Seek

RESEARCH MAGAZINE FOR KANSAS STATE UNIVERSITY

SPRING • 2018

Research that moves

Kinesiology makes everyday lives better

Bugs with benefits

Appreciating the creepier, crawlier life forms

When the wells run dry

Racing for solutions to declining aquifer

All heart

This vascular structure of a sheep's heart was injected with colored liquid plastic solution, which was allowed to harden, and the tissue was corroded away with potassium hydroxide. The red designates the arterial system — arteries and arterioles — and the blue the venous system — veins and venules. The cast is preserved in 10 percent formalin. The model is from the laboratory of David C. Poole, professor of exercise physiology and of anatomy and physiology. Learn more about some of Poole's research on pages 26-31.

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Features

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KANSAS STATE UNIVERSITY

Researchers, scholars and artists at K-State help us examine and understand the world in new ways. They help us by creating new knowledge, and they also help us dispel myths. This issue is full of examples of K-State "myth busting."

One myth is that research doesn't enrich undergraduate education. In "Experimenting for success" on page 12, explore how students benefit from engaging in research. From learning how to pursue answers to difficult questions to learning resilience when studies don't succeed, students who work with researchers learn a range of skills that will serve them well after they graduate. Attending a research university is an excellent way to identify challenges, meet difficult projects head-on, make mistakes and work with colleagues to discover a path forward. K-State is a leading university offering these experiences, which embrace the best possible preparation for career success.

Another widely held myth is that insects are only here to bug us. On page 20, find evidence to the contrary in "Bugs with benefits." Many insects fly under our radar as they help us pollinate crops, fight pests and understand the human genome. Entomologists aren't the only ones working to reveal nature's secrets: On page 26, meet K-State kinesiologists who are enabling us to understand how to fight heart failure and address sedentary behavior as well as helping the U.S. Army and NASA astronauts attain and maintain health and fitness so they are mission-ready.

As our state has worked to dispel the myth that irrigation wells will never run dry, K-State researchers have developed innovative technologies and conducted crucial social science and economic research to help conservation efforts succeed. Read "When the wells run dry" on page 32 for more.

If those examples aren't enough to convince you that our researchers are doing a fabulous job of unveiling myths, take a look at "Fighting fallacies" on page 16. In that article, you'll find out that Kansans do have an accent, that the phrase "natural ingredient" might not mean what you think it means, and that fleas don't behave like you think they do.

All of this work — not to mention the individuals and results highlighted in our short features — underscores the value of K-State research to our state, region and world. We invite you to learn more about how our researchers influence tomorrow by visiting ***k-state.edu/influence-tomorrow*** or reading the news brief about our efforts to spread the word on page 4.

Peter K. Dorhout, Vice President for Research

New initiative highlights successes, future of K-State innovations

Kansas State University researchers have long had their noses to the grindstone to improve the well-being of Kansans. Their innovations have — and continue to — address challenges in agriculture, biodefense, personal and financial health, business, infrastructure, education, basic science and more.

To help Kansans — and the world — learn more about K-State research, the Influence Tomorrow initiative has been created to explore our mission to find answers to important questions and to apply what K-State researchers know to solve both current and future problems.

Since K-State's founding in 1863, the university has transformed fundamental research and technology into real-world solutions. Recent successes include developing disease-resistant wheat varieties, engineering a hydrogel to study and treat cancer, protecting piglets from a devastating disease, and designing unmanned aircraft systems to study and improve crops.

Peter Dorhout, vice president for research, said leading K-State research endeavors is a worthy challenge. Dorhout believes K-State's past, present and future are fused together in a quest to better the world by asking new questions and not accepting the easy path.

"Kansas State University is at the forefront of discoveries that affect lives — from our dinner tables to our hospitals — and as long as there are questions that need answers, we'll continue leading the way," Dorhout said.

This approach requires vast resources, but K-State leaders and researchers realize the importance of efficiency and are successful in obtaining outside support. Researchers received more than 1,400 grants last year totaling $139.3 million. The university also is building more collaborations with industry, with K-State projects funded by industry growing by 80 percent in the last five years. This funding helps the university's researchers put their ideas into practice and builds pipelines of talent for corporate partners. Across the entire research enterprise, K-State contributes more than $190 million to the local and state economy through research expenditures.

Visit *k-state.edu/influence-tomorrow* to continue exploring the power of K-State research.

2018 RESEARCH SHOWCASE

Showcasing research, sparking industry collaboration

According to the Information Technology & Innovation Foundation, Kansas ranks third in the country in the share of university research supported by industry. Kansas State University has a long history of economic engagement and industry collaboration, and the university's upcoming 2018 Research Showcase aims to foster continued growth.

The May 16 event at K-State Olathe will highlight research capabilities, facilities and resources for prospective partners in business and industry. Exhibitors will demonstrate the wide breadth of K-State expertise and how K-State researchers can help industry meet research and development goals, solve problems, develop long-term strategies and more.

K-State is offering the event in the Kansas City region for a second year following a successful event in 2017.

"Companies in the Greater Kansas City region showed us last year that they are hungry for collaboration and innovation with talented researchers," said Peter Dorhout, vice president for research. "Industry benefits from academic partners who help develop and advance the technologies of tomorrow so that they can be brought to a commercial market and used to improve lives."

K-State research projects funded by industry have grown by 80 percent in the last five years, and the university is eager to continue to forge strategic, enduring alliances with industry partners.

Industry registrations for the showcase are welcome through May 1 at ***k-state.edu/researchshowcase***. Information about exhibitors will be available in the Research Showcase module of the K-State mobile app.

A vested discovery: R&D 100 Award for wearable radiation detection technology

A Kansas State University research team has won a 2017 R&D 100 Award for a vest specially designed to contain devices that detect illicit nuclear material. This is the team's fifth award since 2005 for one of the year's 100 top technologies, as selected by R&D magazine.

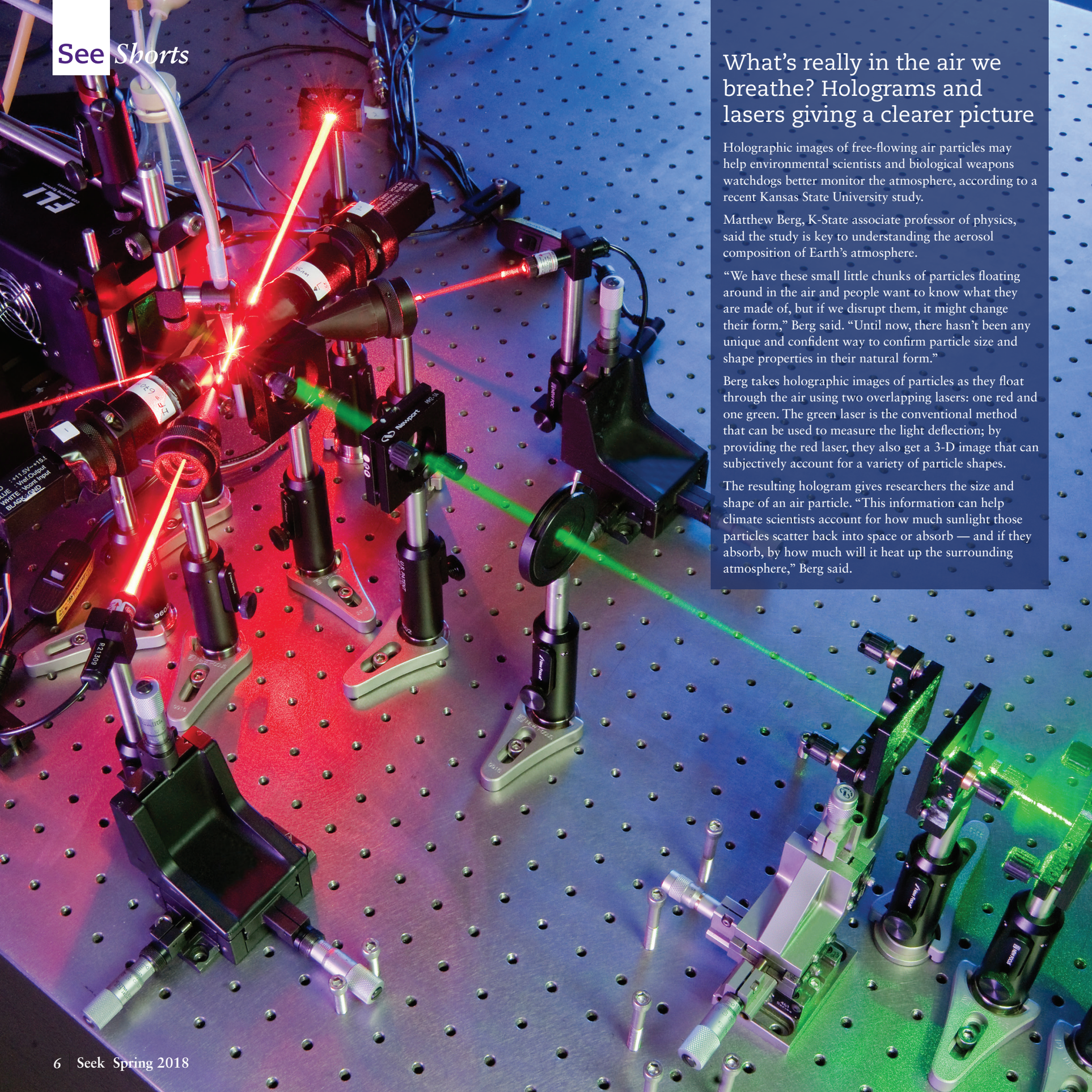
Douglas McGregor, university distinguished professor of mechanical and nuclear engineering, led the team of K-State, industry and government contributors in developing a vest designed to contain multiple gamma ray and neutron detectors. The garment allows the wearer to blend into the environment while detecting dangerous radiation, and the general direction of its origin, with wired or wireless small, lightweight, modular detectors that operate for weeks at a time.

The coveted R&D 100 Award emphasizes the bringing of inventions from their initial concepts on the blackboard, through research and development, and into the commercial marketplace.

"A lot of inventions are good but they never go past publishing a paper," McGregor said. "Our invention is in commercialization. I enjoy the pure sciences, but I keep my eye on practicality."

The project was funded by the Defense Threat Reduction Agency. Contributors included Radiation Detection Technologies Inc.; K-State's Semiconductor Materials and Radiological Technologies Laboratory, or S.M.A.R.T. Lab, and Electronics Design Laboratory; and Alion Science and Technology Corporation. S.M.A.R.T. Lab faculty and graduate students designed the detectors; Electronic Design Laboratory staff and students built the electronics; Radiation Detection Technologies integrated the products; and Alion produced the communications protocols and software, along with McGregor's students.

The project group also worked with Emily Pascoe, a K-State doctoral student in the apparel, textiles, and interior design department. Pascoe's expertise ensured that the team used the best fabric, notions and construction methods for the vest.



What's really in the air we breathe? Holograms and lasers giving a clearer picture

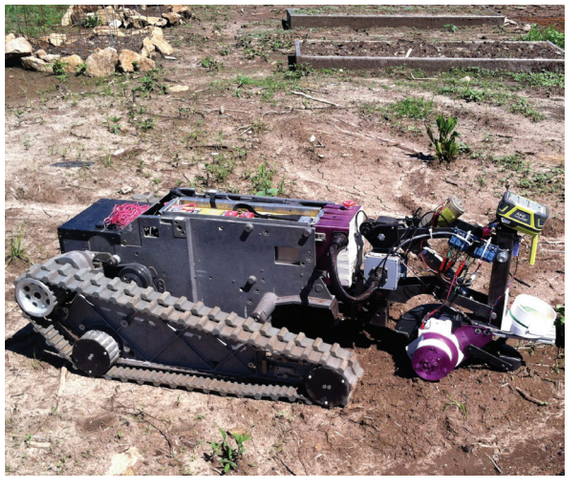
Holographic images of free-flowing air particles may help environmental scientists and biological weapons watchdogs better monitor the atmosphere, according to a recent Kansas State University study.

Matthew Berg, K-State associate professor of physics, said the study is key to understanding the aerosol composition of Earth's atmosphere.

"We have these small little chunks of particles floating around in the air and people want to know what they are made of, but if we disrupt them, it might change their form," Berg said. "Until now, there hasn't been any unique and confident way to confirm particle size and shape properties in their natural form."

Berg takes holographic images of particles as they float through the air using two overlapping lasers: one red and one green. The green laser is the conventional method that can be used to measure the light deflection; by providing the red laser, they also get a 3-D image that can subjectively account for a variety of particle shapes.

The resulting hologram gives researchers the size and shape of an air particle. "This information can help climate scientists account for how much sunlight those particles scatter back into space or absorb — and if they absorb, by how much will it heat up the surrounding atmosphere," Berg said.



USDA-funded robotic farming project could increase world's food supply

Could robotic farming be the solution for meeting the food requirements of a world population of an estimated 9 billion people by 2050? This pressing issue is being taken on by a team of researchers at Kansas State University whose aim is to increase arable land acreage considered too steep for farming with conventional equipment.

The U.S. Department of Agriculture's National Robotics Initiative 2.0: Ubiquitous Collaborative Robots has awarded the team, led by Dan Flippo, assistant professor of biological and agricultural engineering, nearly $1.2 million for the project.

The project is exploring the use of multiple small robots to farm highly sloped land. The robots, the size of a common wheelchair, will work in groups to accomplish fieldwork by unconventional means. Strap-on hardware modules will be designed to allow the small vehicles to plant, manage and harvest wheat on hills with slopes as great as 55 percent, or 30 degrees.

