add to the surveillance data on ticks across the U.S. as well as provide convincing evidence that ticks and their pathogens really are a major issue to the health of horses," Herrin said. "We want to use that fact to encourage veterinary pharmaceutical companies to find more effective, longer-lasting tick control products for horses."



Most ticks go through four life stages. After hatching from the eggs, ticks need a blood meal from a host, such as a human or animal, at every stage to survive.



Makaela Hedberg, master's student in veterinary biomedical science, prepares to test Ixodes scapularis *ticks, collected in the National Equine Tick Survey project, for* Borrelia burgdorferi, *the causative agent of Lyme disease.*

Behind the breadbasket

Wheat scientists help drive state's strength in US, world production

By Pat Melgares

If you lined up train cars and filled them with all of the wheat harvested in Kansas during one growing season, you'd have a load stretching from western Kansas to the Atlantic Ocean. That's 130,000 rail cars covering 1,600 miles from Goodland, Kansas, to Toms River, New Jersey.

That's what it would take to move the 328 million bushels of grain harvested on about 7 million Kansas acres, according to the organization Kansas Wheat. The Kansas Department of Agriculture estimates that the state's 20,000 wheat farmers provide an economic impact of $1.44 billion and more than 3,000 jobs in the state.

In Kansas, wheat really is a big deal. In fact, for most of the past century, Kansas has dominated wheat production in the United States. It may be known officially as the Sunflower State, but some know Kansas better as the Wheat State or Breadbasket of the World.

"Wheat is one of the most important staple crops around the world and is vital for food security," said wheat geneticist Jesse Poland, associate professor of plant pathology in the Kansas State University College of Agriculture. "Kansas is a leader in wheat production, making the crop a key economic driver for the state."

Since its founding 158 years ago, K-State has filled a major need in wheat production by providing basic and applied research for farmers in the state and world.

"K-State is a leader because we have the breadth and scope to address the gamut of disciplines relevant to wheat research — from genomics and molecular biology to breeding, pathology, agronomics and entomology, " Poland said.

Genetic improvements

Wheat breeder Allan Fritz, professor of agronomy, has been with the university since 2000 and has witnessed firsthand the research engine that powers Kansas wheat production.

"We're very fortunate to have some of the best wheat researchers in the world in Manhattan, including outstanding scientists at K-State and the U.S. Department of Agriculture Agricultural Research Service," Fritz said.

In 2019, Kansas farmers harvested more than 328 million bushels of grain, or nearly one-fifth of all the wheat grown in the U.S.

According to Fritz, K-State-developed wheat varieties have been the No. 1 planted wheat varieties in Kansas for nine of the past 10 years.

"Having very talented people is a big part of being a leader in wheat research," Fritz said. "We also have a critical mass of researchers across disciplines, creating a robust research environment. There's strong competence here for almost anything one would want to do."

Wheat geneticist Eduard Akhunov, professor of plant pathology, leads the International Wheat Yield Partnership's Winter Wheat Breeding Innovation Hub, which was established at K-State in 2020 with a $1 million grant from the USDA National Institute of Food and Agriculture. The project involves using advanced molecular techniques to find ways to stack — or combine — desirable traits into elite winter wheat varieties to improve the quality and increase the quantity of wheat produced in the world.

"We are improving wheat yield, disease resistance, quality and drought tolerance by

applying modern genetics and breeding approaches that are based on big data-driven research and next-generation sequencing, functional genomics and genome-editing technologies," Akhunov said.

Genome editing relies on a technology called clustered regularly interspaced short palindromic repeats — better known by its abbreviation, CRISPR.

"CRISPR is a powerful and extremely precise molecular tool capable of making targeted changes in genetic code," Akhunov said. "It allows us to produce novel variants of genes that carry improved properties and create a positive impact on the traits of interest."

Using genome editing to target genes that are linked to valuable agronomic traits allows researchers to accelerate the development of crops that produce higher yields, are more nutritious or yield higher quality grain.

"It's not difficult to find a K-State link among the wheat research community in the U.S. and around the world," said Aaron Harries, vice president of research and operations for Kansas Wheat, a cooperative between the Kansas Wheat Commission and the Kansas Association of Wheat Growers. "The base knowledge gleaned from wheat genetics research at K-State is disseminated nationally and globally. And, the next generation of wheat scientists is being developed at K-State."

Protecting US agriculture

Barbara Valent, university distinguished professor of plant pathology, has worked on understanding blast disease for more than 40 years. In the last decade, her work has focused on wheat blast, a dangerous disease in which the fungus is capable of taking out entire wheat fields.

The wheat-adapted blast pathogen has never been found in the U.S., and Valent hopes to keep it that way. It has devastated farm fields in South America and Bangladesh, where farmers have burned entire fields to stem the spread. Despite those drastic measures, the disease still established.

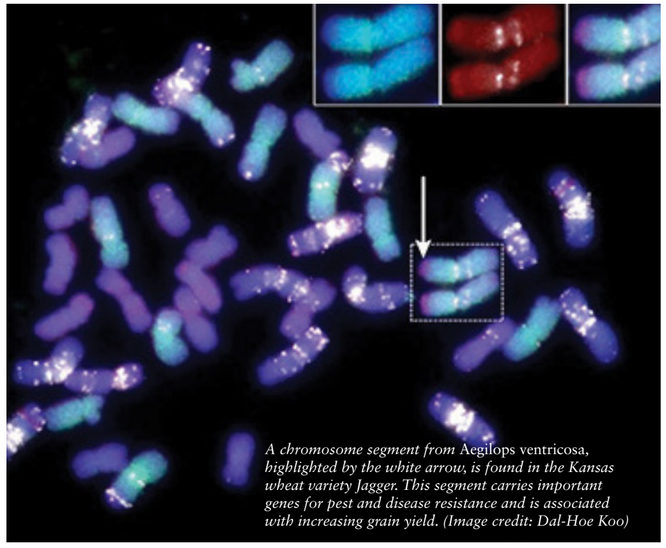
"My lab has focused on knowing the enemy in order to control it," said Valent, who in 2020 became the first K-State scientist to earn membership in the prestigious National Academy of Sciences for research conducted while at the university.

Valent's research focuses on understanding how the destructive blast fungus infects rice and mutates so easily.

"A decade ago, I saw the opportunity to leverage knowledge my lab had gained studying rice blast to protect wheat crops from the new emerging blast disease, caused by a related fungal variant that appeared in Brazil in 1985," Valent said.

Through work in the K-State Biosecurity Research Institute, Valent's research team was the first to discover a resistance gene called 2NS for wheat blast disease. More recently, the scientists completed work showing how microbial pathogens like the wheat blast fungus are constantly evolving to overcome control measures developed by scientists.

Research plots are key to studying the countless number of diseases and pests that can inhibit wheat's growth.



A chromosome segment from Aegilops ventricosa, *highlighted by the white arrow, is found in the Kansas wheat variety Jagger. This segment carries important genes for pest and disease resistance and is associated with increasing grain yield. (Image credit: Dal-Hoe Koo)*

K-State's emerging disease research and work to sequence the wheat genome are two key components that have contributed greatly to Kansas growers' harvest success.

Thus, their work never ends.

"Research to solve emerging problems takes time, so we need to anticipate problems and work to solve them before they become an issue for farmers," Valent said. "That is what we are doing with wheat blast disease."

