RESEARCH AT

NEBRASKA

THE UNIVERSITY OF NEBRASKA–LINCOLN

2015-2016 REPORT

Contents

On the Cover

Below the soil surface, plant roots navigate a world teeming with microbes – both helpful and hostile. Complex interactions between roots and their soil-dwelling neighbors are critical to plant health and productivity. Building on longstanding strengths in plant science, University of Nebraska–Lincoln researchers lead two major initiatives to better understand these vital root-microbe interactions. One project aims to improve health and productivity of agricultural crops; the other seeks to optimize sorghum's biofuel potential. Read more on pages 2-5. The cover illustration shows part of a plant root amid the diverse microbes inhabiting the rhizosphere, the region of soil surrounding plant roots. (Illustration by Joel Brehm, Office of Research and Economic Development)

On the Web

Explore the 2015-2016 UNL Research Report website for more photos, links and videos related to stories in this report:

research.unl.edu/annualreport/2016

A Pivotal Time for Growth, Change

This is a pivotal time of growth and change at the University of Nebraska–Lincoln. We're building on a strong foundation to define and expand our future role in solving the complex challenges facing our world.

Our research enterprise is growing as investments in people, programs and infrastructure pay off. Our success shows in the all-time record research funding our faculty achieved this year. It's reflected in Springer Nature's 2016 list of Rising Star research institutions, which ranked UNL ninth in the U.S. and 90th among more than 8,000 international research institutions chosen as "emerging institutions likely to play a role in addressing some of the globe's most pressing challenges."

We are rising because UNL began focusing on global challenges more than a decade ago under the leadership of Harvey Perlman, our chancellor from 2000-2016. Perlman set a course emphasizing excellence in academics and research. He invested in faculty and programs that exploit our strengths in food production, water, early childhood education and materials research, and in the facilities and equipment needed for world-class research. He cultivated private sector partnerships that launched Nebraska Innovation Campus, our private-public research campus that capitalizes on UNL research and helps drive economic development and innovation for Nebraska.

Vice Chancellor Prem S. Paul (left) and Chancellor Ronnie Green

Now, new leadership is energizing the campus. Ronnie Green became UNL's 20th chancellor in May 2016 after leading a renaissance in our Institute of Agriculture and Natural Resources over the past six years. He is challenging the campus with ambitious goals: more than doubling research expenditures, increasing enrollment from 25,000 to 35,000 students and rapidly expanding public-private partnerships. He sees a strong partnership with the University of Nebraska Medical Center driving innovation in research that will propel us toward a ranking as a top 35 public university.

This report highlights some of the research that is driving us toward these goals. Recent major grants in national priority areas recognize our expertise in soil microbiome research as well as our national leadership in early childhood learning and materials and nanoscience. Nebraska Innovation Campus continues its upward trajectory, including three faculty startups and a fall 2016 groundbreaking on a new building.

Thanks to our strong foundation, our ambitious vision for the future and our commitment to collaboration and partnership, UNL is well positioned to meet the challenges vital to our state, our nation and our world.

Prem S. Paul
Vice Chancellor for Research
and Economic Development

In Memoriam
Prem S. Paul
1947-2016

"One has to look long and hard to find another person in the 147-year history of the University of Nebraska who has achieved the level of impact of Prem Paul." – UNL Chancellor Ronnie Green

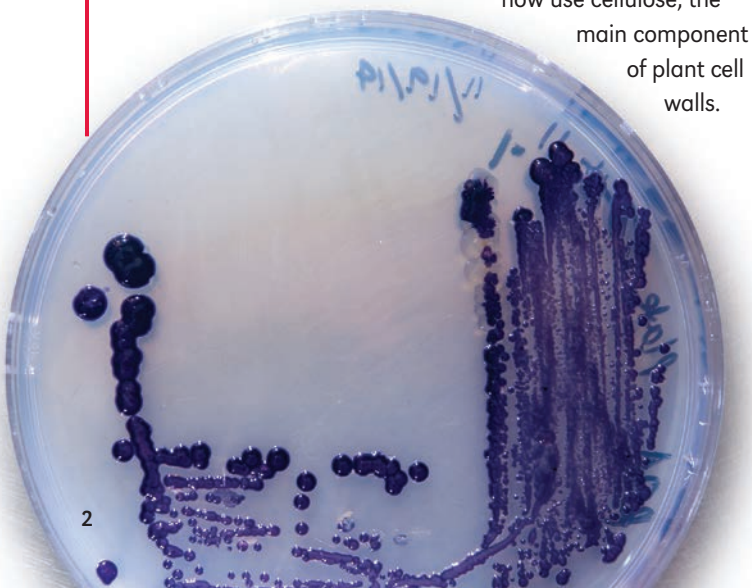
Enhancing Sorghum for Biofuel Production

Corn may be king, but sorghum is a top contender to replace it as the nation's primary biofuel source. UNL leads multi-institutional research to improve sorghum's productivity and significantly advance sustainable ethanol production.

Optimizing sorghum's biofuel potential would relieve pressure on an important global food source. Sorghum grows on marginal lands and needs less water and resources than corn.

"It's becoming increasingly recognized that we need to move biofuel production to more marginal lands so they don't compete with food crops," said project leader Daniel Schachtman, an agronomist who also directs UNL's Center for Biotechnology.

Nearly all U.S. ethanol is made from starch in corn kernels. But technologically advanced ethanol plants now use cellulose, the main component of plant cell walls.



Sorghum bred for energy production creates more biomass for cellulosic ethanol than corn.

With $13.5 million from the U.S. Department of Energy, UNL leads a team of researchers with diverse expertise from nine universities and institutes. UNL's tremendous field research capacity, extension programs and plant research expertise make it an excellent institution to lead the project, Schachtman said.

"Nebraska will be the focal point for much of the work. The university has developed fantastic field research facilities that really put us ahead," he said. "Because we're doing work in the field, it will translate into practical applications much faster."

To improve sorghum's productivity under resource-limited conditions, the team takes a systems approach. Researchers are investigating both sorghum genetics and soil microbes that interact with roots.

Outcomes should include strategies to increase plant biomass as well as to make sorghum production systems more water- and nutrient-efficient.

The work taps advances in marker-assisted breeding, metagenomics and computational genomic analysis. Scientists will identify sorghum varieties and the genes that enhance water and nitrogen use efficiency under limited conditions. Microbiologists will identify and study soil microbes that enhance nutrient uptake, water use efficiency and disease resistance.

Daniel Schachtman

Bringing both approaches together, the team will experiment to find the genetic and microbial combinations that deliver the greatest productivity benefits. Initial research has demonstrated promising results, Schachtman said.

UNL is teaming with scientists at Danforth Plant Science Center, Washington State University, University of North Carolina at Chapel Hill, Boyce Thompson Institute, Clemson University, Iowa State University, Colorado State University and the DOE Joint Genome Institute.

Sorghum roots

Above: Jim Alfano (left) and Edgar Cahoon
Right: Corn roots

Getting to the Root of Crop Improvements

Plants send roots into a world teeming with microbes, both friendly and hostile. The complex relationships occurring below ground influence crop health and yields.

To better understand how plant roots navigate the rhizosphere, UNL leads a major effort to study root and soil microbe interactions and improve crop productivity.

The Center for Root and Rhizobiome Innovation is funded by a $20 million grant from the National Science Foundation's Experimental Program to Stimulate Competitive Research, or EPSCoR.

"This research is the new frontier for plant improvement," said Edgar Cahoon, George W. Holmes Professor of Biochemistry, who co-leads the project with Jim Alfano, Charles Bessey Professor of Plant Pathology.

Researchers are initially focusing on corn, but their findings and new biological tools developed through this project will apply to studying and improving other crops, including soybeans, Cahoon said.

Taking a systems approach, researchers will investigate genetic and metabolic diversity across corn varieties. They seek to understand how root metabolism determines the chemical signals that roots emit, the subsequent effect on soil microbes and, ultimately, corn health and productivity.

A key aim is developing new biological tools that will enable researchers to use their findings to precisely modify plant genomes, targeting specific traits such as drought resistance or yield. Technological advances allow researchers to introduce large numbers of genes, speeding the rate of crop advancements, Cahoon said.

Using UNL's extensive agricultural research facilities, the scientists will test and refine their enhanced crops in the greenhouse and the field.

Sixteen UNL faculty bring a range of expertise to this project, as do faculty at the University of Nebraska Medical Center, University of Nebraska at Kearney and Doane University. The grant funds two new faculty positions at UNL and one at UNK.

"Nebraska has had a reputation of being at the forefront of plant genetic improvement, and this will take us to the next level," said Cahoon, who also directs UNL's Center for Plant Science Innovation. "This project will have considerable benefit for agriculture."

Corn roots close up

New Chancellor Envisions Bold Future for Research

Ronnie Green has a big vision for UNL research.

He sees world-leading research in water and food security, early childhood education, national defense, and materials and nanoscience. He sees the university as a distinctive member of the Big Ten and one of the country's top 35 public universities.

"We are going to be bigger, better and more impactful than ever," said Green, who became UNL's 20th chancellor in May 2016.

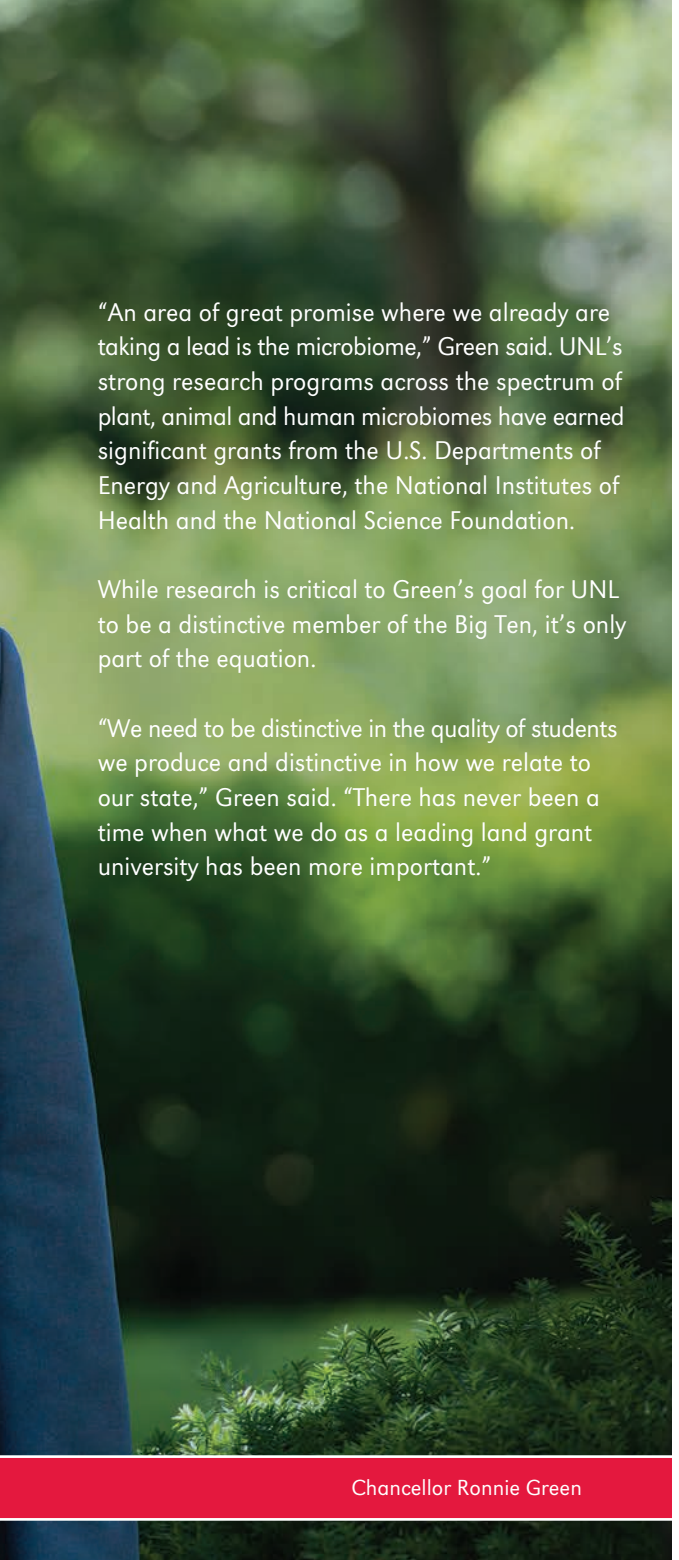
Green knows UNL research. Twenty-two years after earning his doctorate in animal genetics from Nebraska, he returned in 2010 as vice chancellor of the Institute of Agriculture and Natural Resources and vice president for agriculture and natural resources for the University of Nebraska system. In 2015 he added the role of interim senior vice chancellor for academic affairs.

Green's ambitious 2025 goals include doubling research expenditures, increasing enrollment to 35,000 from the current 25,000, graduating students faster and building more private sector partnerships.

Expanding collaborations with the University of Nebraska Medical Center, which Green calls Nebraska's "other flagship campus," is one strategy. UNL research expenditures currently are $278 million and, combined with UNMC, total $407 million. Green thinks the two campuses together can reach $800 million in 10 years or less.

"I'm convinced that the opportunities are there to make it happen," he said, citing the new NU systemwide food for health initiative, research on preventing obesity-related diseases and potential collaborations on health care design and delivery.

"We need to be distinctive in the quality of students we produce and distinctive in how we relate to our state. There has never been a time when what we do as a leading land grant university has been more important."