The small autonomous vehicle farming concept is brand-new, allowing engineers and scientists to rethink cropping operations. It has the potential of not only increasing yield for an enlarging population but to also do so in a sustainable way that will allow continued feeding of the world.

Joining Flippo in the K-State endeavor are Stephen Welch, professor, and Antonio Asebedo, assistant professor, both in agronomy; Arnaud Temme, associate professor of geography; and Sanjoy Das, associate professor of electrical and computer engineering.

Chomp on this:
Alligators eat sharks

American alligators on the Atlantic and Gulf coasts have been eating small sharks and stingrays, according to a study by a Kansas State University researcher. This is the first scientific documentation of a widespread interaction between the two predators.

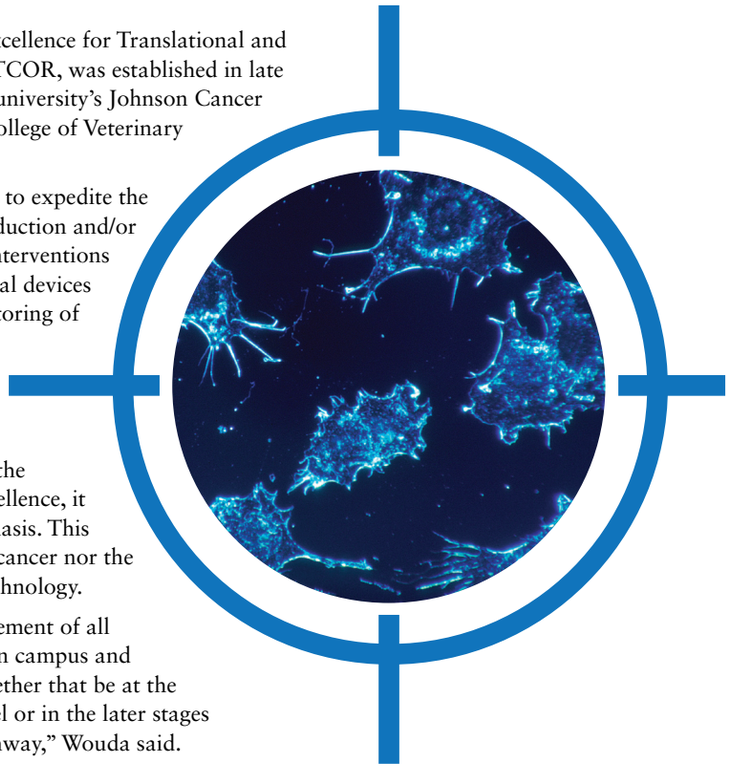
James Nifong, postdoctoral researcher with the Kansas Cooperative Fish and Wildlife Unit at K-State, and Russell Lowers, wildlife biologist with Integrated Mission Support Services at Kennedy Space Center, conducted the cooperative research as part of larger research of freshwater river systems and food web dynamics. The researchers published the alligator diet research in the Southeastern Naturalist.

Despite the freshwater and saltwater differences, Nifong said it is fairly common for sharks and rays to share the water with alligators. Many sharks and rays can swim into freshwater where opportunistic alligators can't pass up a good meal. Although alligators don't have salt glands like true crocodiles, they are resourceful as they travel between freshwater and marine habitats.

Cancer is target of university's newest center of excellence

The College of Veterinary Medicine at Kansas State University has a new center of excellence that focuses on improving the diagnosis, management and treatment of both human and animal cancers.

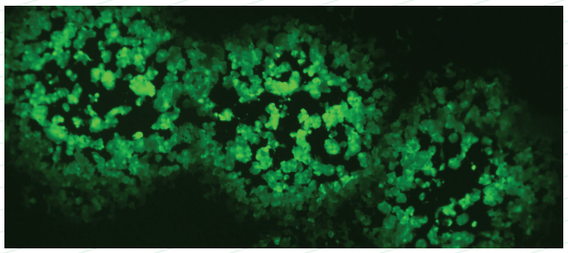
The Kansas State University Center of Excellence for Translational and Comparative Oncology Research, or CETCOR, was established in late 2017 through start-up funding from the university's Johnson Cancer Research Center and support from the College of Veterinary Medicine.



"The overriding objective of CETCOR is to expedite the preclinical and clinical development, production and/or licensure of novel or improved medical interventions — drugs, immunotherapeutics and medical devices — for the treatment, diagnosis and monitoring of both human and animal cancers," said Raelene Wouda, assistant professor of oncology in the college's clinical sciences department.

According to Wouda, a unique aspect of the center is that, unlike many centers of excellence, it does not possess a solitary research emphasis. This center does not focus on a single type of cancer nor the development of a single novel drug or technology.

"Our group aims to facilitate the advancement of all cancer-associated research taking place on campus and within the wider K-State community, whether that be at the basic physiologic and pharmacologic level or in the later stages of the therapeutic drug development pathway," Wouda said.



Compound in red wine, chocolate prevents smallpox virus cousins from replicating

Are chocolate and red wine health foods?

Could be, according to Kansas State University researchers.

"Resveratrol is a small, natural compound in many plants like grapes, cocoa beans, peanuts and blueberries," said Shuai Cao, postdoctoral researcher studying the effects of resveratrol on viruses. "Our recent study found that high concentrations of resveratrol — higher than anything you may find in food naturally — prevent poxviruses from replicating in human cells."

Cao; Anil Pant, doctoral student in biology; Zhilong Yang, assistant professor of biology; and their collaborators at the Centers for Disease Control and Prevention have published "Suppression of Poxvirus Replication by Resveratrol" in Frontiers in Microbiology.

"Resveratrol can be chemically synthesized or extracted from fruits," Pant said. "Our research may be a steppingstone to using resveratrol as a complementary treatment for viruses during a time of growing concern over drug resistance."

The researchers added resveratrol at varying intensities to human cell cultures infected by vaccinia virus, a cousin to the highly dangerous variola virus that causes smallpox. Used as the vaccine to eradicate smallpox, vaccinia virus provides a good model of how viruses work without the danger, Cao said. The cell cultures with high levels of resveratrol prevented vaccinia from replicating in the early stages of the viral infection, which stops the virus from spreading.

"In order for a poxvirus to infect a host, it has to first enter a cell and make a lot of copies of its genome inside the host cell," Pant said. "Our research has shown that resveratrol inhibits vaccinia virus from making copies of its DNA and genome."

The Kansas State University researchers recorded resveratrol's success with vaccinia and collaborated with researchers at the CDC to perform similar experiments with monkeypox, a contagious and deadly virus to humans that has caused periodic disease outbreaks in Africa. Resveratrol had the same effect with monkeypox, which means that it has a good chance of inhibiting all poxviruses, Cao said.

Grand-slam inventions

Kansas State University Research Foundation helps researchers run the bases

By Sarah Caldwell Hancock

Baseball and invention share a surprising similarity: Generate a hit three times out of 10, and you're succeeding at a world-class level.

The Kansas State University Research Foundation — one of the first technology transfer offices in the country — has been helping K-State researchers bat .300 for 75 years.

The foundation transfers research from the minds and labs of investigators into the hands of consumers by helping researchers formally disclose inventions, assess

originality and market potential, and pursue appropriate protection through patents, copyrights, trademarks or plant variety protection certificates. After protections are in place, the research foundation helps market innovations to companies for commercial applications.

The research foundation logged its first base hit with an invention disclosure from Harold W. Batchelor in 1942 for making stoppers for bottles and test tubes. The first patent application, for a plastic container used with food stored in freezer lockers, came in 1944.

Since then, the research foundation has helped K-State innovators secure more than 250 U.S. patents, license more than 300 technologies and generate more than $37 million in licensing revenue.

K-State inventions come from many different fields.

"Researchers at our institution are especially adept at producing innovations that enhance animal health and food and crop production — we have deep expertise in global food systems. We also see innovations in energy storage and nanotechnology that will support clean energy and health applications," said Chris Brandt, Kansas State University Research Foundation president and CEO.

One of the most prolific inventors in K-State history is Paul A. Seib, professor emeritus of grain science and industry. Seib was named a National Academy of Inventors fellow in December 2017. His expertise in carbohydrate chemistry helped him develop ingredients for animal and human food such as shelf-stable vitamin C and nondigestible starch. The nondigestible starch helps maintain desirable texture and taste in food products without converting into sugars, meaning they help people who are managing diabetes or following low-carb diets.

Two other examples of successful technology transfer are a vaccine to prevent diarrhea in neonatal calves and a web-based reporting system to manage and measure the

impact of the Supplemental Nutrition Assistance Program Education, or SNAP-Ed, and statewide cooperative extension efforts. The vaccine, patented in 1999, was licensed to Schering Corp., which was later acquired by Merck Animal Health and marketed as Guardian; the product has been commercially available for more than 14 years. The Program Evaluation And Reporting System, or PEARS, software is copyrighted and is currently licensed to 20 states, with more states interested in adopting the product.

Revenue from licensing of K-State innovations — about $3 million in each of the last several years — is reinvested in K-State research. Inventors receive 25 to 35 percent, some supports the research foundation and central research administration, and some is returned to the researcher's department.

The research foundation is always looking for the next home run. Efforts to educate faculty are spurring more invention disclosures. A few years ago, the foundation processed 30 to 40 disclosures a year, but 2017 brought 73, plus 59 researchers participating in the process for the first time. Brandt said he will keep encouraging researchers.

"As researchers are developing new and interesting things, they should be thinking about an end user: How is this useful, and how can we put this in the hands of consumers?" Brandt said. *k*

Making a CAREER of it

By Jennifer Tidball and Beth Bohn

The Faculty Early Career Development Program, or CAREER program, is the National Science Foundation's most prestigious awards program for junior faculty who have the potential to serve as academic role models in research and education and to lead advances in the mission of their department or organization. According to the NSF, activities pursued by CAREER award winners should build a firm foundation for a lifetime of leadership in integrating education and research.

That promise is holding true at Kansas State University, where several recent recipients of the award say it has helped boost and solidify their careers.

Christine Aikens,

professor of chemistry

2010 CAREER award recipient

1. WHAT ARE YOUR CURRENT RESEARCH INTERESTS?

My research focuses on understanding chemical and physical properties of nanoparticles in their ground and excited states.

2. HOW HAS YOUR RESEARCH PROGRESSED SINCE RECEIVING THE CAREER AWARD?

The CAREER award enabled us to examine catalysis on metal oxide clusters. Our group also studies noble metal nanoparticles. Recently, we have started to put the two areas together to examine factors involved in plasmon-enhanced photocatalysis.

3. HOW HAS THE CAREER AWARD BENEFITED YOUR WORK?

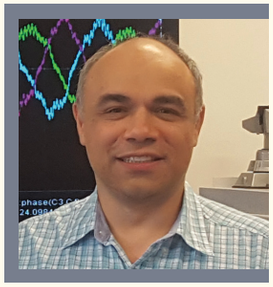
The CAREER award allowed us to study a different area from the noble metal nanoparticles that we had been studying to that point.

4. WHAT ADDITIONAL GRANTS HAVE YOU RECEIVED?

We have received additional funding from the National Science Foundation for studying chemical reactivity and excited state dynamics of gold nanoparticles; funding from the Department of Energy for studying plasmon-enhanced photocatalysis; and funding from the Air Force Office of Scientific Research for studying excited states in silver nanoparticle assemblies.

5. WHAT IS YOUR BIGGEST ACCOMPLISHMENT SINCE EARNING THE CAREER AWARD?

I am proud of the five doctoral students who have finished in the last four years. They are truly our group's biggest accomplishment. Each of them has multiple publications, which represents new contributions to scientific knowledge.



Behrooz Mirafzal,

associate professor of electrical and computer engineering and Michelle Munson and Serban Simu keystone research scholar

2014 CAREER award recipient

1. WHAT ARE YOUR CURRENT RESEARCH INTERESTS?

My current research focus is on advanced energy conversion systems, power electronics for microgrids and on-the-move technologies.

2. HOW HAS YOUR RESEARCH PROGRESSED SINCE RECEIVING THE CAREER AWARD?

The NSF CAREER award provides more visibility in the power electronics society as not many early academic career investigators in the field of power electronics have received this award.

3. HOW HAS THE CAREER AWARD BENEFITED YOUR WORK?

I have done many new activities in research, teaching and university/college/department services.

4. WHAT ADDITIONAL GRANTS HAVE YOU RECEIVED?

I have received several small grants from NSF and local industry, but I have established several multi-university-industry collaborative research activities in which K-State has been the lead institution. I am currently working on an NSF industry-university cooperative center, called COMET, the Center for On-the-Move Energy Technologies. I have also established a collaborative project with European scientists as a direct result of my CAREER award.

5. WHAT IS YOUR BIGGEST ACCOMPLISHMENT SINCE EARNING THE CAREER AWARD?

The power electronics research group at K-State has become established and recognized by other research groups outside of the university.

Gurpreet Singh,

Harold O. and Jane C. Massey Neff professor of mechanical engineering

2015 CAREER award recipient

1. WHAT ARE YOUR CURRENT RESEARCH INTERESTS?

Presently, research in our lab is focused on 2-D materials and composite materials composed of 2-D materials with precursor-derived ceramics. We are studying these materials for applications in rechargeable batteries and high temperature applications.

2. HOW HAS YOUR RESEARCH PROGRESSED SINCE RECEIVING THE CAREER AWARD?

Research on flexible electrodes on 2-D materials, such as graphene and transition metal dichalcogenides, has flourished since the CAREER award. We have published two high-impact papers in Nature Communications and Scientific Reports that have already picked up approximately 100 citations.