Genome sequencing

In the Feed the Future Innovation Lab for Applied Wheat Genomics, housed at K-State, researchers are creating genomics resources and tools to improve wheat germplasm, which in turn helps breeders produce better varieties.

"We look at the most significant challenges facing Kansas growers and prioritize the most economically significant issues," said Poland, who is the lab's director. "Our overall aim is a stable and profitable yield for farmers."

In late 2020, Poland's team, in collaboration with the international 10+ Genome Project led by the University of Saskatchewan, completed genome sequencing of 15 wheat varieties that represent breeding programs around the world. That came on the heels of work completed in 2018 when K-State collaborated with the International Wheat Genome Sequencing Consortium to publish the first complete reference genome of bread wheat.

Both breakthroughs are big news for wheat production around the world.

"Many of the challenges facing wheat in Kansas are not that different from the challenges all over the world," Poland said. "It may be a different pest or disease, but the approach, resources and tools developed in our research can be used to address multiple problems."

Mary Guttieri, a scientist with the USDA Agricultural Research Service, or ARS, Hard Winter Wheat Genetics Research Unit in Manhattan, appreciates the teamwork among her program and many other wheat researchers.

"The active engagement of the K-State wheat research and extension communities with our ARS efforts — and the work of the wheat community across the country — serves to strengthen all facets of the science of wheat," she said. "K-State has been instrumental to the success of these initiatives to understand and utilize the complex genetics of wheat."

Guttieri and colleague Robert Bowden — both K-State adjunct faculty members — were recognized in 2020 as part of a national team that earned the Gene Stewardship Award, given by the Borlaug Global Rust Initiative.

"We're proud to be part of the larger K-State team and the bigger USDA team and even the much bigger global team that is doing this work," Bowden said. "Everybody is working together wonderfully and it's inspiring."

Seek more

View additional photos and videos of wheat research.
k-state.edu/seek

The grid

Engineers make our electric grid smarter, safer

By Jennifer Tidball

The sun rises on the Meridian Way Wind Farm near Concordia.

All it takes is the flip of a switch. Lights on. Lights off.

But as any Kansas State University engineering researcher will tell you, it's so much more than a simple flip of a switch. There are multiple steps for the generation, transmission and distribution of the electricity throughout the power grid to make the light switch work.

The recent surge of interest in renewable energy means the power grid, or electric grid, must adapt and modernize. Researchers from the Carl R. Ice College of Engineering are playing a key role in making the power grid smarter. Several research projects funded by the U.S. Department of Energy, the National Science Foundation, industry and other partners aim to make our electric grid smarter, more stable and more secure.

"K-State strives to be an international leader in power and energy systems and their related cyber-physical security," said Don Gruenbacher, George J. and Alice D. Fiedler distinguished chair and head of the Mike Wiegers Department of Electrical and Computer Engineering. "Nearly 50% of undergraduate and graduate students in our department specialize in the area of power. We have a strong history of power engineering education and research that improves the power grid."

The power grid is an extensive network of generators — including dams, power plants, solar farms and wind farms — as well as substations and power lines that transmit and distribute electricity across the country. Experts say the current infrastructure is dated and vulnerable to failure, blackouts and cyberattacks.

Things can get complicated as we have more electric vehicles, more smart buildings and more renewable energy resources in the grid. The more devices we add, the more difficult it becomes for the current infrastructure to respond to transiency, and that can cause issues.

The solution may come from several K-State projects that are focused on modernizing our grid.

The edge of the grid

One way to modernize the grid is to make it smarter. A smart grid has situational awareness and is able to quickly respond to problems, such as vulnerabilities to hackers.

A team of K-State electrical and computer engineering researchers is using a three-year, $2.8 million grant from the U.S. Department of Energy Solar Energy Technologies Office to study how solar energy can make the power grid smarter and more resilient, particularly when it comes to cyberattacks. It is the first grant from the solar office to be awarded to a university in Kansas.

"Utility companies are definitely interested in managing this power grid evolution in a smart way and making sure that it doesn't affect the customer," said Bala Natarajan, the leader of the project and the Clair N. Palmer and Sara M. Palmer professor of electrical engineering. "With the power grid, there is an actual physical grid, but for it to be smart, you need a cyber-physical system on top of it to process information."

A cyber-physical system includes a series of sensors and control components that communicate over a network and act together. Researchers on the project are developing ways to monitor the power grid so that it knows how to respond. For example, if a natural disaster would cause a power outage for 80% of the power grid, a smart grid could respond by diverting the remaining 20% of power to critical buildings, such as hospitals.

"If you look at the power grid, it's an infrastructure that has been around for many years," said Natarajan, also a Steve Hsu Keystone research scholar. "It has been seeing a lot of changes and it will continue to evolve, especially at the edge of the grid."

The edge of the grid occurs at the home level where the customer interacts with the grid. It's also where cyberattacks are most likely to occur, Natarajan said. A hacker could enter the whole power grid system through an electric car charging station or through a homeowner's solar panel system. The risk increases as more houses and businesses incorporate sources of renewable energy.

Natarajan and the team are developing new ways of obtaining situational awareness at the grid edge. These novel methods and associated algorithms can be integrated into existing systems to monitor voltage issues across the grid, even with minimal grid edge measurements.

"In the next decade, cybersecurity issues are going to be significant," said Hongyu Wu, assistant professor involved in the project and Michelle Munson-Serban Simu Keystone research scholar. "As we modernize our system, we have more and more communication to make the system smarter, but, on the other hand, we have larger areas that can be exploited by an attacker to do damage."

The research team is improving cybersecurity through moving target defense, which can easily detect and deflect a cyberattack. Other electrical and computer engineering faculty members involved in the project include Behrooz Mirafzal, associate professor and Michelle Munson-Serban Simu Keystone research scholar, and Anil Pahwa, university distinguished professor and Logan-Fetterhoof faculty of distinction chair.

Natarajan and Wu also have received a $480,000 National Science Foundation grant to develop modeling tools and framework to help power system operators balance the grid with renewable energy resources, electric vehicles and active consumers.

Bala Natarajan, professor of electrical and computer engineering, stands in front of a series of solar panels on the roof of Engineering Hall.

Bala Natarajan, right, collaborates with an electrical and computer engineering team that includes, clockwise from bottom, Dylan Wheeler, master's student; Shweta Dahale, doctoral student; and Hazhar Sufi Karimi, recent doctoral graduate.

Bala Natarajan studies how solar energy can make the power grid smarter and more resilient.

Renewable and existing

Solar panels, electric vehicle charging stations and other distributed energy resources are dynamically changing the structure of the grid. This can be challenging when it comes to the transmission and distribution of power because voltages must be set within certain limits.

An added problem is that renewable energy is difficult to forecast. Take the Kansas weather as an example. One day it could be gusty at a wind farm and generate wind energy, but the next day could be completely calm. Similarly, several days of sunny weather for solar panels could be followed by several days of cloudy skies.

A wind turbine from the Meridian Way Wind Farm near Concordia

An aerial view of the Midwest Energy community solar array in Colby (Photo credit: Midwest Energy)

To address this issue, Wu is working on energy management of the power grid and developing ways to store and transfer the energy load on days when the weather doesn't cooperate.

