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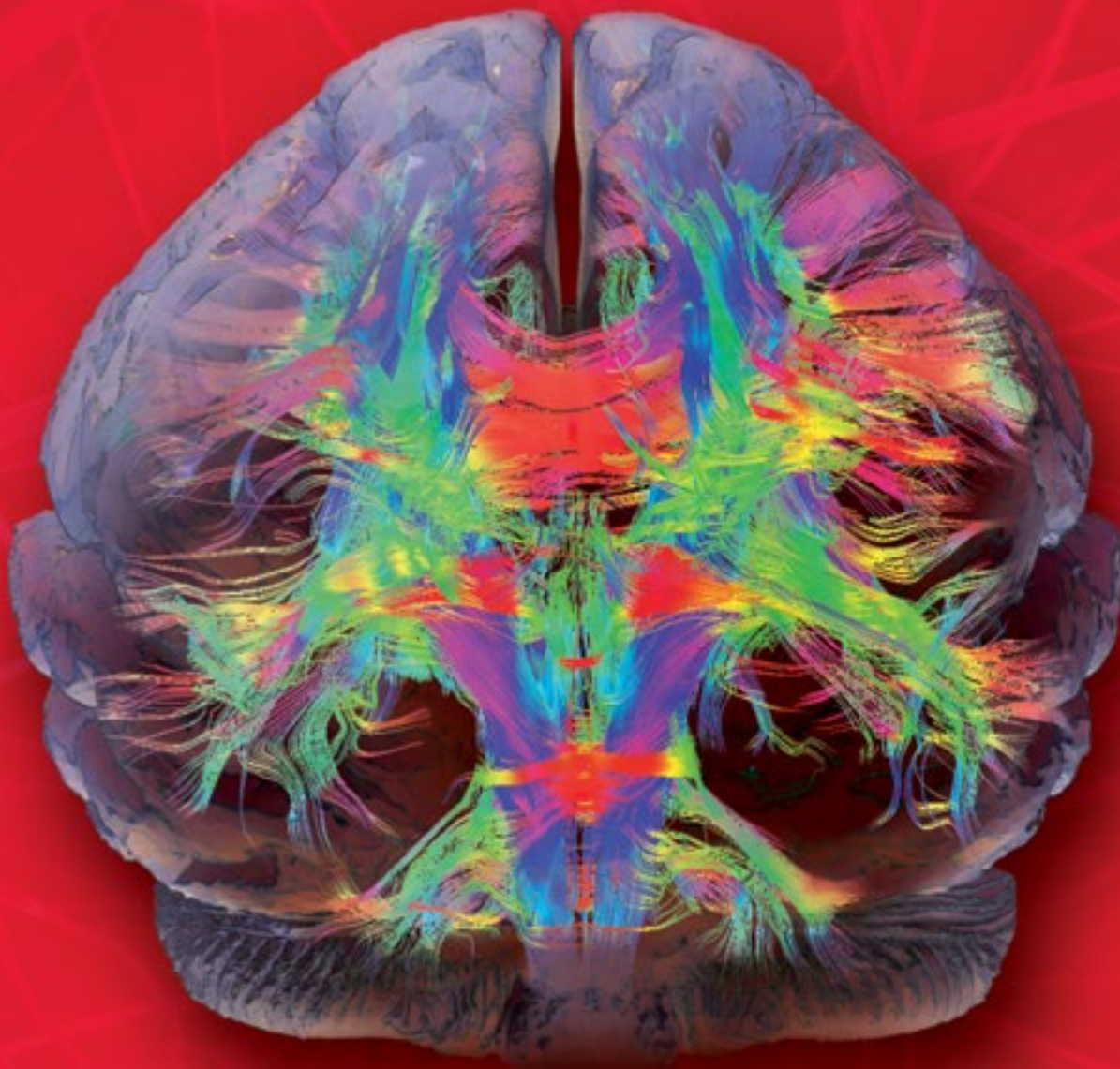
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Research at the University of Nebraska–Lincoln
2012-2013 REPORT



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On the Cover
The University of Nebraska-Lincoln's new Center for Brain, Biology and Behavior is poised to be a leader in exploring how brain functioning affects human behavior. The center's multidisciplinary focus, state-of-the-art-equipment and a unique partnership between UNL research and athletics expand our research capacity in a range of disciplines, including growing expertise in concussion research. The cover illustration shows fiber tracks of the brain, an example of information the center can capture through magnetic resonance imaging and other functional imaging software. The background depicts the brain's synapses. Read more on pages 2-7. (Cover illustrations/design by Joel Brehm and Rob Cope; diffusion tensor image courtesy of Siemens Press Pictures.)



On the Web
Explore the 2012-2013 UNL Research Report website for more photos, links and videos related to stories in this report:
research.unl.edu/annualreport/2013

Innovative Collaborations Drive Success

At the University of Nebraska-Lincoln, a robust culture of collaboration underpins our research success. We believe true innovation emerges at the nexus of strategic partnerships and our research strengths.

We're striving to build productive, innovative relationships within and beyond our university, locally and globally, with public and private partners. This report highlights some of these successes and our promising new endeavors.

An unprecedented partnership between athletics and research at UNL exemplifies the power of collaboration. In 2013, UNL completed a major expansion of Memorial Stadium. Thanks to this partnership, the storied home of Husker football now also houses two multidisciplinary research facilities – UNL's Center for Brain, Biology and Behavior and the Nebraska Athletic Performance Laboratory.

We believe this is the first major athletics-research partnership of its kind. It promises to expand understanding of the brain, behavior and concussions and enhance health and performance research (*pages 2-7*).

Harnessing the power of partnerships to ensure that UNL's discoveries and expertise play bigger roles in Nebraska's economy is central to plans for Nebraska Innovation Campus. Business, industry and entrepreneurs will work closely with UNL faculty and students at this private-public research campus adjacent to UNL. With the first buildings slated to open in 2014 and its first corporate partner on board, NIC is generating interest and excitement (*page 16*).

We're making progress on many fronts. Our commitment to defense-related research was bolstered in fall 2012 when the University of Nebraska and the U.S. Strategic Command partnered to establish a University Affiliated Research Center, part of the university's National Strategic Research Institute (*pages 10-11*).



Vice Chancellor Prem S. Paul (left) and Chancellor Harvey Perlman

We're also expanding our international engagement and capitalizing on our established research strengths. This report highlights our leadership in areas such as digital humanities, education, engineering, nanoscience, plant science and water management, plus hands-on research opportunities for undergraduate and graduate students.

Whether it's tackling a vexing challenge, applying knowledge-fueled solutions, sharing the excitement of discovery with students or moving our technologies from the lab to the marketplace, UNL is a growing Big Ten research university committed to fostering partnerships and collaborations that spur innovation.

Prem S. Paul
Vice Chancellor for Research and Economic Development



Unraveling Secrets of Brain, Biology and Behavior

From studying the neurological basis of decision-making to understanding how the brain behaves after injury, UNL's new Center for Brain, Biology and Behavior is positioned to become an international leader in understanding how brain functioning affects human behavior.

Established in 2013, the center's multi-disciplinary focus, state-of-the-art equipment and a unique partnership between UNL research and athletics deepen the university's research capacity, including its growing expertise in concussion research. Research ranges from uncovering the biological underpinnings of political leanings and the nature of addiction to exploring the heritability of social attitudes and language development.

"I believe we can revolutionize brain research and bring it into the everyday," said center director Dennis Molfese, Mildred Francis Thompson Professor of Psychology.

The center also is the world's only lab to simultaneously capture functional magnetic resonance imaging (fMRI), record brain electrical activity and track eye movement, Molfese said. The goal is to get a complete picture of the brain's structure, how different brain areas interact with each other and how it carries out thoughts and responds to stimuli.

Read more
about the
center's
work on
pages 4-7.

This technology enhances concussion research, a cornerstone of the center's work. Molfese and colleagues study how the brain processes information before and after a concussion. Molfese hopes their findings lead to better tools for assessing injury. This research could improve treatment for other head injuries, as well as concussions. Annually, 10.1 million Americans suffer traumatic brain injuries.

The center, which occupies just over half of a more than 50,000-square-foot addition to East Stadium, features shared research areas that encourage faculty collaboration. It's adjacent to the Nebraska Athletics Performance Lab, a collaborator on health and performance initiatives.

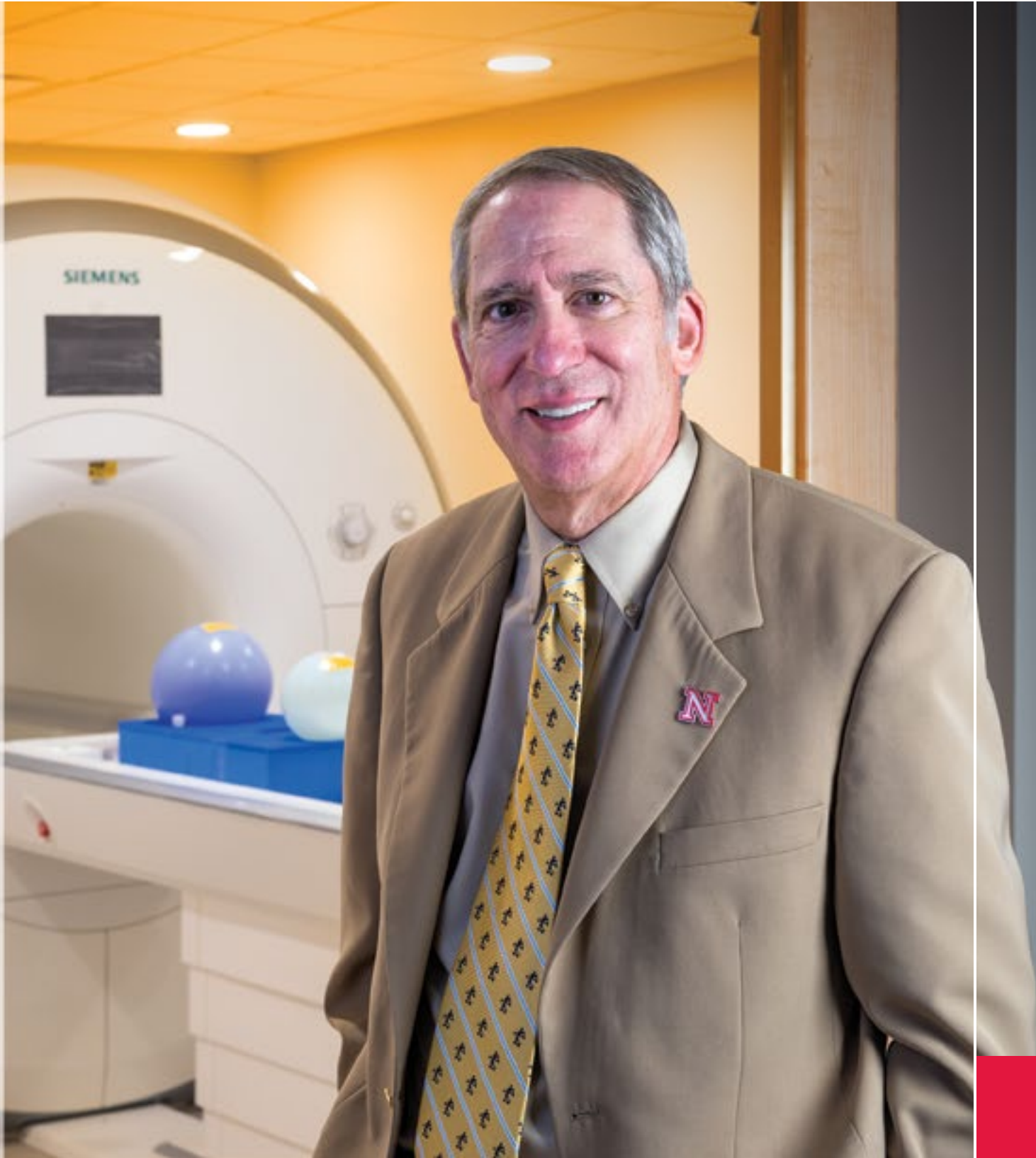
The athletics-research partnership aids Molfese's leadership in a Big Ten Conference/Ivy League effort, in conjunction with the Committee on Institutional Cooperation, to study sports-related head injuries. These findings could reshape collegiate athletics worldwide.