"An area of great promise where we already are taking a lead is the microbiome," Green said. UNL's strong research programs across the spectrum of plant, animal and human microbiomes have earned significant grants from the U.S. Departments of Energy and Agriculture, the National Institutes of Health and the National Science Foundation.

While research is critical to Green's goal for UNL to be a distinctive member of the Big Ten, it's only part of the equation.

"We need to be distinctive in the quality of students we produce and distinctive in how we relate to our state," Green said. "There has never been a time when what we do as a leading land grant university has been more important."

Chancellor Ronnie Green

NU FEWS Sparks Innovation in Food, Energy and Water

Sustaining crucial food, energy and water systems in the face of a changing climate and a burgeoning population worldwide is among our most complex global challenges.

To expand its traditionally strong research in food, energy and water systems, UNL launched the NU FEWS Initiative in 2015. Developed in partnership with Knowinnovation, creators of the Ideas Lab, this universitywide initiative offers an interactive process to build highly interdisciplinary teams and generate innovative project concepts. The goal: novel research proposals responding to Innovations at the Nexus of Food, Energy and Water Systems (INFEWS), a new priority area led by the National Science Foundation and the U.S. Department of Agriculture.

During a series of meetings and workshops, nearly 200 UNL faculty with expertise in fields ranging from physics to economics to geography discussed different dimensions of FEWS and developed novel research questions. A final three-day Jumpstart session generated innovative proposal ideas addressing the question: "How can we build intensive, resilient agro-ecosystems?"

NU FEWS Scoping Workshop

"This initiative lays the groundwork for UNL to play an even more significant role in this area of research so critical to UNL, our state and the world," said Prem S. Paul, vice chancellor for research and economic development.

Closing Achievement Gap for Kids

Young children who experience less stimulating environments than their peers quickly fall behind academically and socially. UNL is leading a national research initiative to determine what families, schools, communities and the nation can do to give all children the best chance to succeed in school and in life.

Susan Sheridan, director of UNL's Nebraska Center for Research on Children, Youth, Families and Schools, leads the Early Learning Network, a $26 million multi-institutional research and policy effort to improve children's learning outcomes. It's funded by the U.S. Department of Education's Institute of Education Science. UNL's share is $6.5 million.

Sheridan's Nebraska team also is conducting research to understand the factors – from classrooms to national policies – that influence children's educational progress. The research covers multiple educational environments, including rural settings, and tracks children from pre-kindergarten programs through third grade.

"The overarching goal of our research, both in Nebraska and nationally, is to understand what it will take to close the achievement gap and sustain positive outcomes for disadvantaged children," Sheridan said.

Although studies show that pre-kindergarten programs effectively close gaps formed early in life, those benefits diminish as children progress through elementary school. Tracking children's experiences over time will help researchers understand why.

UNL's national reputation for both rural education research and putting early education findings into practice contributed to its leadership role, Sheridan said. The Nebraska team will guide the network's efforts to develop strategies and communicate results to federal policymakers.

"For any real, significant lasting change to occur, we have to be very serious about changing the landscape of early childhood education in this country," she said.

Nebraska's team includes researchers from UNL's Nebraska Center for Research on Children, Youth, Families and Schools, the University of Nebraska's Buffett Early Childhood Institute and the NU Public Policy Center.

UNL's team will coordinate research and outreach among the other Early Learning Network collaborators: the University of North Carolina at Chapel Hill, University of California, Irvine, Ohio State University, University of Virginia and MDRC, a policy research organization.

Susan Sheridan (center) and researchers Lisa Knoche, Iheoma Iruka, Mark DeKraai, Jim Bovaird and Greg Welch

Enhancing Early Childhood Development

UNL is leveraging its expertise in early childhood education to improve developmental outcomes for the nation's youngest members.

A team in UNL's Nebraska Center for Research on Children, Youth, Families and Schools is collaborating with Early Head Start programs to implement the Getting Ready intervention.

Developed at UNL in 2004, Getting Ready is a research-based approach to enhance early childhood development by strengthening relationships among parents, educators and children.

Researchers and community partners are tailoring the intervention to support language and social-emotional competencies in infants and toddlers. They'll test its effectiveness with 240 children, their teachers and families before making the intervention accessible to Early Head Start programs nationally. Ultimately, the intervention also will reach other community-based child care centers.

"We want to learn how this integrated intervention approach will support children's well-being so that it can be adopted by other early childhood efforts," said Lisa Knoche, project leader and research associate professor who also directs the Nebraska Early Childhood Research Academy.

A $2.5 million grant from the U.S. Department of Health and Human Services' Administration for Children and Families funds the project.

Drones Could Help Fight Fire with Fire

Imagine sending drones instead of people into dangerous wildfire management situations.

UNL researchers are developing fire-starting drones that could change how wildfires are fought and aid prescribed burns that rejuvenate prairies and quell invasive trees that threaten grasslands.

Team leaders Sebastian Elbaum and Carrick Detweiler, UNL computer scientists and drone experts, envision their technology someday becoming standard safety equipment for wilderness firefighters. They've field tested drones small enough to fit in a backpack but smart enough to navigate in dangerous conditions.

"UNL is pioneering this merging of two very risky, highly regulated technology fields: fire and unmanned aviation," Elbaum said.

Their drones carry a cargo of ping pong-like balls filled with a powder. Before release, balls are injected with glycol, triggering a chemical reaction. Balls drop and ignite within 60 seconds. A similar method is used to start conservation fires using helicopters and hand-held launchers, Detweiler said. Drones also can be flown over fire lines to monitor conditions and gather data.

Prototypes have performed well in field tests, including a prescribed burn in April 2016 at Homestead National Monument of America, in cooperation with the National Park Service and the U.S. Department of the Interior.

Elbaum and Detweiler co-direct UNL's Nebraska Intelligent Mobile Unmanned Systems, or NIMBUS, laboratory. They're patenting their technology through NUtech Ventures, UNL's technology commercialization affiliate.

Fire is a powerful tool for restoring grasslands and one of the most effective ways to control invasive species, such as eastern redcedar, said Craig Allen,

James Higgins and Sebastian Elbaum reload the prescribed fire ignition device.

director of the Nebraska Cooperative Fish and Wildlife Research Unit, and Dirac Twidwell, a fire ecology expert, who are part of UNL's multidisciplinary drone development team. Twidwell leads a Nebraska Game and Parks Commission-funded project to develop tools to control invasive cedars.

"We need to burn more, but we can't because of logistics," Allen said.

Drone technology will make prescribed burning easier and safer, they said.

Federal officials are interested in trying the drones on more rugged federal lands.

"A tool like this might be one of the answers to making these fires safer," said Mark Engler, superintendent at Homestead National Monument of America.

Drone testing at Homestead National Monument of America

"Discovering something unexpected is always extremely interesting for physicists."

Surprising Discovery Contradicts Predictions

What happens when you focus X-ray beams a billion times stronger than the sun's brightness on a spot 100 times smaller than a human hair? A startling discovery that could lead the way to engineering better materials.

That, and it's just cool, said UNL physicist Matthias Fuchs, who led the project.

"Discovering something unexpected is always extremely interesting for physicists," Fuchs said. "This opens a whole new realm of physics."

He and his colleagues smashed X-ray photons into a metal foil to observe a fundamental process whereby two photons that simultaneously hit an atom are converted into a single higher-energy photon, and an atomic electron is ejected.

The process is extremely rare. Observing it requires an X-ray laser so enormous that only two exist in the world. The team used the LCLS X-ray free-electron laser at the U.S. Department of Energy's SLAC National Accelerator Laboratory at Stanford University.

What they observed contradicts theoretical predictions that have stood for 60 years – the energy of the generated photon was significantly lower than expected.

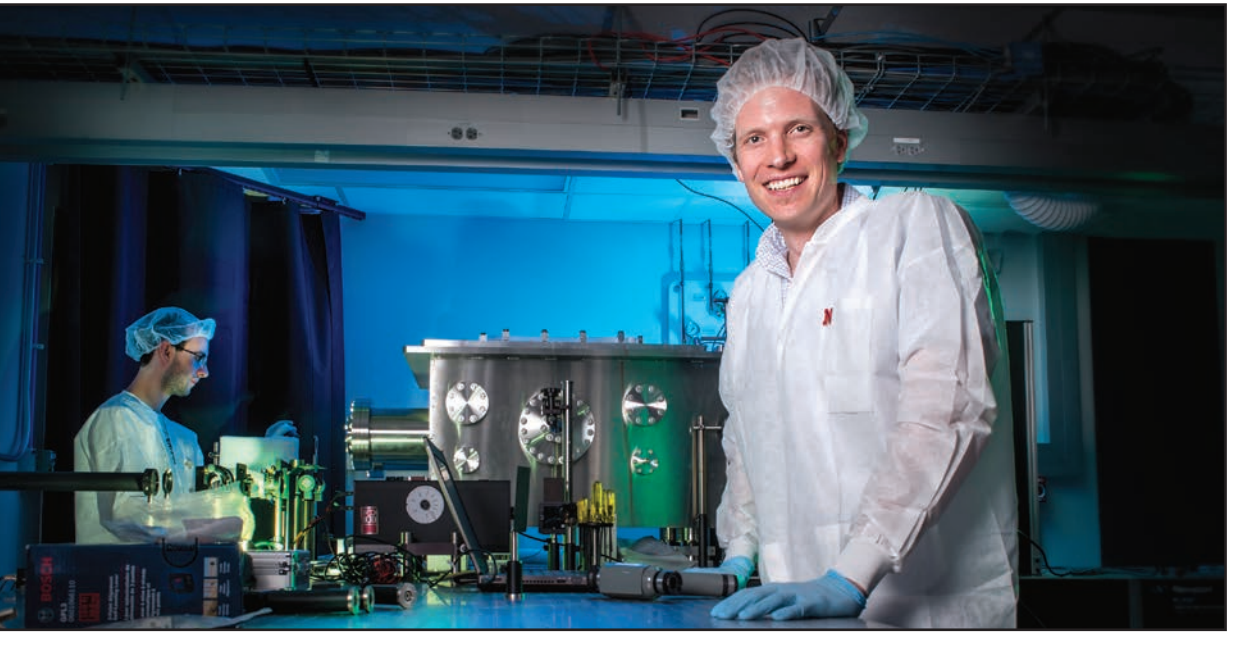
It appears the X-rays interact with the entire atom and not just the atomic electron as predicted, Fuchs said. He continues to investigate the surprising results.

The newly observed process has the potential to provide important clues about both the material's composition and arrangement with atomic spatial resolution.

"This would give you much more information about the material so you can engineer its properties much better," Fuchs said. "But right now we are at the very fundamental stage of trying to understand the physics behind the process."

The research, funded by DOE, was published in the journal *Nature Physics*. Fuchs won an Air Force Office of Scientific Research Young Investigator Award in 2015 to further his next-generation X-ray research.

His collaborators are at the Stanford Linear Accelerator Center, Stanford University and Bar-Ilan University in Israel.



Above: Matthias Fuchs (right) and postdoc Matthew Robinson

Left: As two X-ray photons strike a beryllium metal atom at the same moment, they form a single X-ray photon and the atom ejects an electron.

Laser Creates Surfaces that Mimic Nature

Shark skin, rose petals and moth eyes.

This isn't a weird memory test. It's the seemingly random starting point of Dennis Alexander's research. Each of these biological systems has a unique capability that the UNL engineer's team is exploiting for defense and industrial purposes.

Alexander and colleagues use lasers to copy microscopic structures found in nature onto metal surfaces, giving them similar unique properties already honed by Mother Nature.

"Our structures are very important to the military, Boeing and NASA," said Alexander, Kingery Professor of Electrical and Computer Engineering. "We're emphasizing using these structures in harsh environments, but there really isn't any metal surface we can't functionalize."

His team uses femtosecond laser surface processing, or short-burst laser pulses, to alter the top 100 microns of a metal surface, about the depth of a human hair, producing surfaces that mimic nature. Altering the laser angle and other parameters creates surfaces with different properties.

Sharks, for example, are highly efficient swimmers. By copying their microscale skin onto metal, researchers create a super-hydrophilic, or wicking, material. This property reduces drag, so a shark skin-like submarine shell, for example, would be able to travel farther using less power.

UNL's laser-created surfaces also improve heat transfer, important to many military and commercial systems.

Rose petals, in contrast, are super-hydrophobic. Rainwater slides off in beads. Super-hydrophobic surfaces also reduce drag. Applications include medical supplies that can't be contaminated by blood or other fluids, antibacterial metals for joint replacements, reducing ice buildup on traffic lights and improving condenser heat exchangers, including those used to reclaim water in space.

Current hydrophobic materials are created with a polymer coating that adds weight and eventually breaks down, creating undrinkable water. For the International Space Station, where recycling water is paramount, a super-hydrophilic condenser would avoid these problems. Alexander's team works with NASA on improved heat exchangers.

Remember moth eyes? To see at night and avoid detection by predators, moths absorb a wide spectrum of light. Mimicking the eye's surface creates an anti-reflective metal, improving solar panel efficiency and making stealth aircraft harder to track.

NU's National Strategic Research Institute and NASA fund this research.