3. HOW HAS THE CAREER AWARD BENEFITED YOUR WORK?

The CAREER award has provided increased visibility of research in our lab, access to better students and the opportunity to collaborate with leaders in the field.

4. WHAT ADDITIONAL GRANTS HAVE YOU RECEIVED?

I have received two additional grants. One grant is $5 million from the National Science Foundation Partnerships in International Research and Education to study "Making ceramic fibers and high temperature composites from polymeric precursors." The other $170,00 grant is from OneSubSea for "Investigation of graphene oxide coating for protection against seawater corrosion."

5. WHAT IS YOUR BIGGEST ACCOMPLISHMENT SINCE EARNING THE CAREER AWARD?

Our biggest accomplishment is the ability to produce large quantities of 2-D materials — graphene oxide and transition metal chalcogenides — to make large flexible battery electrodes for high-capacity lithium-ion batteries and sodium-ion batteries. More recently, we have demonstrated the ability to produce hybrids of 2-D materials with polymer-derived ceramics. This is an exciting area and would allow us to manufacture high-performance multifunctional composites at a low cost using additive manufacturing techniques.

Pavithra Prabhakar,

associate professor of computer science and Peggy and Gary Edwards chair in engineering

2016 CAREER award recipient

1. WHAT ARE YOUR CURRENT RESEARCH INTERESTS?

My research interests are broadly in the area of applying rigorous and automated techniques for design and analysis of software that control safety-critical physical systems, such as software in autonomous cars and aircraft.

2. HOW HAS YOUR RESEARCH PROGRESSED SINCE RECEIVING THE CAREER AWARD?

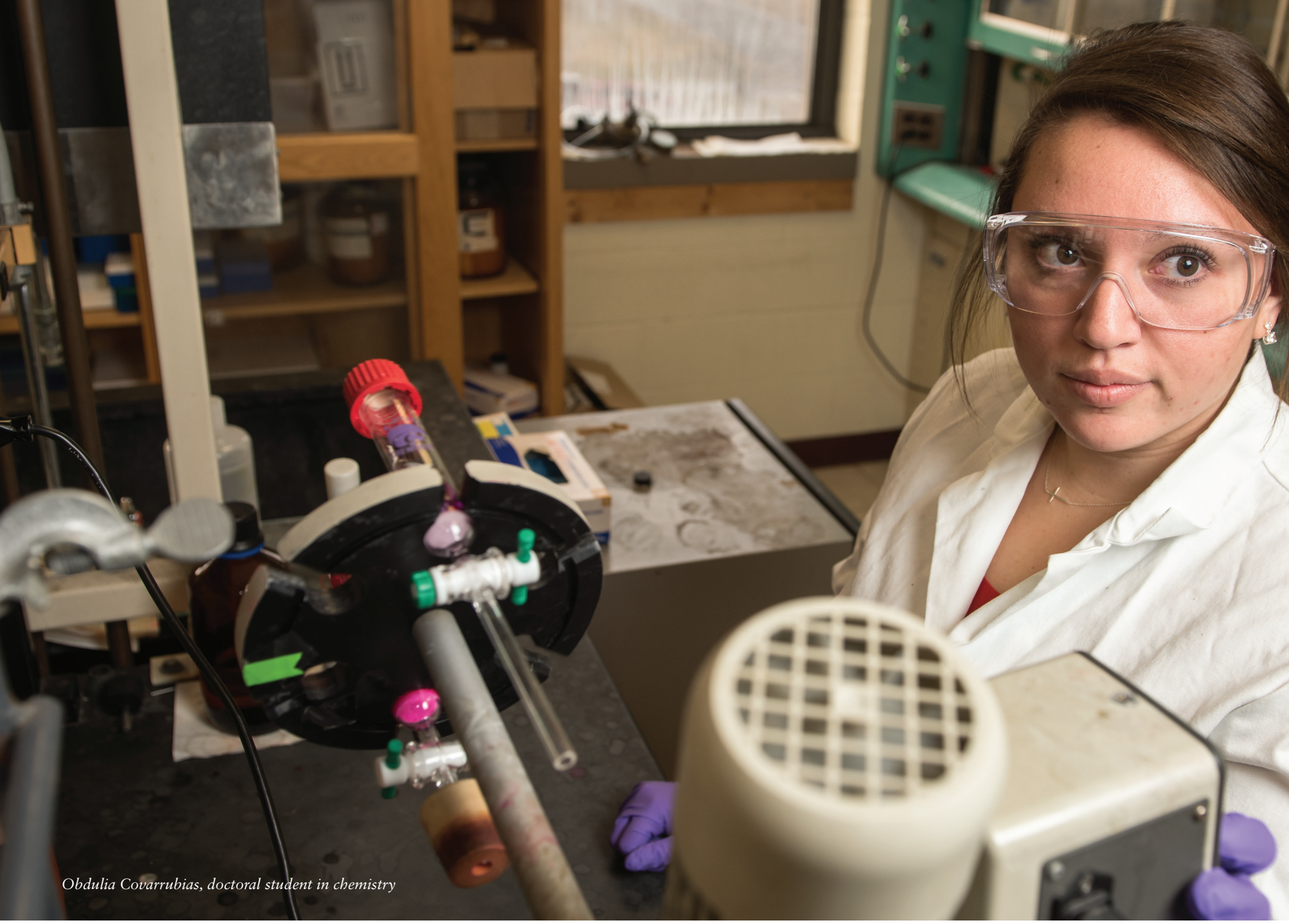
Receiving the CAREER award has helped me jump-start my research at K-State. I have been able to establish the hybrid control systems group that consists of postdocs, doctoral students and undergraduate students.

3. HOW HAS THE CAREER AWARD BENEFITED YOUR WORK?

The award has had a direct impact on research by our group on stability analysis for complex control software. We have developed a novel algorithmic framework and software tools that have been published in top venues such as the International Conference on Computer Aided Verification, Embedded Systems Conference and the International Conference on Hybrid Systems: Computation and Control.

4. WHAT ADDITIONAL GRANTS HAVE YOU RECEIVED?

I have also received a young investigator award from the Office of Naval Research for work on automated control design for autonomous underwater vehicles.



Obdulia Covarrubias, doctoral student in chemistry

Experimenting for Success

The value of undergraduate research

By Beth Bohn

The bulletin board in Anita Cortez's office is covered with photos of many former students who were involved in undergraduate research at Kansas State University. Cortez is director of the university's Office of Undergraduate Research & Creative Inquiry.

Point to any one of the many pictures that cover the large bulletin board in Anita Cortez's office, and she'll have a story to tell.

"He's headed to medical school. She's a dentist in Dallas, and her husband is a distinguished architect. He earned his master's at the University of Wisconsin and is interviewing at several veterinary schools. She won a National Science Foundation Graduate Fellowship on her first try." The stories go on and illustrate how participating in undergraduate research was the first step for these Kansas State University students to become professors, veterinarians, surgeons, lawyers, consultants, obstetricians and more.

"Undergraduate research provides so many valuable experiences to students and can be the pathway to their careers," said Cortez, who is director of K-State's Office of Undergraduate Research & Creative Inquiry. "Undergraduate research is a valued experience. It's important for entry into graduate or professional school, but it is also valuable for all students."

Anita Cortez meets with a student to discuss undergraduate research opportunities at the university.

A university priority

Offering undergraduate research experiences is not unique to K-State, but it has long been a point of emphasis and pride at the university. Promoting and increasing undergraduate research opportunities is part of K-State 2025, which is the university's strategic plan to be a Top 50 public research university by 2025 and the reason the Office of Undergraduate Research & Creative Inquiry was established.

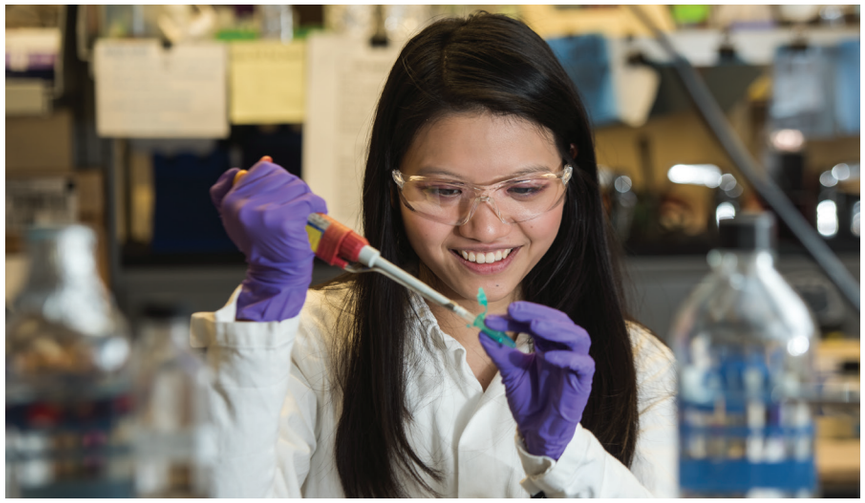
"The Office of Undergraduate Research & Creative Inquiry is a vehicle for awareness about undergraduate research for both students and faculty," Cortez said. "It's the place faculty can turn to for help in involving undergraduates in their research, and it's a starting place for undergraduates interested in getting involved in research."

The office also awards student grants for research and research-related travel every semester, along with offering workshops, seminars and many other resources.

All K-State colleges offer undergraduate research opportunities, with some colleges now awarding grants and scholarships to help give more student opportunities to do research. Some programs, such as the Developing Scholars Program, Bridges to the Future, McNair Scholars Program and the NSF-funded Kansas Louis Stokes Alliance for Minority Participation, or KS-LSAMP, are specifically designed to interest underrepresented and first-generation students in research and graduate school. Other programs focus on the humanities, such as the Chapman Center for Rural Studies, which lets undergraduates research, write and publish Kansas history.

One of the largest providers of undergraduate research opportunities is the Johnson Cancer Research Center at K-State, which presents around 50 students each year with its Cancer Research Award. The awards are funded by private donations to the center. K-State also offers Research Experience for Undergraduate programs and a Summer University Research Opportunity Program to K-State students and students from other universities.

Kathlyn Gomendoza is an award-winning undergraduate researcher in the lab of Lorena Passarelli, professor of biology at K-State.



Filling a need

At least 7 percent of K-State's nearly 23,000 students are estimated to take part in undergraduate research activities. It's a number that university officials hope to grow as a way of enhancing the undergraduate educational experience and ensuring the university continues to attract and retain the best students and faculty.

"Undergraduate research sets us apart as an institution of higher education," said Peter Dorhout, K-State vice president for research. "Our goal isn't to train students for a job — it's to educate them for a career."

That's why Kathlyn Gomendoza is involved in undergraduate research and chose to attend K-State. A senior in biology and pre-medicine, Gomendoza is using her undergraduate research experiences to build a resume for medical or graduate school.

Before her classes begin most mornings, the honors student is in the lab, setting up her experiments for the day. She'll return to the lab to start her experiments when she has time between classes or when they end for the day. Along with a full class schedule, Gomendoza will put in about 15 hours a week in the lab of Lorena Passarelli, professor of biology. Gomendoza has been a member of the lab since her first year at K-State in 2014.

"Undergraduate research is extremely worthwhile in the long run," Gomendoza said. "Not only do you receive a hands-on experience in an environment beyond a classroom or textbook, but you are able to see the real-life applications to the concepts that you have learned."

In Passarelli's lab, Gomendoza studies baculoviruses, which are virulent to insects but not to humans. They are used to produce vaccines against human papillomavirus and influenza virus and are being studied as a potential vector for therapeutic agents. Her research has earned an undergraduate research fellowship from the American Society for Microbiology and honorable mention for the prestigious Goldwater scholarship, for which research is a key requirement. Gomendoza also was selected to present her research to state lawmakers in Topeka at Undergraduate Research Day at the Capitol.

Lisa Wilken, an assistant professor of biological and agricultural engineering, is a strong advocate for undergraduate research at K-State and has been recognized with the Distinguished Faculty Award for Mentoring of Undergraduate Students in Research for her efforts. Wilken said undergraduate research provides students with opportunities and skills that enhance their education.

"I believe any student interested in research can benefit from it," Wilken said. "I find those who are most successful are inquisitive, highly motivated, detail-oriented and hardworking. Students who are also receptive to participating in professional development opportunities and continuing their education often have the most impactful experiences."

Dorhout said participating in undergraduate research teaches students an important life lesson: learning how to deal with failure.

"To quote one of my favorite 'Star Wars' characters, Yoda, 'Failure is really the best teacher,'" Dorhout said. "By that, I mean, when you test your hypothesis, when you pose a question and you try to answer it, you're testing whether you were right to begin with. More often than not, you were wrong, but you discover or learn something along the way. That's a valuable experience. 'To the stars through difficulties,' our state motto, reminds us just how resilient we Kansans are."

> "Failure is really the best teacher."

Why faculty get involved

Their own experiences as undergraduate researchers are why many K-State faculty members have made research opportunities available to students. They also say undergraduate researchers are valuable additions to their research groups.

Wilken earned her bachelor's degree at K-State and was an active undergraduate researcher while doing so. Now as a faculty member, she has advised 17 undergraduate student researchers since 2013. Her students have authored or co-authored five conference papers and two journal publications, and they have earned 25 oral or poster achievements and 17 research awards.

"All of my undergraduate researchers are expected to present their work at university competitions, professional meetings or other venues," Wilken said. "I want to provide undergraduate students opportunities well beyond maintaining the lab. Once students are trained, I assign each of them their own project. This creates a feeling of ownership, fosters accountability and leads to intellectual independence."

