

2013 ANNUAL REPORT



IDEA
EPSCoR
N E B R A S K A

EXPERIMENTAL PROGRAM TO
STIMULATE COMPETITIVE RESEARCH



Experimental Program to Stimulate Competitive Research
Institutional Development Award Program

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Contents

- 1 From the Director
- 2 20 Year Timeline
- 4 EPSCoR News
- 10 Grants
- 12 Research
- 18 Education and Outreach
- 20 Federal Grants

Cover and Inside Cover: Nanostructured thin films can form the basis of new sensing technologies. Read more on page 13.

The staff of Nebraska EPSCoR, (L–R)
NANCY SIMNITT, FRED GARTNER,
FRED CHOOBINEH (Director), **SARAH ZULKOSKI,**
and **HANNA DAY-WOODRUFF.**



Director's Message

GREAT RESULTS emerge from collaborative efforts, and the Nebraska EPSCoR team understands this. Our five-person team is dedicated to customer service in the quest to enhance the state's research capacity. We are committed to investing in excellent science and facilitating excellent outcomes. I am very proud of the accomplishments of the Nebraska EPSCoR staff as we celebrate 20 years of EPSCoR/IDEA investments in the state. Nebraska EPSCoR's efforts to foster a collaborative ecosystem over the last twenty years have helped the state procure \$260 million in competitive research grants. *For a snapshot of the past 20 years, see p. 2.*

Nebraska EPSCoR has been a catalyst for creating a culture of research collaboration among Nebraska's universities. From our earliest

days, we have required multi-institutional participation in our research investments, and it is now commonplace that large grants transcend institutional boundaries. Our NSF EPSCoR Research Infrastructure Improvement (RII) Track 1 award includes researchers from the University of Nebraska-Lincoln, the University of Nebraska Omaha, the University of Nebraska Kearney, Doane College, Creighton University, University of Nebraska Medical Center, and Nebraska Wesleyan. These EPSCoR collaborations are already bearing fruit, as both research areas supported by our Track 1 award received significant external funding this year (*see pgs. 12-14*).

Collaboration is also embedded in Nebraska EPSCoR's commitment to enhancing and enlarging the pipeline of students who pursue

science, technology, engineering and mathematics (STEM). A new partnership with UNL's School of Biological Sciences led to a Young Nebraska Scientists camp this summer on biodiversity (*p.19*). A partnership between faculty at the University of Nebraska-Lincoln, Nebraska Indian Community College, and Little Priest Tribal College is among the first to win an NSF EPSCoR RII Track 3 Award (*p.8*). They will develop a college-level chemistry course based on culturally-relevant topics for the tribal college students.

It has been an honor to contribute to Nebraska's research success over the years. We are excited for what's in store for Nebraska in the next twenty. 🌱

20 Years of Federal EPSCoR/IDeA Investments

THE EXPERIMENTAL Program to Stimulate Competitive Research began in 1979 as an infrastructure investment program of the National Science Foundation (NSF) and expanded to other federal agencies. In 1993, the National Institutes of Health established the Institutional Development Award (IDeA), a similar program in support of biomedical research and training.

Nebraska became an EPSCoR state in 1991 and an IDeA state in 1993. The Nebraska EPSCoR/IDeA office, based at the University of Nebraska, manages statewide, large-scale, multi-institutional NSF EPSCoR Research Infrastructure Improvement (RII) grants and tracks the progress of other EPSCoR programs in the state. EPSCoR/IDeA grants support a vital research ecosystem that promotes collaboration and trains future generations of scientists and engineers. EPSCoR/IDeA researchers contribute solutions to society’s most vexing challenges in the fields of energy, defense, agriculture, the environment, and public health. 🌱

The EPSCoR/IDeA programs have benefitted Nebraska by investing in strong research collaborations across campus lines and increasing national awareness of excellent science occurring here. It has also given the state access to national research discussions in the funding agencies and Congress that otherwise would not have occurred. Serving as director was one of my most enjoyable administrative positions of my career.

—Royce Ballinger, director, Nebraska EPSCoR 1993-2003



IMPACT SPOTLIGHT

As a research cluster in the first EPSCoR grant in Nebraska, my research program in neuroendocrinology and behavior has been significantly and positively impacted. Instrumentation and human resources funded from EPSCoR has resulted in dozens of publications in prestigious journals such as PNAS and Nature, as well as significant collaborations across the country. EPSCoR elevated the international profile of our research group at the University of Nebraska Omaha, encouraging a culture of high performance and research aspirations that persist even 20 years after the initial EPSCoR funding.

—Jeffrey A. French, Varner Professor of Psychology and Neuroscience, University of Nebraska Omaha

\$6.7 million

Nebraska wins its first NSF EPSCoR grant to fund five research clusters: behavioral biology, materials research, metallobiochemistry, bioremediation of xenobiotics, and gene expression in plants. Since 1993, Nebraska has received over \$85 million in NSF EPSCoR funding.

1993

1994

\$1.4 million

Department of Defense EPSCoR awards its first grants to Nebraska. Since 1994, DOD EPSCoR awards have enabled Nebraska research contributions in the areas of advanced optics, semiconductors and materials science. Since 1994, Nebraska has received 44 DOD EPSCoR awards totaling over \$16.2 million.

1996

\$1.5 million

The first major NASA EPSCoR award in Nebraska established the Nebraska Initiative for Aerospace Research and Industrial Development. Since then, NASA EPSCoR has awarded 15 grants in the state for over \$11 million. NASA Nebraska Space Grant, based at UNO, manages NASA EPSCoR projects. Nebraska researchers tackle challenges affecting space exploration on telescopes, satellites, and space stations. Read about the latest grant on p. 16.

\$10.7 million

NIH IDeA's Center for Biomedical Research Excellence (COBRE) awarded to the Nebraska Center for Virology at UNL. Since this first grant, four additional COBREs have been awarded: the Nebraska Center for Cellular Signaling (University of Nebraska Medical Center (UNMC)), the Nebraska Center for Drug Delivery and Nanomedicine (UNMC), the Molecular Biology of Neurosensory Systems (UNMC), and the Redox Biology Center (University of Nebraska-Lincoln). Nebraska was also given the IDeA Network of Biomedical Excellence (INBRE) grant (UNMC). The state has been awarded almost \$140 million in NIH IDeA grants. Read about the latest COBRE grants on p. 17.

\$975,000

U.S. Department of Energy grants Nebraska's first DOE EPSCoR to examine carbon sequestration through soil conservation. Since 2000, DOE has awarded 13 EPSCoR grants for \$5.9 million on a variety of topics, including new energy technology development and nanomaterials engineering.

2000

2003

Nebraska EPSCoR begins collaborating with the state's tribal colleges to address infrastructure needs. Read more about the latest grant on p. 8.

Nebraska EPSCoR began the Nebraska Engineering, Science, and Technology Internship Program (NESTIP) to provide matching funds for undergraduate and graduate STEM internships at Nebraska businesses. It has supported over 200 students and over 100 Nebraska businesses.

Nebraska EPSCoR launches the Molecular Biology for Secondary Classrooms program, which has brought advanced biology lab experiments to nearly 10,000 Nebraska high school students. In 2013, Nebraska EPSCoR piloted new labs focused in Algae Biology.

Nebraska EPSCoR begins the University-Industry Research & Development Partnership Program, which provides matched funding of \$10,000 or \$25,000 for a research collaboration between a university faculty member and a private Nebraska company. Since this time, the R&D Partnership Program has supported 8 collaborations, resulting in 11 patents and four patent licenses. The state of Nebraska has adopted a similar program on a larger scale.