The key is to make these improvements in a cost-effective manner, which is where Mirafzal comes in. He is developing self-learning power electronic devices that can be the interface between renewable energy resources and the power grid.

It's a green approach to incorporating green technology: Use what we already have and improve it.

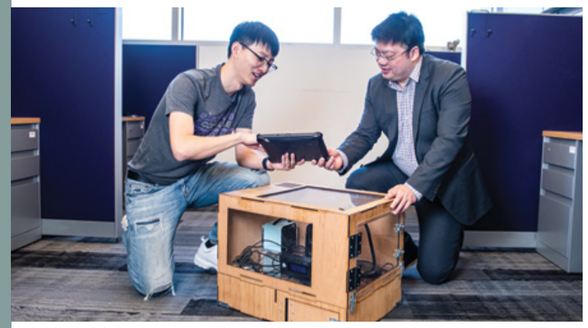
Wu also is contributing his energy management expertise to a large multi-institutional collaborative project called FEWtures, which focuses on food, energy and water needs for rural communities.

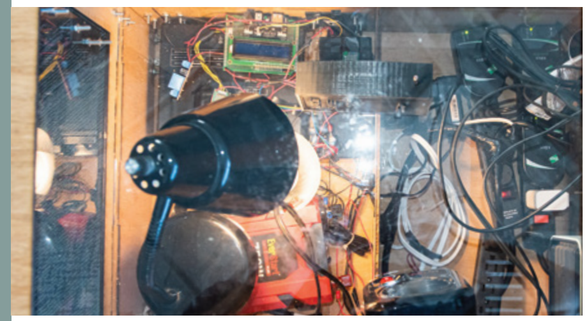
The interdisciplinary project combines natural resources to benefit rural towns, farmers and ranchers. Researchers are taking three ingredients — nitrogen from the air, energy from the wind and hydrogen from water — and combining them to make ammonia. When the energy stored in the ammonia is not needed, it can become available as fertilizer in food production.

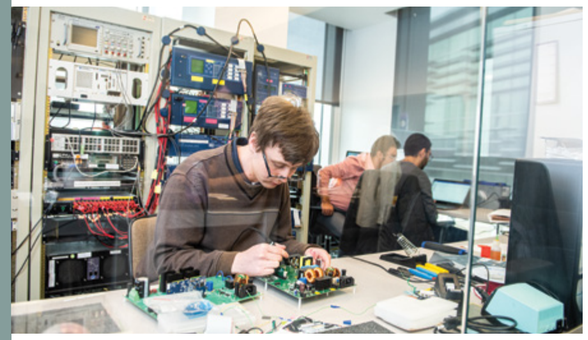
Wu is leading K-State electrical engineers in optimizing production of the captured wind.

The National Science Foundation is funding the five-year study, which involves four universities: K-State, the University of Kansas, Washington State University and Western New England University.

Other K-State researchers involved include Vincent Amanor-Boadu, professor of agribusiness economics and management in the College of Agriculture; Jonathan Aguilar, associate professor of biological and agricultural engineering and K-State Research and Extension specialist based at the Southwest Research-Extension Center in Garden City; and James Bloodgood, professor of management in the College of Business Administration.



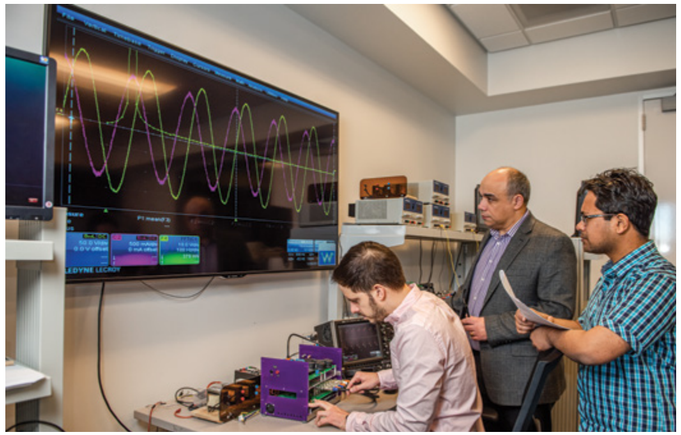




Top: Xuebo Liu, doctoral student in electrical and computer engineering, left, and Hongyu Wu, assistant professor of electrical and computer engineering, look at a smart home energy management system they developed.

Middle: This prototype of a smart home energy management system can improve the energy efficiency of residential buildings with distributed renewable energy.

Bottom: Matthew Baker, doctoral student in electrical and computer engineering, works on designing smart solar inverters.



A grid of nanogrids

Another way to enhance the reliability and security of the existing energy infrastructure is to cluster the power grid into smart nanogrids, which can operate even when there is no utility connection.

On another project, K-State researchers are working on the concept of clustered grids by dividing the large-scale power grid into manageable, smaller nanogrids. A nanogrid could include a single building or several buildings grouped together. Each nanogrid could work independently while it communicates with other nanogrids, and these nanogrids integrated together form part of the larger network.

Such networked grids are a national priority because they are robust to natural disasters, resilient to attacks, and sustainable and affordable in an eco-friendly manner, Mirafzal said.

"Grid-based networks have a tremendous amount of potential as the infrastructure for future cities, but also for a range of other applications," Mirafzal said. "We are looking at how we can secure the electricity and have it in important areas, such as hospitals, and how can we provide electricity without being connected to the grid to make it secure if a cyberattack or natural disaster occurs."

Mirafzal is leading a two-year grant of more than $600,000 from the National Science Foundation Major Research Instrumentation Program to develop a test bed of nanogrids. Other researchers involved in the project include Wu; Fariba Fateh, assistant professor of electrical and computer engineering; and George Amariucai, associate professor of computer science and Michelle Munson-Serban Simu Keystone research scholar.

Mirafzal and the team are building a nanogrid test bed in Engineering Hall. This test bed and the power electronics needed to build smart nanogrids can communicate with neighborhood smart devices and identify security risks.

Top: Behrooz Mirafzal, associate professor of electrical and computer engineering, is leading a team that is developing a test bed of nanogrids.

Middle: Mirafzal, center, looks at signal data with Fahmid Sadeque, doctoral student in electrical and computer engineering, left, and Joseph Benzaquen, recent doctoral graduate in electrical and computer engineering.

Bottom: Tareq Hossen, doctoral student in electrical and computer engineering, left, and Mirafzal work in the lab.

Warren White, associate professor of mechanical and nuclear engineering, studies the mechanical design of wind turbines.

A small wind tunnel in Engineering Hall provides a place for students and researchers to test their wind turbine designs.

The future power grid

As the K-State engineers study smart grid technologies, the key to successful projects is collaboration with the companies and organizations that will use them. The university projects involve organizations such as the National Renewable Energy Laboratory, Midwest Energy, Enphase Energy Inc., Oracle America Inc. and Typhoon HIL Inc.

The National Renewable Energy Laboratory in Colorado is building a large-scale utility test bed to quantify the practicality of the university-developed technologies. Midwest Energy, an energy cooperative based in Hays, is providing real-world data so the K-State researchers can study developments related to solar energy, electric car charging and other distribution generation.

The collaboration between K-State and Midwest Energy is important to address systemwide challenges as the power grid changes from a simple delivery network to a complex network with both generating sources and loads, said Bill Dowling, vice president of engineering and energy supply at Midwest Energy.

