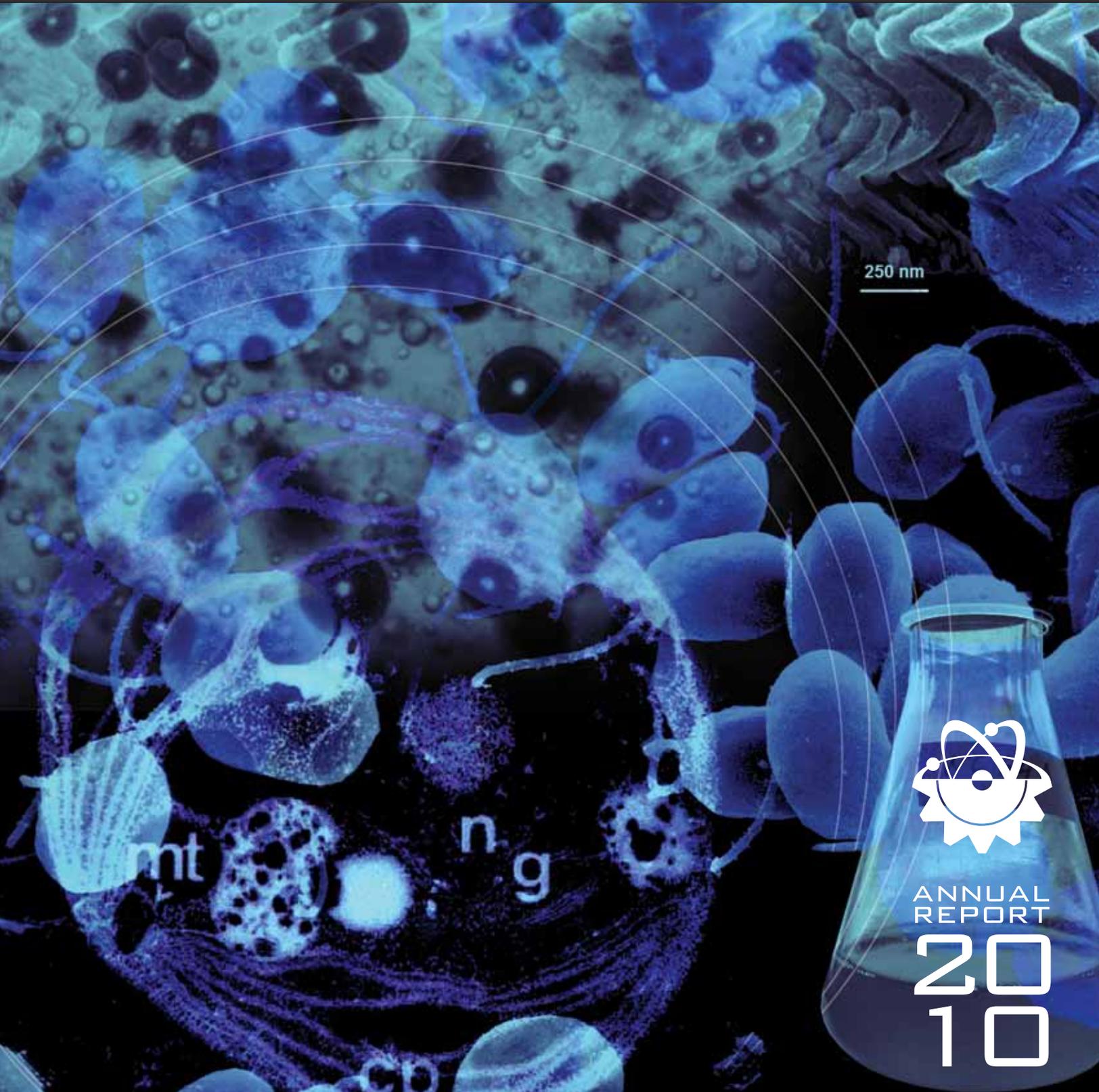


IDEA

# EPSCOR

N E B R A S K A

EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH



250 nm



ANNUAL  
REPORT

20  
10



**MESSAGE FROM THE DIRECTOR**  
**F. FRED CHOUBINEH**

Nebraska EPSCoR/IDeA is motivated by a foundational purpose to galvanize the state's research competitiveness in science, technology, engineering, and mathematics (STEM) and biomedical research. We achieve this through a three-pronged approach: 1) gathering together the most talented researchers on topics with transformative potential

to apply for competitive federal grants, 2) promoting education and outreach programs that nurture the STEM pipeline, and 3) supporting economic and workforce development and public-private sector collaborations. 2010 was a banner year on all fronts.

In 2010, Nebraska EPSCoR won three separate awards from the National Science Foundation, totaling more than \$24 million dollars. One award, for \$20 million, is the largest research grant ever awarded in the state; it will support 27 researchers at five Nebraska colleges and universities conducting transdisciplinary work in the fields of Nanohybrid Materials and Algal Biology. I will be leading all three grants; you can read more about them on pages four and five.

EPSCoR's sister program at the NIH, the Institutional Development Award (IDeA), has also brought significant federal investment to the state. Since 1998, NIH awards in excess of \$109 million have funded biomedical infrastructure improvements and institutional support in Nebraska, with award commitments of \$27 million to come through 2014. The national IDeA program is facing reorganization with potential negative impact on Nebraska activities. We are vigilantly working to minimize the effects of national events on Nebraska programs.

Through our Young Nebraska Scientist camps and the many outreach and education programs we support, Nebraska EPSCoR makes vital investments to expand and enhance STEM opportunities. These inclusive programs for Nebraska middle school, high school, and undergraduate students invite participation from underrepresented groups, broaden the STEM pipeline, and form an integral component of our support of a robust research community.

In addition to our university research and education investments, Nebraska EPSCoR's innovative programs for the private sector form a sustaining bridge between public and private sector research. EPSCoR pioneered a research and development program for university-industry partnerships that has been a model for others.