Stefan Bossmann, professor of chemistry, said the university's undergraduate research program was one of the factors in his decision to join the K-State faculty in 2004.

"Being able to draw upon the pool of bright, young minds we have at K-State is important," Bossmann said. "It allows researchers to have a larger lab for less cost compared to hiring a technician, etc. Having undergraduate researchers is a must. If you have 10 gifted undergraduates, you really can work more in depth than you can with graduate students alone."

Bossmann typically has 10 to 12 undergraduates in his research group each semester. He calls the students integral members of his lab, which focuses on the targeted delivery of drugs to tumors.

Obdulia Covarrubias, doctoral student in chemistry, and Stefan Bossmann, professor of chemistry, consult about research in Bossmann's lab.

Caleb Wurth, a 2013 K-State alumnus and former undergraduate researcher.

"It's important to see that the undergraduates in my research group do real research," Bossmann said. "Many of them excel, while some think they may want to do something else. It is important that they find out what they want to do; it's not about me forcing them to do things. It should really guide them to the best professional life for them."

A path to success

Obdulia Covarrubias is one of the doctoral students in Bossmann's lab. Covarrubias also is an NSF Graduate Fellowship recipient, thanks to undergraduate research. A first-generation student, she transferred to K-State from Seward County Community College, where she got involved with Bridges to the Future, a K-State program that seeks to interest community college transfer students in the STEM fields and research, as well as the Developing Scholars Program. As an undergraduate researcher, Covarrubias also earned the NSF Undergraduate Research Mentoring Fellowship.

Her research projects as an undergraduate were in biochemistry, biology and plant pathology, which she said helped her find her passion to do research on cancer and human viruses. It's why she decided to join Bossmann's lab and seek a doctorate in chemistry.

"My current doctoral research is not part of my undergraduate research directly, but all the experiences and basic skills I learned as an undergraduate researcher — lab techniques, developing a research idea, troubleshooting and communicating research findings, written or spoken — have been very helpful in graduate school and made the transition much easier," Covarrubias said.

Covarrubias works on drug delivery systems to combat pathogen diseases. After earning her doctorate, she would like to continue this research by working at a government agency such as the Centers for Disease Control, Department of Defense or possibly the NSF or National Institutes of Health.

Caleb Wurth, who earned a bachelor's degree in feed science and management from K-State in 2013, said his four years of undergraduate research through the Developing Scholars Program helped set him apart in the job market. Today, after working for a major global food processing and commodity trading company, he is the assistant director of Southeast Asia for the U.S. Grains Council, which develops markets for U.S. grains, co-products and ethanol.

"As the corporate world is becoming more and more competitive, my research experience gave employers concrete validation of my abilities to think critically, identify real-life issues and execute a program," Wurth said. "Through each of my undergraduate research projects, I was able to partner with industry leaders in the field. The connections made and the relationships you forge with industry set you apart from those who merely read about it in a textbook." *k*


FIGHTING
FALLACIES

Fighting Fallacies

Researchers battle false factoids that surround people every day

By Stephanie Jacques

Kansans don't have accents. Natural ingredients are healthier. One flea is all it takes to make a dog itch.

Although most popular beliefs like these are harmless, they can become a barrier to researchers trying to disseminate their findings to a broader audience. Kansas State University researchers in English, food science and veterinary medicine are going toe-to-toe to give everyday preconceived notions a solid research-data right hook.

Fun fact

One of Kansas' most recognized fictional characters, Auntie Em from the "Wizard of Oz," spoke a Hollywood-invented accent called TransAtlantic English, which was a mix of British and American English. The accent came from "Speak with Distinction" by Edith Skinner, first published in 1942.

Fallacy: Among Americans, Kansans don't have an accent.

Fact: Kansans are developing a Hollywood-style accent.

Mary Kohn, associate professor of English, is researching how people say a word and how that changes over time. According to Kohn, the change in Kansans' accents happened around the same time as similar changes in California accents and many other areas across the country.

"We do have an accent," Kohn said. "All dialects do, but one of the cool things about this is that we can show how our accent is looking similar to what has developed in several pockets of the country. That change has developed this stereotype as being Californian."

Kohn said accents are typically identified by the way vowels are pronounced. In English, the tongue's movements produce around 12 to 13 different vowel sounds, which can crowd the mouth. According to Kohn, one way to deal with that is to lose a distinction or two.

"What we find is that Kansas is participating in a vowel shift that we call the California Vowel Shift," Kohn said. "In other words, our young Kansas participants — really anyone younger than 65 or so — are cultivating an accent that sounds very much like you would expect from someone from California."

One example where Midwesterners have dropped a vowel distinction is between the words "cot" and "caught."

"We actually completely lost the vowel difference between 'cot' and 'caught,'" Kohn said. "Most Midwesterners can't hear that sound difference. If you ask them to produce it, they really struggle, but if someone from Great Britain says 'cot' and 'caught,' you could hear the difference."

Kohn says Kansans and Californians say "cot" and "caught" as "c-ah-t." While the pronunciation of "cot" is the same across most U.S. dialects, the vowels in "caught" are pronounced differently in areas without the Californian Vowel Shift. For example, a New Yorker might say "caught" as "c-uh-ah-t" and a Southerner might say "caught" as "c-a-ow-t."

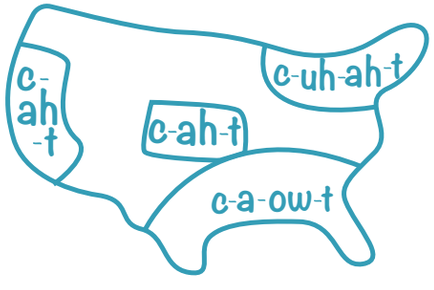
Since the end of World War II, the California Vowel Shift has been popping up across the nation, mostly in areas with a highly mobile middle class.

"We can watch the sound change across generations," Kohn said. "We haven't pinpointed exactly what the social cause of it is yet — and it is going to have to be something that can explain how this same accent pops up in a bunch of different places all at once."

Kohn's sociolinguistic research can help educators and speech pathologists discern between dialect difference and pathology.

"An understanding of dialect difference can help teachers tell when a student is really struggling or when a student just speaks a dialect that differs from expectations in the classroom," Kohn said. "Misunderstandings about linguistic differences can lead to misdiagnoses of speech and learning disorders."

Regional pronunciation of "caught"



Fallacy: The phrase "natural ingredient" is defined and synonymous with healthy.

Fact: Consumers greatly differ in what they consider a natural ingredient, and the Food and Drug Administration has not defined the term.

37.2%

of people said wheat flour — the most common type of flour used in breads, cookies and cakes — was not natural because they didn't know what it was, it contained gluten or it had been processed.

The U.S. Food and Drug Administration, which oversees most food products, has yet to define the term "natural ingredient" because many people interpret it in a variety of ways, according to Edgar Chambers IV, university distinguished professor of food, nutrition, dietetics and health. Chambers and his collaborators are involved in three studies to determine what people consider natural ingredients.

"With the exception of meat, there is not a definition of natural for most food products in the U.S.," Chambers said. "Companies can call just about anything natural and get away with it."

Chambers' collaborators are Edgar Chambers V, research technician; Mauricio Castro, doctoral student; and Thao Tran, master's degree student. Each is in charge of one of the three studies, which when combined — accounting for more than 2,000 participants — did not find a consistent majority of people who agreed on the naturalness of ingredients or on the reasons why an ingredient was not natural.

"The problem with defining 'natural' is that what you think is natural is not the same as what I think is natural," Chambers said. "We are finding from our U.S. research that the term 'natural' is so varied in meaning and it could refer to anything from the growing to the processing to the health issues."

Top reasons participants gave for saying an ingredient was not natural included not knowing what the ingredient was, it was unhealthy or led to health concerns, it was genetically modified, herbicides or pesticides were used in growing it, it was disgusting, it was illegal or it had been changed in some way that could not be replicated in a traditional home kitchen.

"Natural is so misunderstood," Chambers said. "It's so confusing to people. It means something different to so many different people, so it's a rather difficult thing to define, which is why the FDA hasn't defined it."

In one of the studies, 37.2 percent of people said wheat flour — the most common type of flour used in breads, cookies and cakes — was not natural because they didn't know what it was, it contained gluten or it had been processed. The term "wheat flour" was used in the study to differentiate from other flours such as sorghum flour.

"One of the biggest reasons people had for calling something not natural was if they thought it was not healthy; if it's not healthy, it can't be natural," Chambers V said. "This included ingredients with chemical-sounding names, names that sound similar to unhealthy ingredients and those that have a misperception of being unhealthy."

Among the ingredients that were deemed the most unnatural were insect powder, or ground insects used to increase protein, by 93.4 percent; sodium bicarbonate, or baking soda, by 87 percent; corn syrup — not the high fructose kind, just regular corn syrup — by 80.5 percent; gluten by 23 percent; and salt by 45.6 percent. Corn — historically the most genetically modified crop — was considered the most natural ingredient by 69 percent of people, and sea salt was considered natural by 60 percent of people.

"To consumers, this makes complete sense, but to food scientists it makes no sense, which makes it harder to define," Chambers said. "When something like this isn't defined, it can be used any way companies want, creating a niche market."

According to Chambers, natural food stores account for 20-25 percent of the market, and it's growing. To avoid confusion, many companies have started labeling products as what they aren't —non-GMO, no high fructose corn syrup and 100 percent organic — instead of using the term "natural."

"There is a lot consumer education that needs to happen," Chambers said. "We want consumers to understand that because natural is not defined, its use is not very helpful to them. We all should know where our food comes from."

Fun fact

Ingredients like ascorbic acid — vitamin C — and beta carotene — a provitamin and orange food coloring — are found in nature but can also be developed in a lab. When they are developed in a lab, they are called "nature identical ingredients" because although they are artificially made, their structure is the same as the plant version. This may be done to avoid plant waste or because the ingredient is not abundant in nature.

Fallacy: Fleas jump from pet to pet.

Fact: Once a flea finds a host pet, it stays there until it dies.

Michael Dryden, university distinguished professor of diagnostic medicine and pathobiology in the College of Veterinary Medicine, has been fighting fleas — and the myths surrounding them — since the 1980s. Dryden's research in flea biology and habits has helped develop better flea treatments and rid pets of the itchy parasites.

"There were a lot of people who had the misconception that fleas jump on, feed, jump off, lay eggs in cracks and crevices, and then find another host," Dryden said. "The fleas on our pets don't do that, and overcoming that myth radically changed how we approach flea control today."

Dryden, who is known as "Dr. Flea" for his expertise, said that the fleas on pet cats and dogs evolved to feed on Africa's big cats and dogs. If these fleas had jumped off a host — like rodent fleas do — finding another host would be too difficult. Understanding this difference made approaching flea control more proactive, as opposed to reactive flea baths and exterminators for the house.

Fun fact

One pass with an upright bagless suction vacuum can remove 40-50 percent of flea eggs, larvae and pupae from carpet, thus reducing the need for an exterminator. Vacuuming once a day for three weeks — after successfully treating the pet and washing pet bedding to prevent more infestation — can drastically reduce the flea population in the house within a month. Just make sure to dump the contents of the vacuum in the outside trash every day.

"If fleas start reproducing, they don't leave," Dryden said. "They lay their eggs on the animal, which roll off into the environment like little pingpong balls. Once we realized that reproduction was tied to the infected dog or cat, it changed everything in how we approached control."

Dryden and his colleagues started testing methods to attack the flea's reproduction in Florida, the flea capital of the world because of its warm climate. Untreated dogs in Florida average 100 fleas per animal, Dryden said. Using these dogs and cats, Dryden and his colleagues have tested numerous flea products ranging from sprays, spot-ons and ultrasonic collars — Dryden said they don't work because fleas can't hear ultrasound — to the new oral chews, which kill all fleas on the pet in eight to 12 hours.

"With these newer oral treatments, flea numbers dropped dramatically, with 99-100 percent of pets flea-free in less than two months," Dryden said. "It's so much faster than the topical treatments, which result in 50-70 percent of pets being flea-free at the end of the two- to three-month studies in Florida."

in less than two months with oral treatment

Dryden said that the rate at which the fleas are killed is important because most fleas are blood-fed within five minutes of jumping onto Fido and lay their eggs within 24 hours. If owners want to prevent an infestation on their pet and in the home, it's critical to kill females before they lay eggs.

"The idea is, if we can kill the fleas before they lay eggs, they will go extinct within a generation," Dryden said. "Generally, down in Florida, that's within two months."

One of the myths that Dryden has disproved is that the bite of just one flea results in the pet scratching. The researchers worked with a board-certified dermatologist to see if it took many fleas or just one to cause a pet to scratch. They found it takes several fleas to cause the allergic reaction. The researchers also are working with pet owners to help them understand that if their pet has fleas, then there also is an infestation of immature stages — eggs, larvae and pupae — in their home.