He's also a member of a National Academy of Sciences committee on sports-related concussions in youth. The committee's findings, to be released in late 2013, are expected to influence safety recommendations for high-impact sports, including football.

"We need serious interventions that are science guided," Molfese said.

"I believe we can revolutionize brain research and bring it into the everyday."

Dennis Molfese





Research, Athletics Partnership

A unique partnership between UNL research and athletics is forging a new model for health and performance research.

With the expansion of Memorial Stadium, university leaders recognized an opportunity to bring top researchers under one roof to study the biological underpinnings of behavior and performance. Their work could lead to discoveries about brain function, head injury and human performance that benefit athletics and broader society.



Judith Burnfield and Dennis Molfese

The East Stadium addition includes the 28,200-square-foot UNL Center for Brain, Biology and Behavior and the 24,191-square-foot Nebraska Athletics Performance Lab. A bridge connects the facilities, encouraging collaborations.

The brain center's director, UNL psychologist Dennis Molfese, and the performance lab's director, rehabilitation physical therapist Judith Burnfield, are at the center of this partnership. Their groups share data gathered from the brain center's brain-imaging equipment and the performance lab's sophisticated motion-tracking sensors, creating a more complete picture of what influences behavior and performance.

"This extraordinary collaboration bridges not only academics and athletics but also the broader healthcare community to improve athletes' performance and safety well beyond their collegiate years," Burnfield said. "The knowledge, therapeutic and technological innovations emerging from this work will undoubtedly ripple across the nation."

Molfese, a concussion researcher, said the strong relationship with athletics has strengthened his efforts to understand how sports-related head injuries affect behavior, emotions

and cognition. By working with Molfese, Nebraska Athletics hopes to learn more about evaluating injury, boosting safety and helping athletes safely return to play after being hurt. Findings have potential to influence collegiate athletics nationwide and change long-term approaches to dealing with all types of head injuries.

Helping athletes build their skills is one of the performance lab's goals. Burnfield's team uses brain images, movement analysis and eye-tracking information obtained during athletic conditioning and combines this with performance data to learn how players make split-second decisions. This information also could aid broader brain research, especially expanding knowledge about how injury affects cognitive skills.

"Putting good people together leads to good things," UNL Chancellor Harvey Perlman said. "Brain and performance research on student-athletes directly translates into advances for the public at large. Integrating athletics and academic research in this unprecedented partnership positions UNL to become a national leader in this important area."

Understanding Impact of Toddler Sleep Habits

Parents often say their toddlers seem irritable, even irrational, after a night of fitful sleep.

The anecdote may hold truth. UNL Center for Brain, Biology and Behavior researchers are studying the long-term developmental effects of toddler sleep habits, including sleeping too little, waking frequently or varying bedtimes.

Victoria Molfese, Chancellor's Professor of Child, Youth and Family Studies, predicts that 2- and 3-year-olds who don't get enough ZZZs may struggle with cognitive and social skills, like following simple instructions, focusing on enjoyable activities and solving problems. The impact can be lasting: research shows that acquiring these skills in early childhood is a predictor of later academic and social success.

"Since toddlers are establishing their sleep habits and developing better self-regulation, toddlerhood is a critical period to study sleep," Molfese said.

The National Institute of Child Health and Human Development of the National Institutes of Health supports this work, part of broader research on early childhood sleep led by Indiana University that involves UNL, University of California, Berkeley and the University of Virginia. UNL's funding share is \$1.4 million.

Molfese and UNL colleagues, educational psychologist Kathleen Rudasill and psychologist Dennis Molfese, are conducting a five-year longitudinal study of 200 children to examine their sleep quantity, quality and variability at six-month intervals. Researchers track children's night motor activities, which indicate sleep disruptions, and connect the data with parents' observations to identify patterns between sleep habits and children's daytime behavior at home, child care and preschool.

Believing that sleep habits begin at home, researchers also investigate how parenting practices, bedtime routines and family stresses may affect toddlers' sleep.

The team's findings could lead to more accurate information about the consequences of poor sleep. Another goal is establishing clearer definitions and measures of sleep issues that can be replicated in further studies and compared across labs.

Eventually, Molfese said, parents, caregivers and child development professionals will have better information about sleep problems and their symptoms, plus practical tips for establishing beneficial sleep habits.



Victoria Molfese works with a child.



For Nonparticipants, Voting May Just Be Too Stressful

Just 57 percent of eligible Americans voted in the 2012 presidential election. For many who did not, voting may just stress them out.

UNL political science research shows that people who vote less frequently, or not at all, are more likely to have a higher physiological response to stress. This research may lead to new ways to increase voter turnout and strengthen the political system.

“If politics is as stressful as it seems to be, it makes sense that people who are predisposed to higher stress levels would not want to be involved in another thing that’s going to cause them stress,” said John Hibbing, Foundation Regents University Professor of Political Science.

A groundbreaking researcher on the role of biology in shaping people’s political temperaments, Hibbing won a coveted Guggenheim Fellowship in 2013 to broaden his research into variations in political participation.

Early indications are that chronic non-voters tend to have high levels of cortisol, a hormone commonly associated with stress, and other physiological indicators of emotional strain. But does the stress stem from the decision-making itself, or from being in an unfamiliar or public situation?

A preliminary study by Hibbing and UNL political science colleague Kevin Smith found that voting at the polls caused higher cortisol levels than mailing ballots from home, indicating it’s possible to make voting less stressful. The U.S. political system, which is more adversarial and winner-take-all than other systems, also may trigger greater stress and therefore less participation.

“This knowledge might help us understand things we could do either with regard to the political system as a whole or the specific act of voting to increase turnout and improve democracy,” Hibbing said.

Hibbing is a member of UNL’s new Center for Brain, Biology and Behavior. He said the center’s interdisciplinary focus gives him greater opportunity to collaborate with colleagues across a range of expertise and having laboratories in one location facilitates his research projects.

“This knowledge might help us understand things we could do . . . to increase turnout and improve democracy.”



John Hibbing



Collaborating on Nanoelectronics

Transforming university nanoscience discoveries into smaller, faster electronics is the aim of a new multi-institutional collaboration.

A UNL physics team leads the Center for NanoFerroic Devices, a \$7.125 million research collaboration involving six universities and an industry consortium. Funded by the Semiconductor Research Corp. and the National Institute of Standards and Technology, it's one of three new multi-university research centers that are part of the second phase of the Nanoelectronics Research Initiative.

"The new center is a natural continuation of the research that we've been doing. Now we're rising to a new level," Tsymbal said.

Today's electronics use an electric charge to store and process information, which limits the number of transistors that can occupy a chip. The new center is pursuing three alternatives to take advantage of nanoscale properties that require less energy, which could enable more compact and powerful devices.

UNL physicist Alexei Gruverman leads a team focused on nano-thin ferroelectric oxide, a material with both positive and negative polarization directions that can be read like a binary code to store information. A second initiative relies on UNL physicist Christian Binek's work with spintronics, which manipulates electron spin to store information. The third initiative, led by Ilya Krivorotov at the University of California, Irvine, focuses on how electrons carry information by generating spin waves. UNL physicists Kirill Belashchenko and Xia Hong also work with the center.

Tsymbal said collaboration among researchers and industry is critical to moving fundamental principles from the laboratory to specific devices.

UNL's university partners are University of California, Irvine; University of Wisconsin-Madison; University at Buffalo, SUNY; University of Delaware; and Oakland University. Industry partners include IBM, Intel, Micron Technology, Texas Instruments and GLOBALFOUNDRIES. Semiconductor Research Corp. is the world's leading university-research consortium for semiconductors and related technologies.

From left: Alexei Gruverman, Peter Dowben, Kirill Belashchenko, Xia Hong and Evgeny Tsymbal (not pictured, Christian Binek)

The center builds on advances that UNL and its Materials Research Science and Engineering Center have made in exploring nanomaterials to surpass current technological limitations, said physicist Evgeny Tsymbal, George Holmes Professor of Physics who co-directs the new center with UNL colleague Peter Dowben, Charles Bessey Professor of Physics. Tsymbal also directs UNL's MRSEC, which the National Science Foundation funds.



Aftercare Critical for At-risk Teens

Going home after months, even years, in an out-of-home care program is an exciting milestone for at-risk teens and their families.

It's also a vulnerable time. Youth with emotional or behavioral disorders can make laudable progress in treatment, but they may backslide into old, familiar behaviors if their home and school environments don't reinforce new skills. That leaves them at risk for further problems, including quitting school, strained relationships, drug and alcohol abuse, and criminal behavior.

Alex Trout, research associate professor in special education and communication disorders, leads a team of researchers, educators and family service workers from UNL, Boys Town and five other residential agencies in eastern Nebraska to evaluate On the Way Home, a set of programs to help youth make a successful transition.

"These youth receive lots of targeted help and education while they're in treatment," Trout said. "It's heartbreaking to watch them fall apart after they've made big strides."

The aim is to involve the teen's parents, school and workplace in the transition. Interventions include parent training, dropout prevention and intervention, and homework support. A family consultant is available 24/7 for parents to seek advice. Weekly check-ins help identify struggles and problematic behaviors early.

Preliminary findings show that nearly 91 percent of participants maintained their home placement after one year, and approximately 88 percent had graduated or were still enrolled in school.

With a nearly \$3.5 million grant from the U.S. Department of Education's Institute for Education Sciences, the team is building on earlier research, evaluating educational, family and behavioral outcomes at a larger scale and expanding services to additional agencies. More than 4,000 Nebraska youth receive out-of-home care; Trout hopes to include 250 in the research.

The need for proven, research-based programs is huge, Trout said. UNL researchers developed On the Way Home in collaboration with researchers elsewhere, with support from an earlier IES grant. With further research, the program could become a national model for aftercare support.

"The children, families and schools have confirmed the value of supporting these youth through this often difficult transition," said Patrick Tyler, director of the aftercare program at Boys Town. "On the Way Home provides an important service, at the right time, so these children can sustain the gains they've made."

Above: Alex Trout (front) with, from left, Patrick Tyler, Maryia Schneider, Heidi Menard, Scott Johnson and Regina Costello



Defense-related Research Expanding

From engineering, education and physics to anthropology, digital humanities and psychology, UNL is expanding research that supports national defense and security.

That commitment got a major boost in fall 2012 when the University of Nebraska and the U.S. Strategic Command announced a strategic partnership creating a University Affiliated Research Center. It is one of only 14 nationwide, all affiliated with major research universities.

