

2016

Annual Report



IDEA
EPSCoR
NEBRASKA

Experimental Program to Stimulate Competitive Research

(Cover) Work begins with Nebraska's new Center for Root & Rhizobiome Innovation: a Research Infrastructure Improvement (RII) Track-1 project funded the National Science Foundation (NSF) EPSCoR. Read more on page 4.

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*Experimental Program to Stimulate Competitive Research
Institutional Development Award Program*

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DIRECTOR'S MESSAGE

PLANT ROOTS REACH INTO the earth: anchoring downward and channeling resources upward from the soil, sustaining life. With our world's crops, this is where food begins.

Focusing on the root microbiome, referenced in the adjacent quote from *Science* magazine, reveals there's much more to know. Nebraska's five-year, \$20 million Center for Root & Rhizobiome Innovation (CRRI) project, funded by the National Science Foundation's EPSCoR program in 2016, digs for deeper understanding.

The hope is to identify plant traits and symbiotic microbes that could benefit modern crops. The effort could yield compounds that can be applied to plants or soil, but in the long run, scientists hope to find the genes encoding the exudate molecules that attract microbes and reintroduce them into modern crops.

— *Science*, Vol. 349, Issue 6249, Aug. 2015

Our research—by a team of plant scientists, computational biologists, and leading educators—applies multiple perspectives to help crops become more productive, and feed the world's growing population—even as droughts and diseases become more formidable.

It makes sense that this work is happening in Nebraska. Here, centuries of agricultural advances gather with expertise and facilities equipped to excel in addressing this grand challenge: mitigating hunger. Our EPSCoR collaboration aims to yield important discoveries: both food and food for thought.

Get to know CRRI, starting with the overview in this publication. We'll keep you posted on our progress.

F. Fred Choobineh

STATE COMMITTEE UPDATE

NEBRASKA EPSCOR'S STATE COMMITTEE—appointed by the governor—is comprised of 19 leaders from the state's industries, government and major research institutions. This group shapes the policies and priorities that guide Nebraska EPSCoR in its mission to advance transformative research and workforce development for the state.

Committee members serve three-year terms. In 2016 several terms ended, renewed or began; Nebraska EPSCoR thanks these leaders for their service:

REAPPOINTED:

- **Dr. Iqbal Ahmad**, University of Nebraska Medical Center (UNMC)
- **Dr. Kenneth Bayles**, UNMC
- **Dr. Michael Nastasi**, University of Nebraska-Lincoln (UNL)
- **Dr. Nick Stergiou**, University of Nebraska at Omaha (UNO)
- **Dr. Thomas Murray**, Creighton University
- **Dr. Scott Snyder**, UNO

LEAVING THE COMMITTEE:

- **Dr. James McClurg**
- **Dr. Raymond Ward**
- **Senator Ken Haar**

NEW APPOINTMENTS



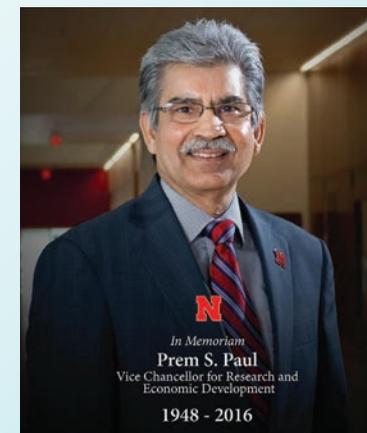
Dr. Jon P. Anderson is Manager of Advanced Research & Development with LI-COR Biosciences, Inc. in Lincoln. He earned a Ph.D. in Bioengineering from the University of Washington and holds an MBA from the University of Nebraska-Lincoln, where he also earned his bachelor's degree in Biology. He has worked with LI-COR since 2003. He also serves as an advisory board member with the Nebraska Business Development Center and has been a National Institutes of Health (NIH) Grant Reviewer, serving on more than 20 scientific review panels since 2009.



Ms. Gloria Thesenvitz is Founder and Chair of the Board with Nova-Tech, Inc. in Grand Island. She began the company in 1988 and has guided it through significant growth and technological change. She leads a staff of 50 and oversees operations in financial reporting, planning, forecasting and information systems; she led the completion of a new \$10.5 million, 50,000-square-foot, aseptic fill pharmaceutical manufacturing facility in 2011. She serves on the board of the Grand Island Chamber of Commerce and is active in the region's economic development.

IN MEMORIAM]

Dr. Prem Paul, Vice Chancellor for Research and Economic Development at the University of Nebraska-Lincoln and longtime member of the Nebraska EPSCoR State Committee, died in September, 2016. "We appreciate Prem's leadership contributions to the Coalition of EPSCoR States, as well as his enthusiastic efforts for the Nebraska research community," said Nebraska EPSCoR Director Fred Choobineh. "We value the presence of UNL's Interim Vice Chancellor for Research, **Steve Goddard**, on our committee until a permanent successor is established."





NSF AWARDS \$20M TO NEBRASKA FOR PLANT-SOIL RESEARCH

The National Science Foundation (NSF) awarded \$20 million to a Nebraska team for five years of collaborative research on soil-plant systems, focusing at the root and rhizobiome level: to investigate the interactions of plants and environment, specifically in plants' genome and phenome relationship, to aid crop productivity and help mitigate world hunger.

VIA NSF'S EXPERIMENTAL PROGRAM to Stimulate Competitive Research (EPSCoR) program, this grant establishes a Center for Root and Rhizobiome Innovation (CRRI) at UNL, engaging researchers from the University of Nebraska-Lincoln (UNL), University of Nebraska at Kearney, Doane University, and the University of Nebraska Medical Center.

Maize, or corn, is the primary subject of study, though the research aims to transfer to other crops. CRRI plant scientists, microbiologists, biochemists, geneticists and ecologists will:



UNL's **ED CAHOON** and **JIM ALFANO**, co-PIs for Nebraska's Center for Root & Rhizobiome Innovation, display plant roots. With funding from the National Science Foundation, the project studies crops' genome-phenome relationship, focused at the root level, to increase yield and help address world hunger.

- Work together to develop a systems-level understanding of root metabolism in maize by comparative analysis of plants' variation for predictive modeling.
- Quantify the chemical diversity of root exudates across maize genotypes and the impact of this diversity on rhizobioomes.
- Develop and implement synthetic biology tool sets for maize, to predictably alter root metabolism to:
 - a) test hypotheses of the role of exudates on root-rhizobiome interactions and plant performance, and
 - b) refine systems-level understanding of roots.
- Assess the effects of variant root exudate compositions on performance of plants and their rhizobioomes in response to abiotic stresses under greenhouse and field conditions.