"Midwest Energy recognizes the use of a utility's distribution network to serve customers is undergoing fundamental changes," Dowling said. "The introduction of distributed resources like rooftop solar and the expansion of new loads to charge electric vehicles drive the need for more detailed and continuous data from various points in the distribution network. Our collaboration with Kansas State University is important because utilities like Midwest Energy need to maintain reliable and secure control of the distribution system as it continues to evolve."

Such university-industry collaborations are key to developing the power grid of the future, Mirafzal said.

"We want to have smarter, more power resilient and more efficient cities in the future," Mirafzal said. "We are addressing some of the challenges that society is facing toward building these smart cities."

Wind and the workforce

A key to smart cities is renewable energy systems, such as wind, which is one of the state's most abundant natural resources. Kansas is No. 1 for wind energy production as a share of total electricity generation, according to the American Wind Energy Association. In 2018, wind power produced 36.4% of the state's total electricity.

Wind power has long been a K-State priority. In 2018, the university signed a power purchase agreement with then-Westar Energy — now Evergy — to provide approximately 50% of the energy needs for the Manhattan campus from a nearby wind farm. The agreement saves the university nearly $200,000 annually.

"Wind energy is growing in the state," said Warren White, associate professor in the Alan Levin Department of Mechanical and Nuclear Engineering. "Renewables are an emerging industry and we need an educated workforce to work in that industry."

While White's own research focuses on the mechanical design of wind turbines, he also focuses on preparing students to work in the Kansas wind industry through the Wildcat Wind Power team.

Tyler Rodvelt, junior in accounting and finance, left, and Hayden Dillavou, senior in electrical engineering, work on a small-scale wind turbine.

Eric Christman, senior in mechanical engineering, left, and Warren White, associate professor of mechanical and nuclear engineering, prepare a small-scale wind turbine for testing.

The competition design team includes 30 engineering students who compete annually at the Collegiate Wind Competition, which is sponsored by the U.S. Department of Energy. The K-State students are successful, too: They took third place in the 2018 competition and second place in 2017. The K-State team was chosen as one of 11 groups to participate in the 2022 competition.

For each competition, the students design, test and build a small-scale wind turbine and create a business plan for it. They also test their design with a small wind tunnel in the basement of Engineering Hall. Recently the team also has been working with College of Business Administration students on the optimal wind turbine strategies in power purchase agreements.

The experience provides K-State students with the research skills and knowledge they need for future careers, White said.

"We want to prepare a workforce for Kansas to keep people in the state once they get their degrees," White said. "We're trying to both stop the brain drain and also improve renewable energy in our state."

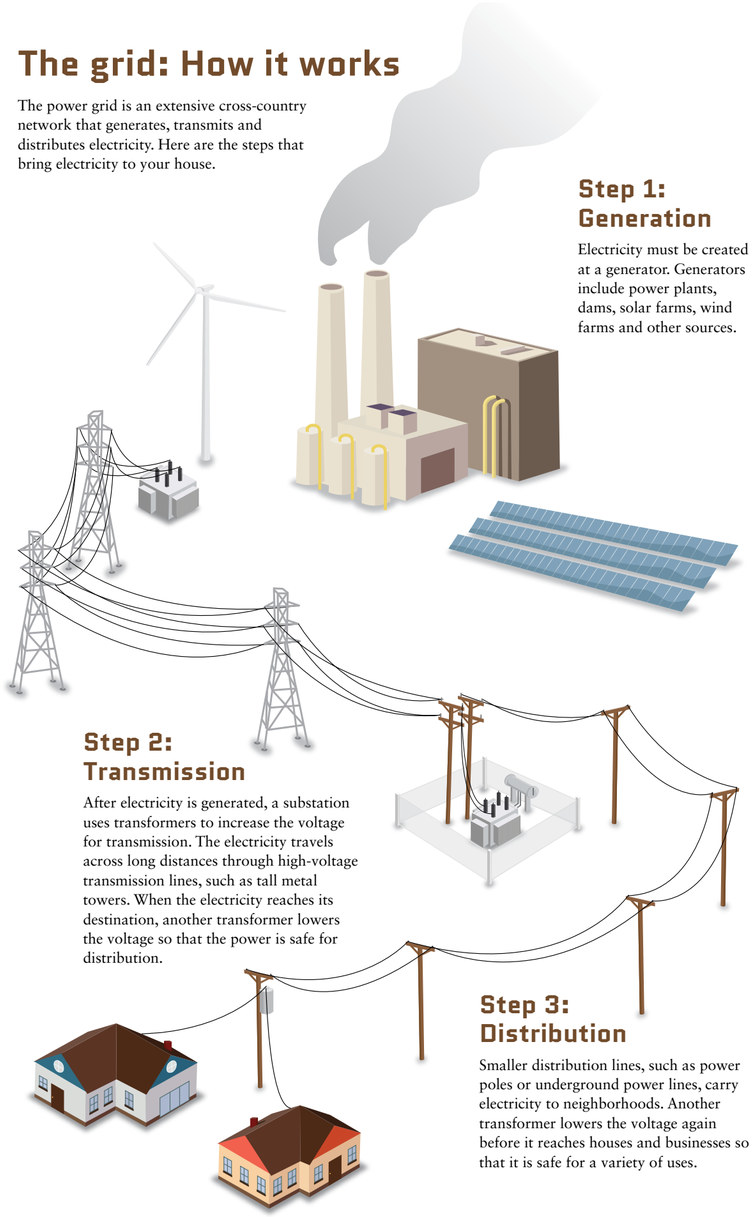
Seek more

View additional photos and read more about the power grid.

k-state.edu/seek

The grid: How it works

The power grid is an extensive cross-country network that generates, transmits and distributes electricity. Here are the steps that bring electricity to your house.



Step 1: Generation

Electricity must be created at a generator. Generators include power plants, dams, solar farms, wind farms and other sources.

Step 2: Transmission

After electricity is generated, a substation uses transformers to increase the voltage for transmission. The electricity travels across long distances through high-voltage transmission lines, such as tall metal towers. When the electricity reaches its destination, another transformer lowers the voltage so that the power is safe for distribution.

Step 3: Distribution

Smaller distribution lines, such as power poles or underground power lines, carry electricity to neighborhoods. Another transformer lowers the voltage again before it reaches houses and businesses so that it is safe for a variety of uses.

Redefining the classroom

College of Education brings research, robots together

By Patrice Scott

Kansas State University College of Education researchers are connecting two worlds within the education system: the one before the COVID-19 pandemic and the one they are creating.

"We are redefining technology's use in classrooms while defining its role in pedagogy," said Debbie Mercer, dean of the College of Education. "By carefully selecting technology that allows us to be interactive, we are pushing the boundaries as we mold the future. This is a time of great opportunity."

College of Education researchers are finding answers to many of education's most complex questions. How can we leverage technology to address teacher supply in rural America? What do teachers need? What factors affect a teacher's decision to leave the profession?

A robotic solution

Rural schools need teachers, and teacher candidates need bustling schools and classrooms to complete their clinical semesters. Enter technology and research as a modern-day approach to K-State's land-grant mission.