The UARC is part of the university's National Strategic Research Institute and provides research and development services to USSTRATCOM and other Department of Defense agencies in areas of faculty expertise. These include: nuclear detection and forensics, detection of chemical and biological weapons, passive defense against weapons of mass destruction, consequence management, and space, cyber and telecommunications law.

"UNL is well positioned to contribute to defense-related research thanks to our faculty expertise and responsiveness, our strengths in areas of DoD interest and strong university infrastructure," said Kurt Preston, UNL associate vice chancellor for research who focuses on physical sciences, engineering and defense-fundable research.

At the end of fiscal 2013, UNL had 47 active projects that were awarded more than \$28 million from all DoD sources. This research is diverse and includes developing: advanced laser applications for nuclear detection and other uses; nanoscale sensors and structural materials; biocomposites to help repair shattered bones; a national flood mitigation database; and programs to support military families.

Those numbers should grow in coming years, said Prem S. Paul, vice chancellor for research and economic development. There's potential to tap UNL's expertise across disciplines, including the humanities and social and behavioral sciences.

For example, UNL and the Joint POW/MIA Accounting Command are developing a partnership that would use UNL's capabilities in forensic science and anthropology to help locate U.S. service members missing in action. Anthropology, history and digital humanities faculty might all have roles, Preston said.

"We look forward to leveraging UNL's diverse research strengths to support our nation's defense and security needs," Paul said.

Reporting Key to Preventing Violence

People who commit violence at work or school often exhibit warning signs in advance. But co-workers, classmates and teachers frequently don't report threatening behavior, even when a reporting mechanism is in place.

To help reduce workplace violence and terrorism, UNL psychology professor Mario Scalora is researching the psychological barriers to reporting with a \$400,000 grant from the U.S. Department of Defense.

"Knowing what can facilitate people reporting, we can do more preventive actions up front, rather than having to react to ugly situations," he said. A national expert in threat assessment, Scalora leads one of the country's most active research programs on the subject. He works closely with federal, state and local law enforcement agencies and is the consulting psychologist to the U.S. Capitol Police.

Following the 2009 murder of 13 people by an employee at the Fort Hood military base in Texas, the DoD decided to expand its use of Threat Management Units across all branches of the military. These teams of specially trained psychologists and law enforcement agents assess and manage employees who exhibit potentially threatening behavior.

The teams rely heavily on co-workers reporting their concerns, but lack of reporting is the biggest obstacle to preventing violence, Scalora said.

To develop strategies that encourage reporting, he and colleagues are conducting surveys, focus groups and individual interviews to determine employees' current understanding of threat assessment, what they see as barriers to reporting and what they think would encourage reporting. Scalora's team will use the information to make recommendations to the DoD.

Several factors contribute to lack of reporting, Scalora said, including insufficient knowledge to assess a threat, denial of its seriousness and nervousness about getting involved, due either to reluctance to get someone in trouble or fear that others will know they came forward.

"We appreciate the opportunity to assist the DoD in making a safer environment for men and women in uniform and civilians who serve our nation," he said. This research also will help prevent violence in workplaces, schools and other targets of violence.

Mario Scalora



Book Opens Cather Letters

Famed Nebraska author Willa Cather, one of the 20th century's great literary voices, was a prolific letter writer who scrawled her most intimate thoughts to friends, relatives and colleagues.

Terms of Cather's will concealed these letters from public view for nearly 70 years, until the April 2013 publication of *The Selected Letters of Willa Cather*. The groundbreaking book features more than 550 of Cather's letters. Co-editors Andrew Jewell of UNL and Janis Stout, Texas A&M professor emerita, present the letters with historical and biographical context to guide readers through Cather's life.



Andrew Jewell

The book, published by Cather's former publisher Alfred A. Knopf, has spurred wide public and scholarly interest and is a bonanza for scholars and biographers, who have long sought to understand Cather with a more accurate, fuller perspective.

Unlike her novels, in which Cather's characters speak for her, the letters capture her personality, aspirations, concerns and complexities directly in her own words, said Jewell, an associate professor of libraries who edits the online Willa Cather Archive for UNL's Center for Digital Research in the Humanities.

"We wanted to put together a group of letters that were representative of the whole record, but we also sought to pick the letters that best let her voice and personality come through," Jewell said.

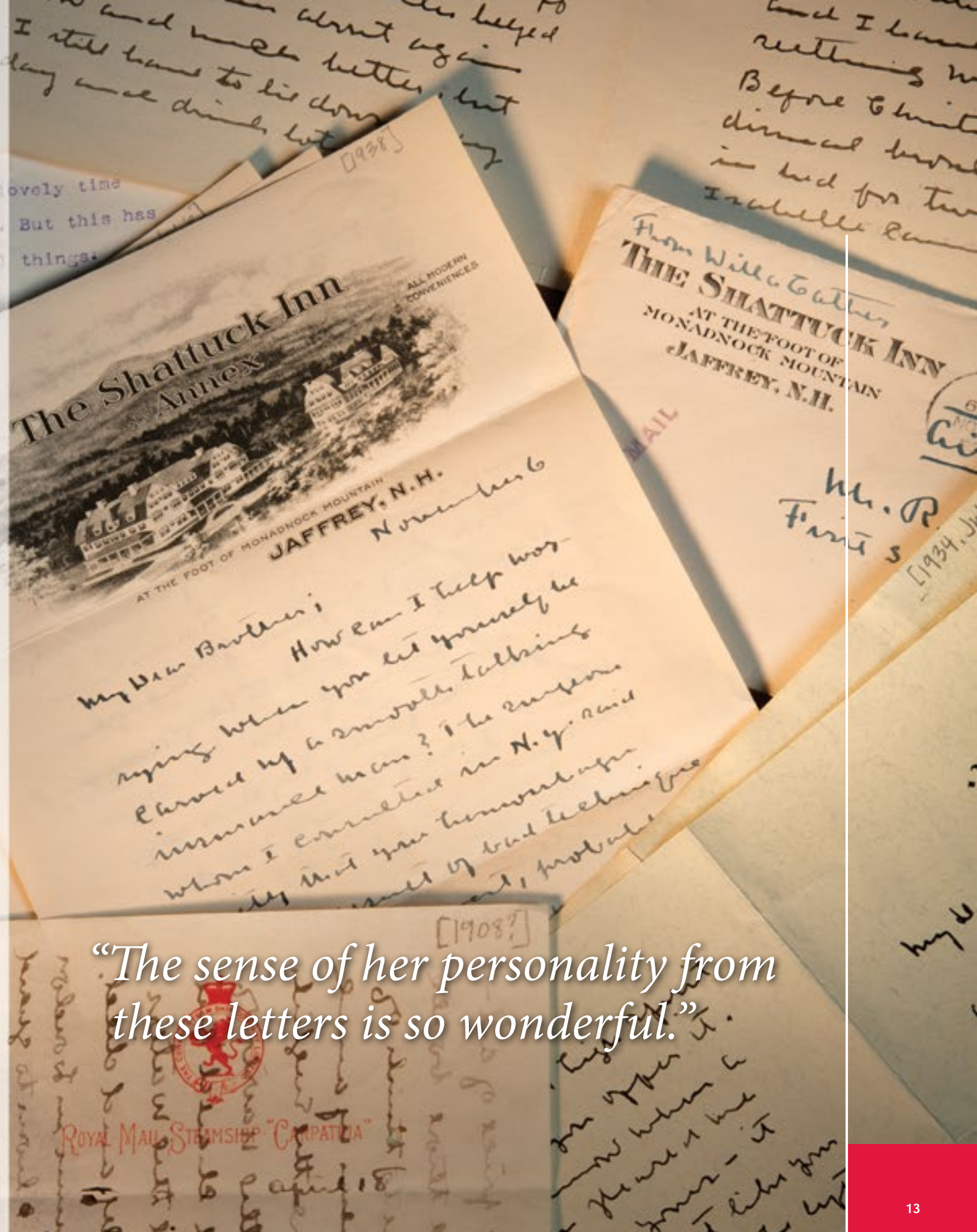
Jewell had been compiling and summarizing the letters for several years in his work with the archive when the ban on the letters' publication was lifted in 2011 following the death of Cather's last surviving heir. He and Stout then began working toward publishing a book of the letters for public view.

The letters illustrate Cather's clever, quick, engaging and sometimes restless mind as she shared her thoughts on war and the Great Depression, on other writers and artists and on the difficult questions of living – love, death and work.

"The sense of her personality from these letters is so wonderful," Jewell said. "She seems to have been the kind of person who couldn't tolerate fakery or insincere emotion, and so she is always vibrantly herself."

"You can feel her vigorous personality on the page."

Right: Willa Cather's letters



"The sense of her personality from these letters is so wonderful."



Matthew Jockers

Matthew Jockers looks at literature the way Keanu Reeves' film character, Neo, looks at The Matrix. The UNL assistant professor of English combines computer programming with digital text-mining to produce deep thematic, stylistic analyses of literary works throughout history – an intensely data-driven process he calls macroanalysis. It's opening up new methods for literary theorists to study literature.

Until recently, his method was limited to a few thousand 18th- and 19th-century works. But an exclusive agreement between UNL and private company BookLamp has given Jockers and researchers from several other U.S. universities the access and tools to look much more deeply into more recent works.

Organizers have dubbed the effort "Unfolding the Novel." Ultimately, they'll consolidate 300 years of high-level book data to study long-term literary trends and patterns.

Like Jockers, BookLamp uses digital tools to compare books by theme and writing style. To power its algorithm, the company works with publishers across the industry

to analyze thousands of titles in its decade-old Book Genome Project. The agreement gives Jockers and other scholars digital access to data from those books, allowing them to study book data as diverse as pronoun usage, prevalence of certain words and phrases, word choices of authors of different nationalities and genders, and how specific eras in history affected different genres of literature.

It's a big step forward and will provide researchers the tools for much deeper understanding of the world's story through its own stories. By looking holistically at writings published over the years, and at a scale that's been impossible to do in the past, researchers can help answer larger questions about changes in literary imagination and culture over time.

The work of understanding and organizing data from 300 years of literature is long and difficult. But Jockers knows that he and his collaborators are inaugurating a game-changing, information-rich era of literary scholarship.

"The potential uses of this information are huge," he said. "It will enable years of future research."

Lizard Fossil Reveals Climate Clues

Some 40 million years before rock and roll singer Jim Morrison became known as "the Lizard King," there was *Barbaturrex morrisoni*, an actual king lizard that roamed Southeast Asia's tropical forests and competed with mammals for food and other resources.

Jason Head, UNL assistant professor of earth and atmospheric sciences and curator of vertebrate paleontology at the University of Nebraska State Museum of Natural History, led a team of U.S. paleontologists that analyzed the creature's fossils for the first time. He found it is one of the biggest known lizards. Fittingly, he named his discovery after Morrison.

At nearly 6 feet long and weighing more than 60 pounds, the giant lizard provides new, important clues on the evolution of plant-eating reptiles and their relationship to global climate and competition with mammals.

Today, plant-eating lizards are much smaller than mammal herbivores. The largest lizards, like the carnivorous Komodo dragon, are limited to islands with few mammal predators. But it's not known whether lizards' size is limited by competition with mammals or by modern climates.

But *B. morrisoni* lived in an ecosystem with many herbivorous and carnivorous mammals during a warm age when carbon dioxide levels were very high. The creature was larger than most of the mammals with which it lived, suggesting that competition or predation by mammals did not restrict its evolution into a giant.