Finally, one of the measures of our success is in the amount of research dollars that come to the state from the National Science Foundation. Between 2008 and 2010, Nebraska saw a steady increase in NSF research funding, from \$20.6 million in FY 2008, to \$25.3 million in FY 2009, to \$30.8 million in FY 2010. In that timeframe, Nebraska EPSCoR's share of NSF research dollars was \$15.5 million, or 20 percent of the total. Furthermore, NSF EPSCoR's Co-funding mechanism enabled awards totaling \$12 million, accounting for almost 16 percent of the total. That translates to more than a third of NSF research dollars coming to Nebraska because of the EPSCoR Program between 2008 and 2010.

It is clear that Nebraska's research competitiveness is on an upward trajectory, and we expect this trend to continue in the coming years. We are proud of Nebraska EPSCoR's contribution to this success.



Experimental Program to Stimulate Competitive Research  
Institutional Development Award Program

**NEBRASKA EPSCoR**

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**Sarah Zulkoski-Benson**, Outreach Coordinator  
**Nancy Simmitt**, Administrative Technician  
**Hanna Day-Woodruff**, Communications Specialist  
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**COVER PHOTO:**The cover montage draws on several images from Nebraska EPSCoR-funded researchers, including algae studied by researchers in the newly-formed Coalition for Algal Biology and Biotechnology (see page 4), nanoparticles created by Nanohybrid Functional Materials researchers (also page 4), and a dental composite material developed out of an R&D Partnership Award (see page 8).

Editor: Hanna Day-Woodruff  
Graphic Designer: Clint Chapman

**INNOVATIVE IDEAS IN RENEWABLE ENERGY DRAW CROWDS AT THE 6TH ANNUAL NEBRASKA RESEARCH AND INNOVATION CONFERENCE**

Over 400 people attended the Nebraska Research and Innovation Conference in October at the Cornhusker Marriott in Lincoln. The theme, "Renewable Energy: Building a Sustainable Future for Nebraska," focused on five tracks: wind, solar, smart grid, algal, and green chemistry. Attendees representing academia, government, industry, and the general public brought national and international perspectives as well as Nebraska-grown knowledge and experience to the forum.

The morning plenary session included talks from distinguished speakers, including Gov. Dave Heineman; University of Nebraska President James Milliken; Dr. Ray Orbach, Director of the Energy Institute at the University of Texas at Austin; Dr. Jan Koninckx, DuPont BioFuels; and Dr. Jim Walker, CEO of enXco, Inc. and former President of the American Wind Energy Association.

The afternoon parallel sessions featured talks given by experts from Nebraska and beyond on the central themes of the conference. The conference concluded with a reception and poster presentation given by students and researchers. Once again, NRIC provided a fertile setting for collaborative discussions between public and private-sector participants.



**WEBSITE AND TWITTER LAUNCH**

Nebraska EPSCoR unveiled a redesign of its website, offering an updated look and a new navigation system to aid visitors. It also launched a Twitter page, where followers can learn the latest about funding opportunities, events and achievements. Visit us at:

<http://epscor.unl.edu/>,  
and follow us on  
**Twitter@NebraskaEPSCoR.**



## GRANTS AWARDED IN 2010

### NSF EPSCoR

Nebraska EPSCoR received three NSF awards, including the largest federal science grant ever awarded in Nebraska. **Principal Investigator:** F. Fred Choobineh, Director, Nebraska EPSCoR.

■ \$20 million: The Research Infrastructure Improvement (RII) Track 1 Award supporting collaborations between five Nebraska colleges and universities to establish two transdisciplinary centers of excellence in the fields of nanohybrid materials and algal biology. Read more about this award on page four.

■ \$3.3 million out of \$6 million: An RII Track 2 Award for collaboration with scientists in Puerto Rico on nanomaterials for energy technologies. Read more on page five.

■ \$1.17 million: RII Track C2 to expand high speed internet access to community colleges, tribal colleges and small colleges in the eastern side of the state. Read more on page five.

### NSF EPSCoR Co-funding:

The following ten awards received partial funding from the NSF EPSCoR Co-funding Program. NSF EPSCoR contributed a total of \$1,679,617 to the following awards:

■ CAREER Award: *How Temporal Fluctuations Alter Indirect Interactions in Duckweed-based Communities and its integration with a Student Report Exchange*; **PI:** Chad Brassil, Biological Sciences, UNL; \$531,141.

■ *An Ecological Model of Latino Youth Development*; **PI:** Gustavo Carlo and Lisa Crockett, Psychology, UNL; \$315,000.

■ Research in Undergraduate Institutions: *Biodiversity Inventory: Gregarines Parasitizing North American Cockroaches*; **PI:** Richard Clopton, Natural Science, Peru State College; \$443,000.

■ *Rebuilding the Astronomy Curriculum around Robotic Telescopes Observations and Active Learning Exercises*; **PIs:** Jack Gabel and Gintaras Duda, Physics, Creighton University; \$199,306.

■ International: *IRES Mexico RFID in Logistics*; **PI:** Erick Jones, Engineering, UNL; \$140,249.

■ *Metal Oxide Solid Solutions: Macroscopic to Nano-scale*; **PI:** Marjorie Langell, Chemistry, UNL; \$449,855.

■ CAREER Award: *Ligand-induced Folding in Peptides for Biosensing*; **PI:** Rebecca Lai, UNL; \$455,000.

■ Computer Systems Research: *Energy Management for Heterogeneous MapReduce DataCenters*; **PIs:** Ying Lu, Computer Science and Engineering, UNL, and David Swanson, Engineering, UNL; \$432,932.