"It's really difficult to overcome those dogmas because people become entrenched," Dryden said. "We all have preconceived notions — good, bad or otherwise; they are there. Our job as scientists is to design a study that regardless of what perceptions are out there, at the end of the day, you've got good undeniable data." k

Bugs with benefits

Why we should appreciate the creepier, crawlier life forms of Earth

By Mary Lou Peter and Stephanie Jacques

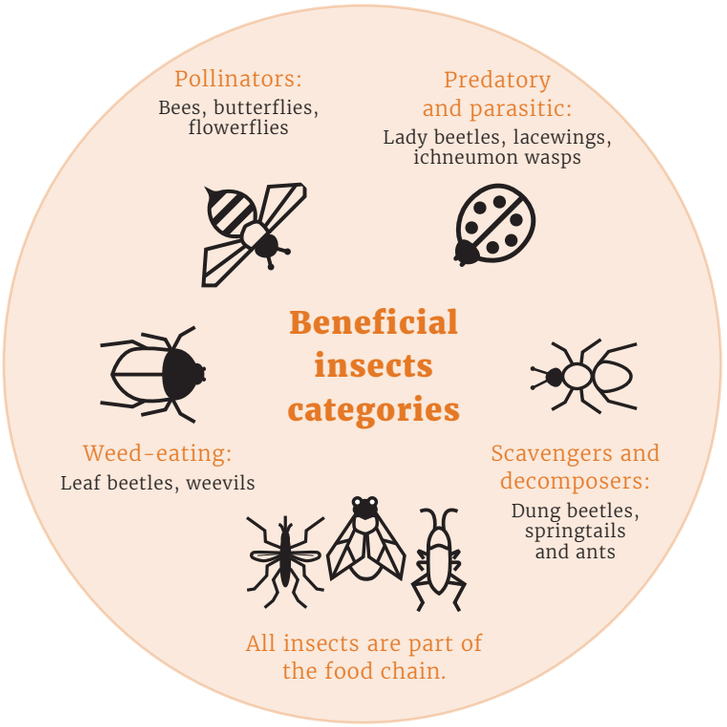
Insects outnumber humans by more than a billion to one. They buzz, creep and crawl into nearly every facet of human life. Kansas State University researchers have given these curious creatures the benefit of the doubt and found they can help people in many ways.

Entomology professor James Nechols, who has studied biological control of pests for more than 30 years, said it's hard to name just a few of the most beneficial insects because there are so many.

Beneficial insects, or "beneficials" as he calls them, fall into five categories: pollinators that help fertilize plants; predatory and parasitic insects that kill other insect pests; weed-eating insects; scavengers and decomposers that feed on dead animals or plants and help break down nutrients to support plant growth; and those that are part of the food chain — in other words, a lot of creepy crawlies.

"Thousands, if not millions, of insect species are part of the food chain, and that alone is a benefit to humans," Nechols said.

Whether people like them, ignore them or squish them, insects are unavoidable. Better understanding of beneficials through research can help us increase the odds of harnessing them to help battle pests, pollinate crops and even comprehend genetics to lead to better medicines.



Aphids, or plant lice, are only about 1.5 millimeters, but in masses they can contribute up to 80 percent yield reduction in some crops, especially without natural predators like lady beetles.

Eating the enemy

Nechols and his K-State entomology colleagues, Brian McCornack, John Ruberson and J.P. Michaud, plus many others, are examining biological control of plant pests, or controlling insect pests with other insects — beneficial insects, that is.

Insect and weed pests destroy millions of acres of crops each year, putting a huge dent into a farmer's bottom line and ultimately raising food and feed production costs. To combat the problem, pesticides have been developed to kill the pests. But pesticides entail both financial and environmental costs.

"Nature has its own predators and parasites that can take care of a significant number of the pest insects plus other pests, such as weeds," Nechols said. "Farmers wouldn't have to spend as much money on pest control if they could take advantage of what is available for free. But often pest controls — especially pesticides — kill beneficial insects that provide biological control as well as pollinators."

The total estimated global potential loss from all biological pests in crops, including insects and weeds, varied from about 50 percent in wheat to more than 80 percent in cotton production, according to a 2006 research paper, "Crop losses to pests," in the Journal of Agricultural Science. The responses were estimated as losses of 26 to 29 percent for soybean, wheat and cotton, and 31, 37 and 40 percent for corn, rice and potatoes, respectively.

Using non-pesticide options like biological controls as an alternative has many benefits.

"It reduces the likelihood that pests will develop a tolerance to pesticides, which results in ineffective chemical control," Nechols said. "It is safer for the environment, and it is sometimes the only feasibly economical way to control pests — especially invasive species that occupy thousands or millions of acres of land."

In his own work, Nechols has studied the use of beneficials to combat the invasive Russian wheat aphid and has evaluated using biological control for squash bugs, an important pest in pumpkins and squash. Because not all pests are found in farm fields, some of Nechols' research has focused on the best ways to control spider mites and thrips using predators in greenhouses.

"There are no biological controls in a greenhouse, so we looked at the best timing and most efficient distribution methods for releasing predators that can be purchased by producers," Nechols said. "Knowing the right number of predators to order also is important because it's possible to get too many or too few, which either wastes money or results in poor control."

K-State Research and Extension entomology specialist Jeff Whitworth works with farmers every day to find the best ways to minimize damage to crops from insect pests. Extension specialists like Whitworth are a conduit, taking the knowledge gained through research and connecting it with real-life, everyday situations for Kansans.

"Aphids can be the bane of farmers and gardeners," said Whitworth, who added that aphids are also called "plant lice." Where you find aphids, you'll also find other insects that feed on them, making these species beneficial insects. The insect that inspired a nickname for the VW bug, the lady bug — also called a lady beetle — is a beneficial insect that preys on aphids, many of which are harmful to vegetable and other crops, such as corn and soybeans.

"Whenever we have a lot of aphids in a field, we always see more lady beetles," Whitworth said.

A recent aphid threat in grain sorghum is the sugarcane aphid, which was first detected in Kansas just three years ago. Kansas is the top sorhum-growing state in the country. McCornack, Michaud and a team of researchers are investigating controlling sugarcane aphids with lady beetles.

Another dainty-sounding insect whose name belies its predatory ways is the common lacewing, whose larvae, and sometimes adults, also feed on aphids.

Lady beetles, or lady bugs, feed on aphids and can be a pesticide-free answer to controlling pests for many gardeners.

A southern plains bumblebee queen, a pollinator of significant conservation concern, gathers nectar from milkweed in a patch-burn grazing cattle pasture. ***Photo by Shelly Wiggam***

"Lacewings can eat a significant number — more than 100 — of aphids a week plus several other pest insects species," Whitworth said.

With a quick stab of its mouthparts, another insect called the assassin bug can kill aphids and much larger insects. Although they are an asset to farmers and gardeners, assassin bugs also can deliver a painful bite to humans. Wasps, ground beetles and minute pirate bugs — also called flower bugs — are examples of other beneficials. But despite their large numbers, beneficials' efforts often go unnoticed.

"Biological control is often unseen in the field and therefore underestimated," Nechols said. "Most of the benefits we get from beneficial insects are undervalued because people aren't aware of how many there are or how much of a factor they can be in controlling other pests."

Nechols pursues two goals in his research. The first is to more efficiently and economically control field pests by protecting and taking advantage of free, natural biological control. The second is to promote and protect pollinators essential to the food supply. He and other scientists use methods known as integrated pest management to make farmers and ranchers aware of beneficials and help protect agricultural crops without harming natural biological controls and pollinators.

"Some people say there's no good insect but a dead insect, but up to 97 percent of insects are beneficial to the environment in one or more ways," Nechols said.

The bee's knees

Entomology doctoral student Shelly Wiggam, working with McCornack and Greg Zolnerowich, professor of entomology, is researching the effects of various rangeland management practices on essential habitat and floral resources of native pollinators. She surveys native bee and butterfly communities on privately owned cattle ranches in the southern Great Plains.

One way to track the bees is by placing tiny radio transmitters on bumblebee queens. Wiggam is tracking the queen bees throughout the Flint Hills and Red Hills of Kansas to help ranchers implement land management practices that help these beneficial insects while potentially increasing profits.

"The research I'm conducting throughout Kansas and the Great Plains on private working ranches has never been done before," Wiggam said. "My research focuses on how

Shelly Wiggam carries a GPS satellite receiver, a handheld computer to communicate with the satellite, and an antenna to track native bees' activities, like foraging, searching for a nest or resting on a plant.
Photo courtesy of Chyna Pei.

to conserve and restore native pollinators on for-profit cattle ranches in native grassland systems while maintaining landowner profitability and operation functionality."

Each of the bumblebee transmitters — complete with a tiny battery, circuit board and antenna — that Wiggam places on the queen bees weighs 0.2 grams. Wiggam — who is actually allergic to bee stings — attaches the transmitter and places the bee back on the plant where she caught it to see where it goes next.

Nechols said Wiggam's work is important for Kansans. Researchers have many unanswered questions about native wild bees' roles as pollinators — especially considering the rapid global decline of wild native bees and butterflies in recent decades, he said.

Wiggam said that landowners can manage their ranches to benefit pollinators and maintain profitability by using patch-burn grazing, where burning and grazing are less uniform, allowing some areas of a pasture to rest. The practice creates greater habitat structure and plant diversity, which supports increased native pollinator diversity. Wiggam found three times the number of native bee species and two times the number of butterfly species in patch-burn grazing pastures compared to traditionally managed pastures.

"The queens of some of our most threatened bumblebee species in North America prefer patch-burn grazing pastures at much higher rates and are more successful than in traditionally managed pastures," Wiggam said. "Queens use each part of a patch-burn grazing pasture for a different purpose to complete different aspects of their life cycle, which all creates a successful nest that supports the production of worker, drones and queen bees all growing season long."

In addition to mimicking the Great Plains ecosystem before European settlement, patch-burn grazing has also been shown to maintain or increase profitability and herd sustainability through livestock gain and reproductive success.

Wiggam attaches a transmitter, which weighs about 0.2 grams, to bumblebee queens and then follows the bee through the prairie as it goes about its bee business, like gathering yellow pollen.

Photo by Shelly Wiggam

Bug of a different color

Susan Brown, university distinguished professor of biology, is taking one of farmers' and homemakers' most hated adversaries away from crops and pantries and into the lab. Her life's work has centered on developing the red flour beetle, a pest that feeds on flour and dry cereals, as a model organism for developmental biology.

Model organisms like the beetle — the fourth insect to have its genome sequenced thanks to Brown and her collaborators' work in 2008 — are intensively studied to understand how biological factors work and are an example for other organisms or systems. The flour beetle can help scientists like Brown understand genetics and developmental biology, which is necessary to develop gene-targeting medicines and pest control.

"The biggest benefit of studying the beetle is the power of genetic analysis," Brown said. "All good model systems have a few things in common. You need something that is small, grows really fast, has a short lifecycle and has a lot of progeny. Then you can do genetics."

The beetle's ability to survive in home flour containers and cereal boxes can be exploited in a laboratory to benefit scientific discovery — making what would be a pest in the wild into a beneficial bug. If scientists can understand basic biology of model organisms, then they can apply that information to help people by developing pest management strategies.

"Anytime you can understand the physiology of the organism, you can find targets to fight it, to control it, to manage it," Brown said. "You want that whether it's a vector of a disease, a vector of a plant pathogen or just destructive in its own right."

The beetle can be compared to the fruit fly — the rival model organism also commonly used for genetics research and the first insect to have its genome sequenced.

"The reason we worked on the beetle was because it was still an insect but it looked very, very different than a fruit fly," Brown said. "We wanted to know how developmental mechanisms work and how the beetle looks and develops so differently than the way a fruit fly develops."

Brown keeps about 30 different strains of beetles in jars with plenty to eat — pesticide-free flour from a nearby natural grocery store — and uses them as a teaching tool. They have helped researchers see that the beetle has more similarities to humans than the fruit fly, which makes the beetle even more important to understanding human genetics.

K-State's lab-pampered beetles offered a way for Brown and her colleagues to develop genetic maps and molecular tools to see a beetle's genes in action. After they had the genome sequence, Brown started

using RNA interference, or RNAi, as a tool to study gene function during the beetle's growth from egg to adult. These tools have helped scientists with understanding development and controlling diseases and pests using the information in the genome — an organism's entire genetic system.

"Everything that scientists are doing now is moving more and more toward precision medicine, which requires an understanding of an individual's genome," Brown said.

Brown used RNAi to look at the development of the beetle's segmentation into head, thorax and abdomen, which happens in waves. This is opposite of the way that the fruit fly develops — all at once — and more like humans, who gradually develop segments, or vertebrae, also in waves.

"Basically, all the things that you need to understand the insect genome are the same things that you need to understand the human genome," Brown said. "Our research with the beetle gives a basic understanding of the evolution of developmental mechanisms, embryogenesis and gene networks."

This research has helped Brown organize a fight against another pest: the Asian citrus psyllid. The tiny tree sap-sucking bug carries bacteria that cause citrus greening disease, which has decimated groves of citrus trees in Florida and is now threatening citrus trees in Texas and California. Brown and her colleagues are in the beginning stages of a study supported by a $6 million grant from the U.S. Department of Agriculture to help fight the problem.

"If we do the basic biology on the insects, that will give us targets that might aid in insect control or keep them from spreading the bacterium from tree to tree," Brown said. "We are targeting things that will either block the psyllid's ability to transmit or take up the bacterium. Anything that we look at to kill the bacterium in the insect can also be tried to kill the bacterium in the tree." k

Top: The red flour beetle, a food systems pest in the wild, is tiny and resilient — qualities that make it a great model system for beneficial laboratory genetics research.

Bottom left: Susan Brown, left, and her research assistant, Michelle Coleman, count live verses dead flour beetles.

Bottom right: Brown's beetles are kept in jars in the lab and feed on organic flour.


D
K-STATE

kinesiology | **noun** | **kə-nē-sē ä lə-jē**

the study of the principles of mechanics and anatomy in relation to human movement *(Source: Merriam-Webster)*

Keeping it moving

By studying physical activity, kinesiology researchers improve our daily lives

By Jennifer Tidball

In Kansas State University's kinesiology department, the study of movement takes a variety of directions: from space exploration to CrossFit and standing desks; from beetroot juice to cancer treatments.