It began when an out-of-state K-State student needed a field experience placement to satisfy the requirements of her Master of Arts in Teaching, or MAT, program. Todd Goodson, professor and chair of the curriculum and instruction department, along with Tom Vontz, professor and director of the MAT program, and Eileen Wertzberger, coordinator of field experiences, suggested a novel approach: a telepresence robot.

A virtual teacher was a first for the university. It was also a first for Clay County USD 379, a member of the college's Rural Education Center Rural Professional Development Schools Network. The school district agreed to the placement.

The future teacher became a virtual teacher at Lincoln Elementary School in Clay Center via a Double 2 robot, which is an iPad suspended on a self-balancing base. The iPad camera allowed the virtual teacher to maneuver around the classroom and interact with third grade students.

At Lincoln Elementary School in Clay Center, teacher Andrew Bent and counselor DeAnna Coughlin regularly use virtual teachers and presenters in the third grade classroom. Clay County USD 379 is a member of the Rural Professional Development Schools Network of the K-State College of Education.

"This experience allowed us to see the ways in which we can use technology to facilitate field experiences that would otherwise not be possible," Wertzberger said. "Ultimately, this experience was successful because of the vision and innovative spirit of the administrators and cooperating teacher involved. Their insights guided best practice and ensured not only a quality learning experience for the pre-service teacher, but also for the students in their care."

The novel solution prompted Wertzberger to publish "The Future of Field Experiences in Distance Education: A Case Study of Co-Teaching Practices in a Telepresence-Facilitated Field Placement" in the national journal Theory & Practice in Rural Education.

"The data collected during the semester illuminates how the cooperating teacher and student teacher not only made the placement work but also relied on co-teaching practices that maximized the use of telepresence technology," Wertzberger said.

The concept worked so well that Rural Education Center leaders Spencer Clark, director, and Lori Goodson, assistant director, received a $146,000 Teaching Rural Students STEM Through Telepresence grant from the U.S. Department of Agriculture. Researchers used the funds to purchase 38 Double Robotics robots, which allowed educators to teach and interact with their students at different locations. The nine schools from eight rural Kansas school districts also received iPads and laptops, as well as other equipment necessary for the project.

A few months later, Clark and Goodson received a second USDA grant — the largest grant the Rural Education Center has ever received — to expand the program in other districts throughout the state. The $451,000 grant involves 103 robots and 20 schools in 10 districts.

Rural school leaders are excited about what this means for students in their districts.

Jamie Wetig, superintendent of USD 220 Ashland Public Schools, said teacher supply is always an issue in rural schools and the K-State partnership may help schools offer more class options to students.

Photos above: Lincoln Elementary School third graders spend an afternoon in a theater lesson taught by remote speaker Jaymie Jenks.

"In an evermore challenging environment to recruit and retain highly qualified teachers, we look forward to expanding the opportunities afforded to USD 220 by the USDA telepresence grant and know this is just the beginning of using an innovative approach to support our students and our community," Wetig said.

Mercer believes in the inherent power of education and the ability of college faculty members to support rural communities.

"We recognize the tremendous potential that exists in our rural students and are excited to take the lead in infusing our district partners with this innovative approach to STEM education," Mercer said.

Reducing teacher turnover

Teacher preparation programs are graduating enough teachers to fill vacancies; but, teachers — especially early career educators in their first five years — are leaving the profession. College of Education researchers want to know why.

Tuan D. Nguyen, assistant professor of curriculum and instruction, has analyzed 120 national research projects that spanned 40 years and focused on teacher turnover.

Tuan D. Nguyen, assistant professor of curriculum and instruction, is analyzing teacher turnover.

Classrooms across Kansas

Two U.S. Department of Agriculture-funded robotics projects with the Kansas State University Rural Education Center have involved 29 schools in communities across the state of Kansas.

Location and school

1 Leon, Kansas: Bluestem High School
2 Buhler, Kansas: Buhler High School
3 Hutchinson, Kansas: Prairie Hills Middle School
4 Bird City, Kansas: Cheylin High School
5 Holton, Kansas: Jackson Heights High School
6 Kansas City, Kansas: F.L. Schlagle High School
6 Kansas City, Kansas: J.C. Harmon High School
6 Kansas City, Kansas: Sumner Academy of Arts and Science
6 Kansas City, Kansas: Washington High School
6 Kansas City, Kansas: Wyandotte High School
7 Ness City, Kansas: Ness City High School
8 Osage City, Kansas: Osage City High School
8 Osage City, Kansas: Osage City Middle School
9 Axtell, Kansas: Axtell High School
10 Sabetha, Kansas: Sabetha High School
10 Sabetha, Kansas: Sabetha Middle School
11 Wetmore, Kansas: Wetmore High School
12 Andale, Kansas: Andale High School
13 Garden Plain, Kansas: Garden Plain High School
14 Troy, Kansas: Troy High School
15 Ashland, Kansas: Ashland High School
16 Bennington, Kansas: Bennington High School
17 Clay Center, Kansas: Clay Center Community High School
18 Dighton, Kansas: Dighton High School
19 Haviland, Kansas: Haviland Grade School
20 Lakin, Kansas: Lakin High School
21 Liberal, Kansas: Liberal High School
22 Pratt, Kansas: Skyline High School
23 Tescott, Kansas: Tescott High School

Photos below: Third grade students at Lincoln Elementary School interact with remote speaker Jaymie Jenks during a theater lesson.

The exhaustive review took more than 2 1/2 years and his data identified incentive and support programs as the keys to teacher retention. His research simultaneously disproved the long-held belief that performance evaluations drive teacher attrition.

Nguyen's team published "The Correlates of Teacher Turnover: An Updated and Expanded Meta-Analysis of the Literature" in Educational Research Review, which is ranked second among educational research journals. Their meta-analysis offered new insights, identified underexamined factors and illuminated the connections between educational policy and teacher turnover. The data remained consistent for veteran teachers as well as early career educators and those in hard-to-staff areas, such as special needs and STEM fields that involve science, technology, engineering and math.

"This crucial study examined the evidence on what drove teachers to quit the profession or move from one school to another," Nguyen said. "It has far-reaching implications for policymakers and school administrators in districts and states committed to reducing teacher turnover."

The researchers discovered substantial evidence that improving school organizational characteristics, such as reducing student disciplinary problems, improving administrative support and supporting teacher collaborations, may reduce the risk of turnover. Moreover, despite some concerns of potential negative consequences of teacher evaluation and accountability from policymakers and educators, the data did not indicate that performance evaluations increase teacher attrition.

To the contrary, the research suggested that when teachers are evaluated and the results of their evaluations or measures of effectiveness are made available, teachers are not more likely to leave. In fact, the evidence indicated that teachers may be enticed to stay as they are provided with some urgency, sense of empowerment and evidence of areas for professional improvement.

Pandemic opens Pandora's box

A sweeping research project conducted by a multidisciplinary team in the College of Education has identified the top needs and challenges K-12 teachers have faced during the COVID-19 pandemic.

More than 800 teachers in rural, urban and suburban school districts across the state participated in the project, "Access, Engagement and Resilience During COVID-19 Remote Learning." The project centered on four key areas: technology/access, student/parent engagement, educator resiliency and social-emotional well-being. The survey was sent in May 2020, after the statewide transition to online learning in the early days of the pandemic.