Dennis Alexander

Demonstrating super-hydrophilic material

USSTRATCOM Delegation Visits UNL

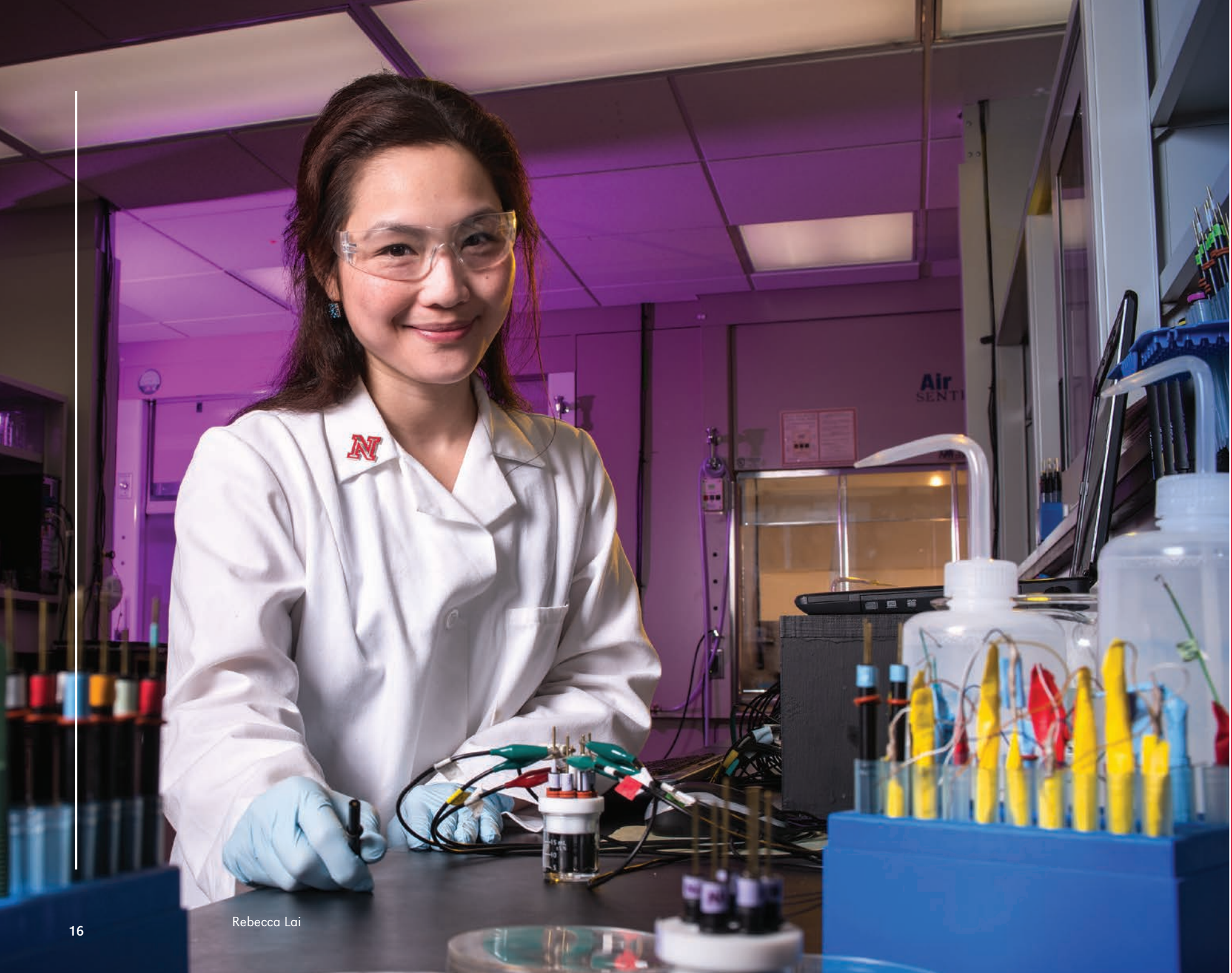
UNL is expanding its innovative defense-related research through the National Strategic Research Institute at the University of Nebraska, one of only 13 U.S. Department of Defense-sponsored University Affiliated Research Centers in the nation.

NSRI-funded projects like engineer Dennis Alexander's laser surfacing of metals have put UNL research on the radar of NSRI's sponsor, the U.S. Strategic Command.

USSTRATCOM executives learned about UNL research with potential defense applications and explored potential areas of collaboration during an April 2016 campus visit. Tours of the Extreme Light Laboratory, Holland Computing Center, Center for Brain, Biology and Behavior and the Nebraska Athletics Performance Laboratory and presentations by faculty from business, computer science, transportation, engineering, physics and food microbiology provided an overview of UNL's capabilities.

Three areas of potential UNL-USSTRATCOM collaboration grew from the visit: developing innovative leadership education and training programs through UNL's Don Clifton Strengths Institute to meet USSTRATCOM's workforce development needs; researching security against cyber threats with UNL computer scientists; and creating simulations with UNL engineers to detect and disrupt proliferation of nuclear weapons.

U.S. Army Maj. Gen. Allen W. Batschelet (left) and USSTRATCOM executives hear from NSRI research director and UNL associate vice chancellor for research Bill Charlton at a campus visit.



Rebecca Lai

Prospecting with Biosensors at Home or in the Field

Prospecting – whether for gold in a mountain or lead in a city's water supply – may one day be as quick and easy as a litmus test.

UNL chemist Rebecca Lai is developing a series of hand-held biosensors to detect a variety of metals, including gold, silver, lead, platinum and mercury. Instead of sending samples away for time-consuming tests, Lai's portable devices can be used in the field or home, saving much time and money.

The reusable sensors, fabricated on paper strips, can handle water, air and solid samples. This flexibility opens numerous opportunities, for mining companies foraging for gold or regulators hunting down water or air contaminants. Homeowners may one day be able to use the sensors to test their tap water or yards for heavy metals.

"Geochemical exploration for gold is becoming increasingly important to the mining industry," Lai said. "There is a need for developing sensitive, selective and cost-effective analytical methods capable of identifying and quantifying gold in complex environmental samples."

The metal sensors rely on a surprising source: DNA's building blocks. Researchers have long known that metal ions recognize and react to different DNA or other molecular building blocks. Lai's sensors exploit that reaction.

They work by measuring the electric current passing from an electrode to methylene blue, a tracer molecule, attached to a molecular probe specific to each metal type. The current changes in the presence of the metal being tested.

To help combat contaminants found in groundwater, Lai also plans to develop biosensors to detect arsenic, uranium and selenium. She uses a similar approach to devise biosensors for viral antibodies, antibiotics and nitrates.

Lai is working with NUtech Ventures, UNL's technology commercialization affiliate, to patent and license the biosensors. The National Science Foundation and the U.S. Environmental Protection Agency support her research.

Paper-based sensor strips detect target substances, including mercury, gold, lead and uranium.

Gift Creates Johnny Carson Emerging Media Arts Center

Interdisciplinary learning, creativity and research in the vanguard of digital virtual production and design is the vision for UNL's Johnny Carson Center for Emerging Media Arts.

A $20 million gift from the Johnny Carson Foundation, the charity of late entertainment icon and Nebraska alumnus Johnny Carson, will fund the center's academic programs and facility.

The Carson Center will offer a unique interdisciplinary program in a new field of study: film and emerging media focused on virtual production and design. Virtual production is at the cutting edge of film, television, theater, game design and visual storytelling in other fields. Graduates will work in diverse professions, from advertising, the arts and business to agriculture, social media and science.

Hiring a director and staff, designing a facility and developing new courses are in the works. The program expects to accept its first students in 2018 and open a building in 2019.

"Johnny Carson was an innovator of television, which was certainly the emerging media of his era," said Allan Alexander, Carson Foundation president. "Because of this and his legacy at Nebraska, we are especially pleased to support the education of future generations who wish to follow in his footsteps as media innovators."

A Nebraska native, Carson graduated from Nebraska in 1949 with a major in journalism and a minor in physics. Through 30 years of success on "The Tonight Show Starring Johnny Carson," he never forgot his Nebraska roots. Previous Carson Foundation gifts supported scholarships, the performing arts and the Johnny Carson School of Theatre and Film.

Johnny Carson

The Carson Center will occupy a 31,000-square-foot facility near the Carson School. Designed for hands-on learning in virtual production, it will include design and editing labs, studios, a sound stage, classrooms and virtual reality technologies.

The center will engage campus partners, other universities and the private and public sectors through an emerging media arts symposium, master classes, internships and more.

"This gift ensures the university is able to prepare many future generations of students for careers in the ever-changing arena of media arts," then-Chancellor Harvey Perlman said when announcing the gift in late 2015.

Then-Chancellor Harvey Perlman (right) conducts a Carson-style interview with University of Nebraska Foundation President Brian Hastings (center) and NU President Hank Bounds during the gift announcement.

System Helps Diagnose, Treat Brain Damage

Even slight movements of the face, mouth and fingers can yield insights into the brain that controls them. The ability to precisely measure the muscle forces driving those movements could improve diagnosis and treatment of nervous system maladies ranging from stroke and traumatic brain injuries to Parkinson's disease and autism.

Steven Barlow, associate director of UNL's Center for Brain, Biology and Behavior and the Corwin Moore Professor of Special Education and Communication Disorders, teamed with students in the Jeffrey S. Raikes School of Computer Science and Management to refine a novel system that does just that.

Known as ForceWIN10, the technology features custom software and pressure sensors that collectively cost only a few hundred dollars. In a matter of minutes, the system wirelessly measures and records how much force is generated – and how well that force is controlled – by muscle groups essential to the fine motor control required for daily tasks such as eating, speaking and typing.

"To be able to accurately sample force in this way, diagnostically, is a window into the intact brain and also the damaged brain," Barlow said. "It gives clinicians, really for the first time, a set of objective measurements that they can use not only for diagnostics but ... as a therapeutic feedback device."

Steven Barlow shows a prototype to Jake Greenwood, lab research assistant.

Barlow is refining the technology through a partnership with Lincoln's Madonna Rehabilitation Hospital, which is testing a prototype of the system. Raikes School students in mechanical and materials engineering, electrical and computer engineering, and computer science have helped construct multiple prototypes and program updates to the system's software.

Barlow began collaborating with the Raikes School at the recommendation of NUtech Ventures, UNL's technology commercialization affiliate, which is helping Barlow patent the system.

Prototype of ForceWIN10 system

"NUtech Ventures really is a catalyst for innovation, and we are very fortunate to have the opportunity to participate in this kind of technology transfer project," said Ian Cottingham, director of the Raikes School Design Studio. "This is what innovation is all about: partnerships, teamwork and making a product that makes a difference."

Momentum Builds on Nebraska Innovation Campus

New partnerships, a burgeoning entrepreneurial vibe and expansion of world-class facilities have moved Nebraska Innovation Campus into the spotlight in Nebraska and beyond.

The private-public research campus adjacent to UNL celebrated its grand opening in fall 2015 and steady growth continues. Phase I construction is nearly finished, more buildings are in the works, more than 20 companies and organizations call NIC home and talks are ongoing with additional partners.

The biotechnology, food and health industries are especially well-positioned for growth at NIC, said Executive Director Dan Duncan.

The Biotech Connector, a 10,000-square-foot research space slated to open in December, is a major addition to NIC's state-of-the-art facilities. The connector positions NIC to attract biotech companies from Nebraska and across the U.S.

"The connector addresses a vital, unmet need for wet laboratory space that small- and medium-sized companies will be able to rent instead of building their own, which can be cost prohibitive," Duncan said. A $750,000 grant from the U.S. Economic Development Administration supports the project, a partnership between NIC, UNL, Nebraska Department of Economic Development, Invest Nebraska and Bio Nebraska.

In 2016, NIC also became headquarters for organizations working to enhance human health and well-being. The Children's Center for the Child and Community joined in June. Created by Omaha's Children's Hospital and Medical Center, the group coordinates public health efforts to address childhood obesity, poverty, injury prevention and food insecurity statewide. Enhance Health Network, a coalition of nine Nebraska health care systems, located its corporate offices at NIC in January. The network partners with the University of Nebraska's Rural Futures Institute to study rural health issues.