2004

2005

Nebraska EPSCoR launches the Young Nebraska Scientists program, with summer science camps for middle and high school students at Nebraska colleges and universities, and summer research experiences for high school students. Over 300 students have participated in the program. Read more on pgs. 18-19.

2008

2010

\$20 million

Nebraska receives the largest federal research grant in state history. The NSF EPSCoR RII Track 1 grant supports two research areas: the Nebraska Center for Nanohybrid Functional Materials and the Nebraska Coalition for Algal Biology and Biotechnology. Read more on pgs. 12-14.

\$750,000

NSF RII Track 3 grant to Nebraska to develop a culturally-relevant chemistry course for the state's tribal colleges. Read more on p. 8.

2013



Photo of FRED CHOOBINEH, Nebraska EPSCoR director; PREM PAUL, UNL Vice Chancellor for Research, and SENATOR MIKE JOHANNS, then-Governor of Nebraska, announcing the 2004 NSF EPSCoR RII \$9 million award to Nebraska EPSCoR for collaborative research. The grant funded four research projects in nutritional genomics, cell biology, nanomaterials, and mobile computing.

IMPACT SPOTLIGHT

EPSCoR funding led to several major discoveries in the epigenetics field associated with enhancing crop yield potential. This work has led to four patents pending, with more coming, and I am now starting a new company called EpiCrop Technologies. This company will seek to commercialize epigenetic methods for enhancing crop performance that are applicable to virtually any crop. It is powerful technology that is now being developed by Michael Fromm [UNL] and myself, a collaboration that originated with that EPSCoR grant.

—Sally Mackenzie, Ralph and Alice Raikes Professor of Plant Sciences at the University of Nebraska-Lincoln.





New State Committee Members

NEBRASKA EPSCoR is guided by policies and priorities set by a 19-member, Governor-appointed state committee. The committee membership includes senior administrators and researchers from the state's major research institutions, industry leaders, and representatives of state government. Members serve 3-year, staggered terms, and in 2013, we welcomed five new members.



KENNETH W. BAYLES, Ph.D., is a professor and vice chair for research in the Department of Pathology and Microbiology and the associate vice chancellor for Basic Science Research at the University of Nebraska Medical Center (UNMC). He received his B.S. in Biology and his Ph.D. in Microbiology from Kansas State University.



KEN HAAR is a Nebraska state senator from District 21. First elected to the Nebraska legislature in 2008, he received his bachelor's and master's degrees in education from the University of Nebraska-Lincoln. A former Lincoln city council member, he is president and CEO of Compliance at a Glance, Inc., and serves on the board of several Nebraska non-profit organizations.



JULIANE STRAUSS-SOUKUP, Ph.D., is a professor of biochemistry at Creighton University. She received her doctorate from UNMC and trained as a structural nucleic acid biochemist. In over ten years at Creighton, she has mentored 56 undergraduate students, almost all of whom have pursued further education in health-related or scientific professional schools.



MICHAEL NASTASI, Ph.D., is the director of the Nebraska Center for Energy Sciences Research (NCESR) at the University of Nebraska-Lincoln (UNL), as well as the Elmer Koch Professor of Mechanical and Materials Engineering. He received his B.S., M.S. and Ph.D. degrees from the Materials Science and Engineering Department at Cornell University. Prior to coming to UNL, he was a laboratory fellow, staff scientist, and director of the Energy Frontier Research Center on Materials at Irradiation and Mechanical Extreme at Los Alamos National Laboratory (1985 – 2011).



JAMES E. MCCLURG, Ph.D., is president of Technical Development Resources Company. He received his Ph.D. in biochemistry from UNMC and B.S. in biology from Nebraska Wesleyan University. McClurg served on the Board of Regents of the University of Nebraska (2002-2012), and serves on the board of directors of several for-profit and non-profit organizations. He has published a number of scientific articles and holds a US Patent in the field of laboratory testing.

Continuing Service

We appreciate the continued service of the following committee members:

IQBAL AHMAD, Ph.D., Professor, University of Nebraska Medical Center; **CHARLES J. BICACK**, Ph.D., Senior Vice Chancellor for Academic and Student Affairs, University of Nebraska at Kearney; **VALERY FORBES**, Ph.D., Director and Professor, School of Biological Sciences, University of Nebraska-Lincoln; **SUSAN FRITZ**, Ph.D., Interim Executive Vice President & Provost, University of Nebraska; **CLAGUE HODGSON**, Ph.D., President, Nature Technology Corporation; **CATHERINE LANG**, Director, Nebraska Department of Economic Development; **JENNIFER LARSEN**, Ph.D., Vice Chancellor for Research, University of Nebraska Medical Center; **LYLE MIDDENDORF**, Committee Chair, Sr. Vice President & Chief Technical Officer, LI-COR Biosciences, Inc.; **THOMAS MURRAY**, Ph.D., Associate Vice Provost for Research and Scholarship, Creighton University; **PREM PAUL**, Ph.D., Vice Chancellor for Research & Economic Development, University of Nebraska-Lincoln; **SCOTT SNYDER**, Ph.D., Associate Vice Chancellor for Research and Creative Activity, University of Nebraska Omaha; **NICHOLAS STERGIOU**, Ph.D., Professor, University of Nebraska Omaha; **RAYMOND WARD**, Ph.D., Ward Laboratories, Inc.; **TERRI WASMOEN**, Ph.D., Assoc. VP (ret.), Merck Animal Health.

Served with Distinction

Three members departed EPSCoR at the end of their terms, and we thank them for their contributions to the research infrastructure of the state:

VIMLA BAND, Ph.D., Professor and Chair of the Department of Genetics, Cell Biology and Anatomy at the University of Nebraska Medical Center; **DAVID KENNEDY**, Ph.D., management consultant and former president and general manager for Teledyne Isco in Lincoln, Nebraska; **ANTHONY STARACE**, Ph.D., George Holmes University Professor in the Department of Physics and Astronomy at the University of Nebraska-Lincoln. 🌟

Neuroscience on Our Minds:

The 2013 Nebraska Neuroscience Symposium

DISTINGUISHED NEUROSCIENTISTS from across the country and the state gathered at the Embassy Suites in Omaha's Old Market for the first Nebraska Neuroscience Symposium in October. The pouring rain did not dampen the enthusiasm of over 300 attendees from Nebraska's neuroscience community, who listened to talks and engaged in lively discussions. Twelve speakers shared their research on a broad range of neuroscience topics, from brain map formation to addiction to the neurobiology of social relationships, and offered those students in attendance an opportunity to interact with some of the most prestigious members of the field.

"The Nebraska Neuroscience Symposium brought an outstanding group of speakers to Omaha. Neuroscience faculty, students and staff in Nebraska had the extraordinary opportunity to learn from and network with neuroscientists such as **Drs. Roger Nicoll** and

Pasco Rakic, both members of the National Academy of Science," said **Thomas Murray**, chair of the Symposium organizing committee and associate vice provost for research and scholarship at Creighton University.

As a research focus, neuroscience is experiencing a moment of unprecedented progress, public awareness and federal funding support. In his 2013 State of the Union address, President Barack Obama declared of neuroscience that, "Now is the time to reach a level of research and development not seen since the height of the Space Race." Nebraska's neuroscientists are contributing to research that uncovers the physical and chemical mechanisms that underpin consciousness, relationships, productivity, and neurological diseases. Their diverse research was on display in a poster session that concluded the day.