The Center for Root & Rhizobiome Innovation group met for strategic planning (* indicates Management Team): *Front Row, Seated*, (L to R): **JAMES ALFANO*** (Co-PI, UNL); **EDGAR CAHOON*** (Co-PI, UNL); **TESSA DURHAM BROOKS*** (Doane University); **ETSUKO MORIYAMA*** (UNL); **FRED CHOOBINEH*** (PI, NE EPSCoR); **TIM VANREKEN** (NSF). *Middle Row:* **DANIEL SCHACHTMAN** (UNL); **NANCY SIMNITT** (NE EPSCoR); **JOSH HERR** (UNL); **PAUL TWIGG** (UNK); **RHAE DRIJBER** (UNL); **JULIE SHAFFER** (UNK); **ERIN DOYLE** (Doane); **TOM CLEMENTE** (UNL); **CYNTHIA PHILLIPS** (NSF). *Top Row:* **JOHN RIORDAN** (facilitator). **HARKAMAL WALIA** (UNL); **JAMES SCHNABLE*** (UNL); **JIRI ADAMEC** (UNL); **BABU GUDA** (UNMC); **KARIN VAN DIJK** (UNL); **SABRINA RUSSO** (UNL); **CAROLE WILBECK** (NE EPSCoR); and **LINDSEY MOORE*** (NE EPSCoR). *Not Pictured:* **MARK GRIEP** (UNL); **TOMAS HELIKAR** (UNL); **KARRIE WEBER** (UNL); **BIN YU** (UNL); **CHI ZHANG** (UNL); **FRED GARTNER** (NE EPSCoR).



Leading the grant is **F. Fred Choobineh**, Nebraska EPSCoR director and Blackman Distinguished Professor of Engineering; the project’s plant science leaders are **Ed Cahoon**, George Holmes Professor of Biochemistry and director of the Center for Plant Science Innovation at UNL, and **Jim Alfano**, Charles Bessey Professor of Plant Pathology with UNL’s Institute of Agricultural and Natural Resources.

In addition to the research, a set of workforce education and development activities to engage the next generation of scientists is taking shape. These activities form a workforce development pipeline: for middle school and high school students, as well as undergraduate

and graduate students, and postdoctoral scholars. Partnerships with Nebraska’s tribal colleges will create related curricula and further educate Native American students for science careers.

The Center for Root & Rhizobiome Innovation gathered in September 2016 in Lincoln for the group’s initial strategic planning meeting. With more than 20 researchers attending, plus National Science Foundation representatives, discussion flowed from an overview of the project—led by co-PIs Ed Cahoon and Jim Alfano—and outlined first year goals for the four research aims as well as the project’s education and workforce development activities.

NEBRASKA-KANSAS COLLABORATION MOVES AMO PHYSICS FORWARD

A Nebraska-Kansas collaboration in Atomic, Molecular and Optical (AMO) physics intensified its productivity this year. The three-year (2014-17) Research Infrastructure Improvement (RII) Track-2 project was funded by the National Science Foundation for \$6 million (which the two states share) and comprises two research thrusts. Year 2 highlights involving University of Nebraska-Lincoln (UNL) Department of Physics and Astronomy faculty include:

▶▶▶ THRUST 1

Probes imaging and controlling ultrafast dynamics of atoms and molecules using ultrashort pulses of electrons and light, ranging from the infrared to the hard x-ray part of the electromagnetic spectrum.

The experimental group of **Martin Centurion**—in collaboration with researchers at SLAC National Accelerator Laboratory in Menlo Park, CA and at Potsdam University, Germany—successfully imaged the rotation of nitrogen molecules using ultrafast diffraction of electron pulses having mega-electron-volt (MeV) energies. Changes in molecular geometry determine molecular reactivity, but imaging these changes has been a challenge. The nitrogen molecules were initially aligned using the electric field of an ultrashort laser pulse and began to rotate. Their rotation was imaged by changes in the diffraction pattern made by the scattered electron pulses. These results are a major advance in making atomically resolved movies of molecular reaction and were published in the high profile journal, Nature Communications.

A collaboration between the experimental groups of Martin Centurion and **Matthias Fuchs** finished the development and construction of a novel

electron beam source. The technology is based on laser-plasma interactions and can accelerate highly charged electron pulses to MeV energies over a distance of only tens of micrometers. The pulses' ultrashort duration of only tens of femtoseconds (a millionth of a billionth of a second) allow ultrafast electron diffraction experiments with the possibility of capturing electron diffraction patterns in a single shot. The first electron beams were successfully generated in summer 2016.

A team of Matthias Fuchs' and **Artem Rudenko's** (Kansas State University) work groups are developing a novel laboratory source of high-energy ultrashort X-ray pulses for planned X-ray experiments involving inner-shell excitations of atoms and molecules. A betatron source (essentially a synchrotron for electrons) has been built to produce the X-rays. In the setup, a velocity map imaging (VMI) spectrometer has been specifically designed to accommodate the large beam size of the hard X-ray source. The first characterization experiments of the X-ray radiation have been performed. This new hard X-ray source infrastructure will permit researchers to image molecular processes by ionizing the innermost electrons of the constituent atoms in a molecule.



(Left) Physics teachers' workshop participants; (Below) YNS High School Researcher **LAURYN WILLIAMS** works with UNL Physics and Astronomy Professor and Department Chair **DAN CLAES** on the Cosmic Ray Observatory Project.

▶▶▶ THRUST 2

Seeks to control electron motion in nanostructures using pulses of light. The work's focus on interactions of electrons and light in the vicinity of nanostructures helps integrate photonics and electronics.

In a collaborative experiment led by **Hui Zhao** (University of Kansas) with theory by UNL's **Xiao Cheng Zeng**, a bi-layer semiconductor heterostructure was formed of sandwich-like monolayers of MoS₂ and ReS₂—with both electrons and holes confined in the same layer. Because of their spatial overlap, their interaction with light is enhanced—yielding a prototype of a light emitting diode that reduces to nanometer-thickness. The results were published in *Nanoscale Horizons*, a new journal on nanoscience.

The research group of UNL's **Herman Batelaan** wrote an invited paper serving as a roadmap to help researchers define and achieve goals on how nanoscale electron sources open the emerging field of free electron quantum optics. This work may lead to previously unexplored technology such as quantum degenerate electron beams, or provide a new way to probe atoms and molecules, with use in electron microscopy. Research in Eindhoven (Netherlands), Goettingen (Germany), and Nagoya (Japan) is pursuing this technology.

▶▶▶ OUTREACH EFFORTS ENGAGE

IN SUMMER 2016, **TRACK-2** outreach included workshops for high school physics teachers and Young Nebraska Scientists' (YNS) participation in the project.

Brad Shadwick and **Cornelius Uiterwaal** led teachers from across Nebraska and Kansas through a three day professional development workshop at the University of Nebraska-Lincoln. These teachers received training on ways to implement hands on lab activities in their classroom curriculum.