The findings — used to inform policy for state and local leaders — revealed a myriad of strengths and weaknesses and identified universal needs for students' social-emotional well-being, which was the teachers' top concern; broadband internet access, which was deemed a dire need by teachers; educator well-being; and strengthening engagement in diverse learning environments.

The survey also showed several bright spots, particularly in the area of engagement:

- Teachers reported that 69% of students were considered highly to somewhat engaged in learning.
- Among rural teachers, 36% reported a higher level of engagement with their students, while 27% of all teachers reported that their personal engagement with students had increased.
- Nearly two-thirds — 64% — of educators reported an increase in personal engagement with parents during the pandemic.

In the areas of social-emotional well-being and technology and access, the survey proved prophetic.

Four out of five teachers listed social-emotional well-being as their highest concern. This included teachers across all school classifications, from 1A to 6A, and in rural, suburban and urban districts.

"My fear was that a mental health crisis was coming, and we have seen evidence of that in the news," said Jessica Lane, a member of the research team and assistant professor of special education, counseling and student affairs. "The survey underscored the need for policymakers and administrators to address the mental health and social-emotional well-being of both our students and educators. It is critical."

The shift to remote instruction also exposed significant inequities concerning technology and access to the internet. The survey found that broadband internet and educational technology were not consistently available in Kansas, and when they were, that did not translate to in-home access. This required teachers and districts to provide varied forms of instruction.

In addition to Lane, the other members of the multidisciplinary research team included Laura Bonella, associate professor at K-State Libraries; Doris Wright Carroll, associate professor of special education, counseling and student affairs; Morgan Jobe, program coordinator; Marilyn Kaff, associate professor of special education, counseling and student affairs; Tonnie Martinez, assistant professor of curriculum and instruction; Leah McKeeman, assistant professor of curriculum and instruction; and Cindy Shuman, associate dean for research.

Seek more

Read more about College of Education research.
k-state.edu/seek

The College of Education robotics project uses a Double 2 robot to bring virtual teachers to classrooms.

The Shelter Medicine Mobile Surgery Unit is a 32-foot trailer that provides educational opportunities and community outreach.

Wildcats on wheels

College of Veterinary Medicine program helps communities while educating students

By Taylor Provine

Kansas State University veterinary students are hitting the road for the sixth year on the Shelter Medicine Mobile Surgery Unit. Their mission: "Future Vets Helping Future Pets."

The College of Veterinary Medicine shelter medicine program is the foundation for the Mobile Surgery Unit, which was developed in 2015 by Brad Crauer, clinical associate professor and director of the program. Shelter medicine is a veterinary medicine specialty that provides care to homeless animals in shelters or other animal welfare organizations.

The purpose of the Mobile Surgery Unit is to educate students while also providing community outreach and service — both key K-State focuses as a land-grant university. Fourth-year students go on two-week rotations to organizations, such as animal shelters, and provide free spay/neuter procedures and medical triage.

"All of our shelter partners have limited resources, so it's a win-win situation in that the organizations are getting free services and they are able to reallocate resources," Crauer said. "Often they'll improve their facilities, increase training, buy supplies or provide higher-level veterinary care such as heartworm treatment or amputations."

The Mobile Surgery Unit is a 32-foot mobile trailer that includes two surgery tables and a prep table. Each rotation team includes Crauer or colleague Cody Dressler, clinical assistant professor, three fourth-year veterinary students and a veterinary nurse. Most of the program's shelter partners are within a two-hour drive across central Kansas and Nebraska, which allows the team to travel, perform several surgeries and return home each day. The students average 50 surgeries in a two-week rotation and the shelter medicine program recently performed its 27,000th spay/neuter procedure.

Fourth-year veterinary student Hayley Barkoviak said she has benefited from the opportunities to gain surgical experience and give back to the community.

"I have received hands-on experience doing surgeries and physical exams and gained exposure to the medical problems in shelters," she said. "I've also learned about how a shelter is important to a community and as a shelter veterinarian what you have to offer that's more than just spays and neuters. It feels good to be helping homeless animals."

According to Crauer, shelter medicine is one of the newest veterinary specialties and provides opportunities to collect data and improve practices.

Hayley Barkoviak, fourth-year veterinary student, examines a cat on the Shelter Medicine Mobile Surgery Unit.

Right: Brad Crauer, right, clinical associate professor and director of the shelter medicine program, works with students on the Shelter Medicine Mobile Surgery Unit.

"As veterinarians, we are dipping into the animal welfare realm, and there's a wealth of research opportunities that are available to us," he said. "We have access to populations coming through animal shelters that allow us to generate data. We have the option to pull blood from dogs on a regular basis from all over the state to see the incidence of disease and change sanitation techniques and design to see what's most effective from a disease prevention standpoint."

While the Mobile Surgery Unit is for fourth-year students, the program has expanded to include shelter medicine and disaster response elective classes for first- and second-year students. Crauer said that a partnership with the T. Russell Reitz Animal Shelter in Manhattan is engaging undergraduate students as well.

"We oversee the medicine and surgery at T. Russell Reitz Animal Shelter, which allows us to bring first-, second- and third-year students into that setting to help with surgery and medical exams," he said.

The shelter medicine program is primarily funded by grant support, private donations and the Kansas pet friendly license plate program.

Through the Shelter Medicine Mobile Surgery Unit, students provide spay/neuter surgeries and medical triage for shelter partners across the state and region.

Next stop: Going beyond the shelter

The College of Veterinary Medicine is adding to its fleet of mobile services in spring 2021 with the rollout of the Wellness on Wheels vehicle. The program allows students and faculty to address animal welfare and provide medical care beyond the shelter setting in populations where it is needed.

"When we look nationwide there's a population of animals and a population of people who don't have access to medical care," Crauer said. "From a pet care perspective, owners either can't afford it, they don't have physical access because there's not a veterinarian near, or they just don't know what they should be doing from a wellness and general medicine standpoint."

In addition to hosting wellness clinics at various locations, the program is partnering with area homeless missions and health care providers to help this population and their pets get care.

"We are addressing it as a One Health approach and looking at how we can engage these populations and help their pets and also help them get out of the situation they're in," Crauer said.

The mobile Wellness on Wheels clinic has a treatment table, surgery table, waiting and holding areas and kennels. It also has basic lab, X-ray and dentistry capabilities.

The new vehicle also can be deployed for disaster response in situations such as tornadoes, flooding or fire to provide medical care, transportation or evacuations for animals.

By the numbers

SHELTER MEDICINE MOBILE SURGERY UNIT

27K+	The number of spay/neuter surgeries the unit has performed.
90	The number of veterinary students who participate on the rotation annually.
50	The average number of surgeries the veterinary students perform in a two-week rotation.
20+	The number of shelter partners.