The symposium was Nebraska EPSCoR's eighth annual statewide gathering in support

of advanced research. Formerly called the "Nebraska Research and Innovation Conference," the event provided a venue for researchers, policymakers, and businesses to come together. Now that other similar conferences have emerged, the format has changed to a smaller, research-focused symposium. Due to the national emphasis on neuroscience research, the 2014 symposium will also focus on this field, highlighting more Nebraska-based research. 🌱



The Nebraska Neuroscience Symposium included talks from distinguished scientists, Q&As with the audience, and a student poster session. To learn more about the speakers and their talks, visit nric.nebraska.edu.



As a research focus, neuroscience is experiencing an unprecedented moment of progress, public awareness, and federal funding support.



NSF EPSCoR RII Track 3

Bringing Culture to Chemistry at the Tribal Colleges

AN NSF EPSCoR Research Infrastructure Improvement (RII) Track 3 grant for \$750,000 awarded to Nebraska will support the development of a culturally-relevant chemistry course at the state's tribal colleges. The principal investigator for the five year project is **Mark Griep**, associate professor of chemistry at the University of Nebraska-Lincoln, with co-principal investigators **Dan Torgerson**, academic dean at the Nebraska Indian Community College (NICC), and **Janyce Woodard**, instructor of environmental science at Little Priest Tribal College (LPTC).

In Nebraska, students at tribal colleges have had little or no access to chemistry due to lack of facilities or faculty to teach the courses and low enrollment when the courses are offered. This project aims to revitalize the tribal colleges' chemistry programs by designing a

compelling chemistry course that could ignite a sustained interest in the discipline. In addition, the project will fund supplies and new faculty to teach the course.

"This project will round out our math and science offerings and create a stronger science curriculum for our students. This grant will also enable creative innovation in our approach to teaching chemistry, which we think will result in greater student interest," said **Hank Miller**, math and science division head and natural resources instructor at NICC.

The project connects classroom and lab experiences with real-life concerns of the community and will be developed collaboratively. In the initial stages of the project, NICC and LPTC will identify topics of interest, and Griep will develop chemistry lab experiences that relate to the topics chosen. LPTC and NICC are exploring the idea of jointly piloting the

course via a video-teleconferencing system that Nebraska EPSCoR funded. Eventually, the course will be disseminated to tribal colleges beyond the state.

"Each laboratory experience will start with learning a new method, move on to demonstrating proficiency in the method, and end by measuring real samples from the community," explains Griep. "In addition, the students will have a classroom discussion about a community topic three or four times in the semester to enrich their understanding of the relationship between things that make a community run and things that are scientifically measurable."

MARK GRIEP, Associate Professor of Chemistry at the University of Nebraska-Lincoln.



Griep has experience using non-traditional approaches to teaching chemistry in ways that connect to his students. His book, "ReAction: Chemistry in the Movies," (Oxford University Press, 2009) uses references to chemistry in over 100 films to engage in such diverse topics as forensic chemistry, chemical weapons, environmental pollution, and the ethical questions that accompany the practice of chemistry. Griep used this approach in writing lab manuals for biochemistry and introductory chemistry.

Woodard said, "LPTC is excited to be a partner in this project. We are always striving to find ways to engage our students and to help them discover the connections between their coursework and their cultures and communities. This project will help us do that."

The NICC has three campuses: Macy, Santee, and South Sioux City. The college serves mostly Native students who live on the Omaha Reservation, the Santee Sioux Reservation, and within

the South Sioux City urban area. Little Priest Tribal College serves primarily the Winnebago Tribe of Nebraska.

This latest EPSCoR grant builds on a decade-long relationship between the tribal colleges and Nebraska EPSCoR. Previous Nebraska EPSCoR awards brought many improvements to infrastructure at the two colleges, such as computers, networking, high-speed broadband internet, ongoing salary support for science faculty, renovations to lab facilities, and funding for travel to national and regional conferences aimed at increasing American Indian participation in the STEM disciplines. 🌟



A meeting of the new Track 3 grant collaborators. (L-R), **DAWN PRICE**, Dean of Student Services at the Nebraska Indian Community College (NICC); **MARY JOHNSON**, NICC Director of Development; **MIKE BERGER**, NICC Grants Writer; **DON TORGERSON**, NICC Dean of Academics; and **MARK GRIEP**, Associate Professor of Chemistry at UNL.



FIRST Awards for CAREER Success

THE NATIONAL Science Foundation's prestigious CAREER award is given each year to outstanding junior faculty who "exemplify the role of teacher-scholars" through the excellence of their research, teaching, and the integration of education and research. In order to support Nebraska scholars in their pursuit of a CAREER award, Nebraska EPSCoR's FIRST Award provides \$20,000 in seed funding for projects that could be the focus of a CAREER award proposal, as well as valuable preparation for the proposal process. In 2013, two former FIRST Award recipients earned CAREER Awards: **Jinsong Huang** (2010), mechanical engineering, University of Nebraska-Lincoln; and **Angela Pannier** (2008), biosystems engineering, University of Nebraska-Lincoln.

2013 Recipients of FIRST Award:

JOSHUA DARR, Chemistry, University of Nebraska Omaha; *Investigation of the Phase and Reactivity of Sea Salt Aerosol Particles Mixed with Amino Acids.*

ASHLEY HALL, Entomology, University of Nebraska-Lincoln; *Evaluation of the Effects of DNA/Histone Interactions on the Incident of Strand Breaks.*

P. ROXANNE KELLAR, Biology, University of Nebraska Omaha; *Phylogenetic Diversity Assessment Using Massively Parallel Sequencing.*

KENNETH KRAMER, Biomedical Sciences, Creighton University; *Direct Analysis of the Glycocalyx During Zebrafish Development.*

ALEXANDER SINITSKII, Chemistry, University of Nebraska-Lincoln; *Highly Selective and Sensitive Analytical Systems Based on Graphene*

WENLIANG ZHANG, Mathematics, University of Nebraska-Lincoln; *Studies in Local Cohomology and Applications.*

RESEARCH SPOTLIGHT

Pannier earns CAREER Award

ANGELA PANNIER, associate professor of biological systems engineering at the University of Nebraska-Lincoln and 2008 recipient of the FIRST Award, earned a prestigious CAREER Award from the National Science Foundation in 2013.

She says, "The FIRST Award was important to me for two reasons. First, it was the catalyst to help me craft my future CAREER proposal. Second, the funds I received as a part of the FIRST Award were used to complete critical preliminary studies that were included in my final CAREER application."

She will use the 5-year, \$419,051 award to develop a novel DNA delivery system that could be used to correct genetic diseases and promote healing and tissue regeneration. The delivery system uses nanoscale thin films that are shaped much like pile carpet or the head of a toothbrush. DNA can be loaded into the space between the individual nanostructures and then offloaded into a target cell. Once new DNA is in the cell, it will direct the production of proteins that can counteract the disease or enable improved healing. Her work is a part of the Nebraska Center for Nanohybrid Functional Materials and is supported from the \$20 million Nebraska EPSCoR RII Track 1 Award. 🌱



ANGELA PANNIER, Associate Professor of Biological Systems Engineering at the University of Nebraska-Lincoln, won a CAREER Award in 2013. She was a recipient of Nebraska EPSCoR's FIRST Award in 2008.

Small College Undergraduate Research Experiences

OPPORTUNITIES FOR paid research positions are rare at Nebraska's small colleges. Students looking for summer positions have few options in research, but Nebraska EPSCoR seeks to change this by offering \$5,000 for projects under the Undergraduate Research Experiences at Small Colleges and Universities grant. Participants can present their research at Nebraska EPSCoR's annual statewide research symposium and are encouraged to submit the results of their research to scientific journals. A broader goal of this program is to expand the pool of undergraduate students majoring in STEM and choosing to pursue STEM careers.