"You can't fully understand the evolution of ecosystems in the modern world without looking at the ones that



preceded them," Head said. "We would've never known this by looking at lizards today. By going

back in time using the fossil record, we can find unique information on the origin of modern ecosystems."

The discovery raises other questions: How long did these giant lizards walk the earth? How far and wide did they move? What does their evolution and time on Earth tell us about global temperature change throughout history?

"That becomes very important in modeling what temperature change will be like across the surface of the planet in the future," Head said. "That, obviously, bears directly on our own health."

Top: Jason Head

Above: Illustration showing giant lizard's size and environment



Innovation Campus Emerging

With its first corporate partner on board, more partnerships in the works and the first buildings slated to open in spring 2014, Nebraska Innovation Campus is generating abundant buzz.

"Innovation Campus has a lot of traction," said UNL Chancellor Harvey Perlman. "We're extremely pleased with the interest and enthusiasm for our plans to create a research campus that enhances opportunities for private business to access faculty research to develop marketable innovations."

Officials announced in November 2012 that ConAgra Foods, a leading food company, is NIC's first corporate partner. The partnership is part of an expanded collaboration between ConAgra and UNL designed to foster a culture of innovation related to food science. The announcement kicked off Phase I construction at the 232-acre private-public research campus adjacent to UNL. NIC is being developed as a world-class conduit for innovation – connecting companies, entrepreneurs and university researchers and students in a collaborative environment to help fuel Nebraska's economy.

"For ConAgra Foods to be the first major partner at Nebraska Innovation Campus is a rare opportunity that we could not pass up," said Gary Rodkin, chief executive officer of ConAgra.



Top: Panorama of Lincoln skyline shows downtown, UNL campus and Nebraska Innovation Campus with Phase I construction boxed. Above: Phase I construction in progress

Nebraska-based ConAgra is an ideal inaugural partner, Perlman said, and an excellent fit for NIC's focus on food, fuel and water, traditional research strengths at UNL.

Four buildings being constructed or renovated in Phase I will provide 350,000 square feet of lab, greenhouse, office and conference space, said Dan Duncan, NIC's executive director. The renovated former 4-H Building and new companion wing will open in spring 2014. The repurposed Industrial Arts Building and a laboratory building with labs for the university, private industry and startup companies are slated to open in winter 2015.

In addition to ConAgra, early NIC tenants will include the university's Robert B. Daugherty Water for Food Institute; UNL's Department of Food Science and Technology; NUtech Ventures, the nonprofit corporation responsible for commercializing university research; NIC headquarters; UNL Industry Relations; and a business accelerator.

NIC is finalizing several more private-sector partnerships, Duncan said, with announcements expected in late 2013.

When fully developed over the next 25 years, NIC will offer 2 million square feet of space and accommodate 7,000 people working and living on the campus.



Architectural rendering of completed Phase I buildings



Research Leading to Water-wise Sensor

With about 40 percent of the world's food produced using irrigation, it's a major factor in food security. Amid concerns about water availability for agriculture, making the most of every drop is increasingly critical.

UNL computer engineer Mehmet Can Vuran developed technology to help farmers boost yields and conserve water, with support from a National Science Foundation CAREER award. Now, an NSF initiative to guide promising discoveries toward commercialization is helping him turn his underground wireless sensor network into a practical irrigation management tool.

"We're always interested in the research side of the story, but you have to think about the business side," he said. "One of the major questions when you're commercializing is what is this product going to be."

Vuran's team set out to answer that question with a \$50,000 NSF Innovation Corps award. After attending training for award recipients, the team traveled throughout Nebraska, talking to farmers, irrigation company representatives, water resources managers and others to understand how best to develop and market the technology.

In addition to Vuran, the team includes entrepreneurial lead, doctoral student Xin Dong; project mentor Stephen Reichenbach, a computer scientist and successful entrepreneur; and team adviser Suat Irmak, Harold W. Eberhard Distinguished Professor of Biological Systems Engineering who heads the Nebraska Agricultural Water Management Network.

Underground wireless sensor networks use sensors buried in soil to gather information about soil moisture, temperature and changing conditions. Information is sent wirelessly to a center pivot irrigation system or a base station, providing accurate, real-time data to help farmers determine when and how much to irrigate.

To further develop the product, Vuran founded Wildsense LLC, which has a licensing agreement with NUtech Ventures, the nonprofit corporation responsible for commercializing UNL research. Wildsense received an NSF Small Business Innovation Research Phase I grant to continue developing and marketing the sensor network.



The technology is being demonstrated on farms throughout Nebraska. Vuran said he expects a product to be ready within two years.

Making the technology so low cost that farmers in developing countries can benefit is the eventual goal.

Top: Stephen Reichenbach, Mehmet Can Vuran, Xin Dong and Suat Irmak
Above right: Underground wireless sensor



Bolstering Plants' Defenses

Like a stealth invader, a disease-causing bacterium strikes where plants are weakest. By following the bacterium behind enemy lines, a UNL scientist is making discoveries to help improve agricultural crops' defenses against a broad range of diseases.

James Alfano, Charles Bessey Professor of Plant Pathology, studies *Pseudomonas syringae*, a bacterial pathogen that disables a plant's immune response by using a syringe-like mechanism to inject virulence proteins, or Type III effectors, into plant cells. These proteins attack a plant's immune response and help the pathogen infect its host.

By stalking these virulence proteins to identify the pathogen's target – a plant's weak spots – Alfano and colleagues in UNL's Center for Plant Science Innovation can strengthen those areas to boost the plant's own immunity.

"I look at these Type III effectors as very unique tools to discover new components of plant immunity that can't be discovered using other, conventional tools," he said.

For example, Alfano identified one bacterial protein, HopU1, which knocks out a component that helps detect the pathogen's presence. By inducing greenhouse-grown soybeans to make more of that component, his team improved the plants' immune response. They'll soon test that immune response in field trials.

Top: James Alfano and graduate student Anna Joe
Above: Test plants



Next, the researchers will test for strengthened immunity in other agricultural crops and against a range of pathogens.

Alfano recently identified another virulence protein that prevents defensive compounds from leaving cells to fight the pathogen. This discovery also may lead to enhancing immunity by boosting a plant's disease-fighting compounds.

While *P. syringae* is not a major costly disease in U.S. crops, the immune boost is effective against other pathogens, including many viruses and fungi, as well as bacteria.

Because plant and animal immune systems have components in common, this research also may lead to improvements in human health.

The National Institutes of Health's National Institute of Allergy and Infectious Diseases, the National Science Foundation, the U.S. Department of Agriculture and the Nebraska Soybean Board help fund this research.

Seeking Salt-tolerant Rice Genes

Rice is the foundation for half the world population's diet. But rice yields are declining in an increasingly saline environment, costing the industry more than \$12 billion annually.

UNL plant molecular physiologist Harkamal Walia and collaborators are using powerful new tools to study rice varieties to discover new sources of salt tolerance.

Most rice production is irrigated. After plants use the water or it evaporates, salt remains in the soil, builds up over time and hinders plant growth and productivity.

"It's already a huge problem, and it's going to become a bigger problem, especially with climate change. There's reason to believe that farmers' incomes will go down," Walia said, adding that the situation is particularly critical for smallholder farmers in Asia surviving on \$2 a day.

With a \$2 million grant from the National Science Foundation, Walia and his team are looking for salt-tolerant rice genes. First, the team uses a sophisticated image-based phenotyping system that takes pictures of rice plants growing in saline conditions over days. Then software scans the images to detect differences among varieties that are impossible to quantify with the naked eye. Matching slight visual variations with differences in each plant's genetic makeup will help the team find those genes responsible for salt tolerance. Breeders can use the information to develop salt-tolerant varieties.

"There will be tons of data that need to be analyzed and computational models developed for understanding salinity response at the whole genome level," Walia said. "That requires a level of expertise that would be very hard to find in a single lab."

His collaborators include UNL statistician Dong Wang, plant breeder Aaron Lorenz and computer scientist Ashok Samal, as well as colleagues at the Australian Centre for Plant Functional Genomics, Cornell University and the International Rice Research Institute in the Philippines. A colleague

at Arkansas State University will coordinate training of predominantly minority students in the techniques.

Because crops share many genes, the team's findings also may improve understanding of salt tolerance in other cereals, such as wheat and corn.



Harkamal Walia



Investing in Math Teachers Adds Up to Success

If you want students to excel at math, invest in outstanding teachers.

Research indicates that enhancing teachers' skills is critical to significantly improving mathematics achievement. A new partnership between UNL faculty and the Omaha Public Schools aims to do just that.

A \$5.5 million grant from The Sherwood Foundation and the Lozier Foundation in Omaha supports a three-year collaboration between UNL's NebraskaMATH team and Nebraska's largest school district. Goals are to strengthen mathematics learning in OPS classrooms, narrow student achievement gaps between different populations and conduct research that informs school improvement efforts.

"Thanks to past support from the National Science Foundation, our NebraskaMATH team has a proven record of providing robust content-based professional development for teachers and research that studies teacher knowledge and student learning," said Jim Lewis,

"We believe that a dramatic investment in OPS mathematics teachers will impact student learning in the OPS district, both short and long term."



project leader and Aaron Douglas Professor of Mathematics. "We believe that a dramatic investment in OPS mathematics teachers will impact student learning in the OPS district, both short and long term."

The NebraskaMATH OPS Teacher Leader Academy consists of Primarily Math, a program for K-3 teachers; Math in the Middle, a master's degree program for grade 4-8 teachers; and fellowships for OPS K-12 math teachers to take courses at no cost through the Nebraska Math and Science Summer Institutes. The grant also supports six K-3 and two middle-grade math coaches for OPS.

The project expects to reach more than 250 OPS teachers over three years. The first teachers began graduate coursework in July 2013.

Throughout the project, UNL faculty will study the impact of professional development on teachers' beliefs and knowledge; student outcomes; and school culture's

impact on student achievement. They'll also establish a studio classroom as a model for implementing instructional change in K-3 classrooms. This project and its research results will provide a national model for effective mathematics teacher education, said Lewis, director of UNL's Center for Science, Mathematics and Computer Education.

The OPS Teacher Leader Academy builds on UNL's NSF-funded teacher education initiatives – Math in the Middle, NebraskaMATH and NebraskaNOYCE. Nearly 75 OPS teachers have participated in those programs, forming a base of teacher-leaders for the current project.



Marni Driessen (top) and Connie Colton (above) in their Omaha Public Schools classrooms. Both graduated from UNL's NSF-funded teacher education initiatives and now are instructors for the NebraskaMATH OPS Teacher Leader Academy.

Above center: Jim Lewis instructing teachers

UNL-French Connection Creates New Composite

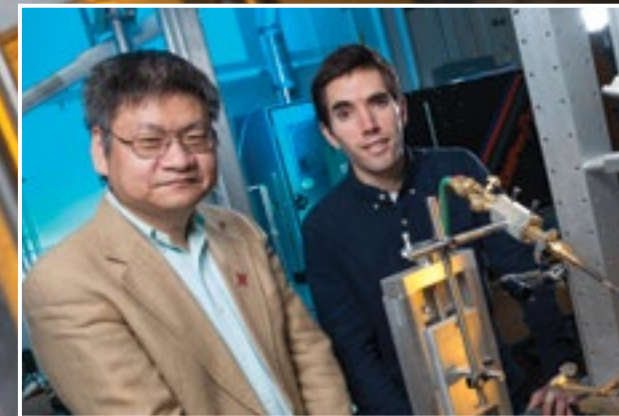
Thermal-conducting superstars diamond and copper would make a great team to cool increasingly powerful and heat-generating electronics. An international collaboration between UNL engineers and French researchers has created a diamond-copper composite material that maintains characteristics of both.