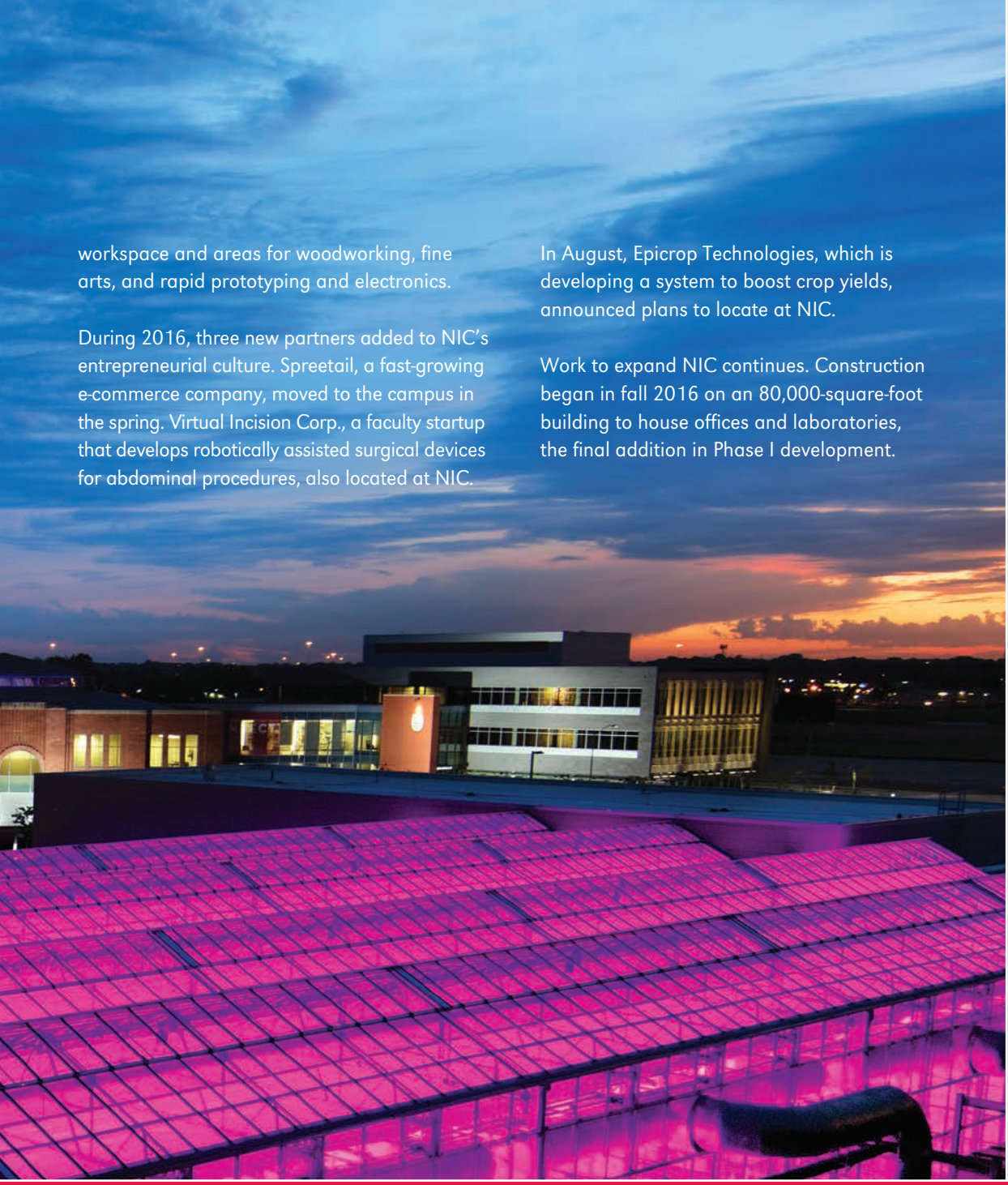
NIC's creative energy got a boost in fall 2015 with the opening of Nebraska Innovation Studio, a 16,000-square-foot maker space for faculty, students, staff and the community. It features collaborative

workspace and areas for woodworking, fine arts, and rapid prototyping and electronics.

During 2016, three new partners added to NIC's entrepreneurial culture. Spreetail, a fast-growing e-commerce company, moved to the campus in the spring. Virtual Incision Corp., a faculty startup that develops robotically assisted surgical devices for abdominal procedures, also located at NIC.

In August, Epicrop Technologies, which is developing a system to boost crop yields, announced plans to locate at NIC.

Work to expand NIC continues. Construction began in fall 2016 on an 80,000-square-foot building to house offices and laboratories, the final addition in Phase I development.



UNL Hosts University, Industry Leaders

Nearly 200 industry, government and university leaders from across the U.S. traded ideas about partnerships and economic development strategies at the University Industry Demonstration Partnership general meeting and conference.

UNL hosted UIDP22 at Nebraska Innovation Campus in April 2016. UIDP is a national organization that brings together global companies and top research universities to identify issues impacting university-industry relations and develop new approaches for working together.

Leaders from research-intensive global companies, including Bayer, Boeing, ConAgra, Cisco, Facebook, Google, John Deere, Intel and Northrop Grumman, participated alongside Nebraska-based companies Lindsay Corp., Streck and Valmont. Speakers included Nebraska Gov. Pete Ricketts, who cited NIC as a prime example of collaboration between a university, government and industry.

"This was a great opportunity to introduce potential industry partners to all that UNL and Nebraska have to offer," said Ryan Anderson, director of UNL Industry Relations.

Bioinformatics Focus for NIC's First Faculty Startup

Combining biotechnology and computational data to ensure food safety and quality is the aim of Metagenome Analytics, the first UNL faculty startup at Nebraska Innovation Campus.

MGA, a bioinformatics company led by UNL food scientist Andrew Benson, targets a growing industry need. Next-generation DNA sequencing technology has vast potential to help companies and regulatory agencies track microorganisms in food and pharmaceutical products. However, that sequencing generates massive and unorganized data, like confetti shooting out of a cannon.

The ability to organize bioinformatics data is key to using it to enhance food safety and security, from detecting foodborne illnesses to improving the quality of food supplements. There's a huge need for companies that can manage, analyze and interpret data for the food industry and for public health purposes, said Benson, the W.W. Marshall Distinguished Professor of Biotechnology.

MGA combines expertise in gut microbiome research and genomic biology of microorganisms with knowledge in cloud-based computing, databases and algorithms. Benson's collaborators include Khalid Sayood, electrical and computer engineering professor; Rohita Sinha, research assistant professor; Ufuk Nalbantoglu of Erciyes University in Turkey; and UNL alumnus The "Ty" Nguyen of Professional Computer Solutions.

Food companies hire MGA to manage, process and analyze data from next-generation DNA sequencing. Clients use the information to improve product quality, prevent foodborne illness or identify spoilage.

Recently, MGA partnered with international food safety company Neogen to develop NeoSeek Salmonella, a tool for detecting and identifying the source of salmonella strains.

Another potential niche for MGA is analyzing the metabolic makeup of food supplements and probiotics, to help companies ensure their products contain the ideal mix of microorganisms for health benefits.

MGA partnered with NIC in fall 2015, advancing NIC's goal of creating an entrepreneurial climate for UNL researchers pursuing commercialization opportunities. For MGA, joining NIC has brought visibility to the growing company and close ties to UNL's Department of Food Science and Technology.

"We view the environment being created at NIC as a tremendous opportunity for MGA to help drive the science that will radically change how we think about the security and safety of our food supply," Benson said.

Andrew Benson

Improving Surgery Through Robotics

Revolutionizing abdominal surgery through robotics is the aim of Virtual Incision Corp., a faculty-led company that joined Nebraska Innovation Campus in early 2016.

Colorectal and lower gastrointestinal procedures are among the fastest-growing surgeries in the U.S. Virtual Incision is developing an advanced miniaturized robot that shows promise for colon resection, a procedure used to treat diverticulitis, large colon polyps, precancerous and cancerous lesions of the colon and inflammatory bowel disease. The goal is to make procedures less invasive, improving patients' recovery and shortening hospital stays.

Virtual Incision was founded in 2006 as a partnership between UNL's Shane Farritor, Lederer Professor of Engineering, and the University of Nebraska Medical Center's Dmitry Oleynikov, professor of surgery. In 2012, chief executive officer John Murphy joined the team. Locating at NIC gives the company room to grow and attract talented experts in engineering, robotics and medicine from across the country.

Robotics Business Review named the company's minimally invasive robotic device "a game changer." A large percentage of colon resections are performed through open surgery, requiring an 8- to 12-inch abdominal incision. Existing robotic surgical tools have limitations for complex procedures, including colon resectioning.

Shane Farritor

Virtual Incision's robotic device is inserted into the abdomen through an umbilical incision, with a surgeon controlling the robot. A monitor and control device gives surgeons a wide view of the surgical site and allows precise movements of surgical instruments. The robotic device is designed to be compatible with surgeons' existing tools and techniques and can be used in a standard operating room. This approach could be much less expensive than robotic alternatives.

The first human surgery with these robots was successfully performed outside the U.S. in January 2016. Verifying the technology's safety and feasibility is a key step toward obtaining Food and Drug Administration approval for commercialization.

"To the best of our knowledge, this is the first time an active miniaturized robot has performed complex surgical tasks with the robot inside a living human, which is a significant milestone in robotics and in surgery," said Farritor, the company's chief technology officer.

CD Celebrates Collaboration with Philip Glass

It began with a job interview, a chance encounter and a fan's boldness.

Twenty years later, the musical collaboration between UNL pianist Paul Barnes and world-famous composer Philip Glass was celebrated with a new CD titled "New Generations," released in November 2015.

"The whole concept of 'New Generations' is that I wanted to really start supporting the work of younger composers," said Barnes, Marguerite Scribante Professor of Music. Glass backed the endeavor and contributed his own pieces.

Barnes learned of Glass' generosity years earlier. Flying home to Chicago after interviewing at UNL, he noticed the musical giant on the flight and introduced himself.

Barnes not only got the job at UNL, but the encounter led to a long friendship and collaborations that have enriched his career and UNL's music program.

"New Generations" is a two-disc CD featuring several newly published Glass piano études and "Dreaming Awake" (2003), as well as works by six younger composers selected from a national composers' festival. The CD, recorded at UNL's Kimball Recital Hall, was published by Glass' Orange Mountain Music. The Hixson-Lied Endowment and Glenn Korff School of Music helped fund the project.

Paul Barnes

Promoting the new work has sent Barnes performing across the U.S., Europe and Asia.

The new CD follows years of collaborative projects, including the 2004 "Piano Concerto No. 2: After Lewis and Clark." Barnes also has transcribed Glass' orchestral pieces for piano and performed them worldwide.

"My relationship with Glass has opened up just tremendous publishing, recording and performing avenues that I would not have otherwise," Barnes said, adding that it also benefits his teaching. "When [students] realize there are young composers writing music that is so exciting and fun to play, it gets them involved in that creative aspect."

The duo is working on a new collaboration. It's another opportune convergence, this one involving an archeological site in Nazareth, a generous Floridian and a Greek Orthodox chant – but that's a story for another day.

Strengthening Region's Nanotech Assets

University and industry scientists across the region are tapping a new resource at UNL designed to strengthen the nation's nanoscience research.

UNL became home to the Nebraska Nanoscale Facility, a center of excellence in nanoscience and nanotechnology, in fall 2015. A nearly $3.5 million grant from the National Science Foundation funds the center, one of only 16 nationwide that constitute the National Nanotechnology Coordinated Infrastructure.

"There is a need for regional facilities," said center director David Sellmyer, George Holmes University Professor of Physics. "Most universities do not have the resources to buy and operate these very expensive pieces of machinery."

The center builds on UNL's highly regarded reputation in materials and nanoscience research. While state-of-the-art facilities have helped UNL researchers make significant contributions to nanotechnology advancements, the university previously had limited capacity to serve researchers and industries beyond UNL, he said.

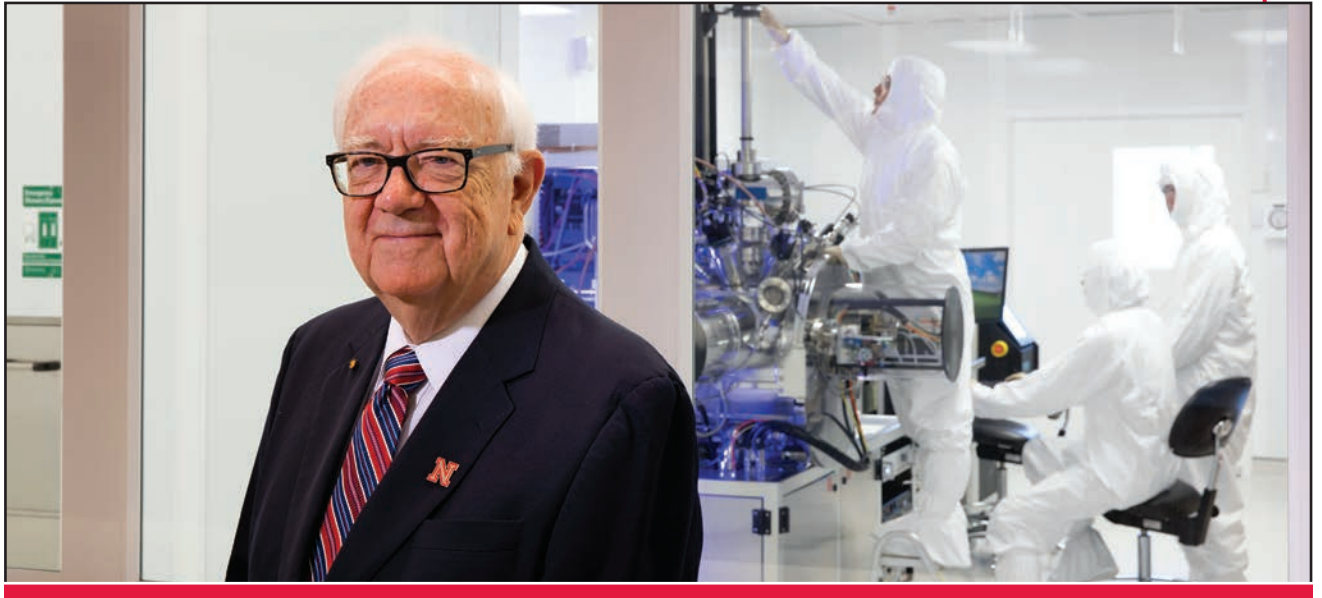
The new center uses shared laboratory facilities and specialized equipment, principally housed in UNL's Voelte-Keegan Nanoscience Research Center, which opened in 2012.

Through the center, UNL makes instrumentation and technical support available to researchers from neighboring universities, companies and others. It has added personnel, purchased new equipment and is offering workshops and mini-courses to introduce visiting scientists to available resources.

Bolstering nanoscience and nanotechnology strengthens regional and national research collaborations and contributes to economic development throughout the U.S., Sellmyer said.