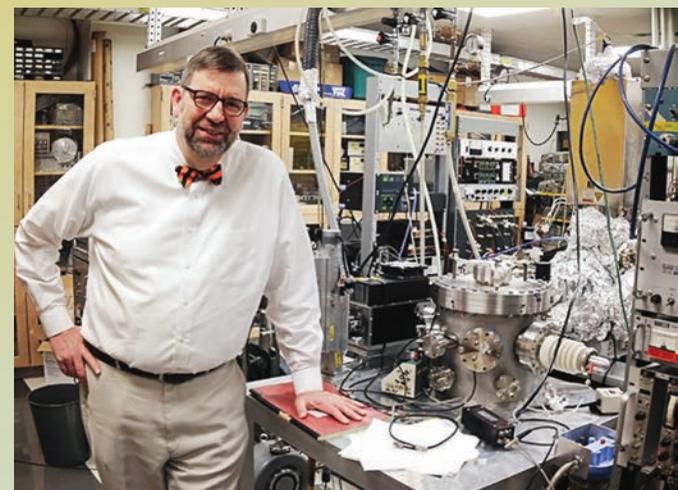
YNS High School Researchers worked with Track-2 researchers in the Department of Physics and Astronomy. **Lauryn Williams**, a junior at Lincoln Southeast High School worked with **Dan Claes** on the Cosmic Ray Observatory Project. **William Twehous**, a senior at Lincoln Pius X, worked with Brad Shadwick to further develop technologies being used in the Physics Teacher Workshops.



EXTERNAL ADVISORY PANEL CITES TRACK-2 ACCOMPLISHMENTS

A PANEL FROM LEADING universities praised the Year 2 efforts of the NSF EPSCoR-funded Ultrafast Physics collaboration between Kansas and Nebraska for “originality, a diverse science portfolio, established leadership, synergy between experiment and theory, and a group of young rising stars.” Hosted in Nebraska in 2016, the panel valued the project’s outreach efforts to broaden physics participation from youth to teachers, and it agreed the grant has fostered scientific collaboration within and across the science areas and between institutions—which would not have been possible without this EPSCoR grant. The panel concluded this Track-2 team is poised to pursue joint federal funding opportunities, and advised leveraging further key advisors and campus resources such as Nebraska’s Extreme Light Laboratory to earn a competitive advantage.

SUMMER RESEARCH AT NEBRASKA in 2016 included undergraduate students studying physics with faculty on the NSF EPSCoR Track-2 project. Participating in this Research Experience for Undergraduates (REU), sponsored via Nebraska EPSCoR, were (*photo below, from left*): **Jenny Banh**, from Smith College, who worked with Tim Gay; **Cody Newlun**, from Hastings College, who worked with Matthias Fuchs; **James Bork**, from Gustavus Adolphus College, who worked with Martin Centurion; and **Lucas Heppner**, from University of Arizona, who worked with **Don Umstadter**. Banh returned to UNL in autumn for the Women in Physical Sciences (WoPhyS) Conference and gave a talk on Precise Determination of Interference Filter Pass Wavelengths, based on her REU learning.



TRACK-2 RESEARCHER AND UNL Professor **Timothy J. Gay** was named Speaker Elect of the American Physical Society’s (APS’s) Council of Representatives, effective 2017.

The APS represents over 51,000 members: physicists in academia, national laboratories, and industry in the United States and throughout the world.

The Speaker of the Council presides over the Council of Representatives, focusing on all matters of science and membership, including science policy, and is a member of the APS Board of Directors.

Physicist **MATTHIAS FUCHS** works in a University of Nebraska-Lincoln laboratory. He is a researcher on a National Science Foundation collaboration and earned a Department of Energy Lab Partnership Award.

TRACK-2 SCIENTIST GETS DOE DISTINCTION



FUCHS EARNS DOE LAB PARTNERSHIP AWARD FOR NEBRASKA

THE DEPARTMENT OF ENERGY'S Office of Basic Energy Sciences awarded a DOE Lab Partnership Award to UNL Physics & Astronomy Assistant Professor **Matthias Fuchs**.

The three-year grant for \$594,760 began in July 2016 and funds Fuchs' research on fundamental nonlinear X-ray interactions with matter—pursuing novel effects and methods to increase their efficiencies.

Initially, these studies are aimed at the understanding of the underlying basic physics, which could then lead to the development of novel diagnostics. Such diagnostics could be applied in many scientific fields and used in supporting research ranging from improving materials to specifically steering chemical reactions and making them more efficient.

His team will investigate processes where multiple X-ray or X-ray and optical photons (particles of light) interact at the same time with a single atom. During this process, the photons are converted into a single higher-energy X-ray photon.

Under “normal” circumstances such a conversion does not happen, Fuchs said, but it can occur for extremely high light intensities. (Because the rate of the converted higher-energy photons depends nonlinearly on the incoming light intensity, these interactions are also called “nonlinear processes.”) Until recently, X-ray sources that can produce sufficiently high intensities did not exist.

Fuchs' group will use a completely new source of X-rays, called X-ray free-electron laser (XFEL), for these studies. XFELs are huge machines, more than a kilometer in length. Recently operational after decades of development, so far only two exist worldwide: one (called LCLS) at the SLAC National Accelerator Laboratory in California and the other (called SACLA) in Japan.

This project “takes advantage of the fact that that XFELs can produce extremely intense X-rays, which are more than a trillion (one thousand billion or 10^{12}) times brighter than the sun,” said Fuchs. “Our work will study in detail the response of matter to such high X-ray intensities.”

During a previous related experiment, Fuchs' team discovered an unexpected effect conflicting with expectations from existing theory and extrapolations. He added, “We will further investigate this effect and expand our studies to get a better understanding of this widely unexplored scientific territory.”



(Top) Drawing the atomic structure of neon; (Middle, L-R) REU teaching team includes **CALEB THOMPSON, MARK GRIEP, SARA RUBECK, ANNE HEINTZELMAN, KATIE GOERL, PHILIP YOX** and **TERIANNE HAMANDA**; (Bottom) Participants conducting experiments

TRACK-3 FRAMES CHEMISTRY CURRICULUM FOR SUMMER NATIVE YOUTH PROGRAM



ATTENDEES AT THE SUMMER 2016 Sovereign Native Youth Program (SNYP), led by the Nebraska Commission on Indian Affairs (NCIA), had great chemistry in their session this year.

University of Nebraska-Lincoln (UNL) chemistry professor **Mark Griep**—who leads a Track-3 grant from the National Science Foundation to expand science course offerings at Nebraska’s tribal colleges—added chemistry learning for the native youth, with help from six college students visiting the University of Nebraska-Lincoln (UNL) for a summer REU (Research Experiences for Undergraduates) opportunity.

Judi gaiashkibos, NCIA director, and **Scott Shafer**, assistant director, advise Griep on his NSF-funded “Framing the Chemistry Curriculum” Track-3 project. Griep returned the favor by sharing chemistry lessons in the SNYP sessions on July 29 at Doane University.

“We offered a five-part, hands-on activity for these 25 middle and high school students from across Nebraska,” said Griep. The activities were: extracting color from indigenous Nebraska plants, which local tribes used to dye fibers; using those paints to depict the atomic structure of neon (“Ne”); separating the pigments in those paints by paper chromatography and applying spectroscopy.

The REU students included volunteers from the 2016 UNL Chemistry Summer Research Program: **Caleb Thompson** of Seattle Pacific University, **Sara Rubeck** of University of Wisconsin-Platteville, **Anne Heintzelman** of Northwest Missouri State University, **Katie Goerl** of Kansas State University; **Philip Yox** of Concordia University, and **Terianne Hamada** of Whittier College.

“The REU helpers really enjoyed the experience,” Griep said, and added that two of the REU students appreciated when several SNYP students asked about the science behind the activities, valuing the college students’ chemistry expertise.