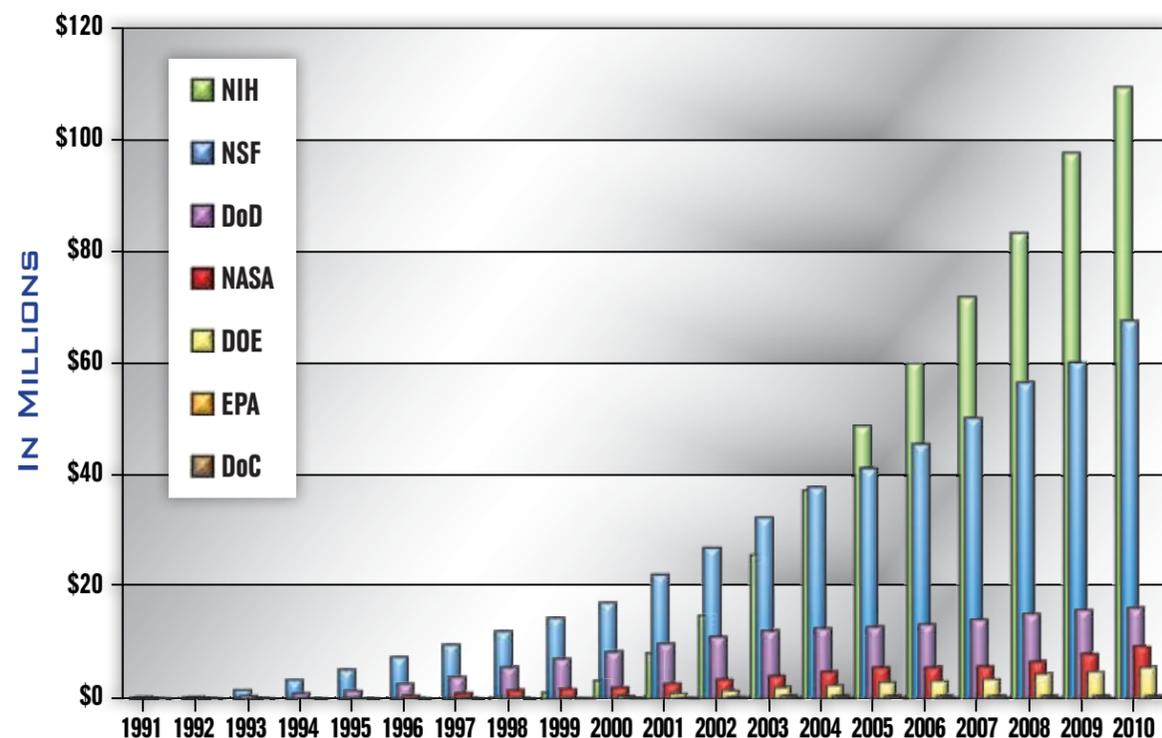
■ Research Experiences for Undergraduates Site: *Optics and Laser Physics*; **PIs:** Cornelius Uiterwaal and Herman Batelaan, Physics and Astronomy, UNL; \$246,450.

■ CAREER Award: *Bringing Wireless Sensor Networks Underground*; **PI:** Mehmet Vuran, Computer Science and Engineering, UNL; \$418,760.

### DOE EPSCoR:

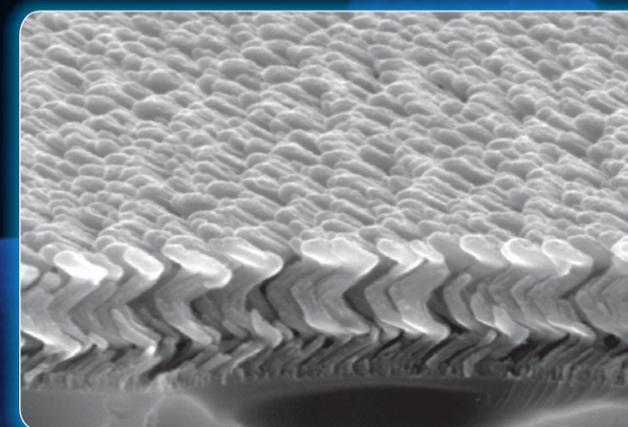
■ Laboratory Partnership Grant: *Nanoscale Studies of Pyroelectric and Thermoelectric Phenomena*; **PIs:** Alexi Gruverman and Stephen Ducharme, Physics and Astronomy, UNL; \$600,000.

## CUMULATIVE FEDERAL R&D FUNDS EXPENDED BY NEBRASKA EPSCoR



## \$20 MILLION RII TRACK 1 AWARD IS THE LARGEST RESEARCH AWARD IN NEBRASKA HISTORY

The National Science Foundation funded Nebraska EPSCoR's 5-year, \$20 million Research Infrastructure Improvement (RII) Track 1 Project: Nanohybrid Materials & Algal Biology. The project will improve the state's research capacity and facilitate economic development through innovative research and university-industry partnerships. Specifically the project will a) support the creation of two transdisciplinary research groups; b) invest in outreach and education in science, technology, engineering and mathematics (STEM) fields to strengthen the pipeline of students pursuing STEM careers; and c) invest to develop public-private partnerships, promote technology transfer, and form project-focused relationships with local and national technology companies.



The image shows a chiral sculptured thin film from silicon grown by glancing angle deposition by scientists at the Nebraska Center for Materials and Nanoscience. Glancing angle deposition is a unique method for designing nanomaterials with tailored geometries, such as spirals, posts, zig-zags or combinations thereof. Nanomaterials with designed shapes have extraordinary physical properties and can be used for unique biosensors, magnetic storage or optical devices.

## THE AWARD WILL CREATE THE NEBRASKA CENTER FOR NANOHYBRID FUNCTIONAL MATERIALS...

The planned Nebraska Center for Nanohybrid Functional Materials will have a transdisciplinary focus at the interface between analytical/bioanalytical chemistry and nanomaterials. The RII funds will enable Nebraska researchers to capitalize on the unique functional properties of nano-scale molecules to develop an entirely new class of materials, called "nanohybrids." This new class of materials is made of tiny nano scaffolds connected to (or "hybridized" with) biological or chemical sensing molecules. These nanohybrids could significantly advance sensing and detection capabilities at the nanoscale, leading to applications in transformative sensor technologies. Potential sensors could have wide-ranging applications, such as computing, disease detection and analysis, and combating terrorism.