"We are well set up to do a lot of things now," he said. "With a larger scientific staff, we're able to do a better job at helping companies in Nebraska and neighboring states with their technical problems."

The facility reinforces the university's materials and nanoscience programs and centers, including the Nebraska Center for Materials and Nanoscience; the NSF-funded Materials Research Science and Engineering Center; the Center for NanoFerroic Devices, funded by the Semiconductor Research Corp. and the National Institute of Standards and Technology; the National Strategic Research Institute, which partners with USSTRATCOM; and others.



David Sellmyer

Geospatial Technology Helps Restore Wetlands

Millions of migratory birds rest and feed annually in south central Nebraska's Rainwater Basin, a vital habitat in the heart of the Central Flyway. Yet three-quarters of this nationally significant wetland complex no longer functions properly.

UNL's Zhenghong Tang, associate professor in community and regional planning, is helping wetland managers evaluate and restore this critical habitat. An expert in environmental planning and geospatial data science, Tang's research will contribute to wetland conservation efforts globally.

In addition to supporting more than 250 bird species, the basin controls flooding, filters runoff and replenishes aquifers. But human activity has diminished the once-vast ecosystem. Accumulating sediment has altered the wetlands' hydrology and ability to support wildlife.

Working with federal, state and local managers, Tang uses several new techniques to evaluate sedimentation and help direct restoration projects. His team recently used ground-penetrating radar to generate sediment maps of the basin. Radar provides faster, more accurate information than traditional soil drilling.

Zhenghong Tang

The maps also showed that restoration efforts do make a difference.

"Sedimentation is a big challenge for the wetlands, and agricultural activities could accelerate the soil erosion," Tang said. "But we found that the wetland areas using conservation practices, such as vegetation buffer zones, reduce sedimentation."

Droughts also can affect the wetlands. Tang's team studied the impact of 30 years of climate change on the basin and will use the information to identify the most vulnerable wetlands.

The migratory spectacle draws millions of tourist dollars to the region. To help educate and engage the public, researchers developed a mobile app that visitors can use to obtain detailed wetland information and report observations to officials.

"It's wonderful to fill the technology gap for federal and state wetland managers by providing more accurate wetland geospatial databases," Tang said. "It's also great knowing my work is helping further sustainable land practices and preserving the environmental quality of these wetlands for future generations."

The U.S. Environmental Protection Agency and U.S. Department of the Interior fund Tang's research.

Above: Mark Pogue

Maximizing Innate Talent

Identifying and maximizing individual strengths in emerging leaders, entrepreneurs and top achievers is at the heart of UNL's new Don Clifton Strengths Institute.

Building on the work of former UNL professor Donald O. Clifton, the institute is a long-term partnership with the Clifton Foundation and Gallup, which together donated $30 million to establish the institute in 2015. The gift includes developing the world's largest Strengths Lab to be housed in the new $84 million, 240,000-square-foot College of Business Administration building opening in 2017.

"Our focus is really about job creation and helping our students leverage their strengths in the workplace," said Mark Pogue, institute director and management professor of practice. "There's a lot of entrepreneurial energy being generated in this state. We're creating great graduates who are self-aware and contributing right out of the gate."

The institute enhances student learning through courses and coaching based on strengths-based leadership and assists undergraduate degree programs in management and entrepreneurship. All incoming CBA freshmen take a strengths-based course with individualized coaching.

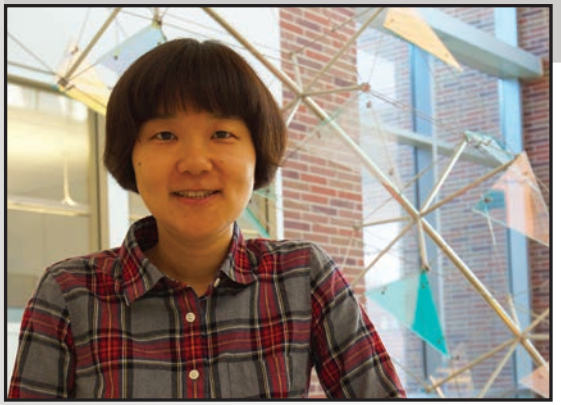
The institute supports broader UNL research on a range of topics and provides faculty and students access to Gallup World Poll and U.S. Nightly tracking data. Organizers also envision the institute offering strength and leadership workshops and learning opportunities to businesses and organizations.

The research and educational programs are based on the Clifton StrengthsFinder®, an online assessment tool Clifton developed to help people understand and maximize their innate talents. He spent 20 years at UNL researching strengths and human development. He was chairman of Selection Research Inc. and later Gallup. The Clifton StrengthsFinder® is used in most major corporations and organizations worldwide.

"This institute positions Nebraska as the worldwide leader in education, research and outreach focused on identifying and maximizing talent. Our business community, our state and our nation will benefit along with our students and faculty," said Donde Plowman, James Jr. and Susan Stuart Dean of CBA.

Early Career Awards Boost Promising Research

From smarter computers, robots and power grids to genetic advances and greener chemistry, UNL researchers are solving diverse problems with early career awards from the National Science Foundation and U.S. Department of Energy. These prestigious five-year awards support research by promising pre-tenure faculty. Eight UNL assistant professors won these awards in 2015-2016.

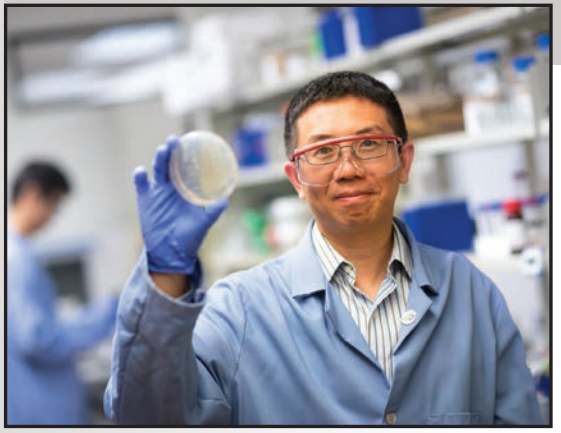


Gaining Control at the Nanoscale

Controlling certain materials' polarization and other properties at the nanoscale could make electronics smaller, faster and less expensive. Physicist Xia Hong received a $750,000 DOE Early Career Award to upgrade equipment and hire researchers essential to that pursuit.

Hong studies extremely thin ferroelectric films, meaning their polarization – the alignment of their positive and negative charges – can be reversed when exposed to an electric field. Combining ferroelectric films with other 2-D materials could produce reconfigurable electronic states that help her team observe new quantum phenomena and expand the versatility of technologies ranging from solar cells to transistors.

Hong said her approach also could help overcome uncertainty inherent in manufacturing and testing nanoscale technology.



Expanding the Genetic Code

Chemist Jiantao Guo envisions expanding the genetic code to create innumerable possibilities for research and commerce, from developing pharmaceuticals to improving crop yields. He earned a $622,000 NSF CAREER award to continue working on a promising new method for incorporating new amino acids into proteins.

Organisms build proteins by linking amino acids, the order specified by the sequence arrangement of nucleotides, DNA's basic structural unit. Three-nucleotide sequences, called codons, identify a single amino acid. Increasing from three-nucleotide to four-nucleotide codons would significantly expand the repertoire of potential amino acids.

Previously, Guo created a tRNA, a molecule critical to linking amino acids together, that is capable of reading quadruplet codons. His discovery expands the potential to encode more artificial amino acids into living cells. With this award, Guo continues investigating quadruplet codon-reading tRNAs.

Spintronics for Ultralow-power Devices

Physicist Alexey Kovalev studies the fundamental properties of magnetic systems at the nanoscale with a $750,000 DOE Early Career Award.

Kovalev's theoretical research focuses on spintronics, which controls electron spin in addition to charge, to generate power and store digital information. His research could lead to developing ultralow-power memory devices for computers and other electronic devices.

Today's hard drives manipulate electron charge and magnetic spin to store information. Kovalev is investigating the strong spin-orbit interactions and interplay between spin and energy flows in magnetic systems. His work also could improve harvesting energy available in temperature gradients (or differences) to power electronic devices.

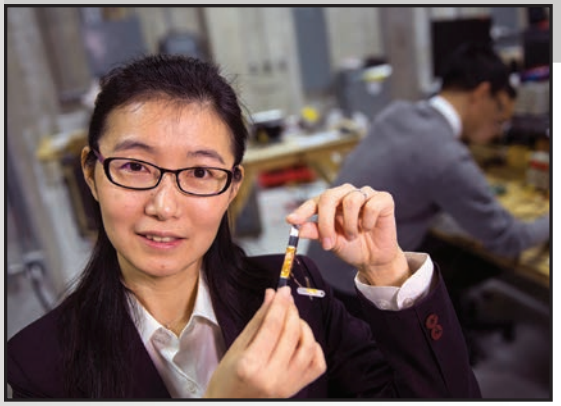
Stretching Possibilities for Hybrid Materials

Combining soft, organic materials with hard, inorganic ones could add important functionality to robotics and other emerging technologies. With a $650,000 NSF CAREER award, chemist Stephen Morin is crafting hybrid materials that could provide diverse properties for many applications.

Morin is exploring how best to deposit rigid films atop the surfaces of elastic polymers. One challenge lies in the different thermal and mechanical properties of the two materials; another is melding a brittle material with something as elastic as a rubber band.

Morin is especially interested in how stretching a polymer affects the harder material's formation and structure. He's already built adaptable patterns of microscopic crystals on rubber films and created elastic materials that become highly reflective when stretched.

Early Career Awards Boost Promising Research



Enabling Next-generation Power Grid

As solar panels and wind turbines proliferate, integrating these new energy sources into the nation's power grid brings increasing challenges. With a $500,000 NSF CAREER award, electrical and computing engineer Liyan Qu is developing a next-generation power grid transformer to enable renewable energy use.

Electricity generated from renewable sources isn't constant and requires a more advanced transformer to control the variable voltage. Qu's device is made of a new composite material that will continuously control transformer voltage output, making transformers more flexible, improving renewable energy integration and helping to minimize energy losses.

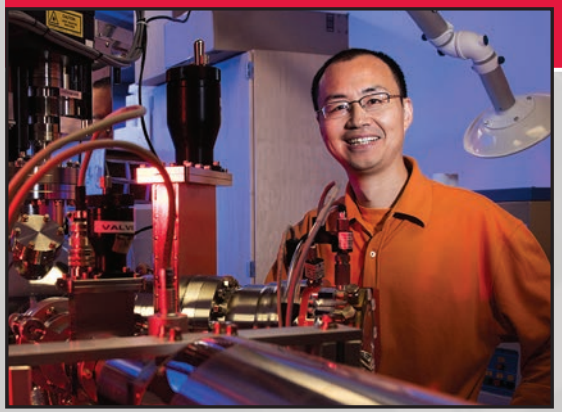
The magnetoelectric device also could improve other applications that use transformer technology, such as electric appliances, devices and motors. Qu is working with NUtech Ventures, UNL's technology commercialization affiliate, to commercialize her technologies.

Enhancing University STEM Teaching

How college students best learn science is well studied, but how faculty teach gets less attention. Instructors who adopt cutting-edge teaching methods improve student learning in science, technology, engineering and mathematics, or STEM, fields.

With a $940,000 NSF CAREER award, chemist and STEM educator Marilyne Stains is researching university STEM teaching. Her study includes understanding what faculty know about new educational strategies, their beliefs about teaching and other factors that influence teaching choices, such as departmental educational norms and instructors' career levels. She'll follow faculty over time to determine how practices adapt to changing influences.

She'll use her findings to inform STEM faculty education nationally and to improve UNL programs that train faculty to better teach science. She'll also help develop a teaching specialization program for UNL chemistry graduate students.

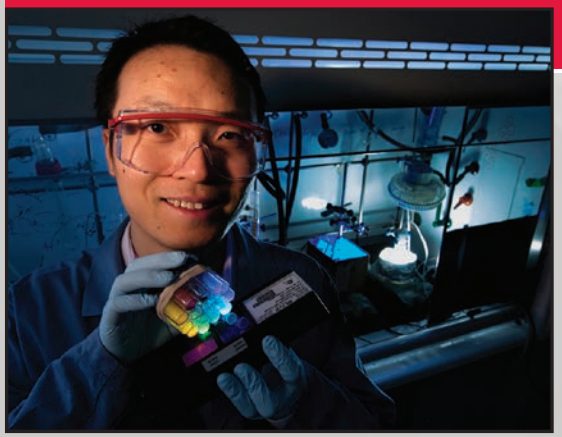


Harnessing a Nanomaterial's Novel Properties

To make electronics smaller, faster and more energy efficient, physicist Xiaoshan Xu earned a $590,000 NSF CAREER award. He's investigating hexagonal ferrite, a nanomaterial with the rare quality of having both magnetic and electric polarizations.

Harnessing that unique property could help shift electronics away from requiring an electric current, which uses energy and produces heat, limiting the efficiency and size of devices.

Previously, Xu helped discover the nanomaterial's multiferroic properties. Now, he's studying the fundamental mechanism underlying the coexistence of electric and magnetic properties and how to couple them for use in devices. The material's multiferroic capability functions at a nippy minus 220 degrees Fahrenheit, so Xu also is investigating ways to raise its functional range to above room temperature.



Green Chemistry Catalyst

Producing clean energy fuels and other "green" chemicals using solar energy isn't as sustainable as it could be. Solar-powered chemical reactions often require a catalyst made with rare and expensive metals.