2013 Grant Recipients:

HAISHI CAO, Chemistry, University of Nebraska Kearney; *Synthesis of Near-IR Fluorescent Molecules for Detection of Carbohydrate Derivatives.*

RAMESH LAUNGANI, Biology, Doane College; *Interactions Between an Exotic Grass and an Invasive Woody Species May Drive Woody Encroachment in Nebraska Grasslands.*

MAHESH PATTABIRAMAN, Chemistry, University of Nebraska Kearney; *Employing γ -Cyclodextrin as Mediator for Hetero-Dimerization of Alkenes in Solid-State.*

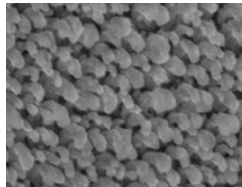
WILLIAM LEE POWELL, JR., Physics & Physical Science, University of Nebraska Kearney; *Observations and Analysis of RR Lyrae Stars by Undergraduate Students*



NSF EPSCoR RII Track 1

Advances

FOR THE two research areas funded through Nebraska EPSCoR's 5-year, \$20 million NSF EPSCoR Research Infrastructure Improvement (RII) Track 1 award (2010-2015), the third year of funding saw the maturation of their group collaborations, validation from external reviewers, and a re-focus on the sustainability of the programs beyond the two remaining years of the grant.

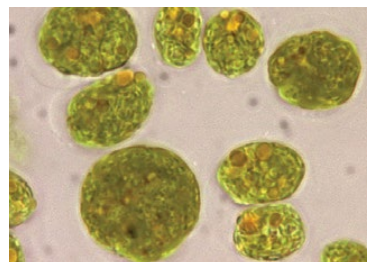


Nebraska Center for Nanohybrid Functional Materials (CNFM)

CNFM develops new, more powerful sensors and separation devices to detect trace amounts of chemicals or biological elements for use in many areas of life, including medicine, environmental management, and law enforcement. In 2013, one new investigator and two exploratory investigators were brought into the Center, expanding the group to 20 faculty members at six Nebraska colleges and universities. Five of its PIs and one of its exploratory investigators have received the prestigious NSF CAREER grant. Among the 12 new grants this year (totaling \$2.59 million) was an NSF-MRI for \$411,501 to develop a new nanostructure fabrication tool (**PI: Eva Schubert**, University of Nebraska-Lincoln (UNL)) and an NSF-CHE for \$402,483 for instrumentation development of a chromatography tool (**PIs: Tino Hoffman, David Hage**, UNL). CNFM continued to expand its Industrial Advisory Council, which includes representatives from LI-COR, the J. A. Woollam Company, Proctor & Gamble, Seagate, and Biosensing Instruments. CNFM's outreach efforts included Young Nebraska Scientists summer camps on nanoscience, hosting of high school researchers, and support for UNL's Women in Physical Science Conference. A panel of external reviewers visited in August and commended CNFM for its "outstanding job," and an NSF Reverse Site Visit panel stated, "The strength of the team and technical depth of the research program are impressive."

Nebraska Coalition for Algal Biology and Biotechnology (NCABB)

NCABB pursues basic research to uncover and influence biological processes that underpin algae's production of lipids that can be used for biofuels. The Coalition includes 12 faculty members from four Nebraska colleges and universities. Among the eight new awards in Year 3 (totaling \$1.16 million) was an NSF-MCB for \$566,910 to explore RNA translation in *Chlamydomonas reinhardtii*, a model organism that can be used to understand other algae (**PI: Heriberto Cerutti**, UNL), as well as an REU for \$276,000 that will expand undergraduate research opportunities in NCABB (**PIs: Heriberto Cerutti, Paul Blum**, UNL). Faculty hosted high school researchers through the Young Nebraska Scientists program, hosted two YNS summer camps, and implemented algae mobile labs for high schools and an algae biology project for undergraduate laboratories. Two NCABB faculty received recognition in 2013: **Concetta DiRusso**, professor of biochemistry at UNL, was named a fellow of the American Association for the Advancement of Science (AAAS) in recognition of her contributions to the understanding of nutritional fatty acids, commitment to excellence in postsecondary education and mentoring, and efforts to broaden participation in science; **Don Weeks**, the Maxcy Professor of Agriculture and Natural Resources, was named a fellow of the National Academy of Inventors. This prestigious honor is given to inventors "who have demonstrated a highly prolific spirit of innovation in creating or facilitating outstanding inventions" with real-world impacts. Weeks developed a method for engineering herbicide-resistant crops. In its annual external review, the group was lauded for its significant accomplishments. 🌱



Track 1 Research Focus

Nanohybrids: The Foundation of New Sensors

EVA SCHUBERT, associate professor of electrical engineering at the University of Nebraska-Lincoln, won a \$411,501 Major Research Instrumentation grant from the National Science Foundation to fund the development of a new tool to fabricate nanostructured thin films. She is also a member of the Nebraska Center for Nanohybrid Materials, which was founded from the \$20 million NSF EPSCoR RII Track 1 Award (2010-2015).

Illicit drugs, disease markers, environmental contaminants—these are just some of the categories of small molecules that the Nebraska Center for Nanohybrid Functional Materials (CNFM) seeks to find. CNFM develops new sensing and detecting devices by exploiting the unique properties of nanometer-sized materials. Of the 19 faculty investigators from six Nebraska colleges and universities, and dozens of undergraduate and graduate students, Schubert is the center hub around which all other work of the Center revolves: her team fabricates the highly porous nanostructured thin films that are the foundation of the nanohybrid materials.

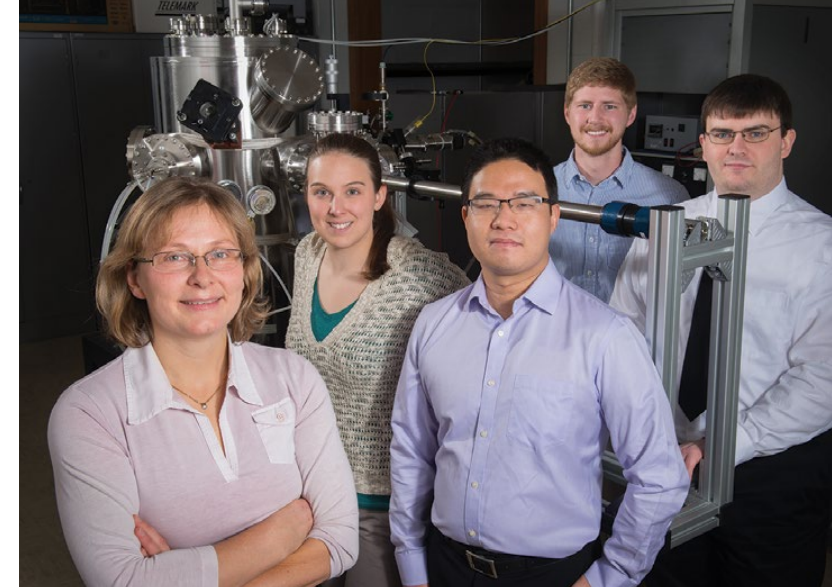
Nanohybrids are formed by combining nanostructured solid thin films and soft materials; they exhibit synergistic functionality based on the properties of each partner in the compound. While CNFM focuses primarily on creating sensors, nanohybrids can be used in other applications.