NEBRASKA BRAIN RESEARCHERS START A NEW COLLABORATION

IN 2016, THE NATIONAL SCIENCE FOUNDATION'S EPSCoR Program awarded funding to several "Track-2 Focused EPSCoR Collaborations (FECs)": multi-state team science efforts to research the brain or food-energy-water systems for better public health.

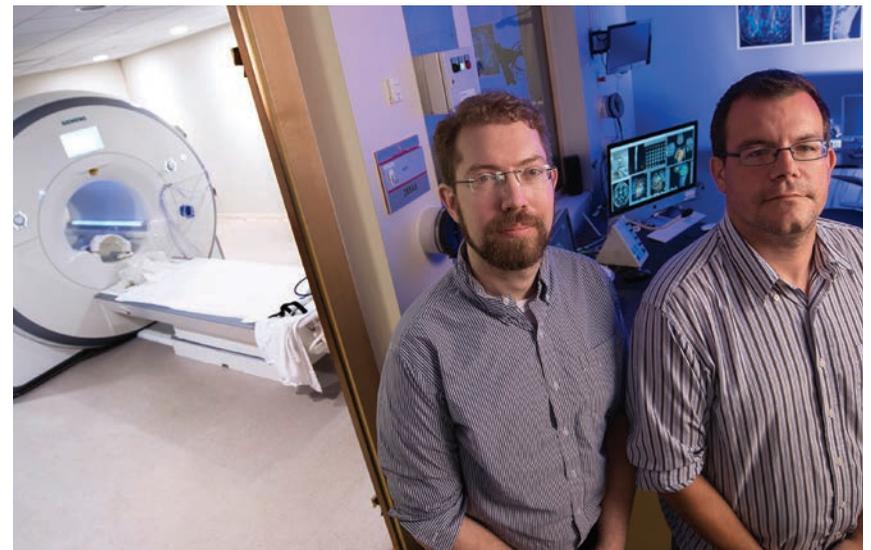
Nebraska is part of one project earning six million dollars to explore the reciprocal relationship between perception and knowledge: how humans pick up new information from the sensory environment, and how existing knowledge and expectations shape perceptions of the world.

University of Nebraska-Lincoln (UNL) Department of Psychology's **Mike Dodd**, an associate professor, and **Matt Johnson**, an assistant professor, are involved in the team's work to build infrastructure needed for excelling in cognitive neuroscience research. In addition to these two colleagues with UNL's Center for Brain, Biology and Behavior (CB3), the team includes faculty at the University of Delaware at Newark and the University of Nevada, Reno—forming a Lincoln-Reno-Newark (LRN) Coalition for the grant's four-year term.

The researchers have expertise in functional MRI, EEG, eyetracking, neuropsychology, and modeling—diverse and complementary areas, Johnson said, "so we'll be able to tackle problems as a group and come up with several

ways to investigate them." Nebraska's participation includes purchase of new equipment for neurostimulation experiments.

The project's plans include paths for training future neuroscientists. Undergraduates may attend a "brain camp" on frontiers being explored in cognitive neuroscience research. Graduate students and postdoctoral researchers can attend in-depth training workshops on various research techniques and data analysis, and will be able to complete rotations in labs at all three institutions. The new opportunities will aid recruiting of graduate students and postdoctoral researchers as well as new faculty members.



University of Nebraska-Lincoln leaders in the LRN (Lincoln-Reno-Newark) Coalition include (from left) **MATT JOHNSON**, assistant professor of psychology, and **MIKE DODD**, associate professor of psychology. This collaborative project to enhance cognitive neuroscience research was funded by the National Science Foundation.

UNMC ANNOUNCES 5-YEAR NIH IDEA AWARD FOR CLINICAL AND TRANSLATIONAL RESEARCH (CTR)



IN OCTOBER, THE UNIVERSITY of Nebraska Medical Center (UNMC) announced its largest grant to date: nearly \$20 million from the National Institutes of Health’s Institutional Development Award program (NIH IDeA), and involving partner institutions in four Plains states.

The funding will create the Great Plains IDeA-CTR Network: helping early career researchers develop into independent scientists and increasing the infrastructure and other resources needed to support clinical and translational research.

Matthew Rizzo, UNMC professor and chairman of the department of neurological sciences, is the project’s principal investigator. Rizzo said the work will focus particularly on expanding knowledge about approaches needed to address diseases of aging and brain health.

Partner institutions include the University of Nebraska-Lincoln, University of Nebraska at Omaha, University of Nebraska at Kearney and Boys Town National Research Hospital, as well as the University of South Dakota, University of North Dakota, North Dakota State University, and the University of Kansas Medical Center.

Jennifer Larsen, M.D.—UNMC’s vice chancellor for research and a member of Nebraska EPSCoR’s State Committee—described UNMC’s efforts in building “clinical/translational research resources steadily for almost a decade to prepare us to compete for this or other large clinical/translational grant awards.” She added: “Receiving this award shows we ‘have arrived,’ and the award itself will further expand the resources available for our faculty to continue to successfully compete on a national level.”

Clinical and translational research, said Rizzo, can take knowledge from “bench to bedside, cells to souls” in order to help people and improve their health.

Did You Know? Nebraska has Eight COBRE Programs:



Three at UNL

- CIBC (see article at right)
- Redox Biology Center
- Nebraska Center for the Prevention of Obesity Diseases through Dietary Molecules



Three at UNMC

- Center for Cellular Signaling
- Center for Nanomedicine
- Center for Molecular Biology of Neurosensory Systems



One at University of Nebraska at Omaha

- Center for Research in Human Movement Variability



One at Boys Town National Research Hospital

- Center for Perception and Communication in Children

UNL GAINS \$11.3M NIH COBRE FUNDING TO STUDY BIOMOLECULAR COMMUNICATION



A FIVE-YEAR, \$11.3 MILLION grant from the National Institutes of Health established the Center for Integrated Biomolecular Communication (CIBC) at the University of Nebraska-Lincoln (UNL), with two EPSCoR grant alumni—**James Takacs** from Chemistry and **Concetta DiRusso** from Biochemistry—leading the new center’s research projects.

Nebraska’s newest Center of Biomedical Research Excellence (COBRE), part of NIH’s Institutional Development Award program (IDeA), will study cellular-level miscommunications—caused by pathogens or environmental factors—which can contribute to complex diseases such as cancer and diabetes.

CIBC aims to foster interdisciplinary research collaborations by combining new techniques to investigate disease pathways that arise from miscommunication at the molecular level. Organizers envision the CIBC as a hub for interdisciplinary collaborations among Nebraska’s biomedical researchers. The center also will include faculty at University of Nebraska Medical Center, with the greater collaboration opportunities involving UNMC earning praise from UNL Chancellor **Ronnie Green**.