But despite the differences, the researchers share the goal of improving human health and well-being by studying physical activity.

The university's kinesiology department was one of the first in the U.S. to adopt the name "kinesiology" and to make a commitment to understanding the connection between physical activity and health, said Craig Harms, department head.

"Our focus is unlike many other kinesiology departments in that our research faculty members specialize in two disciplines: physiology and exercise behavioral science," Harms said. "Our faculty members are truly outstanding."

Their outstanding work shows, and the department is recognized as one of the top kinesiology programs in the U.S.

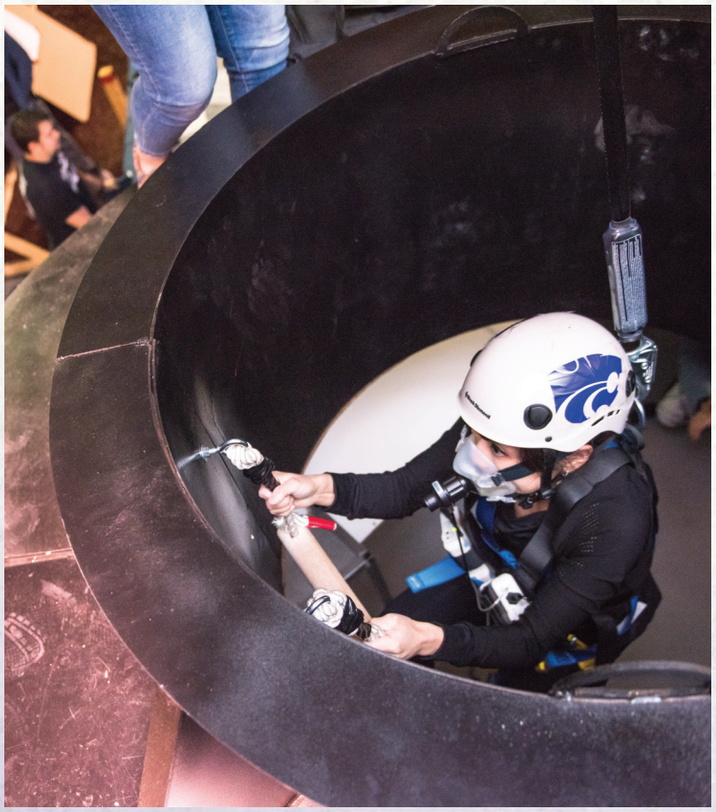
The department's success extends to the classroom, too. Kinesiology students have a high acceptance rate into health professional schools, such as medical, physical therapy, nursing and physician assistant schools. Kinesiology research projects often require large teams, and undergraduate and graduate students play a crucial role helping with the projects. They gain valuable experience in the process.

Research teams frequently collaborate, and faculty members approach their work from multiple perspectives using basic, clinical, behavioral and social science approaches, Harms said.

"It is common to have two or more of our faculty on grants because each is able to provide a unique skill and knowledge set," Harms said. "We are very fortunate that we have great camaraderie within our department. It is not uncommon that new ideas are generated from hallway conversations."

Read on for a sampling of some of the current research projects in the kinesiology department and understand why it is among the best in the country.

Carl Ade, assistant professor of exercise physiology, and his student team are using a mock Orion space capsule to study astronaut fitness.



Exercise for astronauts

Carl Ade, assistant professor of exercise physiology

Area of expertise: Cardiovascular physiology and gravitational physiology

Carl Ade wants to keep astronauts safe. His team of undergraduate and graduate students are researching astronaut health. They created a mock-up of NASA's Orion space capsule to determine how an astronaut's body responds to performing emergency escape maneuvers.

"We need to keep astronauts safe in flight and following landing," Ade said. "With this research, we can develop fitness standards and in-flight interventions that keep astronauts healthy during long-duration missions that can last several years."

Ade and Thomas Barstow, professor of exercise physiology, have collaborated with the Johnson Space Center in Houston to tackle one of the many challenges facing the deep-space astronaut: the return to earth.

After a deep-space mission, the Orion spacecraft will land in the ocean. In emergencies, astronauts must perform a quick escape, which is difficult after months in zero gravity.

"Microgravity deteriorates astronauts' skeleton, muscle and cardiovascular systems, similar to what occurs during several weeks of bed rest," Ade said.

Ade is studying research participants as they perform the same tasks in the model Orion capsule as astronauts would during an emergency escape. Participants wear special equipment that takes physiological measurements — such as muscle activity, oxygen uptake, heart rate and blood pressure — to determine the stress the body experiences during an emergency escape.

Ade also has studied other aspects of astronaut health. For a recent study with the Johnson Space Center, he found that astronauts on the International Space Station have decreased cardiorespiratory function because of a decrease in both the way the heart and small blood vessels move blood and oxygen.

"If we can figure out how to keep an astronaut healthy in the extreme environment of outer space, we can translate that to life on Earth," Ade said. "Our research helps both individuals: the astronaut and those here on Earth."

Army strong and fit

Katie Heinrich, associate professor of exercise behavioral science

Area of expertise: Physical activity and exercise interventions

Nearly 16 percent of U.S. Army personnel are obese — the highest percentage among the armed forces. Katie Heinrich wants to address that by comparing Army fitness with CrossFit, a form of high-intensity functional training.

Heinrich's research team has partnered with Walker Poston from the National Development and Research Institutes to develop the Army Training at High Intensity Study.

The current Army physical fitness test involves two minutes of pushups, two minutes of situps and a two-mile run.

"There has been concern over the Army's current fitness test," said Heinrich, who directs the Functional Intensity Training Lab. "Instead of following the Army physical readiness training manual, many soldiers will just train for the test."

Additional concerns are that the current test does not measure soldiers' combat readiness or fitness relevant to real-world activities, Heinrich said.

She is using a five-year, $2.52 million National Institutes of Health grant to study obesity prevention and health promotion in the military. It is the first cluster-randomized clinical trial on the Army physical fitness training program.

"Because people train for the physical fitness test, there are lots of repetitive stress injuries, such as lower leg injuries from running," Heinrich said. "We're testing to see if a high-intensity functional training program can minimize injury and improve outcomes."

Her team is comparing a group of active-duty soldiers who follow the current physical training method to a group that follows a high-intensity functional training, or HIFT, program. They are comparing changes in body fat percentage, fitness and health levels, and mental and physical aspects.

Soldiers in both groups complete a six-month exercise program of one-hour workouts five days a week. The daily sessions are offered on the Manhattan campus and at the Command and General Staff College at Fort Leavenworth. The HIFT workouts vary each day and include cardio, weightlifting and gymnastics.

"The HIFT workouts offer measurable results," Heinrich said. "The program helps soldiers compare one workout to the next."

Her collaborative team includes co-investigator Craig Harms, department head and professor of exercise physiology; National Development and Research Institutes personnel; and 13 graduate and undergraduate students. They continue to gather data and will analyze results when trials are complete.

"We need an army to test the Army," Heinrich said.

Top left: Katie Heinrich, associate professor of exercise behavioral science, is working with active-duty soldiers to study obesity prevention and health promotion in the military.

Matters of the heart (and blood vessels, too)

Brad Behnke, professor of kinesiology

Area of expertise: Cardiovascular physiology

Brad Behnke is improving patient care, from cancer treatments to heart surgery. His research focuses on the cardiovascular system: the heart and blood vessels.

"The common theme with our research is that we use strategies to alter rapidly the vasculature to improve patient care," Behnke said.

For one project, Behnke is using a $750,000 American Cancer Society grant to investigate how exercise can alter the tumor microenvironment and improve radiation treatments. He has found that moderate exercise — such as a slow jog or a brisk walk — can boost tumor oxygen delivery, which may improve cancer treatments.

But his cancer-related research goes beyond improving treatment itself. Behnke and Carl Ade, assistant professor of exercise physiology, are combating cardiotoxicity associated with chemotherapy. They particularly are addressing the lower five-year survival rates in cancer patients who develop cardiovascular disease, versus those who do not, during treatment.

"We want to maximize long-term survival by mitigating cardiovascular disease," Behnke said.

For another project, Behnke is collaborating with David C. Poole, professor of exercise physiology, to improve mechanical ventilation, which can greatly drive up health care costs when applied.

Mechanical ventilation is when patients — during open chest surgery or resulting from drug overdose — are intubated and a machine breathes for them. Behnke and Poole's team is using a $450,000 National Institutes of Health grant to make it easier for patients to wean off mechanical ventilators.

Regardless of the research area, Behnke and his collaborators — which include graduate and undergraduate students — continue to improve patient care by focusing on the cardiovascular system and the role of exercise.

"As physiologists, we try to understand the coordination of every system in the body," Behnke said. "Many people think exercise is easy, but it's probably one of the most impressive feats a human can perform."

Upstanding workplace behavior

Emily Mailey, assistant professor of exercise behavioral science

Area of expertise: Physical activity interventions

Sedentary behavior is increasing our health risks and decreasing our workplace productivity. But Emily Mailey is standing up for employee health.

Mailey, who directs the Physical Activity Intervention Research Lab, researches behavior change, specifically sedentary behavior. She is developing workplace interventions to reduce sitting time and improve employee health.

"We know that breaking up sedentary behavior is important and a lot of people sit all day at work, which makes the workplace a good place for an intervention," Mailey said.

Her latest research aims to change workplace environments at offices across Kansas with a large number of sedentary employees. Mailey and her collaborators — which include Sara Rosenkranz, assistant professor of food, nutrition, dietetics and health — will evaluate the effectiveness of the Stand Up Kansas intervention over a six-month period.

For the study, workers wear an electronic device called an activPAL to measure time spent sitting, standing and stepping throughout the day. The researchers also are gathering health outcome data — including blood pressure, cholesterol and body composition — as well as fatigue, productivity and job satisfaction.

The project incorporates evidence-based strategies such as health coaching calls and workplace policy changes. The researchers encourage workers to frequently interrupt sitting by taking the stairs or having walking meetings. Workers also receive a standing desk.

"There is good evidence that standing desks are effective for reducing sedentary behavior," Mailey said.

At the end of the study, Mailey and her team hope to have a program that successfully reduces sedentary behavior, which benefits the employee and the employer.

"We want to demonstrate that we can see positive changes in the workplace as people reduce their sitting time," Mailey said. "If we can develop effective interventions, they can potentially be disseminated to have a significant public health impact."

Keeping hearts beating with beetroot

David C. Poole, professor of exercise physiology

Area of expertise: Cardiorespiratory disease and oxygen transport

David C. Poole is helping heart disease patients with a common dietary supplement: beetroot juice. His latest research has found that a daily dose of beetroot juice can help combat diseases related to aging and heart failure.

About 6 million Americans have heart failure, but only about 3,000 new hearts are available for transplants, Poole said. Heart failure treatments cost the U.S. health care system about $100 billion each year.

“One of the most prevalent diseases in America is heart failure,” Poole said. “The No. 1 symptom that sends someone to the clinician with heart failure is a decrease in exercise capacity.”

Poole is using beetroot juice to change that. While many athletes use beetroot juice to improve muscle efficiency and performance, Poole sees possibilities for heart failure patients.

Heart failure starts when the heart cannot pump enough blood, the blood vessels get much smaller and muscles do not get enough blood and oxygen. As a result, a person’s exercise capacity goes down. The problem is that the best way to combat heart disease is an exercise program, said Poole, who directs the university’s Cardiorespiratory Exercise Laboratory.

He started looking into nitrate therapies, particularly beetroot juice, to help oxygen flow to vital muscles. His laboratory demonstrated that beetroot juice increased blood flow to exercising muscles. Subsequently, he partnered with the Penn Cardiovascular Institute in Philadelphia to conduct a National Institutes of Health-indicated patient trial with severely compromised heart failure patients and beetroot juice.

The team found that a single daily dose — about 2.4 fluid ounces — of beetroot juice provided enough nitrates to increase the amount of oxygen that a patient could use by 10 percent.

“That translates to a better quality of life, fewer hospital visits and potentially longer, and certainly happier, lifespans,” Poole said. “It’s offering a lot of hope for these patients.”

The research team is conducting further studies to improve beetroot juice dosages and make it more effective when partnered with exercise. By making exercise seem easier and physical activity less onerous, there is the likely possibility that the efficacy of exercise for cardiac rehabilitation will improve, Poole said.

“The real key is to get these people more active,” Poole said. “When they’re more active, they’re happier and healthier. That is a message that should resonate with all of us.” *k*

Page 30, top left: Brad Behnke, professor of kinesiology, far left, researches with his team, including, from left, Joseph Pyle, Alexander Opoku-Acheampong and Taylor Rand.

Page 30, top right: Emily Mailey, assistant professor of exercise behavioral science, helps an employee use a standing desk.

Page 31, top: David C. Poole, professor of exercise physiology, works with Ayaka Tabuchi in the Cardiorespiratory Exercise Lab.

Page 31, bottom: A glass of beetroot juice.

When the Wells

Agriculture in race for solutions to the declining Ogallala Aquifer

By Pat Melgares

Run Dry

Tom Willis pays attention to every drop of water that touches his western Kansas farm. That's the reality of farming in this region.

In western Kansas, crops and livestock rely on often sparse amounts of annual rainfall and water pumped from the Ogallala Aquifer, a large underground body of water that scientists say is quickly drying up.

The aquifer covers 175,000 square miles, or about 112 million acres in parts of eight states. For nearly 80 years, farmers and communities have been using the aquifer for agriculture and public water supplies. The Ogallala supports about 30 percent of all U.S. crop and livestock production, accounting for an estimated $35 billion in agricultural products annually.