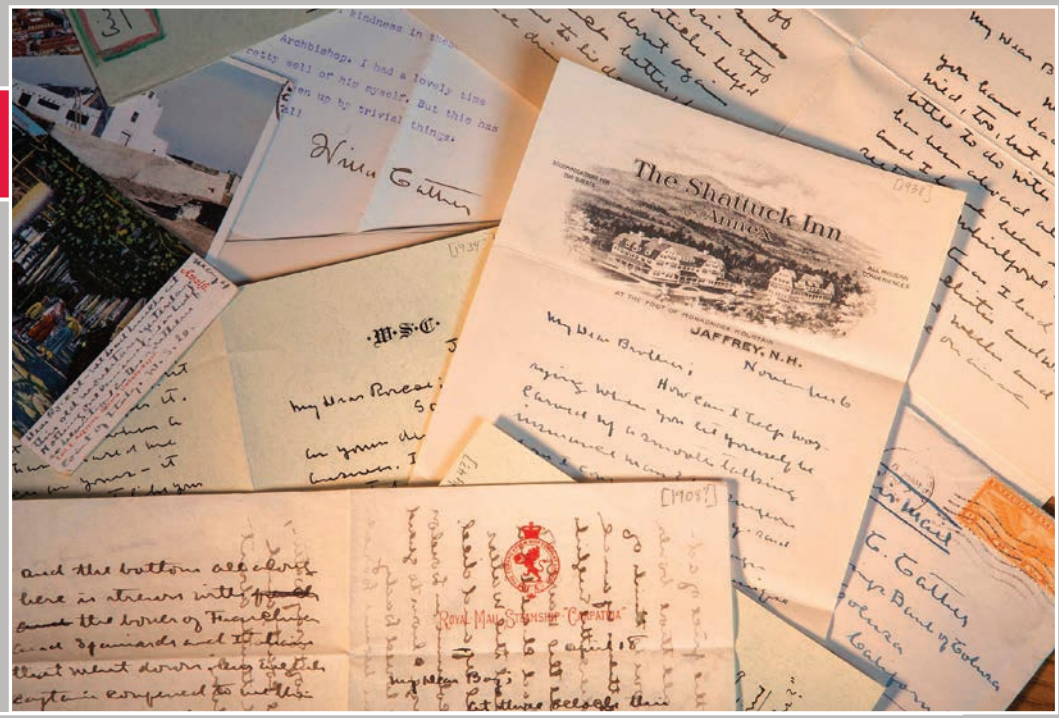
Chemist Jian Zhang developed a solar-powered, organic-based catalyst to facilitate chemical reactions. With a $527,000 NSF CAREER award, he is further investigating and improving its properties for industrial uses. The material, a type of porous organic framework, acts like a semiconductor, encouraging electrons to move when hit with solar energy.

Industry could use the organic catalyst to develop more environmentally friendly products, including cleaner hydrocarbon-based fuels. Zhang also is investigating using the catalyst to break down lignin, an abundant plant-based carbon source, for use in creating industrial products, such as pharmaceuticals and biofuels.

Research Highlights

Major Gift for Cather Initiatives

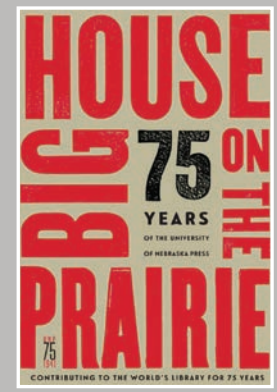
A $5.8 million gift from the nephew of renowned author Willa Cather will support and enhance UNL's many Cather initiatives. Charles E. Cather's estate gift to the University of Nebraska Foundation enables UNL to pursue diverse programs of interest to Cather scholars and the broader community. UNL Libraries, the Willa Cather Archive, the English department and the Cather Project share the funds to support Cather special collections, public programs, students and the *Willa Cather Scholarly Edition* publication. UNL has a long tradition of scholarship and teaching focused on the life and work of Cather, a Nebraska alumna. The Cather Project, founded in 2002, supports research and teaching on the Pulitzer Prize-winning author. The Willa Cather Archive in UNL's Center for Digital Research in the Humanities provides a rich and accessible digital site for studying Cather's life and writings.



Ankerson Named Architecture Dean

Katherine Ankerson is the new dean of UNL's College of Architecture. She joined UNL July 1 from Kansas State University where she headed the Department of Interior Architecture and Product Design University. Ankerson was associate dean in the UNL architecture college from 1996 to 2011. She is an award-winning author and, as lead of the 20th Anniversary Nuckolls Lighting Grant, helped initiate and produce the award-winning web-based resource, Lighting Across the [Design] Curriculum. She has held academic positions at Radford and Washington State Universities after spending many years as a practicing architect and designer. She earned master's and bachelor's of architecture degrees and a bachelor of science in architecture from WSU.

University of Nebraska Press Celebrates 75 Years



In honor of its 75th anniversary in 2016, the University of Nebraska Press published *Big House on the Prairie,* which features Press highlights, profiles of key historical employees and lists of its 75 most significant books, 30 journals and 75 most noteworthy book covers. Rooted in the Great Plains, the Press is the largest and most diversified university press between Chicago and California. It publishes 170 new and reprint titles annually under the Nebraska, Bison Books and Potomac Books imprints, and in partnership with the Jewish Publication Society. Started as a one-person operation in 1941 at Nebraska's land grant university, the Press has grown into an internationally recognized publishing house. With more than 4,000 books in print, it's best known for producing notable works in Native studies, history, sports, anthropology and geography, American studies, cultural criticism and creative works.

Space Law Offerings Expand

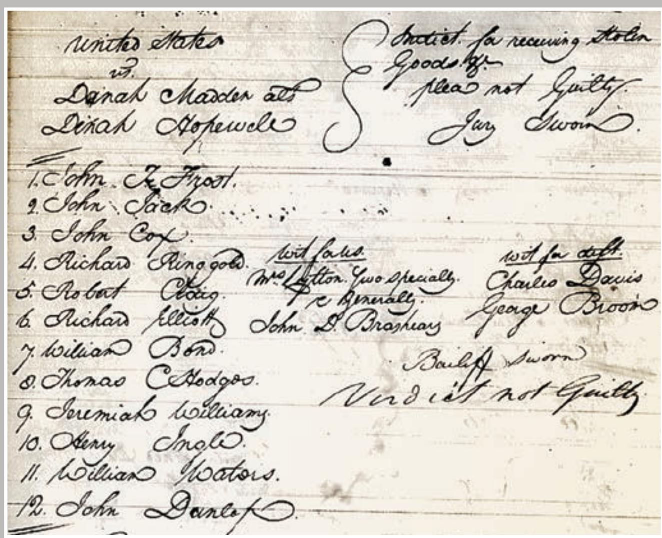
The Nebraska College of Law recently expanded offerings in space, cyber and telecommunications law to give busy, practicing attorneys a fast track to the specialized information they need. The three new executive certificate programs build on the program's Master of Laws and Doctor of the Science of Law degrees. The two-year certificate programs are designed for practicing attorneys interested in expanding their expertise in one of three certificate tracks: space law, cyber and cyber security law or cyber and telecommunications law. Nebraska offers the only doctoral-level space law program in the U.S. The master's program was the first of its kind in the U.S. and the only one worldwide taught in English.

Digital Distraction Increasing in Class

College students spend more class time than ever playing with smartphones and other digital devices, according to a UNL study. In a survey of 675 students in 26 states, students estimated that, on average, they spent 20 percent of classroom time using digital devices for activities unrelated to class. They were mostly text messaging, but also emailing, web browsing, checking social media and even playing games. Barney McCoy, associate professor of broadcasting and journalism, reported his results in the *Journal of Media Education.* He said the findings indicate faculty and students must change their practices to adapt to the now-ubiquitous devices.

Minority Adolescents Expect to Die Young

Minority youth in the U.S. are more likely to doubt they'll live to be 35 than their white counterparts, UNL sociologist Tara Warner and colleagues found. Adolescents who anticipate short lives are more likely to engage in violence, substance abuse and risky sex. They also don't plan for the future, an important step toward improving lives. While two-thirds of white youth were "almost certain" to survive to age 35, only 38 percent of foreign-born Mexican youths and half of young African-Americans expressed similar confidence. Stressors, such as discrimination, deportation fears and police harassment, may play a role, Warner said. U.S.-born Cubans were the only minority group whose survival expectations matched white youth. The research is based on data collected during Add Health, a nationwide longitudinal study from 1995 to 2009. The study appeared in the *Journal of Health and Social Behavior.*



United States
vs.
Dinah Marden als
Dinah Hopewell

Indict. for receiving stolen Goods &c.
plea not Guilty
Jury Sworn.

1. John T. Frost.
2. John Jack
3. John Cox.
4. Richard Ringgold.
5. Robert Clagg.
6. Richard Elliott
7. William Bond.
8. Thomas C. Hodges.
9. Jeremiah Williams
10. Henry Ingle.
11. William Waters.
12. John Dunlop

wit for U.S.
Mrs. Litton sworn specially
generally.
John D. Brashear

wit for deft.
Charles Davis
George Broom

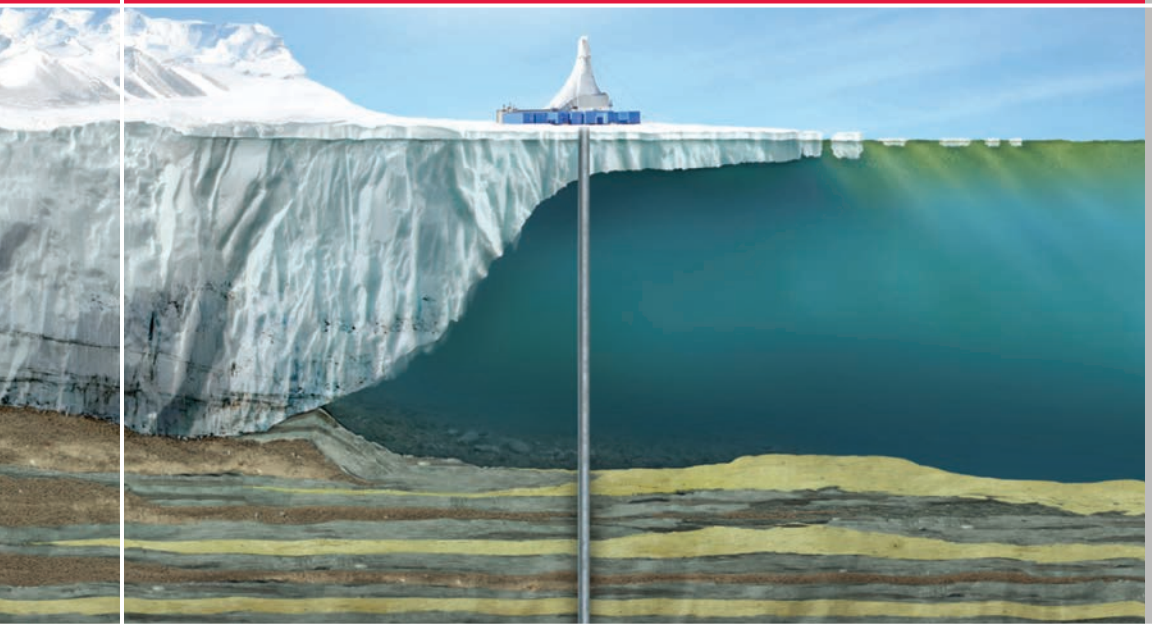
Bailiff sworn

Verdict not Guilty

New Web Tools for Studying Slavery

American slaves seeking their freedom left a trove of documents that reveal insights about slavery and 19th century American society. UNL digital humanists, led by historian William G. Thomas, digitized all of the roughly 500 petitions for freedom filed in the District of Columbia Circuit Court between 1800 and 1862. The information, available online, allows users to easily visualize and study the connections between slaves and slaveholders, and their legal and business ties. The website aids those studying and teaching slave history and people seeking information about their family's part in slavery. The project, funded by the National Endowment for the Humanities, is a feature of UNL's Center for Digital Research in the Humanities website "O Say Can You See: Early Washington, D.C., Law and Family," at http://earlywashingtondc.org. The University of Maryland partnered on the project.