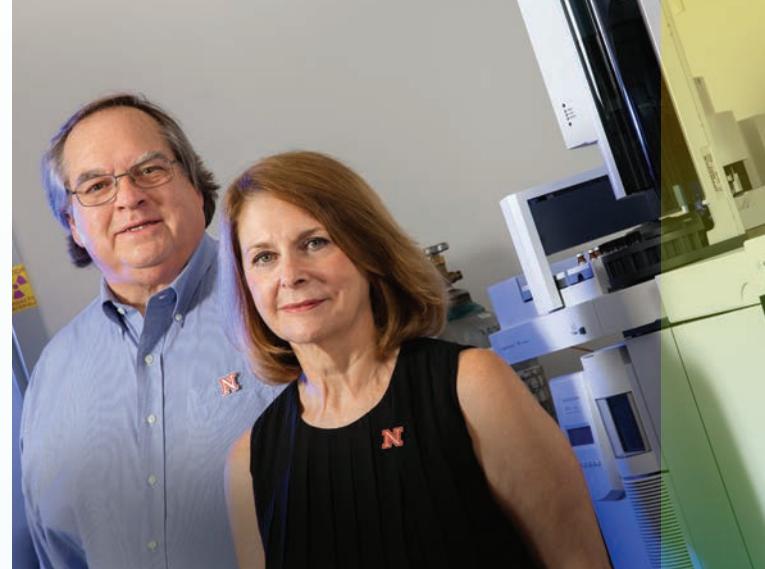
“We want the center to be a mixing chamber of ideas,” said center director James Takacs, Charles J. Mach University Professor of Chemistry. “The goal is to bring together outstanding researchers from several disciplines and to use the center to facilitate an integrated approach. An interdisciplinary team working together will bring a unique perspective to complex diseases.”

The center’s systems approach will engage research by chemists, biochemists, engineers and bioinformaticists; their collaborations may develop new molecular probes and analysis to better understand the mechanisms of diseases.

“Bringing in a multilevel approach to a problem opens opportunities that will make us more competitive and more effective in research,” Takacs said. “It’s basic research, but this is where the therapies of the future are going to come from.”

“The university has very successful Centers of Biomedical Research Excellence,” said co-director Concetta DiRusso, George W. Holmes University Professor of Biochemistry. “Those centers have helped build infrastructure and propelled the careers of young scientists in specific areas of biomedical research. We plan to build on those past successes.”

The NIH COBRE program funds health-related research and fosters faculty development and research infrastructure; it is managed by the National Institute for General Medical Sciences.



JAMES TAKACS and **CONCETTA DIRUSSO** lead UNL’s Center for Integrated Biomolecular Communication (CIBC), funded by the NIH COBRE program.

CAREER AWARDS BUILD SUCCESS

Nebraska EPSCoR FIRST Awards Solidify Steps for Finalists, Recipients

WHEN THE NATIONAL SCIENCE Foundation and Department of Energy announce annual Early Career Development Program honors for pre-tenure faculty, these “CAREER Awards” are a significant boost to the teacher-scholar recipients: a handful of scientists from across the nation. CAREER Awards—including substantial, multi-year funding—open the door to further outstanding research, education and the integration of these important pursuits.

To help Nebraska scientists prepare for these rigorous opportunities, Nebraska EPSCoR conducts a preliminary version of the CAREER Award process—called the FIRST Award. Each year, several dozen Career Award aspirants submit pre-proposals to Nebraska EPSCoR’s FIRST Award competition, with a select group of these applicants

meriting FIRST Award “Finalist” status; this year, 14 Finalists were chosen to move forward in the FIRST Award process with their proposals patterned after the CAREER Award format. All of the Finalists gain the value of expert reviews from the field, gathered through the FIRST Award evaluations.

Those selected from among the Finalists as FIRST Award “Recipients” gain Nebraska EPSCoR funding of \$25,000 for their further submission efforts toward the NSF CAREER Award—as well as the helpful reviews on their proposals. FIRST awards’ combination of support has equipped many Nebraska scientists for success in pursuing further distinctions.

▶▶▶ IN 2016, SEVERAL FIRST AWARD RECIPIENTS AND FINALISTS EARNED CAREER AWARDS:



Stephen Morin’s (*left*) research at the University of Nebraska-Lincoln (UNL) is a study in contrasts. An assistant professor of chemistry, he works on combining “hard, inorganic structures with soft, organic structures”—which he says yield “a diversity of properties applicable to many technologies,” including electronics and robotics. His expertise spans organic and inorganic classes of materials, and he also balances the rigors of research and teaching—earning recognition for promise in this path.

Morin was a Nebraska EPSCoR FIRST Award Recipient in 2015 and then received the National Science Foundation’s CAREER Award, with funding of \$649,474. He investigates how best to place rigid films on the surfaces of elastic polymers, reconciling the varied thermal and mechanical properties of these materials.

In addition to his FIRST Award, Morin also benefitted from attending a science communication workshop led by NSF with Nebraska EPSCoR. Conducting in-depth research and sharing it meaningfully with the public is another way scientists can develop their careers.

For **Jian Zhang** (*right*), assistant professor of chemistry at UNL, making chemistry more sustainable—by minimizing the use of toxic chemical reagents and precious metal reserves—is a priority. Zhang was a FIRST Award recipient in 2012, then went on to receive a five-year, \$527,154 NSF CAREER Award. He’s developing an organic-based catalyst that uses the sun’s energy to facilitate chemical reactions, with potential for cleaner fuel production.

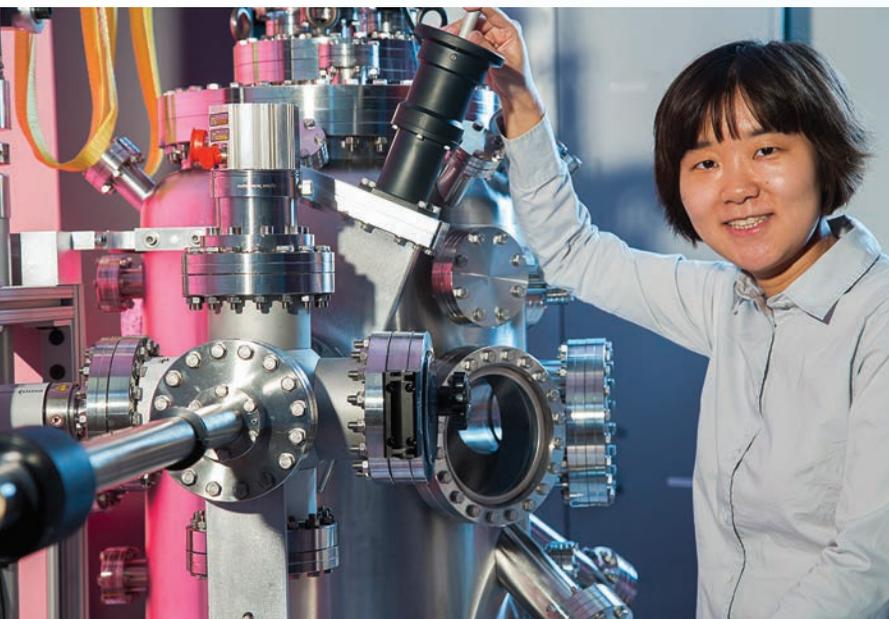
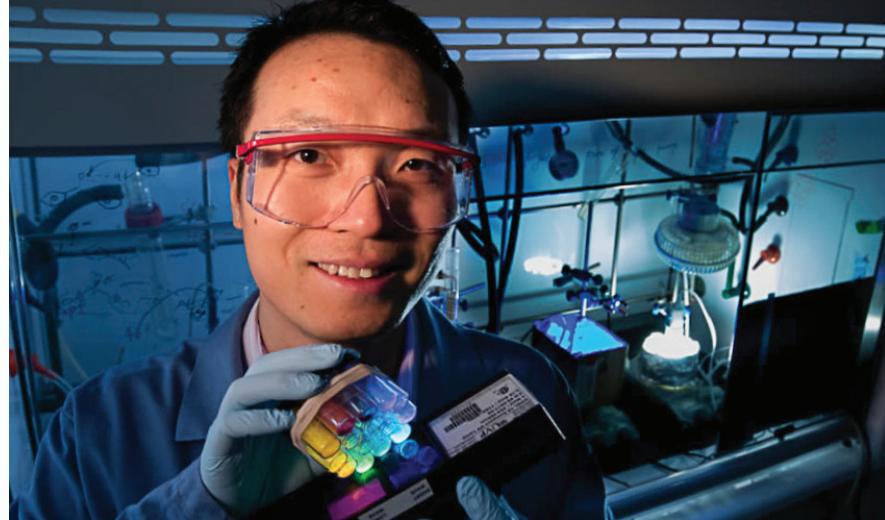
Solar power’s chemical reactions require a metal-based catalyst and Zhang aims to make those processes more sustainable with cheaper, organic materials. He created an organic catalyst: a nanomaterial with a porous organic framework, or POF. Its enhanced surface area aids chemical reactions and acts like a semiconductor, encouraging electrons to move when exposed to solar energy. His POF could also serve in improving solvents or synthetic gasoline and biodiesel.