So, it's a pretty big deal when scientists say that parts of the aquifer — much of that in western Kansas and south through Texas — may not last more than 20 years.

"I think people conceptually get it that the aquifer is declining, but I don't think they understand that when the aquifer is gone, the feed yards are gone, the farms are gone, the implement dealers are gone, the stores are gone," said Willis, whose farm is about 18 miles south of Garden City.

Science and K-State researchers are on the farmers' side.

Funding groups prioritize the Ogallala

In 2016, the U.S. Department of Agriculture's National Institute for Food and Agriculture awarded $10 million to universities in six states to further improve technology and practices that will slow the drain on the Ogallala.

K-State is among nine groups involved in the work, called a Coordinated Agriculture Project, which includes more than 40 university researchers and extension specialists along with their graduate and postdoctoral students.

"The impetus of the project was to provide research and information to producers and policymakers on how to sustain the aquifer or at least extend its life," said Chuck Rice, university distinguished professor of agronomy who coordinates K-State work on the project.

> **"We want to learn if there is anything we can do to soften the transition from irrigated agriculture or if we can still find ways to sustain the aquifer."**

That award is in addition to $1.5 million from the USDA Agricultural Research Service that K-State shares with four universities for the Ogallala Aquifer Program.

"The overriding philosophy of these research efforts is to reduce water use in this region and help producers gear up for the eventuality that the aquifer will not be there," said Jonathan Aguilar, a water resource engineer at the K-State Research and Extension Southwest Research-Extension Center in Garden City.

"But at the same time while we're gearing up, we want to learn if there is anything we can do to soften the transition from irrigated agriculture or if we can still find ways to sustain the aquifer," Aguilar said.

K-State researchers are working to improve center pivot irrigation, shown here, for crops.

"The climate projections are that the Ogallala area is going to be drier, and you're going to have more weather extremes in both temperature and rainfall, and that means more intense and frequent droughts," Rice said. "You have two issues: changing climate that is not going to be beneficial to the region because of declining rainfall events, and then the declining aquifer."

K-State innovations

K-State has focused research on irrigation in some form since the 1950s, but researchers made a big splash in 1989 when they introduced subsurface drip irrigation, a technology in which underground hoses carry water and fertilizer directly to plant roots. The technology conserves water by reducing evaporation, which is a common shortcoming of traditional center pivot sprinklers that spray water above the crop.

Freddie Lamm, an irrigation engineer at the Northwest Research-Extension Center in Colby, Kansas, has led the university's development of subsurface drip irrigation and is an internationally known expert in his field.

"Our goals in 1989 and now are to conserve water, protect water quality and to adapt the technology to our region and production practices," Lamm said. "In western Kansas, we have conservatively estimated that subsurface drip irrigation can reduce crop irrigation needs by 25 percent."

Researchers recently began more fully testing mobile drip irrigation, a combination of drip irrigation and traditional center pivot irrigation. Mobile drip irrigation relies on hoses attached to a center pivot instead of spray nozzles. As the center pivot rotates in a circle, the hoses snake along the ground and deliver water to the plant roots without wetting the leaves.

"Mobile drip irrigation is catching on," Aguilar said. "The way we see it is if a farmer is on a very limited well capacity, he will see some advantages by using mobile drip irrigation."

Willis has a mobile drip system running on land where one of his wells was on a steady decline.

"On this field, we've been able to reduce the pumping to half and still raise a good crop," Willis said. "It was a 350-gallon-per-minute well, and we're running it at 200. Our challenge is not how do we raise bigger crops, but it is how do we reduce water and keep our income at least static. On part of the farm, it meant going to a livestock program. We're experimenting with the mobile drip to see just how low we can go."

K-State researchers have developed other technologies to ensure efficient water usage. Danny Rogers, a longtime biological and agricultural engineer, was one of the university's pioneers in using soil moisture sensors to determine crop water use in a farm field. Sensors are installed below ground at strategic locations in the farmer's field.

Rogers was also instrumental in promoting climate-based irrigation scheduling. He developed software that helps farmers decide when and how much irrigation water to apply based on crop water use or evapotranspiration, determined by current weather data.

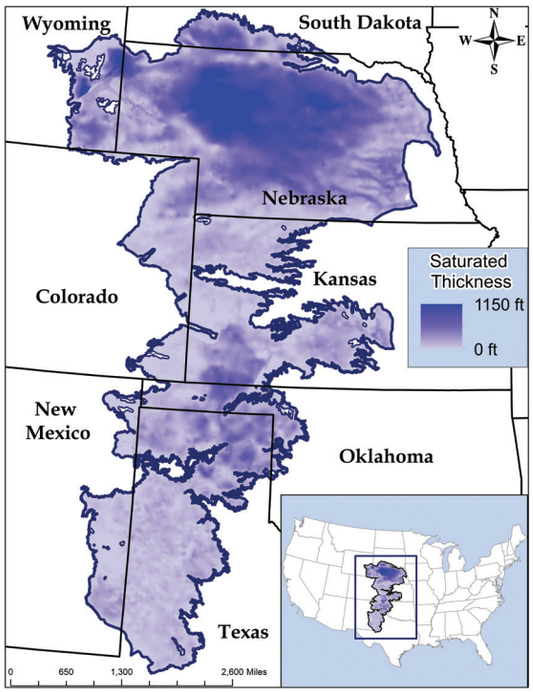
Today's versions of those technologies send real-time information to farmers' cellphones, allowing them to make water management decisions based on data rather than just a hunch.

"There are a lot of promising technologies, but the technology has to be implemented, and you still have to implement a management decision based on the information that technology gives you," Rogers said.

The Ogallala Aquifer, also called the High Plains Aquifer, touches parts of eight states. Geologists say that the aquifer is thicker in the northern sections but dwindling quickly in southern sections.

Subsurface drip irrigation was developed by K-State researchers in the 1980s. Underground hoses carry water and fertilizer directly to the plant's roots, thereby conserving water by reducing evaporation.

Tom Willis, who farms about 18 miles south of Garden City, checks hoses on his mobile drip irrigation system. The Willis farm is one of five water technology farms in Kansas and was established to help farmers see how new technology works.



Targeting dryland agriculture

In addition to incorporating new technology, farmers in western Kansas are looking at new ways to farm the old-fashioned way. Dryland agriculture relies on natural rainfall and is common in regions like Kansas where a cool, wet season is followed by a warm, dry season.

Much of western Kansas received less than 20 inches of precipitation last year. John Holman, an agronomist at the Southwest Research-Extension Center, is studying the best ways to make use of rain. Holman said fewer wells are pumped each year. In addition to the water table varying across the aquifer, some areas are experiencing high salt content, which means the water quality is becoming poor.

"My main focus is once we are at that point of depletion as we are farming mostly dryland, what do we do to sustain the farm?" Holman said. "Not only does it have implications for the producers, but it has implications on the whole regional economy. You're no longer buying as much fertilizer or chemical from those suppliers, you're not hauling as much grain into the elevator … you have that whole ripple effect."

In addition to overseeing on-farm trials and working directly with local farmers, Holman is conducting studies at the research station, testing the effectiveness of such things as tillage practices and crop rotations. He is exploring the benefits of planting corn, sorghum, canola, wheat and more.

"If producers knew what the weather was going to be like in the coming growing season, they could manage their inputs and crops better," he said. "The unknown is a real challenge without irrigation."

Community cooperation

Willis and other farmers agree that it's going to take more than just a few of them to adopt technology or water-saving practices to make a positive difference on the Ogallala Aquifer.

"One of the problems is that some farmers believe that if they reduce water use and their neighbors don't, the neighbors are just going to use the water that's under his land," said Bill Golden, an agricultural economist with K-State Research and Extension. "That way of thinking makes matters worse and lessens the chance that everyone works cooperatively to solve the water decline problems."

In 2013, Kansas farmers set up a 10-square-mile conservation zone in western Sheridan and eastern Thomas counties, called the Sheridan 6 Local Enhanced Management Area. Farmers in this area agreed to reduce irrigation by 20 percent for five years to see if they could maintain profitability while helping to extend the aquifer's life.

Golden recently released a report of the first four years of that project, and it's very promising. Compared with their neighbors outside the management area's boundary, irrigated crop producers reduced total groundwater use by 25.7 percent and did not experience any loss of profits.

"We say there is no profit loss, but actually, the people who have reported their corn yields are making a little more money and have reduced water," Golden said. "I hesitate to jump up and down and say you're definitely going to make more money when you reduce water use, because that's a little unbelievable. We just say there is not going to be any profit loss."

Water as a social issue

K-State sociologist Matthew Sanderson is working with the Coordinated Agriculture Project grant from the National Institute for Food and Agriculture to understand the cultural norms, values, traditions and other variables that farmers consider when voluntarily choosing to reduce water use.

"This is not an area that has been looked at by researchers, especially in agriculture, but we think it is a promising direction when we are trying to find answers to a problem that has been around a long time," Sanderson said.

So far, Sanderson's graduate student Stephen Lauer has interviewed Kansas farmers in person, and over the winter, Sanderson and Lauer sent surveys to farmers in more than 200 counties in Nebraska, Colorado, Kansas, Oklahoma, Texas and New Mexico. Concrete results will take time, but Sanderson is already seeing some trends.

"In the first 20-30 minutes of our face-to-face interviews, we hear a lot about economics and prices and the need to keep their operation financially viable," Sanderson said. "But as these conversations go on, we start to hear more about people's fears and hopes, we start to hear about why they farm — we start to hear about what's important to them.

"They're making a living, clearly, and I don't want to diminish that. But making a living is something else than just earning the money for a lot of these folks. It has to do with longevity of the farm and about passing it on. Their farm is not just a retirement plan — it is a way of life. Water clearly has a monetary value, but it also has a cultural value, and it has a set of principles and ideas in it that people want to pass on."

Top: Soil moisture sensors installed below fields give farmers important information on the amount of moisture available to their crops. Bottom: Center pivot sprinklers have served Kansas well over the years, but new technologies aim to make irrigated agriculture more efficient.

Water tech farms help boost technology

Dan Devlin is the director of the Kansas Center for Agricultural Resources and the Environment at K-State and manages funding and priorities for the center's Kansas Water Resources Institute.

"If somebody at K-State wants to know about water, they come to our center," Devlin said. "I work with stakeholders and agencies to determine the research needs and extension needs for our state."

One of the priorities that Devlin helped move along with the Kansas Water Office, a state agency, was the idea of water technology farms. Willis' farm is one of five in Kansas funded by private and public groups to test the newest technology for saving water. The farms host several field days so that farmers can see firsthand how well these technologies work.

"We want to find tools to make change, to save water," Devlin said. "We often think about the individual farmer and the irrigator, but we're really thinking about 40 years in the future and the next generation or two."

Willis says he hopes the water technology farms will help to stop the aquifer's decline.

"We've done the damage, so now we need to find out if there is a way to hold it static so that instead of lasting 20 years, it will last 60 or 70 years," Willis said. "Maybe the next variety of super corn or milo that comes out will be one where you can raise 200 bushels on 10 inches of moisture."

He adds: "This is a stop-gap to get you to the next generation of technology. This in and of itself is not going to save the aquifer. What I'm trying to do is take pressure off it, make it more sustainable, with the hope that there are new technologies that continue to come that allow us to do more with less."

See *UDP Focus*

Jankowiak shines light on the mysteries of photosynthesis

Sarah Caldwell Hancock

The chemistry lab in your mind's eye contains glass beakers full of different-colored chemicals bubbling over Bunsen burners or sitting under fume hoods. That's definitely not what you'll find in Ryszard Jankowiak's lab at Kansas State University.

Instead, you'll see lasers, spectrometers, cryogenic equipment and other instruments to conduct sophisticated experiments with light. Jankowiak, a university distinguished professor of chemistry and ancillary distinguished professor of physics, studies processes involved in photosynthesis. Spectroscopy is the analysis of the interaction between light and matter, and it helps Jankowiak understand the fundamental nature of the primary events in the seemingly miraculous process whereby plants and various photosynthetic bacteria convert light into chemical energy.

The process is complex, but a simplified explanation is that higher plants and photosynthetic bacteria contain various light-harvesting antennas and reaction centers. Antenna systems funnel the absorbed light energy into the reaction centers where the photochemistry takes place, thus executing energy conversion. Jankowiak's goal is to understand and model these processes, which one day could help researchers imitate the energy transfer and charge separation processes and design better solar power systems.

Advances in understanding natural electronic structure and energy transfer are coming in the form of better tools, better methodologies and more advanced theories.

"The photosynthetic processes are very fast — and scientists have developed better lasers and methodologies to study them — but what is most important is the development by scientists of many new theories that need to be tested. In my group, we use a density matrix theory and a new algorithm to fit simultaneously different types of spectra with one set of parameters to understand the electronic structure and dynamics of these complex biological systems," Jankowiak said.

Jankowiak works with postdoctoral researcher Anton Khmelnitskiy and doctoral student Mahboobe Jassas. Both Khmelnitskiy and Jassas are thankful for Jankowiak's productivity, high standards and skills as a mentor.

"Working for Jankowiak was what kept me in chemistry."

"I have worked with many professors, and sometimes they are too busy to contact you personally and give you advice," Khmelnitskiy said. "He never refuses to give you advice or talk to you about your job or your results."

Jassas added that Jankowiak and his wife are caring and help international students adjust, often hosting dinner parties and making sure students have what they need.