"Nanohybrids' functionality depends on what type of material is attached to the nanostructured thin film platform; if biomolecules are added to the surface, it can be used as a biosensor. If cells are added, it can be used for tissue engineering. They can also be used as platforms for new battery or supercapacitor designs...we can find a broad variety of applications simply by combining functionality of different materials on the nanoscale," Schubert said.

The nanostructured thin film platforms look similar to piled carpets with individual fibers. The space between the nanostructure fibers is the key to their use, because other materials can be placed into the pores. The attached materials could provide a nurturing environment for living cells, recognition of specific target molecules, or perform other functions.

Schubert fabricates these nanostructured

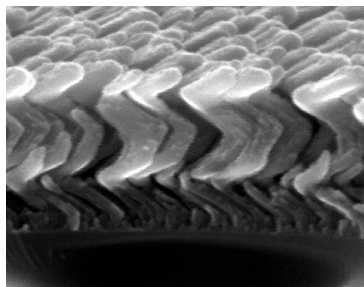
EVA SCHUBERT, front left, Associate Professor of Electrical Engineering at the University of Nebraska, and her team of graduate student researchers, (L-R), **ALYSSA MOCK**, **DAN LIANG**, **DEREK SEKORA**, and **RYAN DAVIS**.



thin films from metals, oxides, and other materials. In an ultra-high vacuum chamber, a vaporized particle stream of the metals or oxides is condensed onto a plate. The growth of the thin films is controlled by varying the angle at which the particle stream is directed at the plate. If the plate is also rotated during growth, the vapor strikes the plate from various directions and thus changes whether fibers grow as a straight wire, a spiral, or zig zag. The shape affects the porosity of the films, thus allowing Schubert to adapt to the needs of the attaching functional molecule.

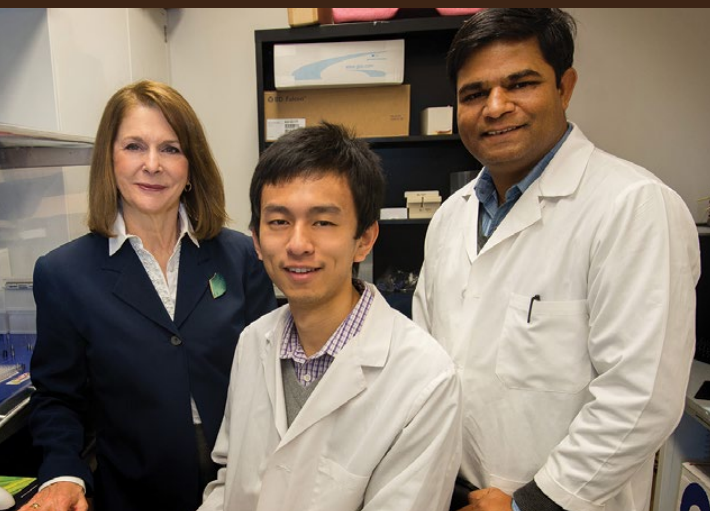
She frames her work as "truly interdisciplinary," because researchers from many fields can make use of her nanostructures for diverse purposes; her current collaborations are with chemists, biosystems engineers, and mechanical engineers. 🌱

A zig-zag nanostructured thin film fabricated by Schubert's team can be used as a platform for chemical sensors.



Track 1 Research Focus

Toward Abundant Algae Biofuels



ACCORDING TO a 2012 National Academy of Sciences report, biofuels made from algae oil, called lipids, could be a renewable alternative to fossil fuels. **Concetta DiRusso** and her team at the University of Nebraska-Lincoln are several steps closer to bypassing one of the main barriers to abundant algae lipid production: in a natural setting, algae only make lipids under the stress of nutrient starvation, when the cells are shutting down and dying. What would seem to be

a renewable resource becomes nonrenewable, limiting potential biofuel production. DiRusso was able to find a method to stimulate lipid production without nutrient starvation.

DiRusso is a professor of biochemistry and a member of the Nebraska Coalition for Algal Biology and Biotechnology (NCABB). EPSCoR funding allowed her to develop a method to test, or “screen,” for cell growth and lipid production in samples of *Chlamydomonas reinhardtii* algae exposed to 2,000 different chemicals compounds. The compounds came from a repository, called a “test library,” containing a diverse collection of chemicals such as steroids, detergents, and sex hormones synthesized by organic chemists.

She used an automated machine to dispense a mixture of algae and test chemicals into wells on a microtiter plate, a diagnostic tool that has many wells that are essentially mini-test tubes. After 72 hours, each well was assessed to see whether the algae was still growing, and of those that were, which ones had begun to make lipids. “We did find one compound of the 2,000 that had some of the features that we wanted to see,” said DiRusso.

This one positive outcome formed the basis of a second grant from the Nebraska Center for Energy Sciences Research to test an additional

44,000 chemicals. Of this group, 360 were found to result in healthy and reproducing cells that accumulate lipids. Further experiments will be conducted with the most promising of the compounds, and eventually she will test the compounds on higher lipid-producing algal strains. The final goal is to patent the use of the best compounds for commercial lipid biofuel production; in the meantime, her team will learn as much as possible about what types of compounds affect lipid production and the internal processes, proteins, and metabolites that are involved in lipid production.

This is DiRusso’s first project working with algae, but for years she has studied fatty acids, a type of lipid, in humans and other animals. In 2013, she was elected a fellow of the American Association for the Advancement of Science due to her work on nutritional fatty acids.

DiRusso’s lipid production work in algae began with funding from the National Science Foundation’s \$20 million EPSCoR Research Infrastructure Improvement Track 1 Award, which founded NCABB. The Coalition contributes basic algae research in support of algae as an alternative energy fuel source. 🌱

*Above (L–R) **CONCETTA DIRUSSO**, Professor of Biochemistry, with **TU BOQIANG**, an undergraduate, and **NISHIKANT WASE**, a postdoctoral researcher.*



NSF EPSCoR RII Track 2 Research Focus

Linking Form to Function in Nanogold Catalysts

AT THE nanometer and sub-nanometer scales, gold clusters exhibit unique properties that are not observed at larger scales. Scientists at the University of Nebraska have confirmed a theory that explains at the atomic level how nanoscale gold clusters, highly effective and also costly, are able to act as a catalyst for certain reactions.

Catalysts, chemicals that speed up or enable reactions between other molecules but are themselves unchanged by the reaction, are agents of transformation. One of the most visible areas of transformation has been the dramatic improvement of air quality in the urban areas of the United States that occurred since 1975 after catalytic converters on cars became widespread. Catalytic converters convert toxic waste products from combustion engines into non-toxic by-products, and gold is one of several that can be used. Nanoclusters of gold attract oxygen (O₂) and carbon monoxide (CO), the toxic waste, to its surface where they combine to form carbon dioxide (CO₂), a non-toxic gas.

“We wanted to understand the origin of the extraordinary catalytic activity of gold

clusters,” says **Barry Chin Li Cheung**, associate professor of chemistry at the University of Nebraska-Lincoln (UNL). “If we know the origin of how it works, then we will know how to design better catalysts.” This is a critical issue for gold, an expensive commodity.

The team confirmed that the catalytic activity is related to gold’s electronic structure. For gold clusters at the nanometer and sub-nano scale, catalytic activity results from the partial sharing of electrons between the outer two electron orbitals. This partial sharing leaves these outer orbitals less occupied and thus more available to bind to molecules like oxygen. The presence of the orbital electron sharing, or hybridization, was confirmed experimentally and through theoretical computations enabled by the UNL’s Holland Computing Center.