With CAREER Award funding, he plans to create an online database of POFs to promote more widespread research using these materials. Working with the Nebraska Center for Materials and Nanoscience, Zhang is preparing 3-D models of nanoporous materials to augment youth science learning. His new chemistry ambassadorship program aims to help faculty and graduate students share their research with general audiences.

In 2011, UNL physicist **Xia Hong** (*below*) was a Nebraska EPSCoR FIRST Award recipient; she received an NSF CAREER Award in 2015. And through her 2016 U.S. Department of Energy Early Career Award—five years of funding, totaling more than \$750,000—the assistant professor augments her lab’s research with scanning probe microscopy equipment and additional scientists.

Hong aims to increase electronics’ data storage and functionality through nanoscale manipulation of extremely thin films by ferroelectricity. Altering materials’ polarization (alignment of positive and negative charges) through exposure to an electric field, she studies interactions of materials in combinations—to potentially generate new advances for versatility and reliability in materials’ magnetic and electronic behavior, for devices ranging from transistors to solar cells.

She focuses on creating programmable nanoscale patterns and controls, using a reconfigurable approach which allows her team to test different nanostructure designs on the same material platform. Success could enhance the material’s functionality or performance, or provide opportunities to observe new phenomena in quantum mechanics at this tiny scale.



NASA NEBRASKA EPSCoR



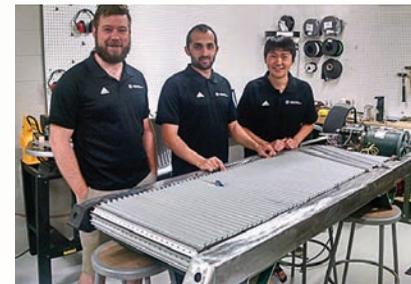
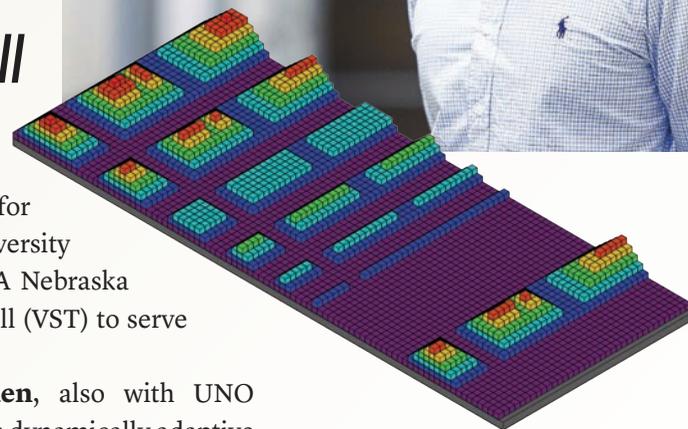
With NASA EPSCoR Mini-Grant, UNO Biomechanics Researchers' Treadmill Helps Space Travel, Mobility

WITH SPACE A "FINAL FRONTIER," astronauts could benefit from training for movement challenges in variable gravity settings. A team at the University of Nebraska at Omaha's (UNO) Biomechanics program received NASA Nebraska EPSCoR mini-grant funding for developing a Variable Surface Treadmill (VST) to serve space goers and help people on earth who have mobility challenges.

Kota Takahashi, assistant professor, and **Travis Vanderheyden**, also with UNO Biomechanics, are co-principal investigators for the VST which generates dynamically adaptive terrain. Maintaining and improving astronaut health during long-duration space operations is a critical objective of NASA's Human Exploration & Operations Mission Directorate. Simulating a variety of extra-terrestrial terrain conditions for astronauts during mission training can better prepare them for environments encountered during operational activities, and may help astronauts post-mission: to recover strength, balance, and motor skills subject to deterioration during extended periods of microgravity.

Takahashi and Vanderheyden's team also propose using the VST as a high resolution, variable robotics testing platform. By dynamically altering terrain surfaces, researchers can conduct a range of robotics control and mobility tests across a variety of terrains under specified conditions. Terrain simulation reduces robotics' development time and improves efficiency with testing across more environments in a shorter timeframe than traditional evaluation for a similar set of test cases and conditions.

As part of the VST design and testing, the team investigates basic principles governing sensorimotor functions in human locomotion. Knowledge gained in this area can be used to develop novel interventions to retrain people with mobility-affecting disorders, as well as astronauts returning from extended space flight.



(Top) **KOTA TAKAHASHI**; (Middle) Treadmill data; (Bottom, L-R) UNO Biomechanics' **TRAVIS VANDERHEYDEN, NIKOLAOS PAPACHATZIS**, and **KOTA TAKAHASHI** work on the variable surface treadmill

BIOMECHANICS SYMPOSIUM HIGHLIGHTS UNO PROGRAM

THE 2016 NEBRASKA RESEARCH & Innovation Conference (NRIC) took place October 13 with 100+ attendees at the University of Nebraska at Omaha. For 2016, Nebraska EPSCoR partnered with UNO's Department of Biomechanics on the event themed "Symposium on Biomechanics."

Speakers were biomechanics thought leaders including **Andrew Biewener** from Harvard University and **J.A. Scott Kelso** from the University of Florida Atlantic, as well as speakers from the University of Nebraska Medical Center, the University of Nebraska-Lincoln, and UNO.

Sessions included tours of UNO's NIH-funded Center for Research on Human Movement Variability, housed in the Biomechanics Research Building: a \$6 million facility built in 2013 and measuring 23,000 square feet, with labs focusing on movement issues related to peripheral arterial disease, stroke, chronic obstructive pulmonary disease (COPD), autism and more.