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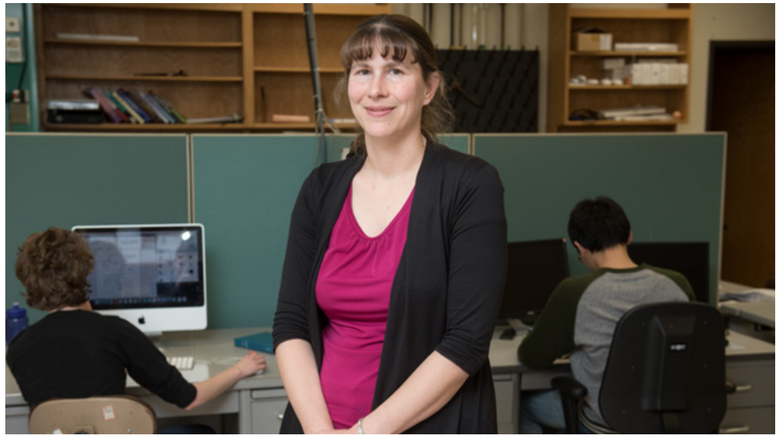


Christine Aikens, university distinguished professor of chemistry, leads a research group that is studying the structure and properties of nanoparticles.

Connecting the dots

Physical chemist uncovers nanoparticle behavior

By Michelle Geering

A love of science fuels Christine Aikens' quest for better understanding of electron movement.

The Kansas State University distinguished professor of chemistry in the College of Arts and Sciences aims to understand the relationship between the structure and the properties of nanomaterials. She is especially interested in gold and silver nanoparticles for future practical applications.

The U.S. Department of Energy is funding Aikens' research on electron dynamics in nanoparticles. Understanding these processes could lead to more efficient solar cells and cleaner energy in the future, she said.

"We are trying to understand the physical phenomena that occur when nanoparticles are excited by light," Aikens said. "If we can understand the underlying physics of these systems, then we can figure out what knobs we need to turn to tune everything to make it practical."

Aikens' research has been instrumental in rethinking the plasmon resonance, which is the collective motion of electrons in nanoparticles and is responsible for many properties of nanoparticles.

"The plasmon resonance was always treated in a certain way and scientists did not think you could have plasmons in smaller particles," Aikens said. "We were able to show that it is really a continuum and that you do still have plasmon-like processes in smaller nanoparticles."

Aikens' research group is now studying what happens after the plasmons get activated and how the activation works.

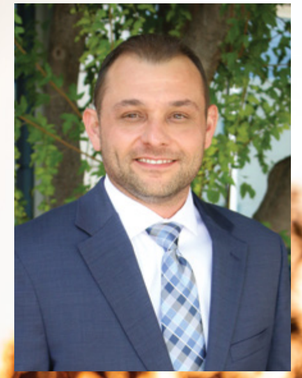
"One of the applications of interest right now is solar cell sensitizers," she said. "The idea would be that light comes in and excites some electrons in the nanoparticle and then those electrons may be transferred to other parts of the solar cell. The nanoparticles might work as a catalyst. Or there might be another molecular transformation going on and something about the nanoparticle or its interaction with light changes the environment of the reaction that would occur. We've been trying to figure out the fundamentals of these reactions and how the process works."

With National Science Foundation funding, Aikens and her team are working on two projects to explore photoluminescence of nanoparticles. Photoluminescence is how the nanoparticles give off light.

In one collaborative project, Colorado State University researchers are synthesizing nanoparticles and Pennsylvania State University researchers are measuring their optical properties. Aikens' group performs theoretical calculations that aid in understanding the experimental results.

In a second project, graduate students in Aikens' group are developing theoretical methods that can be applied to calculate photoluminescence in nanoparticles. They derive mathematical equations and write computer code to develop methods that are both accurate and computationally efficient.

Aikens has contributed significant findings during her career with more than 120 peer-reviewed publications. Since joining K-State in 2007, she has earned more than $3.8 million in research funding. She also has received numerous honors, including a National Science Foundation CAREER award in 2010 and the 2020 Women Chemists Committee of the American Chemical Society Rising Star Award.



Tom Haritos, K-State Polytechnic research program manager, is developing ways to safely integrate unmanned aircraft systems into U.S. airspace.

Leader in the sky

Unmanned aircraft researcher pilots FAA projects

By Kimberly Bird

Unmanned aircraft are becoming more common in our everyday lives: They can deliver our online orders, help farmers monitor crops, provide invaluable assistance in emergencies and disaster relief, or even help photographers capture beautiful images.

But as more unmanned aircraft take to the skies, they also bring safety and security concerns to the U.S. airspace.

Tom Haritos is addressing those concerns. Through multiple research projects in the Applied Aviation Research Center on the Kansas State University Polytechnic Campus, Haritos is leading a team of innovators who are developing ways to safely integrate unmanned aircraft systems, or UAS, into U.S. airspace.

The research comes at an exciting time for the UAS industry.

"The aviation paradigm associated with unmanned aircraft systems is experiencing revolutionary growth," said Haritos, UAS research program manager at K-State Polytechnic. "Industry expansion efforts have provided many opportunities for the Applied Aviation Research Center and K-State Polytechnic to continue at the forefront of this evolving industry."

Haritos oversees collaborative research with the Federal Aviation Administration through the Alliance for System Safety of UAS through Research Excellence, also called ASSURE. K-State Polytechnic is a member of ASSURE, which is the FAA's Center of Excellence for Unmanned Aircraft Systems. ASSURE involves 24 world research institutions and more than 100 industry and government partners.

Under Haritos' direction, K-State is currently the lead university for three research projects that total more than $1 million in FAA funding.

The research projects cover areas such as UAS operations over people and UAS operations beyond visual line of sight, which is when an aircraft is no longer visible by the remote pilot. Research from K-State and partnering institutions also is providing direction on safety assessments when the FAA receives waiver requests for UAS operations.

Haritos is helping the FAA develop safety standards for UAS operating in the National Airspace System — where UAS pilots, manned pilots, air traffic controllers and more all interact with each other.

K-State is a nationally recognized leader in UAS research, operations and training. Haritos' leadership in these research areas is providing new transportation solutions and economic benefits.

"Unmanned aircraft systems are a reality and the integration of these systems into the National Airspace System is certainly coming to fruition," Haritos said. "I believe the technology alone is fascinating and incorporates many scientific domains outside of aviation, such as aspects of computing technology, human-machine interface design and communication protocols."

Sarah Lamm, master's student in geology, spent time on the Curiosity rover team and now researches the chemical composition of chlorite on Mars.

Mars makings

Geology student researches makeup of the red planet

By Katie Messerla

Sarah Lamm is passionate about Mars, science communication and student outreach.

For the last three years, Sarah Lamm, master's student in geology in the Kansas State University College of Arts and Sciences, has spoken to audiences totaling more than 2,000 about the Curiosity rover, a car-sized rover currently exploring the Gale Crater on Mars as part of NASA's Mars Science Laboratory mission.

Lamm was on the Curiosity rover team for three years, which gave her unique insight into the operations and science behind the Mars rovers — Curiosity in particular. She now shares her experience with youth at every opportunity. While she has spoken in New Mexico and Arizona, about 70% of her presentations have been in rural Kansas.

"It is important to show students new career paths simply because they can't be what they can't see," Lamm said.

Lamm's extensive outreach led to her selection as a NASA Solar System Ambassador in 2018. Since then, she has held more than 50 successful events at museums, science clubs, local clubs and schools.

"I'm very passionate about outreach and I'm always looking for ways to make my outreach more effective," Lamm said.

Lamm was selected as a 2019 Mars Generation 24 Under 24 Leader and Innovator in STEAM and Space for her work in rural Kansas. Additionally, in November 2020, Lamm received a Science Communication Award from the Kansas Science Communication Initiative, which helps K-State faculty, students and staff engage the public in science and research.