The research will have 3 major themes: 1) preparation of three-dimensional nanostructures that are hybridized with chemical or

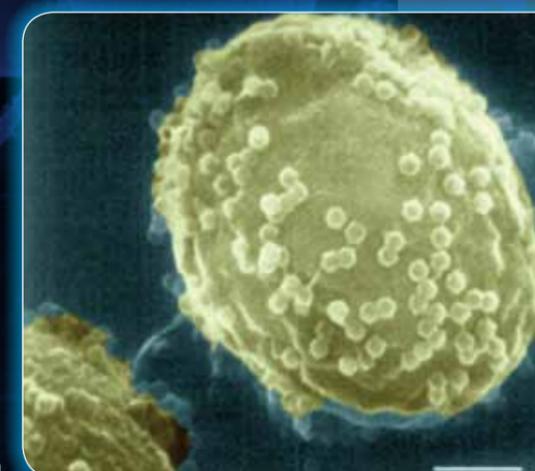
biological sensing elements; 2) investigation of the fundamental properties of the new nanohybrids; and 3) investigation of these new nanohybrids for applications in separation and sensing.

Researchers on this project are: Patrick Dussault, Area Co-Coordinator, Chemistry, UNL; Mathias Schubert, Area Co-Coordinator, Electrical Engineering, UNL; Scott Darveau, Chemistry, UNK; Chris Exstrom, Chemistry, UNK; Stephen Gross, Chemistry, Creighton University; David Hage, Chemistry, UNL; Ming Han, Electrical Engineering, UNL; Andrea Holmes, Chemistry, Doane College; Natale (Ned) Ianno, Electrical Engineering, UNL; Rebecca Lai, Chemistry, UNL; Yongfeng Lu, Electrical Engineering, UNL; and Eva Franke Schubert, Electrical Engineering, UNL. Two additional UNL faculty members - one in Chemistry, one in Electrical Engineering - will be hired as part of this project.

## ...AND THE NEBRASKA COALITION FOR ALGAL BIOLOGY AND BIOTECHNOLOGY

As the national search for a viable clean fuel source expands to algae, Nebraska researchers will be on the forefront of algae's research and biofuel innovations. Algae species contain high percentages of lipids that can be converted into fuel, but significant research is needed to understand the organism's lipid biosynthesis and regulation. Current algae research focuses on a small subset of species; the Coalition will expand the number of species that are studied and will support future applications in algal biofuels and biotechnology. This research holds promising possibilities for the development of applications in health diagnostics, environmental monitoring, domestic security, and renewable and ecologically-friendly energy production. It is a goal to become a national center for knowledge in algal biology and biotechnology.

Researchers on this project are: Donald Weeks, Area Co-Coordinator, Biochemistry, UNL; Ed Cahoon, Area Co-Coordinator, Biochemistry, UNL; Cheryl Bailey, Biochemistry, UNL; Paul Black, Biochemistry, UNL; Heriberto Cerutti, Biological Sciences, UNL; Thomas Clemente, Horticulture & Agronomy, UNL; Concetta DiRusso, Nutrition & Health Sciences/Biochemistry, UNL; Brad Elder, Biology, Doane College; Robert Spreitzer, Biochemistry, UNL; Paul Twigg, Biology, UNK; Karin van Dijk, Biology, Creighton University; and James Van Etten, Plant Pathology, UNL.



The Coalition for Algal Biology and Biotechnology brings together experienced researchers to expand fundamental knowledge of molecular, biochemical and genetic systems in algae. The image above is a *Chlorella*-like alga under attack from a virus. Several *Chlorella* species have been found to contain high levels of lipids and are potentially suitable for biofuel production.

## NEBRASKA EPSCoR TO LEAD A JOINT EFFORT WITH PUERTO RICO TO STUDY NANOSCIENCE FOR ENERGY APPLICATIONS

The National Science Foundation awarded Nebraska EPSCoR a 3-year, \$6 million collaborative Track 2 grant to study nanomaterials for advanced energy technologies with scientists in Puerto Rico. Nebraska EPSCoR's share of the award is \$3.3 million.

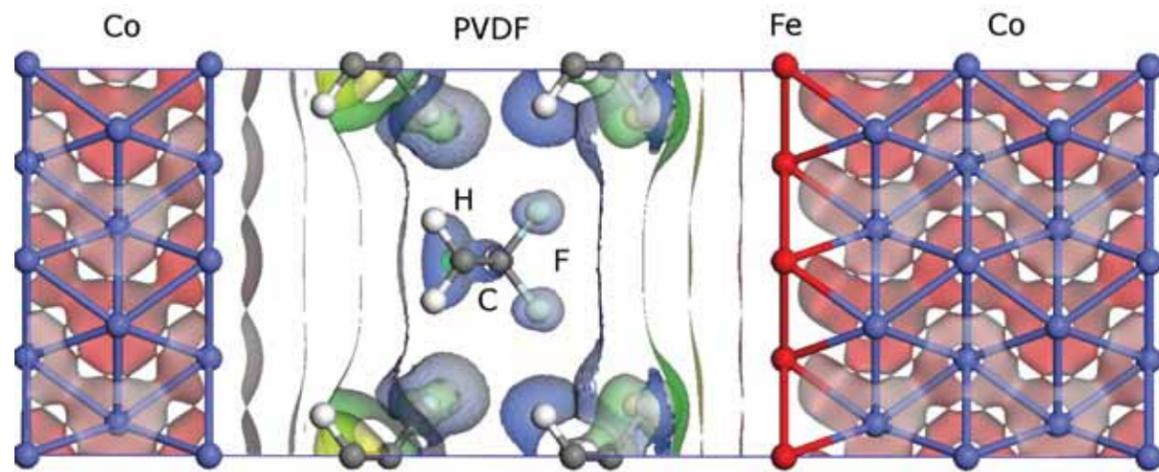
The research will have two aims: a) to create and explore nanomaterials that could be used by the electronics industry to improve energy efficiency; and b) to develop nanocatalysts for energy applications that could help key chemical reactions, namely those used in hydrogen fuel cells.