This discovery emerged from a collaboration among the faculty and graduate students in UNL’s Department of Chemistry and Department of Physics and Astronomy, in the University of

Nebraska Omaha’s (UNO) Department of Physics, and the National Tsing Hua University in Taiwan (NTHU). The team included Cheung, **Peter Dowben** and **Xiao Cheng Zeng** at UNL; **Wai-Ning Mei** at UNO; and **Yun-Liang “Jack” Soo** at NTHU. The work was funded from an NSF EPSCoR RII Track 2 grant that seeks to improve catalysts for future energy production and energy efficient technologies. 🌱

*Part of the nanogold cluster research team. (L–R), **NEIL LAWRENCE**, graduate student; **BARRY CHIN LI CHEUNG**, associate professor of chemistry; **XIAO CHENG ZENG**, Willa Cather Ameritas Professor of Chemistry; and **YUNYUN ZHOU**, graduate student.*

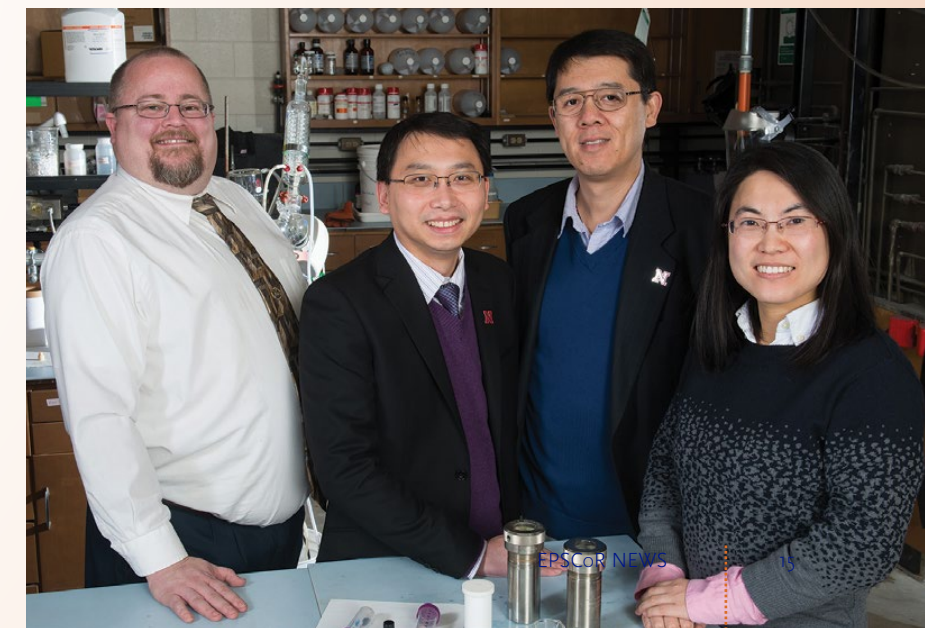


Photo Credit: NASA; ESA; G. Illingworth, D. Magee, and P. Oesch, University of California, Santa Cruz; R. Bouwens, Leiden University; and the HUDFog Team

NASA EPSCoR

NASA awards \$750,000 for Deep Space Neutron Voltaics

TO ASTROPHYSICISTS and many others, the deep space at the edge of and beyond our solar system offers clues to better understand the universe. A critical tool of exploration is the space probe, an unmanned space craft. In 2013, Nebraska researchers were awarded a three-year, \$750,000 NASA EPSCoR award to develop new ways to power those probes and protect them from the radiation that they encounter. The principal investigators are **Scott Tarry**, NASA Nebraska EPSCoR Project Director (University of Nebraska Omaha), and **Axel Enders**, Science PI (University

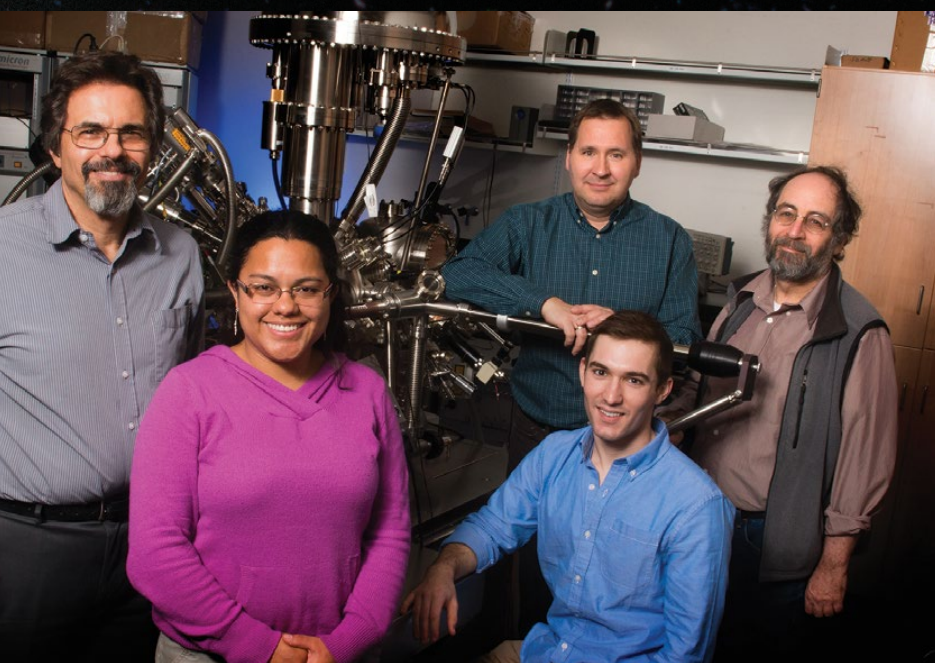
of Nebraska-Lincoln). The project, *Neutron Voltaics for Deep Space Missions*, includes faculty from UNL and UNO.

Deep space probes can travel vast distances for many years, even decades, transmitting information sometimes to a new generation of scientists who may not have been born when the probe was launched. They must be powered by a non-solar source, while at the same time shielded from intense neutron exposure during exploration. Enders, Tarry and their team will work on the development of a robust lightweight neutron absorber material made of boron carbide, which would shield the probe while at the same time generate electricity for its operation. This power generation approach relies on the direct conversion of neutrons into electric power, which

can be highly efficient and allow for the probe to carry a smaller amount of radioactive material than current technologies allow. This new approach to powering deep space satellites is an important new space technology for exploration and could be an important element for all unmanned spacecraft by extending their operational lives.

Boron carbide thin films will enable three distinctive but intrinsically related applications: (i) light-weight *coatings* for deep-space probes to shield them from intense neutron exposure during exploration, (ii) effective *neutron-voltaics* devices to power deep space probes, and (iii) all-boron carbide gamma-blind neutron *detectors* of unprecedented efficiency, to provide insight into cosmic rays, solar neutrons, neutron stars, pulsars and supernovas during NASA's deep space missions. 🚀

(L–R) **NATALE IANNO**, Milton E. Mohr Professor of Electrical Engineering; **ELENA ECHEVERRIA MORA**, graduate student; **AXEL ENDERS**, Associate Professor of Physics and Astronomy; **PAULO COSTA**, graduate student; and **PETER DOWBEN**, Charles Bessey Professor of Physics, at the University of Nebraska-Lincoln.



TATIANA BRONICH, PH.D., is the principal investigator on the \$11.2 million COBRE award to the Center for Drug Delivery and Nanomedicine.