Her master's research at K-State focuses on creating a Raman calibration to determine chlorite chemical composition. She works under adviser Brice Lacroix, assistant professor of geology.

Chlorite is a clay mineral group made of different layers of elements that can change. One layer might be silicon or aluminum, or a mixture of the two, while another layer might be aluminum, iron or magnesium, or a mixture of the three. Lamm uses Raman spectroscopy to analyze the chemical data of these chlorite minerals from an electron microprobe.

"In Raman spectroscopy, we shoot a laser at a substance and the substance will briefly absorb the energy from the laser, then transmit it back out," Lamm said.

The frequencies transmitted are dependent on the mineral structure and the elements of the mineral. Lamm studies the tiny frequency changes and correlates them to changes in elemental composition. Chlorite's chemical composition is based on the temperature at which it is formed. If a Raman laser is used to determine chlorite's chemical composition, that data can be used to determine the temperature of the mineral's formation.

Lamm's research will help planetary scientists determine the chemical composition of chlorite on Mars, which will give more insight into the past Martian environment.

Lamm will graduate with her master's degree by August and is planning to continue in a doctoral program. *k*

A novel experience

Student's narrative map brings Spanish story to life

By Michelle Geering

Delving into the quality of life for Spanish women in the early 20th century calls on all facets of Anna Welsh's triple major of art, psychological sciences and Spanish. Welsh is researching and creating a visual interpretation of a recently rediscovered Spanish novel.

Welsh, senior in Kansas State University's College of Arts and Sciences, is using a research grant from the Office of Undergraduate Research and Creative Inquiry for her project, "Mapas, mujeres y Madrid: del nacimiento a la muerte con las mujeres madrileñas en 'La Rampa' (1917) de Carmen de Burgos," which translates to "Maps, women and Madrid: From birth to death with women of Madrid in Carmen de Burgos' 'The Ramp' (1917)."

"La Rampa" is a gritty, realistic look at life in Madrid during a time of great growth in the early 20th century. The story emphasizes the lives of lower-class women from birth through death. Life is not easy for the main characters and the novel explores their decline of quality of life through the metaphor of the ramp.

"I really enjoyed reading this book," Welsh said. "It was one of the more complete Spanish novels that I have read during my Spanish studies. I enjoyed and fully understood it like I would any other book in English."

In her research, Welsh is exploring the correlation between age and quality of life during this time in Madrid. She is creating a narrative cartography, which is an illustrated map of specific data points. Welsh is using three broad age groups — infants/children, young adults from 20-40 years old and adults older than 40 years — and is plotting the areas of Madrid where these age groups appeared in the novel. While the book is fiction, it is based in historical facts that support Welsh's research and examination of the novel and map of Madrid side by side.

"This is such a dream project," Welsh said. "It's a synthesis of all of my majors and I'll be able to use my Spanish at a higher level than I've been able to do in the past."

In fall 2020, Welsh was introduced to "La Rampa" in a 20th century Spanish literature course, "Mapping Madrid," taught by Rebecca Bender, assistant professor of Spanish. According to Bender, Burgos' books and books of other authors were censored, lost or destroyed during the Francisco Franco dictatorship.

"Essentially, when the dictatorship ended in the 1970s, people started finding and rediscovering these authors and texts," Bender said. "That's why people today are just starting to study and do work on Carmen de Burgos. Her novels are now being published in Spain under new, modern publishing presses."

Welsh presents her research this spring at Initials, which is the K-State modern languages departmental research symposium. Additionally, Welsh and Bender are working to publish her illustrated map in relevant locations and media outlets in Spain to share her research with a broader audience and promote Burgos' overlooked literature. *k*

Anna Welsh, senior, is using her triple major of art, psychological sciences and Spanish to create a visual interpretation of the Spanish novel "La Rampa."

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mRNA

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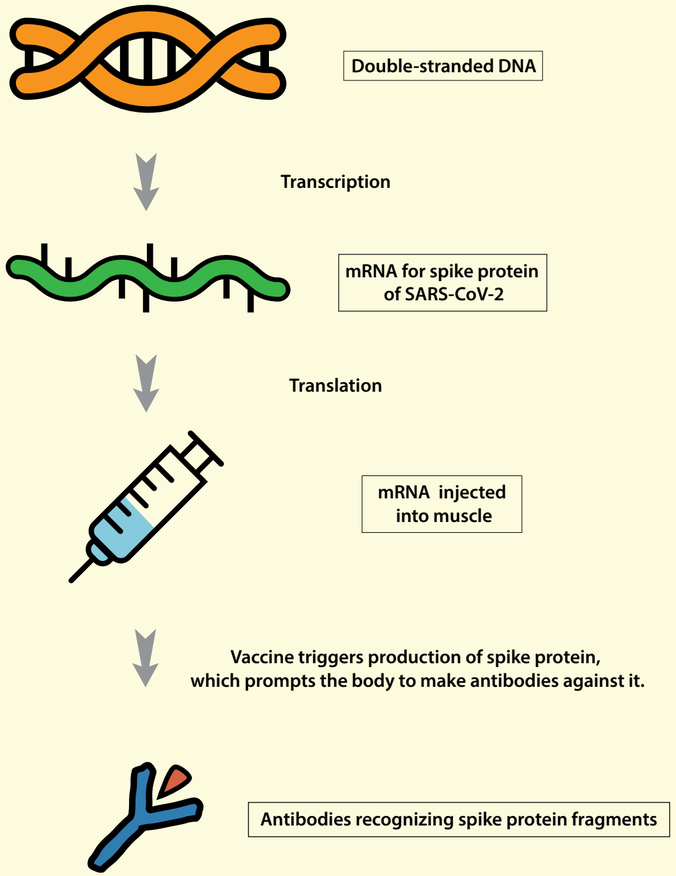
Anna Zinovyeva, assistant professor of biology in the College of Arts and Sciences, studies gene expression and RNA biology. Zinovyeva explains, in fewer than 100 words, what mRNA is and why revolutionary mRNA vaccines are so important during the COVID-19 pandemic.

mRNA, short for messenger RNA, is a molecule produced based on the instructions encoded by DNA, or genes. mRNA molecules serve as templates for making final gene products, or proteins. The proteins then go on to perform various functions inside our cells. mRNA vaccines take advantage of the fact that cells can rapidly produce the protein encoded by the mRNA sequence, bypassing the need for pharmaceutical protein production. An mRNA-based vaccine delivers mRNA "instructions" into our cells, triggering production of a portion of a viral protein, such as the spike protein of SARS-CoV-2. That activates an immune response.

See page 8 to read more about research related to COVID-19.



Molding the future

The College of Education at Kansas State University traces its lineage back to courses in vocational education, which began in the late 1890s. In 1965, the Kansas Board of Regents approved the College of Education as an independent academic unit offering both undergraduate and graduate degrees.

In this 1970 photo, a K-State student teacher helps a student in a classroom in Manhattan. Field-based experiences have long been part of the teaching curriculum to ensure students understand and apply appropriate strategies to meet individual learning needs. See page 28 to learn how K-State continues to help classrooms across the state through research and innovative technology.

Photo courtesy of the Richard L. D. and Marjorie J. Morse Department of Special Collections.

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