Diamonds are exceptionally hard and corrosion resistant. Yongfeng Lu, Lott Distinguished Professor of Electrical Engineering, has developed a technique using lasers to grow nano-thin films of diamond particles. It is less expensive than current methods. But diamonds also are brittle and difficult to mold.

Materials scientist Jean-François Silvain of the Institute of Condensed Matter Chemistry at the University of Bordeaux, France, has developed a technique to mold copper, similar to that used for making ceramic pottery.

Together, the two researchers and colleagues developed a method to join copper and diamond particles into a composite material that is both rugged and flexible, as well as thermally conductive.

"The diversity in ideas, diversity in culture gives us many more angles to figure out the whole picture much more effectively," Lu said.



Yongfeng Lu and Thomas Guillemet

Thomas Guillemet, the first student in a joint program between the two universities, was the bridge.

"We made this material bind together, which for diamond and copper is very difficult because they don't like each other very much," said Guillemet, who graduated with doctorates from both universities in August 2013.

The French student learned techniques that he passed along to colleagues at each location. "It was an amazing experience for me," he said. "In addition to a scientific and professional aspect, the human enrichment is very strong in this program."

Guillemet's mastery of English and American culture will help him land employment in either the U.S. or Europe.

He also can point to the diamond-copper composite material he helped develop, which may help strengthen electronics subjected to harsh conditions like those found in airplanes and military equipment or vehicles.

UNL and the University of Bordeaux are recruiting additional students from both countries to participate in the joint program.

Outstanding Postdocs Strengthen Research

From basic lab research to applied field studies, postdoctoral fellows contribute to the breadth and diversity of UNL's research enterprise.

Christopher Chizinski and Alan Veliz-Cuba, winners of the 2012 Outstanding Postdoc Awards given by UNL's Office of Postdoctoral Studies, exemplify these contributions.

Better management of Nebraska fisheries is Chizinski's goal for the Nebraska Angler Survey project. The Nebraska Cooperative Fish and Wildlife Unit at UNL and the Nebraska Game and Parks Commission collaborate on the annual survey of up to 15,000 anglers, which shows the impact of recreational fishing on Nebraska lakes and reservoirs. Chizinski works with state biologists to improve survey methodology, including more accurate ways to track when and where people fish. A \$3.1 million grant from the commission supports this work.

The survey's findings also inform Chizinski's research on how predators – in this case, anglers – affect life-history traits of fish, such as reproductive age and offspring size.

Since 2010, Chizinski has co-authored 17 peer-reviewed articles and is a key contributor to research led by his mentor, fisheries ecologist Kevin Pope, assistant unit leader. Chizinski also has held Postdoc Advisory Council leadership positions.

Mathematical modeling enables Veliz-Cuba to unravel the complexities of biological networks. He found that Boolean networks can be used to predict how individual genes behave depending on the circumstances being tested. By assigning mathematical values to cell proteins, Veliz-Cuba can detect patterns in how proteins interact. This could give biologists valuable information about how a single gene change affects an entire biological network.

Mentors Carina Curto and Vladimir Itskov, assistant professors of mathematics, have used Veliz-Cuba's modeling expertise in new mathematical neuroscience projects.

While at UNL, Veliz-Cuba authored or co-authored 10 publications and was faculty adviser for the Nebraska Research Experience for Undergraduates in Applied Mathematics, a summer workshop funded by the National Science Foundation. He's now at the University of Houston.

"Chris and Alan exemplify what it means to be researchers, teachers and scholars," said Richard Lombardo, director of the postdoctoral studies office, a resource for professional and career development and support for postdocs and faculty. "Not only are they highly productive, innovative researchers, they are outstanding mentors to our students."



Top: Christopher Chizinski (left) and Kevin Pope
Above: Alan Veliz-Cuba





Hands-on Experience Instills Confidence

A white flower in an otherwise deeply pigmented population offers another clue for UNL student Latifa Obaidi, a veteran of UNL's Undergraduate Creative Activity and Research Experiences program, which enables students to assist with faculty research and launch independent projects that prepare them for work or graduate school.

The senior biochemistry major from Lincoln, Neb., studies how mutations in two genes, chalcone flavanone isomerase (CHI) and dihydroflavonol 4-reductase (DFR), affect certain pigments in *lochroma*, a genus of flowering plants, trees and shrubs. A white flower instead of blue, purple or red indicates a mutation in the genetic pathway.

She is comparing CHI, located higher in the pathway, and DFR to determine whether their locations within a pathway influence the rate of DNA changes. These genetic changes, and the speed at which they occur, can explain how traits like flower color evolve.

Understanding the relationship between gene mutation and evolution has applications beyond plant science, including human health. For example, cancer often begins with a "mistake" in a cell's DNA. Knowing where the mutation occurred and how that may affect the entire gene sequence could provide important clues about how cancer cells behave.

"Many of the same molecular activities occur in both plants and humans. They just have slightly different rules," Obaidi said.

She has gained real-world genetics research experience working for two years alongside Stacey Smith, her project adviser and assistant professor of biological sciences, and now conducts her own independent research.

Obaidi said she has developed valuable expertise from designing experiments and learning to interpret data, and the confidence to pursue her goal of becoming a physician and scientist after graduation in 2014. She's interested in genetics and oncology.

She also is a UCARE ambassador, encouraging other students to participate. Now in its 13th year, UCARE has become a national model for undergraduate research programs.

Obaidi is a "natural and patient mentor" to other students, Smith said. "I predict the growing number of outstanding students that participate in research at UNL will be one of the biggest contributors to our visibility as a research institution in the coming years."



Latifa Obaidi and Stacey Smith

Improving Rural Education

Nearly 10 million U.S. children attend school in rural areas, yet education research largely focuses on urban issues. UNL's National Center for Research on Rural Education leads the country in addressing the needs of rural schools.

"We have a broad mission to conduct research in rural settings, and also a leadership role for the country in terms of bridging the gap between research, practice and policy," said the center's director, Susan Sheridan, George Holmes Professor of Educational Psychology.

A national rural education conference in spring 2013 is an example of the center's leadership. Drawing participants from 18 states and the federal government, the conference emphasized the value of establishing partnerships among researchers, teachers, families and policymakers to solve long-standing problems, such as resource limitations and isolation. John White, deputy secretary for rural outreach at the U.S. Department of Education, addressed the need to attract talented educators to rural schools.

The center conducts research to understand education in a rural context and improve educational opportunities for

students and professional development for teachers in rural communities.

One study, for example, investigates professional development for teachers through distance learning, such as web-based coaching, email and social media. Another looks at improving reading instruction to struggling rural students using individualized assessment data. Yet another project assesses how collaborations between schools and parents influence young children's learning in rural settings.

Established in 2009 with a nearly \$10 million grant from the U.S. Department of Education's Institute of Education Sciences, UNL's is the only national center for rural education funded by the department.

"Assumptions are made all the time about rural schools and communities," Sheridan said. "What we're trying to do is learn firsthand from our partners in these communities about their strengths, their challenges and how researchers and practitioners can work together to enhance opportunities for children, families and educators."



Panel at 2013 National Conference on Rural Education Research



Developing Sensors to Enhance Rail Safety

Once a freight train leaves the station to rumble across the countryside, it's difficult to monitor the condition of railcars and their cargo. Potentially hazardous situations can develop undetected.

To improve safety in rail freight transportation, UNL computer and electronics engineer Hamid Sharif and his team are developing a wireless sensor network to provide real-time railcar monitoring that alerts the engineer to potential problems.

"The locomotive engineer needs to be aware of each railcar's status all the time, or an undetected problem could cause major problems, such as derailment, major leak or other issues," said Sharif, the Charles J. Vranek Distinguished Professor based at Omaha's Peter Kiewit Institute. "Currently, real-time monitoring isn't available for freight railroads. The engineer doesn't know if something happens in a car while the train is moving."



From left: Fahimeh Rezaei, Sushanta Mohan Rakshit, Pradhumna Shrestha and Michael Hempel

Wireless sensor networks use sensors to gather data. Information is sent hopping wirelessly across a web of these devices to a central location where it's collected and analyzed. Wireless networks can keep an eye on situations impossible to monitor otherwise, such as a moving train.

Sharif's network will use sensors to detect current conditions in each railcar, such as temperature, track status or wheel imbalances, and the presence of chemicals or radiation. This information will be sent wirelessly to the locomotive engineer, and even ahead to the next station or to headquarters.

Such real-time data can help prevent spoilage if refrigeration fails, monitor livestock conditions, detect intrusions or tampering, and identify malfunctioning parts to help prevent breakdowns or derailments.

Sharif's team designed a system to use standard technology, so trains from different companies or countries can communicate, improving convenience and safety. His system is now being field-tested at the Transportation Technology Center Inc., near Pueblo, Colo.

Sharif expects the new wireless sensor network to be available by 2015. A \$750,000 grant from the U.S. Department of Transportation funds this work. Omaha-based Union Pacific Railroad also supports this research.



Sensor mounted on railcar

"The locomotive engineer needs to be aware of each railcar's status all the time."



Hamid Sharif



NSF CAREER Awards Support Diverse Research

UNL researchers are developing novel ideas to harness the sun, cure genetic diseases and prevent software glitches with support from National Science Foundation CAREER awards.

These five-year awards support research by junior faculty who exemplify the role of teacher-scholar through outstanding research, teaching and the integration of education and research. Recent UNL winners are tackling diverse projects.

Harnessing the Sun



Jinsong Huang thinks solar energy devices will become so inexpensive and pliable that nearly any surface – from windows to clothing – will harness the sun. Scientists are working to replace today's silicon-based solar cells with organic polymers, or plastics, which are cheaper and more flexible, but less energy efficient.

With a \$400,000 CAREER award, Huang, assistant professor of mechanical and materials engineering, is improving the polymer's efficiency

as a semiconductor. By inserting ultra-thin layers of ferroelectric polymers, inexpensive materials that hold large permanent electrical polarizations on each side, he's able to increase a solar cell's internal electric field. That, in turn, generates more electrical current.

Organic polymer solar cells' low cost and increased pliability will lead to new applications and greatly expand the ability to capture the sun's energy.

Tackling Software Glitches



Developing today's complex computer software involves thousands of people working – sometimes at cross purposes – in numerous countries. Resolving inevitable glitches is expensive and time-consuming. A \$500,000 CAREER award supports Anita Sarma's work to develop software to help programmers work more efficiently, which will reduce costs and software defects.

Sarma, assistant professor of computer science and engineering, uses data-mining techniques to analyze the effects various tasks and file changes

had on previous programming efforts. That information allows her to make predictions about future programming. She'll use these predictions to develop software that can analyze, in real time, the current development situation and identify the best next task. So when a programmer finishes a task, the program analyzes what is happening and suggests tasks that avoid conflicting with others.

Sarma's solution will be available as a plug-in for Eclipse, a software development program.