Research Highlights

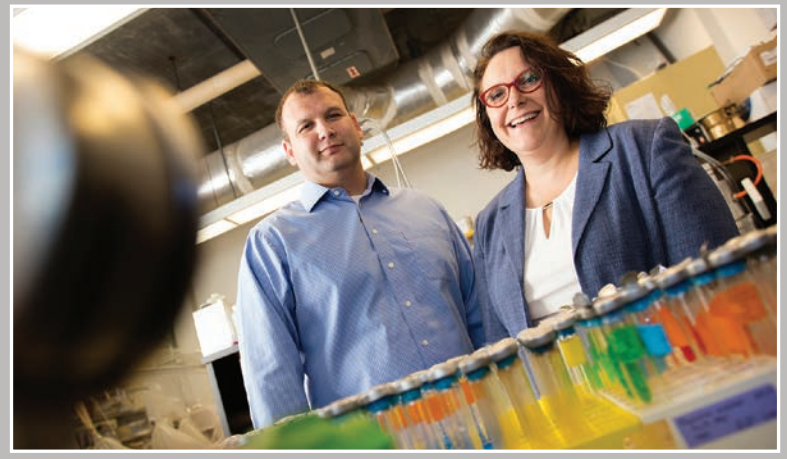


CO2 and Rising Sea Levels

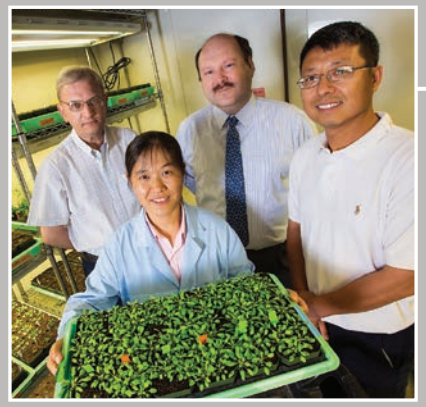
Sea levels will rise substantially following even modest increases of atmospheric carbon dioxide, according to findings from the international Antarctic Geological Drilling, or ANDRILL, program. In studies reported in the *Proceedings of the National Academy of Sciences,* scientists demonstrated that past carbon dioxide levels similar to those projected in the near future have caused the Antarctic Ice Sheet to shrink, said co-author David Harwood, UNL's E.E. and T.M. Stout Professor of Stratigraphy. One study reconstructed changing conditions from 14 million- to 20 million-year-old rock samples extracted from beneath Antarctica's McMurdo Sound. When the greenhouse gas reached 500 parts per million, the sea warmed and ice retreated. In a companion study, a new computer model projects sea levels will rise about 100 feet when carbon dioxide reaches 500 ppm from its present 400 ppm. UNL is home to ANDRILL's science management office. The National Science Foundation funded this research.

Tracking Uranium Contamination in Groundwater

Runoff is causing widespread uranium contamination of two major U.S. aquifers, a UNL study found. California's Central Valley and the High Plains aquifers irrigate a significant portion of U.S. cropland and supply drinking water to nearly 2 million people. Microgeobiologist Karrie Weber and colleagues tested 275,000 groundwater samples from the aquifers for naturally occurring uranium as well as nitrates, which originate primarily from fertilizers and animal waste. They found pervasive contamination, with concentrations of both contaminates often far exceeding federal guidelines. Nearly 80 percent of the uranium-contaminated sites were linked to nitrates. Through a series of bacterial and chemical reactions, nitrates make natural uranium soluble in groundwater. Uranium isn't often monitored, and more research is needed to better address contamination, Weber said. The research, funded in part by the U.S. Geological Survey, was published in *Environmental Science and Technology Letters.*



Jason Nolan and Karrie Weber



From left, Heriberto Cerutti, Zhen Wang, Jean-Jack Riethoven and Chi Zhang

Finding Genetic Clues to Drought Resistance

UNL biologists have uncovered clues about the collective role two genes play in protecting plants against drought. Their discoveries are an important step toward developing crops better able to defend against challenging environmental conditions. Heriberto Cerutti and colleagues studied the results of breeding a mutant variety of model plant species *Arabidopsis thaliana* that effectively deactivated both genes. The mutations stunted plant growth and increased susceptibility to drought. The team discovered that the double-mutant plants lack two kinases, catalysts required to facilitate histone phosphorylation. Research suggests that adding phosphate molecules to histone proteins helps optimize plant responses to environmental cues. They reported their findings in the *Proceedings of the National Academy of Sciences.* The National Science Foundation funded the research.

Solving Nitrous Acid Puzzle

UNL chemists have solved the long-standing puzzle of how nitrous acid forms in Earth's lower atmosphere, where it contributes to both cleansing and polluting. Scientists first detected nitrous acid in the 1970s, but how it forms in the ionosphere remained unclear. Through quantum mechanics-based simulations, the UNL team identified how the atmosphere's charged atoms and electrons combine to form nitrous acid 40 to 55 miles above the Earth. This discovery contributes to better understanding of how to manage human activities that harm health and the environment, said study co-author Joe Francisco, Elmer H. and Ruby M. Cordes Chair in Chemistry and dean of the College of Arts and Sciences. Xiao Cheng Zeng, Ameritas University Professor of Chemistry, and colleagues co-authored the study, which appeared in the *Proceedings of the National Academy of Sciences.*

From left, Chongqin Zhu, Xiao Cheng Zeng, Lei Li, Joe Francisco and Jie Zhong

McCornick Heads Water for Food Institute

Peter G. McCornick, an internationally known water and food researcher, became the new executive director of the Robert B. Daugherty Water for Food Global Institute at the University of Nebraska in August 2016. McCornick is former deputy director general for research at the International Water Management Institute in Colombo, Sri Lanka. He has dedicated his career to improving sustainable water resource management and has led research and development programs on water, agriculture and the environment in Africa, Asia, the Middle East and the U.S. McCornick earned his doctorate in agricultural engineering from Colorado State University and has been a senior fellow at Duke University's Nicholas Institute for Environmental Policy Solutions. The Scotland native grew up on a livestock and dairy farm. He succeeded Roberto Lenton, the institute's founding executive director.

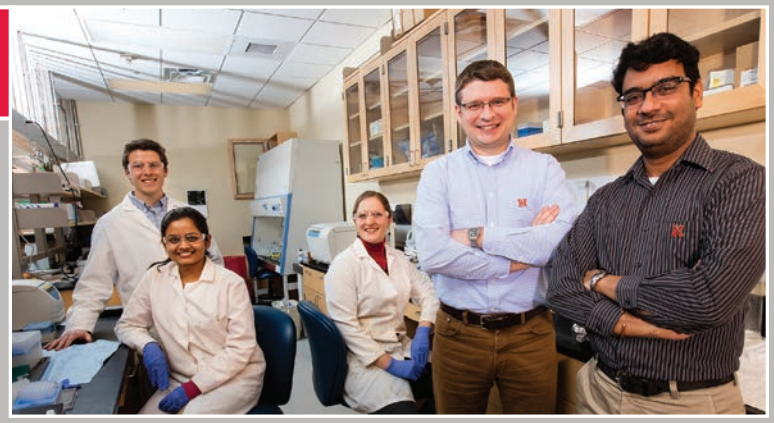
Fritz Co-leads Climate Change Group

UNL geoscientist Sherilyn Fritz is co-chairing the international Scientific Steering Committee for Past Global Changes, or PAGES. The organization includes scientists from 125 countries and sponsors research exploring climate shifts across millions of years to better predict future climate and environment. During her two-year term, Fritz will guide decisions on the diverse international PAGES-sponsored research. She'll also advance the organization's effort to engage more closely with policymakers, resource managers and business leaders. Sharing research results with those who can use them is increasingly important in promoting sustainable practices, she said. Formed in 1991 with support from the U.S. and Swiss National Science Foundations, PAGES features a co-chair from each country. Fritz, George Holmes University Professor of Earth and Atmospheric Sciences, studies North and South American lakes to better understand historic climate change.

Research Highlights

Common Nanoparticle May Harm Brain

Even moderate concentrations of a common nanoparticle used to whiten foods, milk and toothpaste could compromise the brain, UNL research found. Biochemist Oleh Khalimonchuk, engineer Srivatsan Kidambi and colleagues examined how three types of titanium dioxide nanoparticles affect the functioning of astrocyte cells, which play important roles in cognition, memory and learning. The team found that many rat-derived astrocyte cells died following exposure to titanium dioxide and those cells that survived were severely impaired. Evidence suggests these nanoparticles can cross the blood-brain barrier, but more research is needed, Khalimonchuk said. The study was featured on the cover of *Nanoscale.* The National Institutes of Health funds this research.

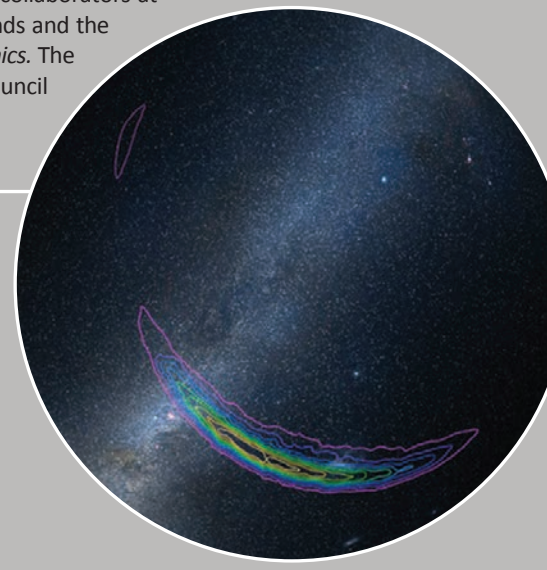


From left, Stephen Hayward, Vaishaali Natarajan, Christina Wilson, Oleh Khalimonchuk and Srivatsan Kidambi

Methylammonium lead tribromide crystals

Safer Material for X-rays

UNL engineers have identified a material that could reduce the risk of X-ray exposure. Used for more than a century to detect broken bones, X-rays are increasingly employed at security checkpoints. But exposure poses a cancer risk, particularly for youngsters. Jinsong Huang, Susan J. Rosowski Associate Professor of Mechanical and Materials Engineering, and colleagues discovered that methylammonium lead tribromide, a type of perovskite crystal, is four times more sensitive to X-rays than leading commercial detectors. This property could allow for lower X-ray doses in medical and security settings, making the material a substantial upgrade over the commonly used amorphous selenium, Huang said. Huang and collaborators at Ohio State University, University of Groningen in the Netherlands and the University of Rochester reported their findings in *Nature Photonics.* The Defense Threat Reduction Agency, the European Research Council and the National Science Foundation funded this research.



Detecting Gravitational Waves

The university's Holland Computing Center helped make history as part of the global supercomputing network that detected gravitational waves emerging from colliding black holes, a scientific first. UNL is part of the Open Science Grid, which provided computing assistance to the U.S.-based Laser Interferometer Gravitational-Wave Observatory, or LIGO, which led the research. The grid, a global consortium of over 125 institutions, offers its collective large-scale computing power to scientific projects. Holland served as a hub for distributing LIGO's data to 15 computing clusters nationwide, said UNL computer scientist Brian Bockelman, who leads an Open Science Grid division.

System Mimics Breast Cancer Tumors

UNL engineers have created a model system that better mimics the environment cancerous tumors face inside the breast. The nanostructured material is helping researchers elucidate how tumor cells function as cancer progresses and could accelerate testing for effective therapies on individual patients. Srivatsan Kidambi and colleagues used the engineered polymer-based film to study late-stage resistance to the drug Herceptin. They determined that breast cancer cell proximity to certain stem cells affects the drug's effectiveness. The finding provides a potential research target to combat resistance, Kidambi said. Clinicians could one day use this system with cancer cells drawn from a patient to quickly determine the best drug regimen. Patients now often wait months to see if a treatment is working. The team's studies appeared in the journals *Langmuir* and *Scientific Reports.*

Potentially Reducing Stroke Damage

UNL chemists are advancing stroke treatment with help from National University of Singapore collaborators. David Berkowitz, Willa Cather Professor and chair of chemistry, and colleagues developed a molecule that inhibits an enzyme linked with the onset of stroke. Most strokes occur when a disruption of blood flow prevents oxygen and glucose from reaching brain tissue, killing neurons and other cells. The team found that the molecule, known as 6S, reduced brain tissue death as much as 66 percent when administered to a rat's cerebrum following a stroke. It also appeared to reduce inflammation that typically accompanies stroke. The study, published in the journal *ACS Central Science,* is a step toward developing a drug to treat strokes. The American Heart Association, National Science Foundation and National Institutes of Health helped fund the research.

Kids Taking ADHD Meds Have Trouble Sleeping

Addressing a long-standing dispute, a UNL study found that stimulant medications prescribed for attention-deficit/hyperactivity disorder (ADHD) cause sleep problems in children. Poor sleep leads to cognitive impairment and behavioral issues, including inattention and irritability, potentially undermining the medications' benefits. ADHD medications, such as Ritalin and Adderall, have long been suspected of affecting sleep, but opinions and evidence conflict. Psychology doctoral student Katie Kidwell, associate professor Tim Nelson and colleagues reviewed the results of past studies, choosing only randomized and objective studies for detailed analysis. The team determined that medicated children have poorer quality and shorter duration sleep and take much longer to fall asleep. One in 14 U.S. children is diagnosed with ADHD, and about 3.5 million children are prescribed stimulant medication. The study appeared in the journal *Pediatrics.*

Tim Nelson, Alyssa Lundahl and Katie Kidwell

Getting Preemies Home Sooner

UNL leads research that could help preterm infants leave the hospital sooner. Steven Barlow, Corwin Moore Professor in Special Education and Communication Disorders and associate director of UNL's Center for Brain, Biology and Behavior, heads the randomized, multi-site study of the link between the brain's molecular pathways and oral feeding skills development. Babies receive therapy using the NTrainer System, a device Barlow developed to stimulate early development of essential feeding skills. The study explores the NTrainer's ability to trigger positive changes in genes related to feeding. Before being discharged, babies must feed by nursing or bottle. If successful, the therapy could speed that ability. Findings also may benefit other children, the elderly and people with brain injuries. A $2.8 million grant from the Eunice Kennedy Shriver National Institute of Child Health and Human Development, part of the National Institutes of Health, funds the study.