Nebraska EPSCoR thanks our speakers and State Committee member **Nick Stergiou**—UNO professor and Distinguished Community Research Chair in Biomechanics—whose team helped make this year's NRIC another success.



(Above) Nebraska EPSCoR Director **FRED CHOUBINEH** addresses the 2016 NRIC audience at the University of Nebraska at Omaha's Thompson Alumni Center; (Right) Students share their biomechanics research at the event's poster session.



New Outreach Coordinator Arrives

LINDSEY MOORE JOINED NEBRASKA EPSCoR in 2016 to lead the Young Nebraska Scientists programs and other Nebraska EPSCoR workforce development activities. Her bachelor's degree is in Secondary Education with a Natural Science Endorsement from the University of Nebraska at Omaha and she taught high school science in Omaha. While teaching, she earned her master's degree in Secondary Education, along with a graduate certificate of Instruction in Urban Schools. In her graduate work, she focused on researching how to better apply science and STEM instruction in urban schools. She is currently pursuing a Ph.D. in Educational Studies at the University of Nebraska-Lincoln.



Young Nebraska Scientists Adds Opportunities

IN 2016, YNS CAMPS covered new ground to interest youth in science careers for the future.

At University of Nebraska at Kearney's Department of Computer Science and Information Technology, Assistant Professor **Matt Miller** led a CyberSecurity camp for middle and high school students; more than 50 students attended and each kept his or her Raspberry Pi (small computing device) used for learning coding during camp.

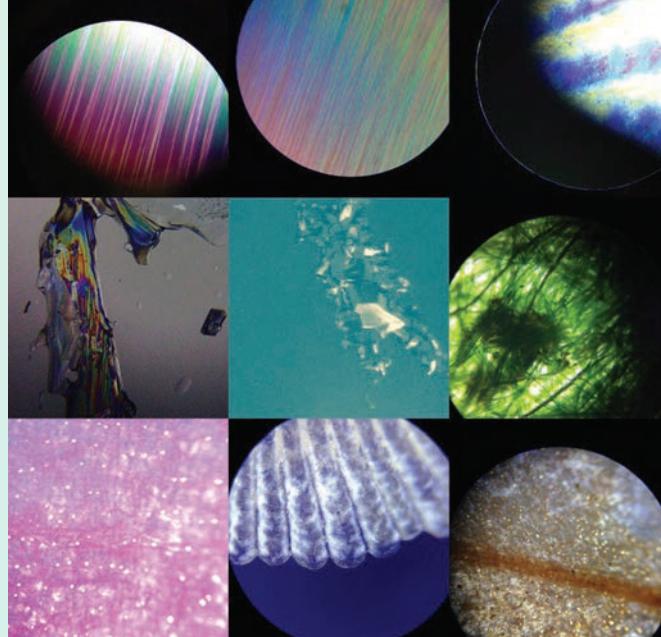
At Creighton University, Assistant Professor **Eric Villa** offered a "Secret Life of Metals" camp, focused on inorganic chemistry for middle school students.

YNS nanoscience camps brought high schoolers into UNL's Chemistry Department, and middle schoolers built their own microscopes using 3D-printed parts, thanks to camp leaders from the Center for Nanohybrid Functional Materials at UNL. YNS Algal Biofuels Camp continued at Doane University in Crete, and YNS Biodiversity and Field Science Camp at UNL's Cedar Point Biological Station had another adventurous year on the shores of Lake McConaughy in Ogallala.

Looking ahead to YNS camps in summer 2017, new camps will connect to Nebraska EPSCoR's new \$20 million grant from the National Science Foundation: Agricultural Biotechnology: Rooting for a Bright Future, and Life Underground: The Unseen Power of Microbes. The research aims to increase yield of plants, initially corn, and combat drought and disease for greater crop productivity to mitigate hunger among a growing world population. YNS participants in these camps will learn from UNK and UNL scientists using their expertise and top facilities to address global challenges.

YNS high school researchers (*right*) and camps are featured in new promotional videos made this summer. View the videos at yns.nebraska.edu, including the "Camps" and "Research" pages.





(Far right) **MCKENNA ARMSTRONG**, an 8th grader, was amazed with (and proud of) the images she obtained by taking cell phone photos (right) of everyday objects — onion skin, flower petals and fish scales — placed in her microscope.



YNS Campers Build Microscopes

A 2016 Young Nebraska Scientists’ camp gave middle schoolers a new view of the world—through their very own microscopes. The best part was, they built the microscopes themselves.

The Center for Nanohybrid Functional Materials has led YNS nanoscience camps with funding from the National Science Foundation, through Nebraska EPSCoR. **Charles Rice**, a Nebraska Engineering graduate student with CNFM, researched how to use a 3D printer to build plastic parts that could assemble with a lens (obtained separately) to make a microscope; he found that cellular phones or flashlights could be used as a light source with these homegrown microscopes, and students could observe stunning cellular level views of household items—to gain a sense of the “micro” scale along the way to understanding the (even smaller) nanoscale realm.

“It’s great that we gave the YNS campers this hands-on experience of building microscopes, so they can see themselves as makers now,” said **Lindsey Moore**, Nebraska EPSCoR’s outreach coordinator and YNS program supervisor. “This puts them even further along the path to becoming scientists.”

(Middle, bottom) Young Nebraska Scientists explore new worlds at tiny scale using microscopes they built during YNS nanoscience camp.



NEBRASKA EPSCoR SUPPORTS SCIENCE COMMUNICATION BOOST TO BROADER IMPACTS



On a warm, late September evening, downtown Lincoln's Railyard area was swarmed with scientists engaging the public in fun and learning.

►►► **NEBRASKA'S HOSTING OF A** National Alliance for Broader Impacts (NABI) conference gathered hundreds of researchers seeking to grow the greater good through their funding.

Federal funders encourage grantees to make their projects more meaningful by outreach to engage wider audiences and develop STEM talent, especially among underrepresented groups such as racial and geographically underserved communities.

NABI guests in Lincoln gained and shared inspiration and information at a concurrent #SciComm workshop, with sponsors including Nebraska EPSCoR.

UNL School of Biological Science's Post-Doctoral Research Associate **Matt Wilkins** led a planning group that coordinated sessions ranging from "Science Storytelling" to "Networking Researchers and Farmers."

SciComm evening activities invaded the Railyard (a public gathering space in the downtown Lincoln Haymarket area) for a public "Science Slam" and "speed dating" interactions on science topics.

Special guests in the game show experience included faculty and students from Doane University's Biology Department (*right*), featuring leaders of Nebraska EPSCoR's Young Nebraska Scientist camps. For more information about Nebraska's #scicomm organization, see nescicomm.com.

Students and faculty from Doane University shared their smiles and science expertise.