Upgraded cyberconnectivity between the University of Nebraska—Lincoln, University of Nebraska at Omaha, and the Puerto Rican Institute of Functional Nanomaterials (IFN) will enable the creation of an advanced web portal to facilitate project collaborations. A consortium of computational scientists from Nebraska and Puerto Rico will use the web portal to develop an open source code library for research on nanomaterials.

The increased capacity created by this advanced computational environment will allow the consortium to bring the maximum talent to bear on the problems of energy efficiency.

This grant builds on existing collaborations between the University of Nebraska's Materials Research Science and Engineering Center (MRSEC) and Puerto Rico's IFN, which have participated in student and faculty exchanges for several years.

The co-principal investigators on this award are Evgeny Y. Tsybal, Professor of Physics and director of the MRSEC at UNL, and David Swanson, Director of the Research Computing Facility at UNL. Other researchers on the award are: Kirill Belashchenko, Physics, UNL; Chin Li (Barry) Cheung, Chemistry, UNL; Sitaram Jaswal, Physics, UNL; Hui Li, Chemistry, UNL; Wai-Ning Mei, Physics, UNO; Renat Sabirianov, Physics, UNO; James Takacs, Chemistry, UNL; and Xiao Cheng Zeng, Chemistry, UNL.



This is a representation of an Organic Multiferroic Tunnel Junction, a nanomaterial structure designed by Charles Bessey Professor Evgeny Tsybal and his postdoctoral associate J. D. Burton of UNL, in collaboration with Associate Professor Julian Velez and his student Juan M. López-Encarnación of the University of Puerto Rico. This collaborative nanomaterials research, supported by the Track 2 Award, aims to transform the energy efficiency of electronics and develop better nanocatalysts for energy applications.

## STIMULUS FUNDS WILL EXPAND STATE'S CYBERINFRASTRUCTURE

The National Science Foundation awarded Nebraska EPSCoR a 2-year, \$1.17 million grant to invest in a statewide cyber backbone for high speed data and video transfer. This investment will expand the Nebraska University Regional Optical Network (NEURON), a 10 Gigabit fiber ring between Lincoln and Omaha campuses of the University of Nebraska. Over the next two years, NEURON will be extended to Creighton University and the University of Nebraska at Kearney. In addition, Wayne

State College and several smaller institutions and tribal colleges in the eastern part of the state will connect to the NEURON on data lines with a 1 Gigabit capacity. This capacity allows for data-intensive internet activities such as real-time internet classes, remote health care consultations, and large scale computing. Funds for this project come from the American Recovery and Reinvestment Act of 2009.

"All of Nebraska stands to gain by these investments," said University of Nebraska

President James B. Milliken. "With this project, our colleges and universities will have enhanced opportunities for advanced research and collaborations, and our rural residents will have greater access to education and specialized health care."

Co-principal investigators on the award are David Swanson, Director of the Research Computing Facility at UNL; Walter Weir, NU Chief Information Officer; and Hesham A. Ali, Dean of the College of Information Science & Technology at UNO.

## INBRE RESEARCHERS WIN \$3.3 MILLION FROM NIH TO STUDY IMMUNE IMPACTS OF HIV, METH, AND ANTIRETROVIRAL DRUGS

Thanks to a \$3.3 million grant from the National Institute of Drug Abuse, researchers at the University of Nebraska Medical Center and the University of Nebraska at Omaha will apply a multidisciplinary systems biology approach to look at how the combination of HIV, methamphetamine use, and the use of antiretroviral drugs interact and alter the immune system of infected individuals.

All three variables alter the macrophage, a type of white blood cell and a vital component of the immune system. Little is understood about the molecular changes that occur in the presence of these three conditions and how the impacts are compounded by each other. The experimental approach will include mass spectrometry experiments, and the data will then be used in modeling and computational techniques that will offer further insights.

Principal investigators are Pawel Ciborowski, Ph.D., director of the National Institutes of

Health's Institutional Development Award (IDeA)'s Networks of Biomedical Research Excellence (INBRE) Mass Spectrometry Core and Proteomics Core facilities at UNMC, and Howard Fox, M.D., Ph.D., senior associate dean for research in the UNMC College of Medicine.

Nebraska's INBRE project works to enhance research competitiveness by promoting collaborations, providing professional support, investing in infrastructure, and training the next generation of biomedical researchers. It does this, in part, through financial support for instrumentation and personnel in key areas, called 'cores.'

Ciborowski credits three of the research cores as necessary prerequisites to this work: the Mass Spectrometry and Proteomics Core Facility, the Genomic Core Facility (directed by Dr. Jim Eudy, UNMC) and the Bioinformatics Core Facility located at UNO (Drs. Hesham Ali and Kiran Bastola). These cores made this grant "feasible to be performed in Nebraska and was critical for overall competitiveness," he said.

James B. Turpen, Ph.D., principal investigator of Nebraska's INBRE project, adds, "INBRE support has been instrumental in the development of these cores, which are now having a major impact on our ability to do cutting edge science in Nebraska. This is an excellent example of the high quality, transformational science that is associated with and supported by NIH and the IDEA Program."

Nebraska's INBRE network is led by the University of Nebraska Medical Center and includes Creighton University Medical Center and College of Arts and Sciences, Doane College, Nebraska Wesleyan University, the University of Nebraska at Kearney, the University of Nebraska at Omaha, Wayne State College, Little Priest Tribal College, Western Nebraska Community College, Chadron State College, and the University of Nebraska-Lincoln.



Stacy Wolfe, Dr. Pawel Ciborowski, and Melinda Fittje in the INBRE-funded Mass Spectrometry and Proteomics Core Facility at the University of Nebraska Medical Center. The core's broad range of analytical capabilities provides a strong basis for research competitiveness.