Research Highlights

Nebraska Lectures

Taking risks that spark innovation and studying the role gut bacteria play in human health were topics of the 2015-2016 Nebraska Lectures: Chancellor's Distinguished Lecture Series. Shane Farritor, Lederer Professor of Engineering, presented "Making for Innovation" at the fall lecture. Farritor, who established Nebraska Innovation Studio and co-founded a startup company that develops miniature surgical robots, explored why hands-on making and experimentation lead to better solutions to problems. Andrew Benson, W.W. Marshall Distinguished Professor of Microbiology, presented "Guts, Germs and Stainless Steel: Creating Winners and Losers in Food." In his spring lecture, Benson discussed what scientists are learning about gut bacteria and their broad impact on human health. He leads UNL's Gut Function Initiative, which aims to develop food-based strategies for balancing the gut ecosystem and preventing infection and diseases. The Office of the Chancellor, Research Council and the Office of Research and Economic Development, in collaboration with the Osher Lifelong Learning Institute, co-sponsor these lectures featuring prominent faculty.

Above: Andrew Benson
Left: Shane Farritor

Above: Graduate student poster session
Right: John H. Thompson, U.S. Census Bureau director, speaks at the Research Fair.

Research Fair Celebrates Success

Exploring university research priorities, learning from federal and industry experts, and celebrating faculty and student successes were highlights of the biannual UNL Research Fair. The fall 2015 event featured the grand opening of the Central Plains Research Data Center, established in partnership with the U.S. Census Bureau. It included a panel discussion on U.S. Department of Defense research opportunities, mentoring for postdocs and Nebraska Department of Economic Development Innovation Act programs. Featured presenters included John H. Thompson, U.S. Census Bureau; Robert Tillman, University of Texas MD Anderson Cancer Center; Jon Mogford, Defense Advanced Research Projects Agency; Mark Cromer, U.S. Strategic Command; and Joe Fox, Nebraska Department of Economic Development. The spring 2016 event featured poster sessions showcasing research and creative accomplishments by UNL graduate and undergraduate students. Focused workshops addressed industry careers for Ph.D.s, technology transfer and Sigma Xi research insights. Featured presenters included Andrew Cockerill, executive coach and facilitator, and E. William Colglazier, American Association for the Advancement of Science.

Accolades

Eight UNL Faculty Named AAAS Fellows

David Berkowitz, Scott Gardner, Ronnie Green, Andrzej Rajca, Mark Riley, Daniel Schachtman, Janos Zempleni and **Tian Zhang** were named American Association for the Advancement of Science Fellows in 2015. It was the first time eight UNL scientists were elected fellows in the same year.

- **Berkowitz,** Willa Cather Professor of Chemistry and chair of chemistry, was recognized for contributions to chemical biology and synthetic chemistry.
- **Gardner,** professor of biological sciences and parasitology curator at the University of Nebraska State Museum, was recognized for contributions to parasitology and biodiversity.
- **Green,** UNL chancellor and professor of animal science, was honored for contributions to quantitative genetics and advancement of science through academic and federal administration, advocacy and service.
- **Rajca,** Charles Bessey Professor of Chemistry, was recognized for contributions to organic magnetic materials.
- **Riley,** professor and department head of biological systems engineering, was recognized for contributions to biological engineering.
- **Schachtman,** professor of agronomy and horticulture and director of UNL's Center for Biotechnology, was honored for service to the life sciences and contributions to plant molecular physiology.
- **Zempleni,** Willa Cather Professor of Molecular Nutrition and director of the Nebraska Center for the Prevention of Obesity Diseases through Dietary Molecules and of the Nebraska Gateway to Nutrigenomics, was recognized for contributions to nutrition research.
- **Zhang,** professor of civil engineering, was honored for exemplary professional work and research, prolific contribution to technical literature and voluntary activities as a technical expert and global adviser.

William G. Thomas III, John and Catherine Angle Professor in the Humanities and professor of history, received a John Simon Guggenheim Memorial Foundation Fellowship to research his book *A Question of Freedom: The Ordeal of an American Family in the Age of Revolution,* which chronicles a mixed-race family's history over four generations in Maryland. Thomas, a pioneer in digital history, specializes in the Civil War, the U.S. South and slavery.

Terri Norton, associate professor of construction engineering, earned a Fulbright Scholar grant to travel to Japan and research the country's faster-than-expected recovery from a devastating earthquake and tsunami in 2011. The grant also allows her to investigate how people in the U.S. have responded to major disasters.

Galen Erickson, Nebraska Cattle Industry Professor of Animal Science, received the American Feed Industry Association Award in Ruminant Nutrition Research from the American Society of Animal Science.

William Kranz, professor of biological systems engineering, received the 2015 Heermann Sprinkler Irrigation Award from the American Society of Agricultural and Biological Engineers in recognition of his outstanding contributions toward the advancement and worldwide adoption of sprinkler irrigation systems.

Kathy Krone, professor of communication studies, received the Charles H. Woolbert Research Award from the National Communication Association. The award honors scholars whose journal article or book chapter stimulates new concepts of communication phenomena. The award recognizes Krone's work with a colleague for a *Journal of Applied Communication Research* article, "The policy exists but you can't really use it: Communication and the structuration of work-family policies."

James Van Etten, William B. Allington Distinguished Professor of Plant Pathology, earned the Award of Distinction of the American Phytopathological Society. The society's highest honor, this award is presented on rare occasions to people who have made exceptional contributions to plant pathology. An international leader in algal virology, Van Etten is a member of the National Academy of Sciences.

John Brunero, Robert R. Chambers Distinguished Associate Professor of Philosophy, won the 2016 Article Prize from the American Philosophical Association for his "Cognitivism about Practical Rationality," published in *Oxford Studies in Metaethics, Volume 9.*

Tian Zhang, professor of civil engineering, and **John Stansbury,** associate professor and associate chair of civil engineering, won the Rudolph Hering Medal from the American Society of Civil Engineers. The award honors their *Journal of Environmental Engineering* article, "Contributions of Internal and External Fouling to Transmembrane Pressure in MBRs: Experiments and Modeling."

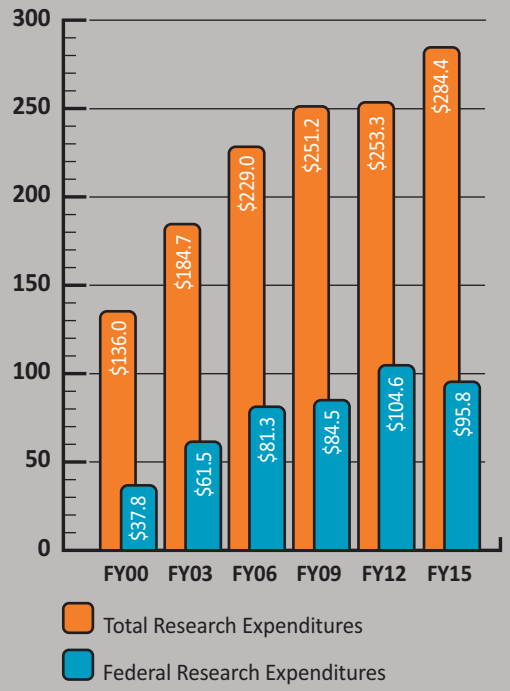
Patricio Grassini, assistant professor of agronomy and horticulture, received the 2016 Early Career Professional Award from the American Society of Agronomy for outstanding contributions in agronomy. Grassini is an internationally recognized authority on crop yield gaps and input-use efficiency.

Financials

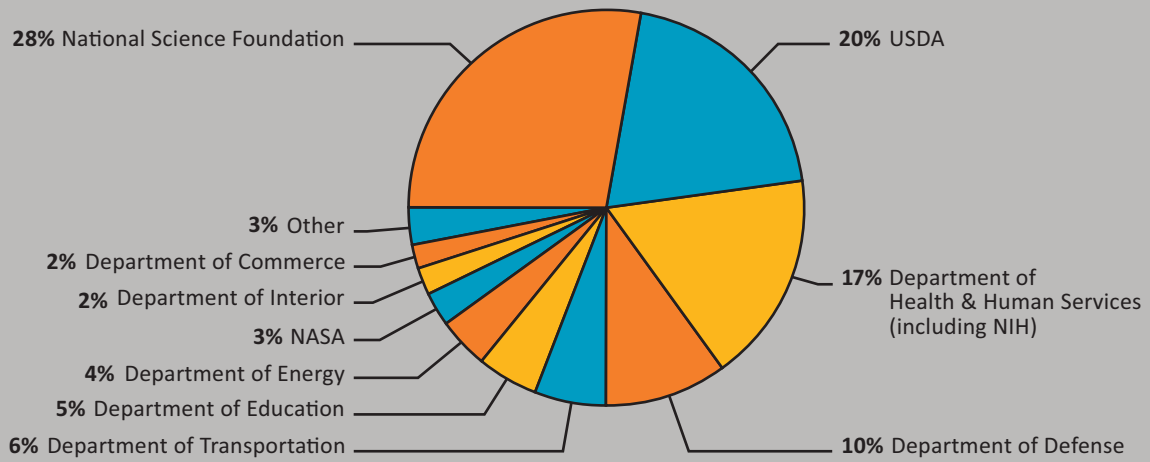
Research Expenditures

UNL's research expenditures totaled more than $284 million in 2015, the most recent fiscal year for which expenditure information is available. This total included nearly $96 million in federal research expenditures. The National Science Foundation accounted for 28 percent, followed by 20 percent from the U.S. Department of Agriculture, 17 percent from the Department of Health and Human Services (including the National Institutes of Health) and 10 percent from the Department of Defense. UNL's goal is to achieve $300 million in research expenditures by 2018.

Total Research Expenditures
(in millions)



FY 2015 Research Expenditures by Federal Agency



Credits

The 2015-2016 UNL Research Report is published by the University of Nebraska–Lincoln Office of Research and Economic Development. For more information, go to http://research.unl.edu or contact:

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In Memory of Prem S. Paul
Vice Chancellor for Research and Economic Development
2001-2016

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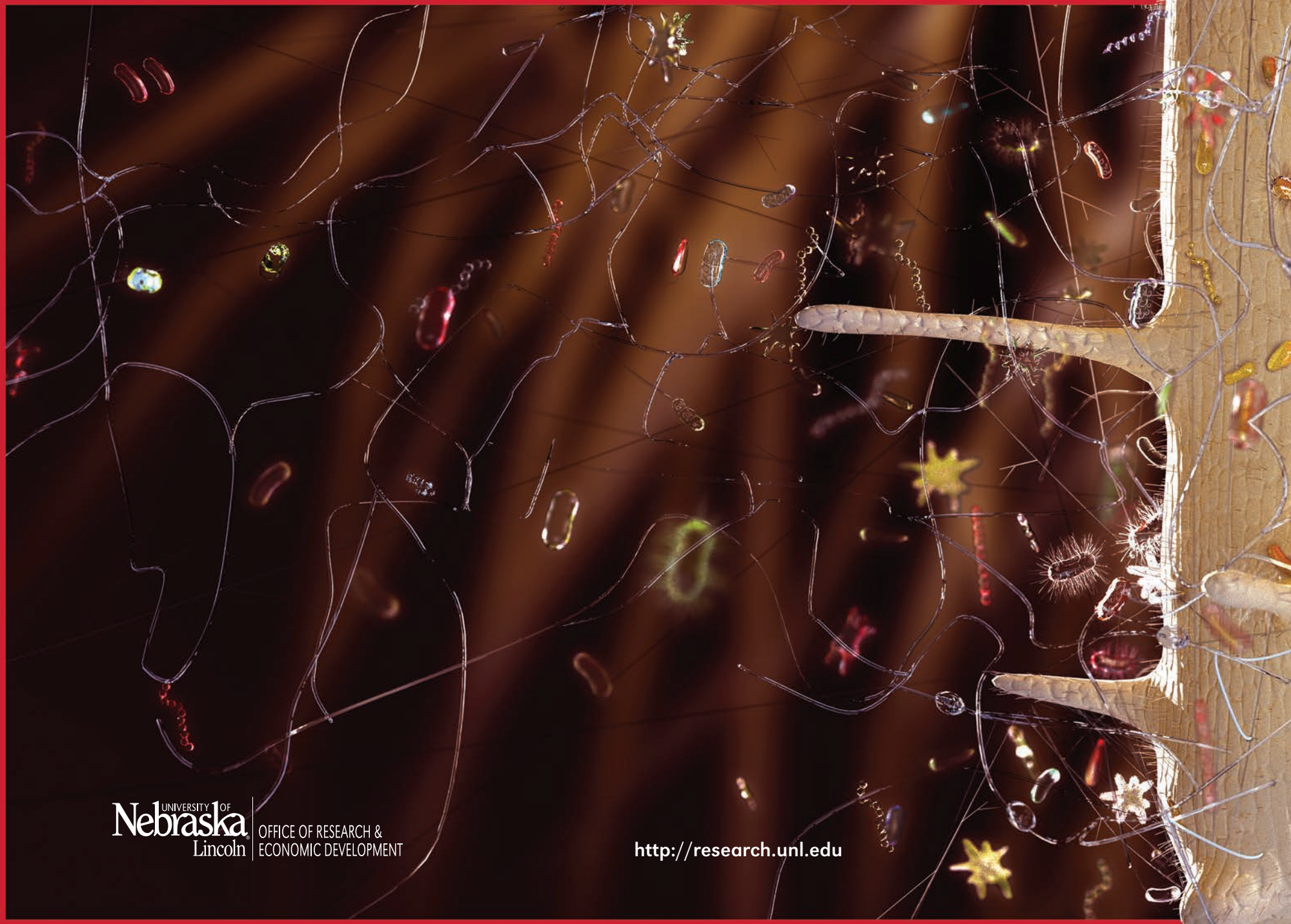
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