SMALL COLLEGE UNDERGRADUATE RESEARCH EXPERIENCES

To increase undergraduate research opportunities at Nebraska's smaller colleges and universities, Nebraska EPSCoR offers funding up to \$5,000 per project for collaborations in science, technology, engineering and math (STEM) areas. Faculty and students involved in the selected proposals report their project results to Nebraska EPSCoR and often present their research in scientific publications and at conferences. The 2016 recipients were:

TYLER MOORE

Department of Biology, Bellevue University

"Interplay Between Tregs and B cells During Persistent Viral Infection"

ALLEN THOMAS

Department of Chemistry, University of Nebraska at Kearney (UNK)

"Identification of Functional Groups to Improve LAT-1 Substrate Activity of Amino Acid Analogs"

KEITH GELUSO

Department of Biology, University of Nebraska at Kearney (UNK)

"Ecology of Two Mammalian Species of Concern on Freely Flowing Rivers in New Mexico"

BARBARA CLEMENT

Department of Biology, Doane University

"Groundwater-Seep Geomicrobial Environments of the Niobrara Valley and their Implications for Regional Microbial Diversity and Life Beyond Earth"

AUSTIN MOHR

Department of Mathematics, Nebraska Wesleyan University

"Spanning Subgraph Isomorphism Using Cut Vertices"

DUNESH KUMARI

Department of Chemistry, College of St. Mary

"Quantitative and Qualitative Analysis for Simultaneous Detection of Curcumin and Resveratrol for the Development of a Synergistically Acting Novel Drug Delivery System"

NSF EPSCoR CO-FUNDING

In 2016, National Science Foundation co-funding brought \$4.11 million to Nebraska; \$1.96 million of that year's total was from NSF EPSCoR. Recipients were:

BAI CUI | University of Nebraska-Lincoln (UNL) | Mechanisms of Toughening Structural Ceramics by Thermal Engineered Laser Shock Peening

JUDY WALKER | UNL | NSF INCLUDES: WATCH US (Women Achieving Through Community Hubs in the United States)

JEYAMKONDAN SUBBIAH | UNL | Immersive Educational Game Simulations to Enhance Understanding of Corn-Water-Ethanol-Beef System Nexus

ALEXANDRA SECELEANU | UNL | Symbolic Powers, Configurations of Linear Spaces, and Applications

NATALE IANNO | UNL | REU Site: Research Experience for Undergraduates in Nanohybrid Functional Materials

STEPHEN MORIN | UNL | CAREER: Morphological Control of Crystalline Materials Using Deformations of Elastomeric Substrates and Fluid Flow for the Bottom-up Fabrication of Hybrid Materials

MARTIN CENTURION | UNL | OP: Diffractive Imaging of Complex Isolated Molecules

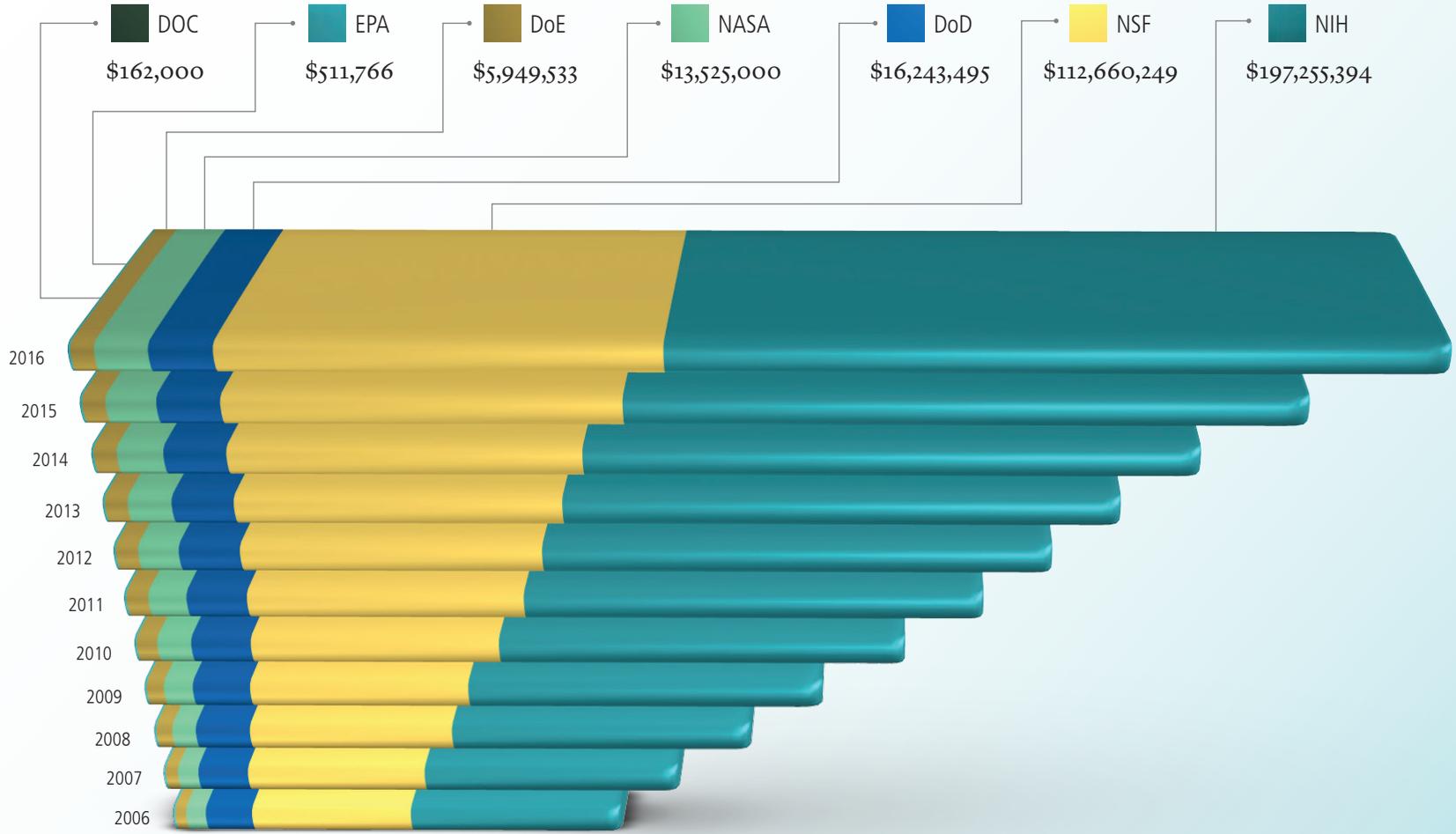
LIYAN QU | UNL | CAREER: Adjustable-Voltage-Ratio Magnetoelectric Transformer: A New Voltage Conversion and Control Device for Smart Grids

YUFENG GE | UNL | IDBR: TYPE A: Multispectral Laser 3D Ranging and Imaging System for Plant Phenotyping



TOTAL FEDERAL EPSCoR FUNDING IN NEBRASKA

NEBRASKA BECAME AN EPSCoR state in 1991 and has successfully competed for more than \$346 million in federal research funding. This chart shows funding by agency and the cumulative growth of funding over time, from 2006 through 2016.



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(ret.)*, Merck Animal Health (Elkhorn)
Senator Ken Haar, Nebraska Legislature
(21st District)

*Please see page 3 for members joining and departing
the Nebraska EPSCoR State Committee in 2016.*