UNMC COBRE

NIH IDeA Awards \$16.1 Million

IN 2013, the University of Nebraska Medical Center received more than \$16.1 million from the National Institutes of Health for the renewal of two Institutional Development Award (IDeA) Center of Biomedical Research Excellence (COBRE) grants. COBREs support the cultivation of strong biomedical researchers by investing in and mentoring junior faculty to build successful research programs of their own. The centers are collaborative and organized around a research theme.

The Nebraska Center for Nanomedicine (NCN) will receive more than \$11.2 million to continue and expand cutting-edge, interdisciplinary research into nanotechnology. Nanomedicine uses nanomaterials, small polymeric particles, to deliver drugs safely to disease sites, such as cancer tumors. NCN research has developed a new protein delivery platform to enhance the delivery of therapeutic proteins and improve treatment of traumatic brain injury and obesity-associated cardiovascular disorders.

“This grant was first funded in 2008, with the scientific mission to improve drug delivery through basic and applied advances in nanotechnology in order to advance treatment of

human diseases,” said **Courtney Fletcher**, Pharm.D., dean of the College of Pharmacy.

UNMC researcher **Tatiana Bronich**, Ph.D., principal investigator on the grant, is the Parke-Davis Professor in Pharmaceutics, and co-director of the Center for Drug Delivery and Nanomedicine.

Bronich said, “This will further and solidify our efforts in the areas of drug delivery and nanomedicine. It allows us to continue our truly interdisciplinary research at the university.”

The grant will also support the bioimaging and the nanomaterials core facilities.

The Nebraska Center for Cellular Signaling (NCCS) also received a COBRE renewal for almost \$4.9 million. Cellular signaling is the process by which cells sense and respond to their environment, and one focus of the Center is on understanding the cellular signaling of cancer cells.

Keith Johnson, Ph.D., director of the Department of Oral Biology, is the principal investigator on the grant. He said, “Our greatest accomplishment has been fostering the development of junior investigators into independent investigators who then have gone on to foster the development of others. We have

KEITH JOHNSON, PH.D., is the principal investigator on the \$4.9 million COBRE for the Nebraska Center for Cellular Signaling.

developed a culture of mentoring that we hope persists for the long term.”

This is the third phase of funding for NCCS, which began in 2003. The late **Margaret Wheelock**, Ph.D., obtained the awards for Phases I and II. With this award, total COBRE funding for the Center is \$25 million.

“The Phase III COBRE renewal will further strengthen the Nebraska Center for Cellular Signaling under the leadership of Dr. Johnson,” said **Jeffrey Payne**, D.D.S., the College of Dentistry’s associate dean for research. “This grant will support collaborative research across UNMC colleges and departments in the area of cellular signaling and will facilitate the NCCS’ trajectory as a self-sustaining center.” 🌟





Young Nebraska Scientists

Summer Research Experiences

FOR TWELVE ambitious and talented high school students, the 2013 summer break was not just filled with lazy days at the pool or grueling hours working at the local mall. Instead, these participants in the Young Nebraska Scientists (YNS) High School Summer Research Experience program spent their days in university labs contributing to research at the University of Nebraska-Lincoln and Creighton University.

The YNS research program, now in its sixth year, offers high school students a paid, six- to eight-week taste of the camaraderie and focus of a university research team. Guided by graduate student or postdoctoral mentors in each lab, participants worked alongside mentors and other members of the team to accomplish their research tasks. Research areas included electrical and civil engineering, chemistry, agronomy and biological sciences.

Mia Azizah, a junior at Lincoln East High School, worked in the lab of Professor **Brian Waters** in the Department of Agronomy & Horticulture at the University of Nebraska-Lincoln. She contributed to two projects that aimed to better understand plant

physiology and root response to iron in the soil. Mia said, “I was surprised that researchers don’t give up easily when results of their experiments are not what they are expecting.”

The high school researchers were not the only beneficiaries of the program. As **Angela Pannier**, associate professor in the Department of Biological Systems Engineering, who hosted junior **Greta Petersen**, put it, “My graduate students got the opportunity to learn how to be better teachers and gained some new insights into their project during the process. Greta performed some valuable data analysis that advanced my research program. It was a wonderful experience!”

To participate in the program, students complete a competitive, multi-part application process. Of the over 30 applicants in 2013, the top 12 were chosen and matched to labs according to their research interests. It is a priority of Nebraska EPSCoR to increase the participation of underrepresented minorities, women, potential first generation college students,

and economically disadvantaged students. YNS partners with various programs in Lincoln serving these student populations and encourages qualified students to apply. 🌱

BASED ON EXIT INTERVIEWS conducted by the Bureau of Sociological Research at the University of Nebraska-Lincoln, the experiences : 1) dissolved misconceptions about research; 2) made them comfortable and confident in a research setting; 3) reinforced a desire to pursue a STEM career for most students.



Eight of the 12 2013 YNS Summer High School Researchers. From L to R, standing, **GRETA PETERSEN**, **TRENTON HAYS**, **AKSHAY RAGAJOPAL**, **TIANYE CHEN**. L-R Seated, **LESLEY GARCIA**, **TIFFANY TRUONG**, **ELLIOT SANDFORT**, and **TINA VU**.



Young Nebraska Scientists YNS Discovers Biodiversity of the West



A NEW collaboration between Nebraska EPSCoR and the University of Nebraska-Lincoln (UNL)’s School of Biological Sciences led to a one-week Young Nebraska Scientists high school summer camp focused on biodiversity. Camp

participants explored the biodiversity of local terrestrial and aquatic habitats, including box turtles, bees, fish, parasites, and plants. UNL faculty transformed the campers into field biologists for the week.

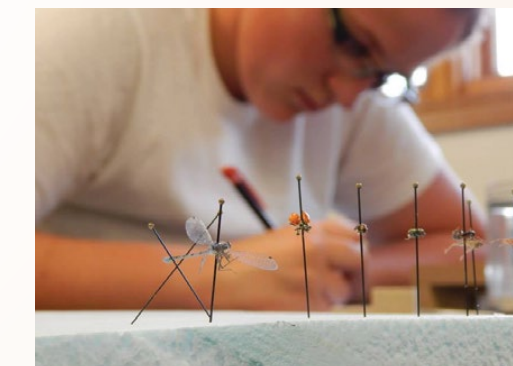
The camp was held at the Cedar Point Biological Station (CPBS), a 900-acre field research facility for the University of Nebraska-Lincoln in western Nebraska, north of Ogallala.

“Since 1975, UNL Biological Sciences has offered intense, hands on, group learning experiences in advanced biology at Cedar Point Biological Station. Our YNS camp was a full immersion sample of our courses and life at a biological field station,” said **Jon Garbisch**, associate director of CPBS.

This was the first YNS camp held away from a formal college campus. The location increased geographic accessibility for students in the western part of the state, a priority of the YNS program and Nebraska EPSCoR.

UNL biological sciences faculty members developed the camp content and ran the field activities. They relied on Nebraska EPSCoR’s infrastructure for organizing and administrating the camp and promoting the camp across the state.