## NESTIP 10-YEAR REPORT CARD

2010 marked a full decade of the Nebraska Engineering, Science, and Technology Internship Program (NESTIP), a key component of EPSCoR's economic and workforce development portfolio. Under this program, Nebraska EPSCoR provides

matching funds of up to \$5,000 to support undergraduate and graduate students in STEM-related internships at Nebraska businesses. In its first decade, Nebraska EPSCoR invested \$428,146 into the NESTIP program, averaging \$42,800 per year.

NESTIP has strong participation from the business community. Since its inception in 2001, 77 business participants have hosted 144 Nebraska students. Prospective businesses conduct recruiting and approach Nebraska EPSCoR with a proposal that is tailored to each individual student.

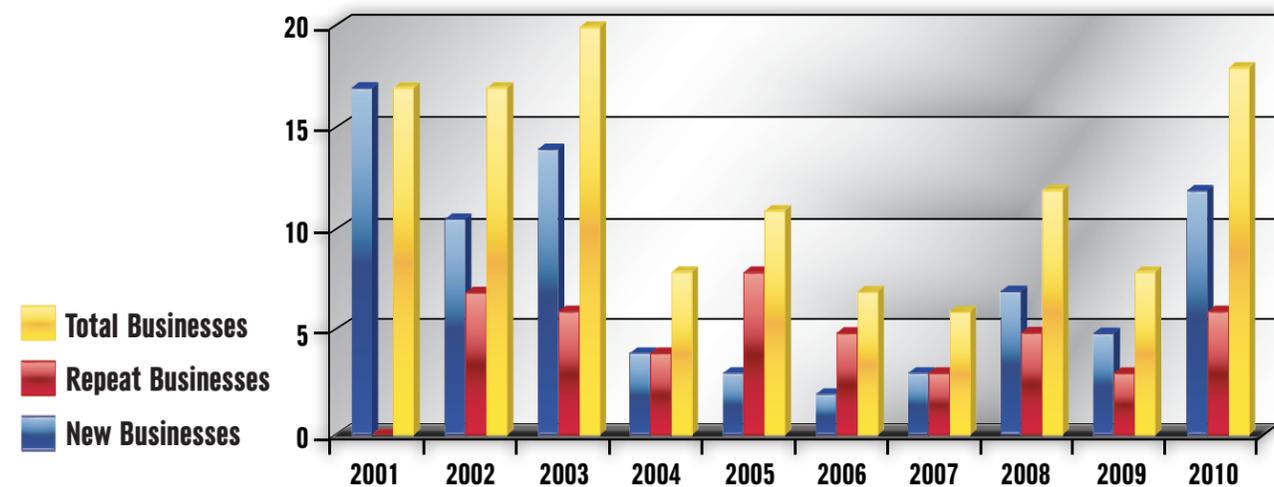
### DEMOGRAPHIC DISTRIBUTION

Twenty-four percent of participants have been female, and 9% have been from ethnic groups that are traditionally underrepresented in the sciences. Nebraska EPSCoR strongly encourages the participation of underrepresented minorities, including women, ethnic minorities and first-generation college students.



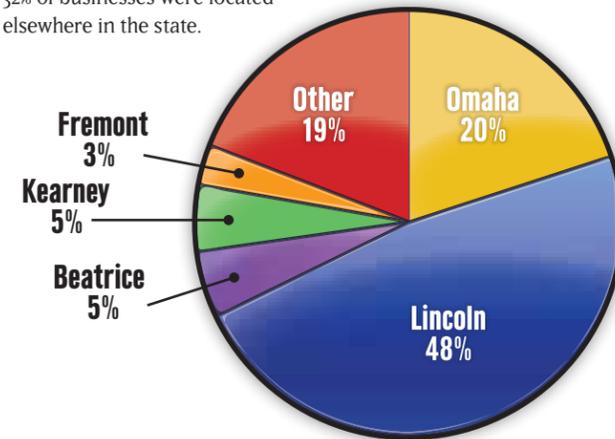
### NEW AND RETURNING BUSINESSES IN NESTIP

Annual participation in NESTIP has fluctuated in terms of total participation and in the balance between new and returning businesses. Of the 77 business participants, 50 were single year participants; 19 participated for two years, and eight have participated for three or more years. 2010 saw the largest influx of new business participants, reflecting the robustness of the program. More information on NESTIP can be found on the Nebraska EPSCoR website at <http://epscor.unl.edu/nestip.shtml>.



### LOCATION OF BUSINESSES PARTICIPATING IN NESTIP

At 48%, Lincoln is home to the largest percentage of NESTIP's business participants. Omaha businesses represent 20% of the total; 32% of businesses were located elsewhere in the state.



## NEBRASKA EPSCoR: A PIONEER IN UNIVERSITY-INDUSTRY COLLABORATIONS 2010 AWARDS

Nebraska EPSCoR's R&D Partnership program has fostered scientific and technological collaborations among research universities and industry since its beginning in 2004. The program subsidizes a portion of the cost of an industry R&D project when a faculty member is contracted by the industry to participate in the project.

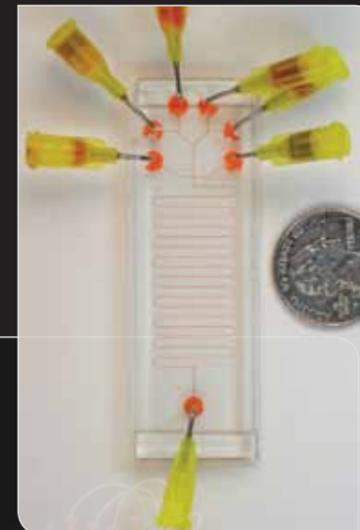
The program offers two funding levels. The Phase I proposal is intended for first time partners who do not have prior University-Industry collaboration or for companies that have had prior collaboration with the university but are exploring partnerships with a new faculty member. The maximum cost share provided for a Phase I proposal is \$10,000.

The Phase II proposal is open to all other partners and has a cost share of \$25,000, with the same matching requirements as Phase I. Phase II recipients are required to submit a proposal to NSF for additional funding by the end of their funding period. Both Phase I and Phase II grants require at least a one-to-one match from the industry partner.