Mike Reppert, Banting postdoctoral fellow at the University of Toronto, worked for Jankowiak while he was an undergraduate student at K-State. He graduated in 2009 and now holds a doctorate from the Massachusetts Institute of Technology. He studies quantum mechanical effects in biological processes, including photosynthesis.

"Working for Jankowiak was what kept me in chemistry," Reppert said. "He gave me a different perspective on what research in chemistry is actually like. Working in a research lab is a lot more interesting than doing research in a lab class — you're working on questions that no one actually knows the answer to."

Reppert appreciated Jankowiak's approach.

"He never pushed me to support a result I didn't actually believe or agree with," Reppert said. "He supported intellectual honesty — reporting what you find, and not what you want to find."

Jankowiak's internationally known findings continue. He has published more than 240 papers and his lab boasted 13 major publications in 2016-2017. His current focus is to unravel mutation-induced effects in various antenna systems and reaction centers and their impact on excitonic structure and relevant photosynthetic processes. Researchers change a single amino acid close to a particular molecule within a complex antenna system, for example, and see how the electronic structure and dynamics are affected.

"We aim to reach a unified understanding of the ultrafast solar energy-driven primary events of photosynthesis," Jankowiak said. "It's not easy to describe very complex biological systems — you need experimental data, then you model it and see if it makes sense." *k*

Real-time design

By Taylor Provine

Graduate students in the College of Architecture, Planning & Design's fifth-year Design + Make Studio at Kansas State University are doing more than just creating their first piece of architecture; they are essentially working at their first job.

Real clients, real research and real building materials await these students, who work on real projects — many of which have received attention regionally and nationally.

Angel Llanes, back, and Nicole Bauknight review photos of the kit house the Design + Make Studio is renovating for its 2017-2018 project.

The studio, now in its seventh year, is an academic collaboration between Kansas State University and el dorado, an architecture, urban design, curatorial and fabrication practice in Kansas City, Missouri.

Led by David Dowell, studio consultant and principal architect for el dorado, the studio engages with clients to design and build a functioning piece of architecture from inception of design to the full completion of a project in one academic year. The projects often address public issues and challenges, such as affordable housing, environmental sustainability and more.

"The message of the studio is that these students are creating a world-class piece of architecture right now; it's not something that happens next year or two years from now, or when they are a licensed architect," Dowell said. "The students are having an impact on public issues and things of relevance to all of us right now, and they're creating works of architecture that are significant right now."

The students work as a cohesive group while collaborating with other designers and facing inescapable constraints such as budgets and schedules.

Angel Llanes, Denver, Colorado, and Nicole Bauknight, Minneapolis, Minnesota, both fifth-year architecture students, are members of the 2017-2018 studio. For their project, the studio is partnering with The Volland Store, a refurbished bed-and-breakfast and art gallery in Volland, Kansas. They are renovating an existing 24-by-24-foot kit house from the 1930s to help create an artist residency program and additional accommodation space.

The students' extensive research on the history of the area made them realize that not much art is available to small towns in Kansas.

"We are working on ways to further the artist experience and the relationship to the community, so we're engaged with organizing an artist residency program in Volland for the community and for artists," Llanes said. "The intent is that this place becomes an artist community or a place for artists to come for their residency programs, serving multiple people at a time."

By engaging with a real client — with supervision from Dowell — the students also gain additional skills that will be important after leaving the classroom.

"It is that relationship that you can develop with a client that gives you a chance to work on your skills and communication skills, because you're explaining something architectural for someone who doesn't necessarily understand that language, and communicating that effectively is really important," Bauknight said.

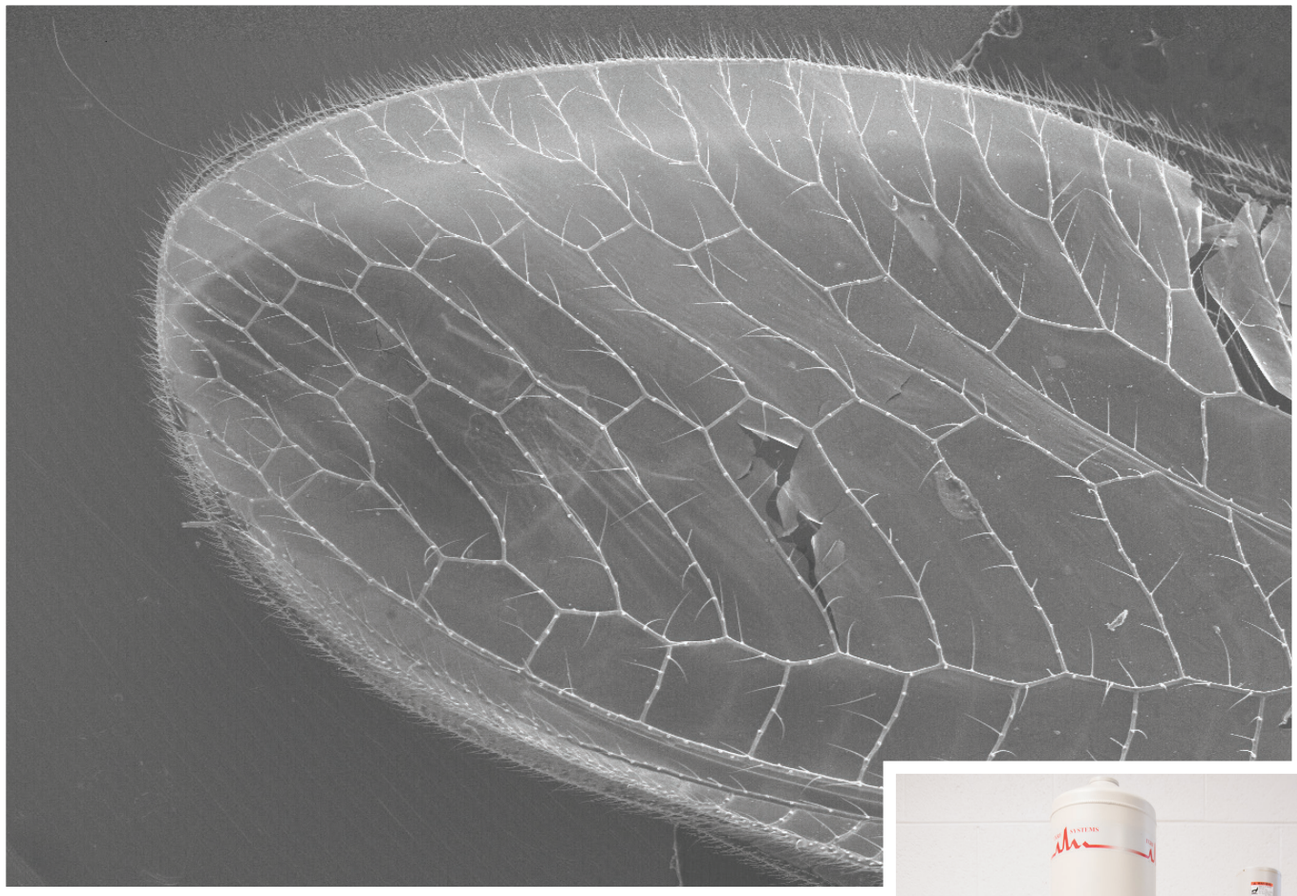
The studio's 2016-2017 class project, the Waldo Duplex in the heart of the Waldo neighborhood in Kansas City, Missouri, is the largest and most comprehensive project from the studio, according to Dowell. The 1,500 square-foot duplex was built to give individuals earning no more than 80 percent of average median income an opportunity to afford living in a vibrant neighborhood.

The Waldo Duplex received the 2017 AIA Central States Excellence in Architecture Honor Award; 2017 AIA Kansas City Honor Award — Small Architecture; 2017 Residential Architect Design Awards — Affordable Housing; a Project Honoree: 2017 Interior Design, Best of Year Award — Budget; 2017 Architect's Newspaper Best of Design Awards — Student Work, honorable mention; and was featured on several major websites and in publications.

Through these opportunities, the studio is developing a highly skilled and educated citizenry to advance the well-being of Kansas, the nation and beyond.

"As a land-grant university, it's service learning we need to be able to articulate and the public benefit of these projects every year, and I'm happy to say we can do that," Dowell said.

View previous projects and a blog from the Design + Make Studio at ***ksudesignmake.com/***.

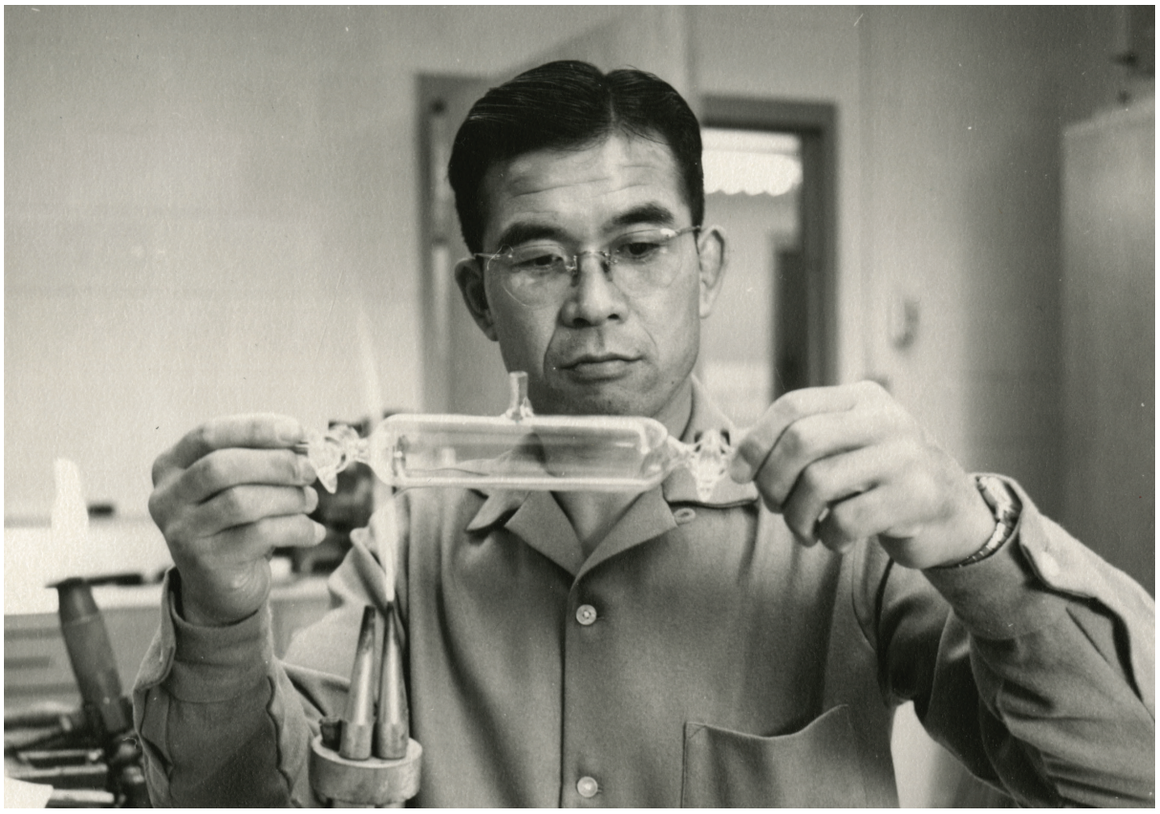


Scanning electron microscope

ˈskan- nin i-ˈlek-trän mī-krə-skōp

Douglas McGregor, university distinguished professor of nuclear engineering and director of the Semiconductor Materials and Radiological Technologies Laboratory, or S.M.A.R.T. Lab, in K-State's College of Engineering, explains in just a little over 100 words how a Hitachi scanning electron microscope, right, was used to produce an image of the honeybee on the cover of Seek and the photo of the lacewing's wing above. The microscope is used to investigate microstructures in semiconductor devices produced by various etching methods. Equipped with X-ray fluorescence and detection capability, the microscope is also used to analyze elemental composition of materials and electrical contacts.

A lifeless insect is first coated with a submicron layer of conductive material, usually gold or carbon. The insect is then placed in the vacuum chamber of the scanning electron microscope, where a focused beam of electrons is scanned over the sample, causing the emission of secondary electrons. These secondary electrons are detected by a sensor, producing a synchronized signal that provides information about the sample surface topology and composition. The signal is converted into an image. The conductive layer prevents the accumulation of space charge around the sample while being scanned and ultimately improves the image resolution.



Master of glass

Mitsugi Ohno was Kansas State University's first full-time scientific glassblower. Ohno created custom glass research apparatus for many departments on campus. He also is known for his glass sculptures and replicas, some of which are permanently displayed at the K-State Student Union. Ohno worked at K-State from 1961 until his retirement in 1996. He died in 1999. In this photo, Ohno is creating a gas sampling tube with a syringe port, which is used for the collection and storage of gas samples. Jim Hodgson now serves as the university's senior scientific glassblower and worked with Ohno before his retirement. The scientific glassblowing shop serves many departments on campus as well as other universities with their research needs for specialty scientific glass devices.

Photo courtesy of the K-State Archives.

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‘Time Flies’

An Aquarelle graphite and oil crayon drawing on Stonehenge paper, “Time Flies” is by Teresa Schmidt, professor of art at Kansas State University. The drawing is part of the art faculty’s exhibition at the university’s Marianna Kistler Beach Museum of Art, “Here, and Now.” Schmidt, an art faculty member since 1972, describes the work as a double self-portrait, showing her first younger and now older, with a surprised look. “Spontaneity, rhythm and expression are a simple but constant goal,” Schmidt said of her art. “Most of my work is larger, organic and abstract; this was done for a fun image of this aging artist.”