“Nebraska EPSCoR has a comprehensive infrastructure for running and operating the Young Nebraska Scientists camps. The partnership with UNL biological sciences was just the kind that we seek; their mission for the camp fit perfectly with our outreach goals,” said **Sarah Zulkoski**, Nebraska EPSCoR’s outreach coordinator and YNS camp director. “We encourage faculty to consider developing a YNS camp as a part of their broader impacts plans on funding proposals. There’s no need for them to struggle with camp administration issues when our program is well established.” 🌱



HIGH SCHOOL
CAMPS
5 Nanoscience
Coding
(2 Camps)
Biodiversity
Algae for
Biofuels

HELD AT
University of
Nebraska-Lincoln
Doane College
Creighton University
University of
Nebraska Omaha
UNL’s Cedar Point
Biological Station

2 MIDDLE
SCHOOL
CAMPS
Algae for Biofuels
Nanoscience

OF THE
73 PARTICIPANTS:
38%
WOMEN

16%
UNDERREPRESENTED
MINORITIES

38%
RURAL



2013 Federal EPSCoR/IDeA Grants

NASA EPSCoR

Neutron Voltaics for Deep Space Missions; **PIs:** **Axel Enders**, Physics & Astronomy, University of Nebraska-Lincoln, and **Scott Tarry**, director, NASA Nebraska EPSCoR. \$750,000

NSF EPSCoR

Framing the Chemistry Curriculum; **PI:** **Mark Griep**, Chemistry, University of Nebraska-Lincoln (UNL); **CoPIs:** **Janyce Woodard**, Little Priest Tribal College; **Don Torgerson**, academic dean, Nebraska Indian Community College. \$749,285

NSF EPSCoR Co-funding

The EPSCoR Co-funding mechanism provides supplemental funds to grants in EPSCoR jurisdictions when limited NSF division budgets might otherwise prevent the funding of a worthy project. The following seven awards received a combined \$1.01 million in EPSCoR co-funding.

RUI: Survey and Inventory of Parasites of Fishes in the Big Thicket National Preserve; **PI:** **Michael Barger**, Biology, Peru State College. \$267,000

Mechanistic Study of Cellulosome Through Reprogramming Its Assembly; **PI:** **Jiantao Guo** and **Wei Niu**, Chemistry, University of Nebraska-Lincoln. \$307,741

Topology and Geometry of Cayley Graphs for Groups; **PI:** **Susan Hermiller**, Mathematics, University of Nebraska-Lincoln. \$246,021

Career: Nanostructured Thin Films for Substrate-Mediated Gene Delivery; **PI:** **Angela Pannier**, Biosystems Engineering, University of Nebraska-Lincoln. \$419,051

Collaborative Research: Testing the Link Between Climate and Mammalian Faunal Dynamics in the Early Paleocene Record of the San Juan

Basin, New Mexico; **PI:** **Ross Secord**, Earth and Atmospheric Sciences, University of Nebraska-Lincoln. \$142,827

Managing Sustained Online Engagement to Solve Community Problems: An Exploration of Virtual Town Hall Meeting Systems; **PI:** **Gerardus de Vreede**, Information Systems Engineering, University of Nebraska Omaha; **CoPIs:** **Roni Reiter-Palmon**, Psychology, and **Douglas Derrick**, IT Innovation, University of Nebraska Omaha. \$360,304

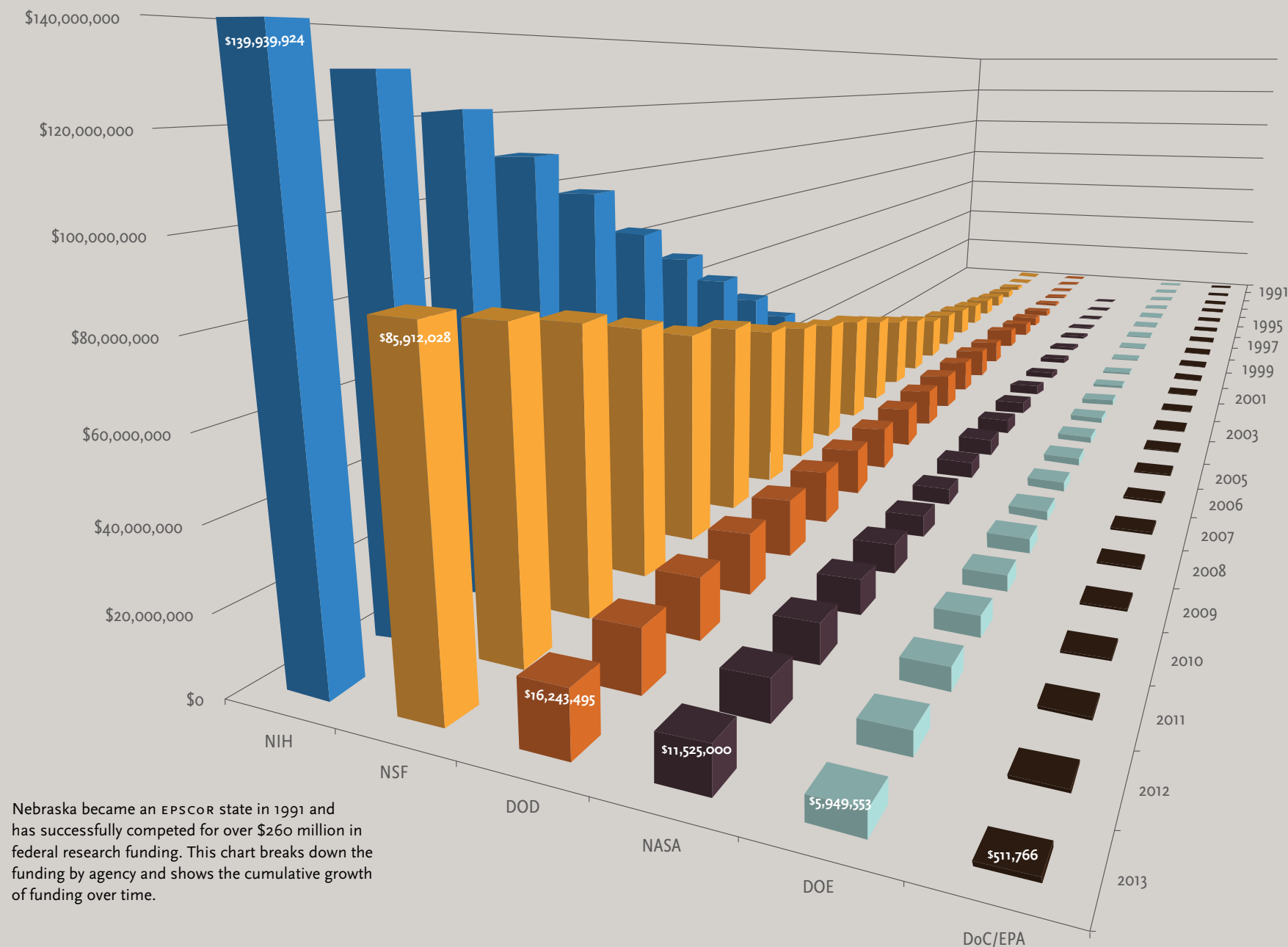
Exploring Iron and Copper Cross-Talk in Iron Deficient Arabidopsis Thaliana; **PI:** **Brian Waters**, Biology, University of Nebraska-Lincoln. \$391,077

NIH IDeA

COBRE: Nebraska Center for Nanomedicine; **PI:** **Tatiana Bronich**, College of Pharmacy, University of Nebraska Medical Center. \$11,244,059

COBRE: Nebraska Center for Cellular Signaling; **PI:** **Keith Johnson**, Oral Biology, College of Dentistry, University of Nebraska Medical Center. \$4,854,525

Total Federal EPSCoR Funding in Nebraska



Nebraska became an EPSCoR state in 1991 and has successfully competed for over \$260 million in federal research funding. This chart breaks down the funding by agency and shows the cumulative growth of funding over time.



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Dr. Raymond Ward, President, Ward Laboratories, Inc., Kearney

Dr. Terri L. Wasmoen, Associate Vice President (ret.), Merck Animal Health, Elkhorn

Senator Ken Haar, State Senator, State of Nebraska