During 2010, three R&D Partnership proposals were received and approved for funding. Three additional R&D Partnerships that began in 2009 finished in 2010.

### PHASE 1

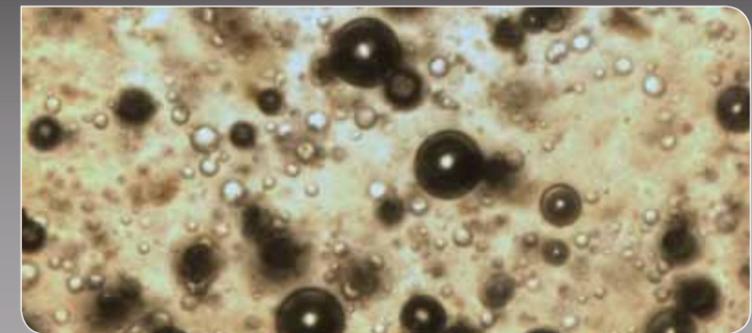
**Experimental study of plasmonic enhanced molecular detection using microfluidic controlled aggregation; Principal Investigators:** Gregory Bashford, Biological System Engineering, UNL, and Michael Furtaw, LI-COR Biosciences, Lincoln, Nebraska, \$4,538.



Dr. Greg Bashford of UNL and Michael Furtaw of LI-COR Biosciences collaborate to improve early disease detection with support from a Nebraska EPSCoR R&D Partnership Award. They are investigating a method that uses a microfluidic device (shown at left), a technology popularized by the inkjet printer, to add metallic nanoparticles to samples that have fluorescent-labeled biomarkers. Metallic nanoparticles amplify the signals from the fluorescent labels, reducing the concentrations at which the biomarkers can be detected. This increased detection sensitivity could lead to earlier disease detection and treatment.



**Self Healing Dental Composites; PIs:** Stephen Gross, Chemistry, Creighton University, and Mark Latta, GL Materials Research, Omaha, Nebraska, \$10,000.



The team of researchers at Creighton University and GL Materials Research LLC won an R&D Partnership Grant to focus on the development of additives for dental materials that result in greater strength and durability. A much broader platform involves the delivery of biologically active agents to help prevent and treat dental disease. This image, acquired by confocal microscopy, depicts a dental formulation used for a composite filling. The formulation contains novel encapsulated additives that improve mechanical properties and release bioactive agents useful in fighting tooth decay.

### PHASE 2

**Improved Detection Technologies for Biologically-Active Contaminants in Water;**

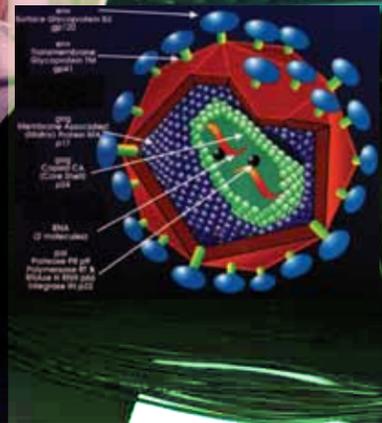
**PIs:** David Hage, Chemistry, UNL; Daniel Snow, School of Natural Resources, UNL; and Jack Silver, Teledyne Isco, Lincoln, Nebraska, \$25,000, with a \$50,000 match from Teledyne Isco.



Efthimia Papastavros, a graduate student in the lab of Dr. Hage, Chemistry, UNL, works with one of the high-performance liquid chromatography columns that the Hage lab is developing in partnership with Teledyne Isco. This column contains an immobilized protein for use in the selective extraction of drugs, estrogen mimics and other emerging contaminants from water.



## Rebecca Lai catapults from FIRST Award success to receive NSF CAREER Award



Nebraska EPSCoR designed its annual FIRST Award program to serve as a critical stepping stone for early career faculty to help them win one of the National Science Foundation's prestigious CAREER Awards. In 2010, Rebecca Lai, UNL Assistant Professor in the Department of Chemistry and 2009 FIRST Awardee, became the seventh FIRST Awardee to go on to receive a CAREER Award.

Over the next 5 years, Lai will receive \$455,000 from NSF to support her research on ligand-induced folding in peptides for biosensor applications. CAREER applicants have three opportunities to submit a proposal – Lai was successful with her first submission. She gives credit, in part, to Nebraska EPSCoR's FIRST Award program for helping her sculpt a successful proposal.

As part of the FIRST Award proposal process, top applicants are invited to submit proposals to Nebraska EPSCoR that follow the CAREER proposal guidelines. The FIRST Award proposal functions as a first draft for a CAREER proposal. Nebraska EPSCoR has these proposals reviewed by experts who provide written feedback on their strengths and weaknesses according to NSF review criteria.

According to Lai, the expert reviews were "really insightful," compelling her to alter her proposal to better meet the priorities of the National Science Foundation. "I think that the expert

reviews... enhanced my chances of getting the Award," she said. The seed money also helped her continue with the research.

Lai is an electrochemist who studies how surface-bound biomolecules can be used in the design and fabrication of sensors for disease diagnosis. The FIRST Award grant supported her efforts to study how peptides - short chains of amino acids that are taken from the proteins of invading substances like bacteria and viruses - might be used as biosensing elements for HIV diagnosis.

Viral peptides change shape when they interact with antibodies, our body's immune system warriors. In her experiments, peptides from an HIV antigen are attached to a gold-plated electrode and labeled with a marker molecule, methylene blue. When the electrode is exposed to a specific voltage, she can measure the rate at which electrons are shuttled to the marker molecule. The rate of electron transfer to the marker molecule is dependent on the shape of the antigenic peptide, which changes upon binding to a specific antibody that is present only in HIV positive blood.

This sensing technology could provide a quicker and less expensive way to test for HIV than the current methods. She hopes to one day develop an inexpensive home HIV testing kit, similar to a glucose meter for diabetics, that could be readily and affordably produced and sold in underdeveloped countries. The FIRST Award and the CAREER Award support Lai's fundamental research to refine this new biosensing method.