Unraveling Clues to Prevent Restenosis

Linxia Gu uses powerful computers to better understand the biological mechanism of restenosis, a debilitating and sometimes fatal complication of a common treatment for coronary heart disease and other conditions. Propping open clogged arteries using tiny mesh tubes called stents sometimes leads to strokes or heart attacks when vascular cells react by making new cells that restrict blood flow.

With a \$406,248 CAREER award, Gu, assistant professor of mechanical and materials engineering

and a member of UNL's Nebraska Center for Materials and Nanoscience, is building computer models to understand the changes cells undergo and how those changes relate to alterations in arterial tissue structures.

This knowledge will help researchers improve prevention and treatment options, and help manufacturers design better stents. The technique also could be used to interpret other clinical observations, such as aortic aneurysms and traumatic brain injuries.



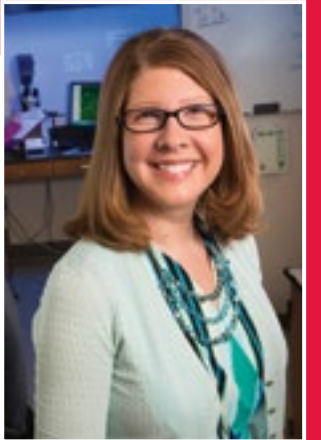
Devising Gene Delivery Tools

Gene therapy holds tremendous potential, but it requires an effective, safe method of delivering genes to cells.

Angela Pannier, associate professor of biological systems engineering and a member of the Center for Nanohybrid Functional Materials, earned a \$419,051 CAREER award to develop 3-D nanostructured surfaces to use as gene delivery tools. The surfaces have columns, and the spaces between columns can be loaded with DNA,

similar to a toothbrush holding toothpaste. Touching the nanostructure to the cell unloads the DNA. She's also designing nanostructured surfaces that alter cells to make them more receptive to receiving genes.

This method allows cells to use genes without incorporating them into their chromosomes. Potential uses include reducing post-surgery inflammation, promoting bone integration after a hip implant and treating genetic diseases.



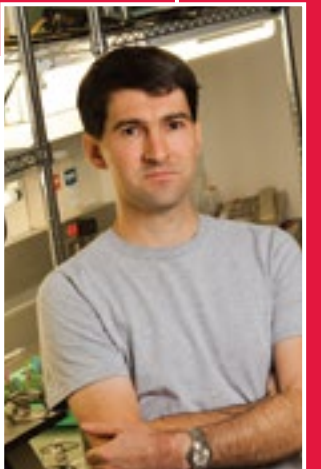
Studying Coenzyme Q

Gilles Basset, associate professor of agronomy and horticulture, studies coenzyme Q, an elusive micronutrient found in nearly all organisms, including humans. This vital compound is so fragile that conventional research approaches can't reveal many aspects of its production.

With a \$784,820 CAREER award, Basset, a member of UNL's Center for Plant Science Innovation, is harnessing computer power to identify the genes involved in coenzyme Q synthesis. Using bioinformatic techniques, such as comparative

genomic data mining, he looks for associations within the entire genetic makeup of different types of organisms. Organisms that synthesize coenzyme Q should have genes in common that are missing in those that don't. Additional techniques further narrow the list of gene candidates by identifying similarities in how genes are expressed.

Basset's research may lead to improving plant-based foods and human health.





Research Highlights

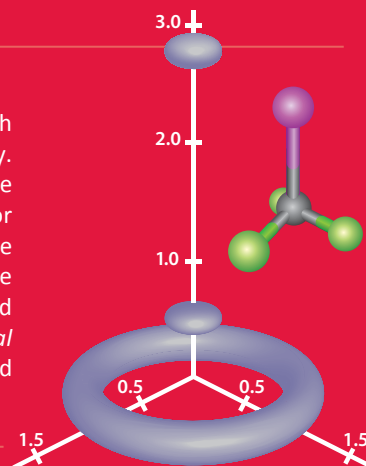


Tough, Strong Nanofibers

UNL materials engineers have developed a structural nanofiber that is both strong and tough – two properties once thought mutually exclusive – that could transform everything from airplanes and bridges to body armor and bicycles. Most advanced fibers are strong, but can break relatively easily because they lack toughness. To compensate, engineers use more material, which makes airplanes and other products heavier. Yuris Dzenis and colleagues created an exceptionally thin nanofiber and found that by making it even thinner, it became both stronger and tougher. Tougher structural materials would allow products to be both lightweight and safe, said Dzenis, R. Vernon McBroom Professor of Mechanical and Materials Engineering. Their findings were featured in *ACS Nano*. The National Science Foundation, the Air Force Office of Scientific Research and a U.S. Army Research Office Multidisciplinary University Research Initiative grant fund this research.

Capturing Ultra-fast Molecular Change

Molecules that react to light undergo structural changes so fast – in less than 1 trillionth of a second – that the initial stages of photosynthesis and vision remain largely a mystery. UNL physicist Martin Centurion and colleagues discovered a way to use lasers to capture 3-D images of molecules undergoing these super-fast structural changes. It's a major advance toward studying how light energy is converted into chemical energy. It may one day lead to better alternative energy sources, help solve vision problems and improve skin cancer prevention and treatment. To prove their technique works, they created an image of a simple five-atom molecule and reported results in the journal *Physical Review Letters*. A \$750,000 Department of Energy Early Career Research Program award supports this research.



International Water-Food Challenges

Improving food production and water management in the Middle East and North Africa was the focus of a visit to UNL by the international Founders Committee of the Middle East and North Africa Network of Water Centers of Excellence in early 2013. Chancellor Harvey Perlman is vice chair of the seven-member committee, which is charged with implementing the new Water Centers of Excellence network. The network links technical institutes across that region with U.S. institutions, such as the university's Robert B. Daugherty Water for Food Institute. The visitors learned about UNL's water and food research expertise and discussed how the Daugherty Institute could help address the region's water challenges. In 2012, NU and the U.S. Agency for International Development signed an agreement to expand research and development capacities to support the network's goals.



Microbes and Moqui Marbles

Microbes helped form Moqui marbles, unusual balls of rock found in southwestern U.S. sandstone, roughly 2 million years ago. That discovery by UNL geomicrobiologist Karrie Weber and colleagues has implications for finding life on Mars and for better understanding Earth's past. Moqui marbles have a soft, sandy interior and a hard, round shell made of iron oxide. Weber learned that microorganisms feeding on a mineral rich in iron carbonite began the process that created the marbles, which range in size from BBs to cannonballs. Knowing that life could persist in this type of rocky, iron-rich environment provides a guide for searching for life elsewhere on Earth, or even on Mars, where similar structures have been found. Weber's team included UNL geoscientists Richard Kettler and David Loope, Othmer Schultz Professor of Stratigraphy, and researchers at the University of Western Australia. This research was featured on the cover of the journal *Geology*.

Press Acquires Potomac Books

The University of Nebraska Press acquired Potomac Books in early 2013. "Potomac Books has an excellent reputation for producing fine books in fields that fit perfectly with University of Nebraska Press's catalog," said Donna Shear, UNP director. Potomac Books continues to conduct business as usual, building on its strong roots in military and general history, world and national affairs, foreign policy, defense and national security, terrorism, intelligence, memoirs and biographies, and sports history. UNP is the largest and most diversified university press between Chicago and California, with nearly 3,000 books in print. It's best known for publishing works in indigenous studies, history and literature of the American West, translated literature and sports history. UNP signed a collaborative agreement with the Jewish Publication Society in January 2012 to edit, publish, market and distribute its books.



Interdisciplinary Dance Exploration

UNL's Lied Center for the Performing Arts and partners are teaming with the groundbreaking dance company, STREB, on an interdisciplinary exploration of dance in spring 2014. The project involves UNL students from dance, theater, gymnastics, architecture, and computer science and engineering, and faculty from several departments, along with local K-12 students, teachers and community members. The project will culminate with a public performance at the Lied Center. UNL dancers and gymnasts, under direction of STREB members, will provide student matinees and workshops based on STREB teaching techniques to local schools in spring and fall 2014. A National Endowment for the Humanities grant helps fund this project, which aims to increase accessibility and appreciation of modern dance for Nebraska audiences.



Research Highlights



Telling the Story of Marginalized Women

Research on street-level prostitution tends to focus on statistics and demographics but provides little insight into prostitutes as women. UNL family scientist Rochelle Dalla decided to tell the stories of marginalized women in Nebraska and around the world through her research. For the past two summers, she has interviewed brothel workers in Mumbai, India, to better understand their lives and the sex trafficking trade, particularly the cycle that leads children of brothel workers into the sex trade. “I wanted to give these marginalized women a voice,” she said. She’s analyzing the interviews and hopes her research informs efforts to help women in the sex trade. Dalla, a member of UNL’s Human Trafficking team, also has studied prostitution in Omaha, Neb., and published her findings in the 2006 book, *Exposing the “Pretty Woman” Myth*.

UNL Team Evaluates Army Program

The U.S. Army strives to increase the health of its soldiers through a program that addresses both psychological and physical fitness. UNL College of Business Administration researchers partnered with the Army through private contractor TKC Global to evaluate the Comprehensive Soldier Fitness Program. Analysis by Peter Harms, assistant professor of management, postdoctoral research associate Dina Krasikova and research analyst Mitch Herian indicated the fitness program is achieving its goals, which include offsetting the effects of post-traumatic stress disorder. Learning to regulate emotions effectively helps soldiers develop strong relationships and avoid drug and alcohol abuse, depression and anxiety. The research showed that emotionally healthier people are more likely to be promoted within the Army and receive awards, which helps with retention.



Surprising Mosaic Discovery Yields Insights

A massive mosaic unearthed in Turkey by a UNL team is providing new insights about the Roman Empire’s reach and cultural influence during the third and fourth centuries AD. UNL’s Michael Hoff, Hixson-Lied Professor of Art History, directs the archaeological excavation. The meticulously crafted, 1,600-square-foot mosaic of decorative handiwork was part of a Roman bath. Hoff said it’s surprising to find a mosaic of this size and caliber in the area. It demonstrates the empire’s strength in this far-flung region. “We’re beginning to understand now that it was more Romanized, more in line with the rest of the Roman world than was suspected before.” Hoff leads a team of students and scholars from UNL and other U.S. and Turkish universities, as well as local residents and colleagues from Atatürk University working on the project.

Better Nuclear Reactor Materials

A UNL engineer is developing a composite material that could lead to safer and more efficient energy production in current and advanced nuclear reactors. Michael Nastasi, Nebraska Center for Energy Sciences Research director and Elmer Koch Professor of Mechanical and Materials Engineering, is teaming with researchers at the Massachusetts Institute of Technology and Texas A&M on this project, funded by a \$980,000 Department of Energy grant. Nuclear fission releases highly energetic particles from metal alloy-clad fuel rods. But the particles can damage the fuel rods at atomic levels, which can lead to a loss of mechanical integrity and even catastrophic failure. Nastasi aims to develop a ceramic-based nanostructured composite with an unorganized, or amorphous, molecular structure that allows it to recover its original configuration after particle bombardment. The material also will contain iron, providing a radiation sink at the material’s interface and another layer of protection.



UNL photojournalism student Matt Masin’s photos of Brazil

Student Journalists Visit Brazil

Gaining international reporting experience and learning about emerging cultures has become a tradition for UNL photojournalism students. Ten students traveled to São Paulo, Brazil, during the 2013 winter break to capture photos, videos and stories for a multimedia project highlighting the country’s pressing issues. Led by Bruce Thorson, associate professor of news-editorial, the group spent three weeks documenting the landless farmers’ movement, services for children with physical disabilities and drug abuse rehabilitation centers. A gift from prominent photographers Howard G. Buffett, Thomas Mangelsen and Joel Sartore supports the biannual trips. Previous groups traveled to India, Kazakhstan, Kosovo and South Africa.

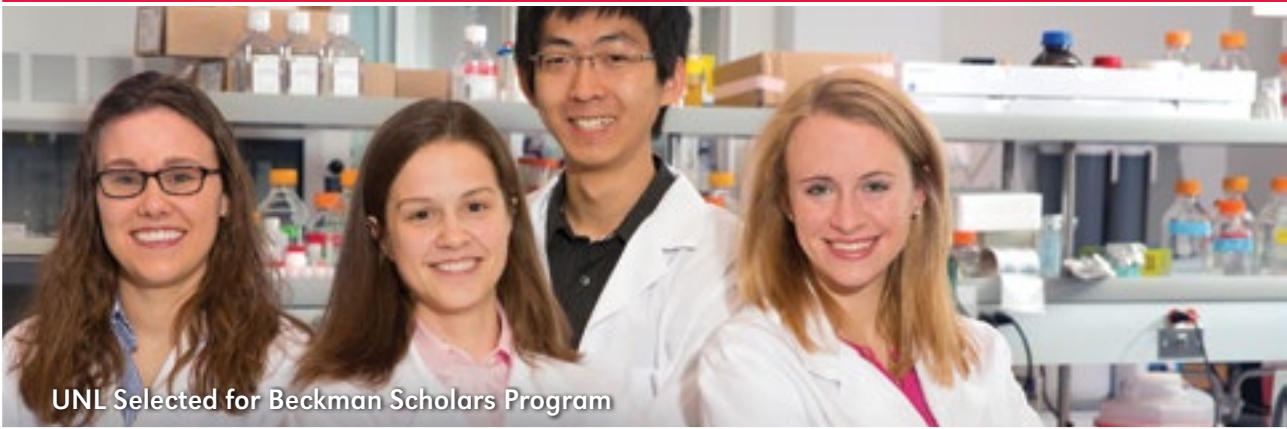


Childhood Hunger Linked to Adult Pain, Depression

Children who often go hungry are at high risk of experiencing depression and chronic pain as adults, a UNL study found. Sociologist Bridget Goosby examined results from the National Comorbidity Survey Replication, looking for relationships between circumstances in childhood and physical and mental health as adults. “The most robust child socioeconomic condition was experiencing hunger. Kids who missed meals have a much higher risk of experiencing pain and depression in adulthood,” she said. Her study, published in the *Journal of Health and Social Behavior*, also found that having a depressed mother correlated with adult-age depression and that the children of parents with less than 12 years of education were at higher risk of experiencing chronic pain as adults than those with more highly educated parents. The National Institutes of Health’s National Institute of Child Health and Human Development funded this research.



Research Highlights



UNL Selected for Beckman Scholars Program

UNL was one of 10 U.S. institutions selected for the prestigious Beckman Scholars Program in 2013. The \$115,000 award provides interdisciplinary fellowships to undergraduates conducting research in chemical and biological sciences alongside faculty mentors. The four students selected as the first UNL Beckman Scholars are part of an elite Beckman Scholars Community in which all scholars live in the same residence hall, participate in specialized events with high-achieving students from other disciplines, take part in leadership and professional development programs, and receive individualized support for graduate school applications. Each student’s goal is to have his or her work published in a peer-reviewed journal.

Above: First UNL Beckman Scholars, from left, Ashley Thelen, Valerie Eckrich, Qianli Wang, Jessica Chekal

Good or Bad Mutation – It Depends

A genetic mutation’s reproductive survival was traditionally thought to depend on whether its effect was good, bad or inconsequential. However, UNL research published in *Science* shows the dichotomy between “good” mutations and “bad” may be more complicated than once thought. Evolutionary biologist Jay Storz and colleagues at UNL and Aarhus University, Denmark, found that whether a given mutation is good or bad often is determined by other mutations associated with it. Studying genetic variation in the hemoglobin protein in deer mice populations from different elevations, they found certain individual mutations that increased hemoglobin’s binding affinity for oxygen in some mutational combinations, but decreased it in others. Because these mutations have context-dependent effects, the order in which mutations occur can determine which pathways evolution is more likely to follow, said Storz, Susan J. Rosowski Professor of Biological Sciences. The National Institutes of Health’s National Heart, Lung and Blood Institute and the National Science Foundation funded this research.



Hibberd Leads UNL Extension

Charles Hibberd, former district director of the Panhandle Research and Extension Center, returned to UNL in fall 2012 as extension dean and director. He had been director of extension and associate dean of agriculture at Purdue University since 2007. Earlier, he led the Panhandle center at Scottsbluff for 13 years. He received a bachelor’s degree in agriculture, a master’s degree in animal science and a doctorate in animal nutrition from Oklahoma State University, where he was a faculty member for 12 years. UNL Extension, with a network of 83 offices throughout Nebraska, is part of the Institute of Agriculture and Natural Resources.

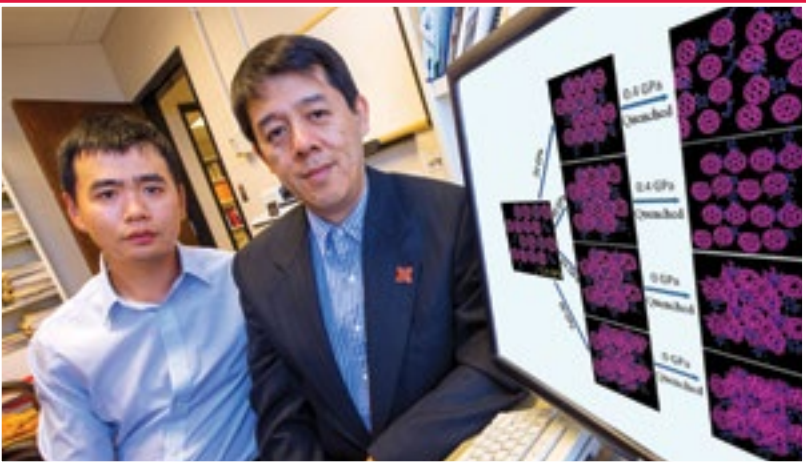
Busch Named UNL Libraries Dean

Nancy Busch is the new dean of the UNL Libraries. Busch served as interim dean for 11 months before becoming dean in July 2013. She previously was associate dean. Busch also has taught research methods courses and has extensive experience in evaluation and assessment initiatives for public, academic and state libraries. Before joining UNL in 2003, Busch was deputy director of the Nebraska Library Commission. Earlier, she directed library systems in Nebraska’s Panhandle and Gila County, Ariz., and worked for several other libraries. She earned a bachelor’s degree in experimental psychology and a master’s degree in library science from the University of Iowa and a doctorate in library science from the University of Michigan.



New Material Dents Diamonds

Diamonds are the hardest known material – at least they used to be. A research team that included UNL’s Xiao Cheng Zeng, Ameritas University Professor of Chemistry, has created a new form of matter so hard it can even dent diamonds. The recipe involves crushing buckyballs, well-ordered carbon structures resembling nano-sized soccer balls, under



Hui Li and Xiao Cheng Zeng

extremely high pressure. The magic ingredient is a solvent related to benzene that allows the buckyballs to collapse while maintaining an ordered structure. Zeng and postdoctoral researcher Hui Li used supercomputers at UNL’s Holland Computing Center and Oak Ridge National Laboratory in Tennessee to perform large-scale quantum molecular dynamics simulations to provide atomic insight into the material. The ability to preserve the super-hard, high-pressure structure in ambient conditions may provide important future practical applications, Zeng said. The discovery was reported in *Science*.

Preparing Mexico’s Judges for Legal Changes

U.S.-style oral arguments and cross-examinations will soon become part of Mexico’s legal system. In preparation for judicial reform, UNL law professor Steven Schmidt led a team of instructors that provided two weeklong trial advocacy courses for family law judges and magistrates of Mexico’s Superior Court. Participants learned every aspect of an oral adversarial trial as well as the judge’s role. Although the training familiarized participants with U.S.-style oral advocacy, it used facts and legal issues derived from Mexico’s judicial system. The collaborative agreement between UNL and Mexico’s Superior Court of Justice for the Federal District, signed in May 2013, builds on a partnership between the Universidad Nacional Autónoma de México and UNL’s College of Law. Previously, UNL provided advocacy training for Mexican lawyers for several years with funding from the U.S. Agency for International Development.



Research Highlights

Program Targets Human Biology

A new science education program – Biology of Human – will help the public, particularly young people, better understand recent biomedical research that has transformed scientific understanding of human biology. With a \$1.3 million grant from the National Institutes of Health’s Science Education Partnership Award, the University of Nebraska State Museum of Natural History and UNL researchers are teaming to create educational materials for use nationwide. Judy Diamond, the museum’s curator of informal science education, leads the project in collaboration with Charles Wood, Lewis Lehr/3M Professor of Biological Sciences and Nebraska Center for Virology director, and Julia McQuillan, sociology department chair. They’re working with nationally known science writer Carl Zimmer, multimedia developers and others to create the materials, such as comics, essays, interactive apps and a website.



Judy Diamond



Julia McQuillan



Charles Wood

Museum Named Smithsonian Affiliate

The University of Nebraska State Museum of Natural History became a Smithsonian Affiliate in 2013, joining an elite group of museums and organizations that partner with the internationally renowned Smithsonian Institution network. The university museum has long-standing research collaborations with the Smithsonian in entomology and vertebrate paleontology, as well as in education and outreach; three of the museum’s curators are Smithsonian research associates. Affiliate designation broadens opportunities for collaborations in research, traveling exhibitions, educational programs and loans from Smithsonian collections. “This honor strengthens and expands our relationships with the Smithsonian and will help us share more of the Smithsonian’s resources with Nebraskans,” Museum Director Priscilla Grew said.

Nebraska Lectures

The 2012-2013 Nebraska Lectures: The Chancellor’s Distinguished Lecture Series featured a small grains breeder and a physicist. In his fall lecture, P. Stephen Baenziger, Nebraska Wheat Growers Presidential Chair, presented “The Joy of Applied Science While Feeding the World.” He discussed the challenges of feeding a growing world population, possibilities for expanding food production and science’s role in solving these challenges. In his spring lecture, Timothy Gay presented “Football: Its Physics and Future.” He explained the history of American football, the physics of large forces on the field and the inherent dangers, and UNL and national research efforts to understand and mitigate injuries. The Office of the Chancellor, the Research Council and the Office of Research and Economic Development co-sponsor these lectures featuring prominent faculty.



UNL Research Fair

The biannual UNL Research Fair provides opportunities for faculty to explore priority research areas and for postdocs and students to attend professional development sessions. The fall 2012 event featured a workshop focused on UNL’s new Social and Behavioral Sciences Research Initiative, a supercomputing symposium and National Science Foundation Day. The fair also included presentations from representatives of the National Institute of Standards and Technology, a session on building algal biofuels and bioproducts partnerships, career planning sessions for postdocs and faculty recognition events. Featured speakers included George Wilson, Sean C. Kennan and John E. Snyder, NSF; Stella Fiotes and Lloyd Whitman, NIST; Kurt Johnson, Pennsylvania State University; Kevin Leicht, University of Iowa; L. Rowell Huesmann, University of Michigan; and Keith Micoli, New York University School of Medicine. The spring 2013 event focused on students, including a workshop on communicating about research and poster sessions for graduate and undergraduate students.



Top: NSF Day at UNL Research Fair
Above: Kevin Leicht (left), University of Iowa, visits with Ellen Weissinger, UNL’s senior vice chancellor for academic affairs.

College of Law Launches Doctorate in Space Law

The College of Law launched the nation’s only doctoral program in space law in fall 2013, expanding its leadership in space, cyber and telecommunications law. For the past five years, UNL has been the only U.S. law college to offer an LL.M., or master of laws, degree in space, cyber and telecommunications law, which has been offered online since the 2012-2013 academic year. The Doctor of Juridical Science, or J.S.D., program “is going to widen opportunities for experienced lawyers and legal scholars to delve into very intricate and complex issues facing the regulation of outer space activities in an in-depth manner,” said Matthew Schaefer, Law Alumni Professor and director of the college’s Space, Cyber and Telecommunications Law program.

Fossilized Feces Lend Clues about Diabetes in Native People

Native Americans’ increased susceptibility to diabetes has long been thought to stem from fat-hoarding “thrifty genes” acquired during ancient cycles of feast and famine. But an analysis of fossilized feces found in a Southwestern cave suggests the type of diet, not its frequency, may have led to the fat-hoarding genes. UNL forensic scientist Karl Reinhard and archeologist Keith Johnson of California State University, Chico analyzed fossilized feces for insight into what people in prehistoric hunter-gatherer civilizations ate. They found clues to a food regimen dominated by maize and high-fiber seed from sunflowers, wild grasses, pigweed and amaranth. Very high in fiber, low in fat and dominated by foods with limited effect on blood sugar levels, the diet could have given rise to fat-storing genes that today convey greater susceptibility to diabetes in people on a modern low-fiber, high-fat diet, Reinhard said. The study was published in *Current Anthropology*.



Accolades



James Alfano



Michael Nastasi



L. Dennis Smith

Three Named AAAS Fellows

James Alfano, **Michael Nastasi** and **L. Dennis Smith** were named American Association for the Advancement of Science Fellows in 2012. Alfano, Charles Bessey Professor of Plant Pathology, was recognized for notable research on plant pathogens. Nastasi, Elmer Koch Professor of Mechanical and Materials Engineering and director of the Nebraska Center for Energy Sciences Research, was honored for contributions in energy, manufacturing, nanotechnology and microelectronics. Smith, University of Nebraska president emeritus and School of Biological Sciences professor emeritus, was recognized for his work in developmental biology and education advocacy.



Brian Larkins



Prem S. Paul



James Van Etten

National Academy of Inventors Fellows Include Three from UNL

The charter class of National Academy of Inventors Fellows includes **Brian Larkins**, **Prem S. Paul** and **James Van Etten**. The distinction is a high honor for academics whose inventions have impacted quality of life, economic development and the welfare of society. Larkins, associate vice chancellor for life sciences and the John F. Davidson, Ph.D., and Marian J. Fuller, Ph.D., Chair in Life Sciences, is internationally known for contributions to plant molecular biology and plant agricultural biotechnology. Paul, vice chancellor for research and economic development, has extensively researched viral pathogenesis and holds 21 patents on methods for protection against swine viruses. Van Etten, William B. Allington Distinguished Professor of Plant Pathology and co-director of the Nebraska Center for Virology, has expanded understanding of the evolution of genes and genomes through his work isolating and characterizing icosahedral, dsDNA-containing viruses that infect certain green algae.

Faculty Recognized

- The Fulbright Program provided UNL scholars opportunities to expand teaching and research. **Karen Kunc**, Willa Cather Professor of Art, received a project specialist grant to teach a contemporary woodcut printmaking workshop at Dhaka University, Bangladesh, in spring 2013. **Gregory Rutledge**, associate professor of English and ethnic studies, is spending a year in South Korea studying the historical and cultural links between African-Americans and Koreans. **Alison Stewart**, professor of art history, will conduct research at the University of Trier, Germany, in spring 2014 for her book on the 16th-century painter and printmaker Sebald Beham.
- UNL mathematicians joined the American Mathematical Society's inaugural class of Fellows: **Luchezar Avramov**, Dale M. Jensen Chair in Mathematics; **Jim Lewis**, Aaron Douglas Professor of Mathematics and director of the Center for Science, Mathematics and Computer Education; **Judy Walker**, Aaron Douglas Professor; and **Roger Wiegand** and **Sylvia Wiegand**, professors emeriti of mathematics. **David Manderscheid**, former College of Arts and Sciences dean, also is a Fellow.
- **Wendy Katz**, associate professor of art and art history, received a 2013 Smithsonian Senior Fellowship to research her new book, *The Politics of Art Criticism in the Penny Press, 1833-1861*, which will delve into how critics' political and economic agendas influenced their points of view.
- **Matthew Dwyer**, Henson Professor of Computer Science and Engineering, was named an Institute of Electrical and Electronics Engineers Fellow in recognition of his often-cited research on software dependability, particularly methods for assuring correct operation of software used in transportation.
- **John Woollam**, George Holmes Professor of Electrical Engineering, won the 2013 Prize for Industrial Application of Physics from the American Physical Society. The honor recognizes excellence in the industrial application of physics and research. Woollam is founder of J.A. Woollam Co., a global leader in ellipsometry.
- **Alan Kamil**, George Holmes Professor of Biological Sciences and Psychology, received the Comparative Cognition Society's Research Award for his 40 years of work to understand animals' cognitive abilities in the context of their natural history.
- The American Society of Plant Biologists honored three UNL plant scientists in 2013. **Brian Larkins**, associate vice chancellor for life sciences and the John F. Davidson, Ph.D., and Marian J. Fuller, Ph.D., Chair in Life Sciences, won the Stephen Hale Prize for groundbreaking work in bringing together molecular biology and plant studies, leading to important discoveries in seed development. **Sally Mackenzie**, Othmer/Raikes Distinguished Chair of Agronomy, and **Ray Chollet**, emeritus professor of biochemistry, were named ASPB Fellows.
- **Anne Duncan**, associate professor of classics and religious studies, was awarded a Solmsen Fellowship from the University of Wisconsin-Madison Institute for Research in the Humanities. Duncan will spend a year at UW working on her book, *Command Performance: Tyranny and Theater in the Classical World*, about the connections between absolute rule and tragic drama in ancient Greece and Rome.
- **Joseph Turner**, Robert W. Brightfelt Professor of Mechanical and Materials Engineering, received a Friedrich Wilhelm Bessel Research Award from the Alexander von Humboldt Foundation. The award enables Turner to expand UNL's international reach through a research collaboration with Konrad Samwar of the University of Göttingen, Germany. They will examine the application of contact resonance atomic force microscopy and nanoscale mapping of the properties of bulk metallic glasses.
- "Homesteading on the Prairie," an essay by **Richard Edwards**, economics professor and director of UNL's Center for Great Plains Studies, was included in a historical portfolio that Congress presented to President Barack Obama at his second presidential inauguration. The volume showcased 2013 as the 150th anniversary of significant legislation and events. Edwards was invited to write about the Homestead Act, which took effect Jan. 1, 1863.
- **Kwame Dawes**, Chancellor's Professor of English and editor of *Prairie Schooner*, won *The American Poetry Review's* Jerome J. Shestack Prize. The award recognizes the authors of the best poems published by the APR's magazine during the past year. Dawes and fellow American poet Jorie Graham earned the honors as top 2012 contributors.

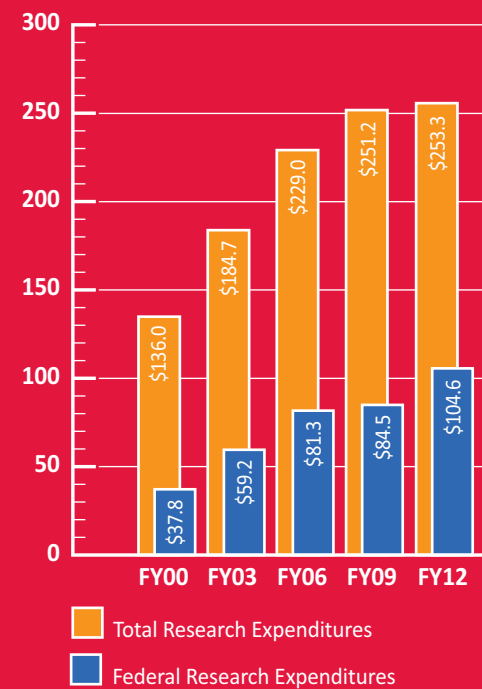


Financials

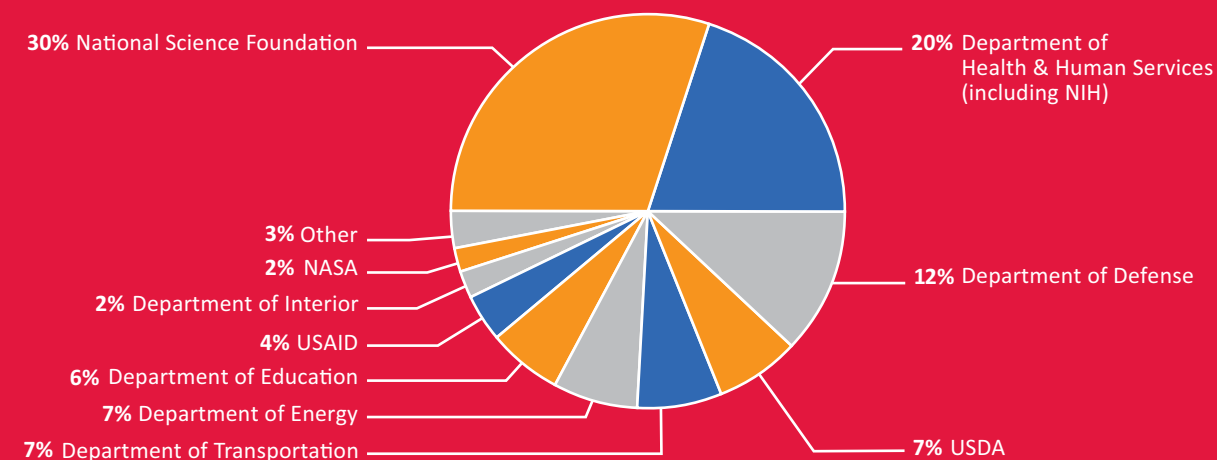
Research Expenditures

UNL's research expenditures totaled more than \$253 million in 2012, the most recent fiscal year for which expenditure information is available. This total included nearly \$105 million in federal research expenditures. The National Science Foundation accounted for 30 percent of UNL's federal research expenditures, followed by 20 percent from the Department of Health and Human Services, including the National Institutes of Health, and 12 percent from the Department of Defense. UNL's goal is to achieve \$300 million in total research expenditures by 2017, with at least half coming from federal agencies.

Total Research Expenditures
(in millions)



FY 2012 Percentage of UNL Research Expenditures by Federal Agency



Credits

The 2012-2013 UNL Research Report is published by the University of Nebraska-Lincoln Office of Research and Economic Development. More information is available at <http://research.unl.edu> or contact:

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