## 2010 FIRST AWARDS GIVE EARLY CAREER FACULTY A BOOST

Seven Nebraska early career faculty were awarded Nebraska EPSCoR's FIRST Award in 2010. The FIRST Award grant program provides crucial funds and expert feedback to help Nebraska faculty members initiate successful research programs. The size of the grant is limited to \$20,000 for one year with a 100% matching requirement, and awardees must submit a CAREER proposal to NSF during the duration of the funding period.

The FIRST Award has a two-part application process, beginning with an open call for pre-proposals. Those pre-proposals are reviewed by a committee of Nebraska scientists, which selects approximately 10 applicants to receive invitations to submit CAREER-like full proposals. Full proposals are evaluated by experts in the field based on NSF criteria and chosen for funding by the Nebraska EPSCoR State Committee. All full proposals receive written evaluations that can be used as guidance with CAREER proposal submissions, regardless of success in this competition.

# 2010 AWARDS

**Analyzing Evolution of Large-Scale Networks: Prediction, Updates and Response;** PI: Sanjukta Bhowmick, Computer Science, University of Nebraska at Omaha.

**Imaging Biomechanics;** PI: Shadi Othman, Biological System Engineering, University of Nebraska–Lincoln.

**Monitoring and Modeling of Groundwater Recharge Responses to Weather Events with Radar-based Upper Boundary Conditions;** PI: John Gates, Earth and Atmospheric Sciences, University of Nebraska–Lincoln.

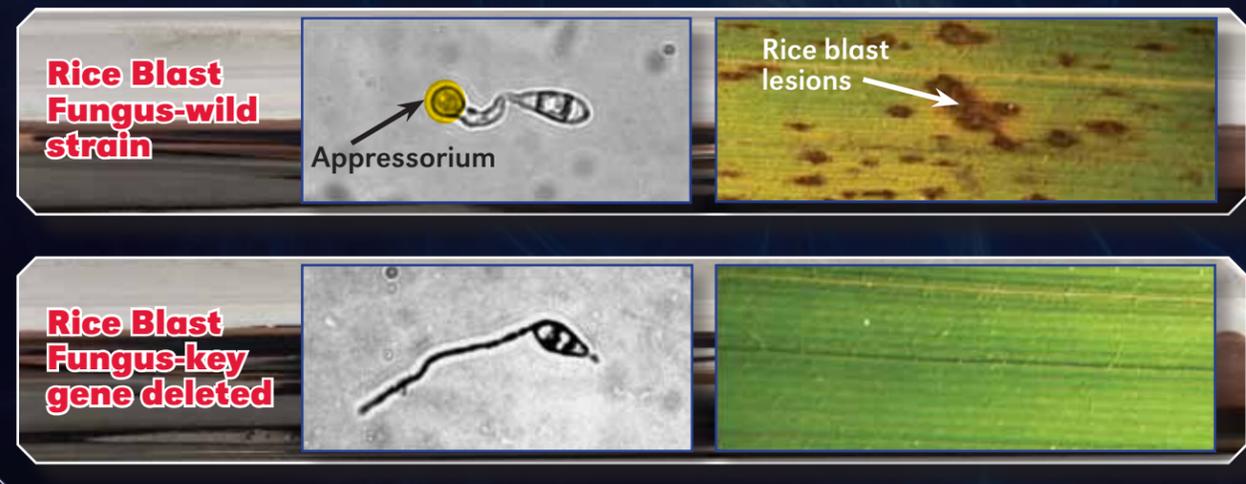
**Exploring Martingale Structure for Wireless Communications and Sensor Networks;** PI: Yaoqing (Lamar) Yang, Computer and Electronics Engineering, University of Nebraska–Lincoln.

**Improving Current and Voltage Output of Organic Solar Cell by Interface Dipole;** PI: Jinsong Huang, Mechanical Engineering, University of Nebraska–Lincoln.

**Discovery of Functional Mimicry in Bacterial Virulent Effectors to Plants;** PI: Chi Zhang, School of Biological Sciences, University of Nebraska–Lincoln.

**Pathogenic Gene Discovery in the Devastating Rice Blast Fungus *Magnaporthe oryzae*;** PI: Richard Wilson, Plant Pathology, University of Nebraska–Lincoln.

Each year 60 million people could be fed with rice that is destroyed by the devastating rice blast fungus. With FIRST AWARD funding, Dr. Richard Wilson's lab seeks to uncover the pathogenic genetic mechanisms of the disease. In the images below, the leaf that shows the yellow-brown discoloration was infected with normal rice blast fungus. The Wilson lab successfully identified and deleted a fungal gene that is implicated in development of the appressorium, an organ used to penetrate and invade cells (see microscope view). The disease-free leaf was sprayed with the benign rice blast mutant, which is unable to develop the appressorium and infect the plant.



# NASA EPSCoR Projects Propel Innovations for Satellites and Space Software

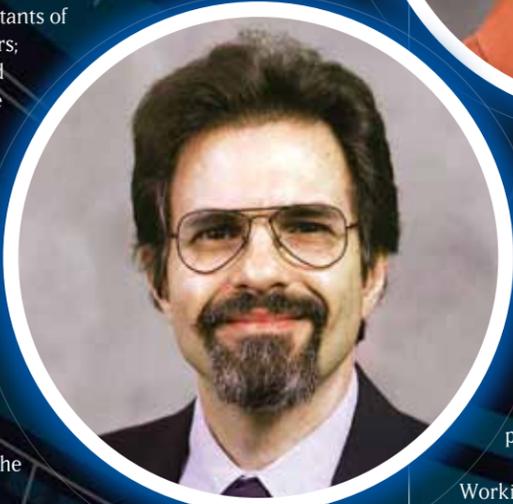
**A**erospace research in Nebraska remains at the forefront of the field with support from two NASA EPSCoR awards. Ned Ianno, UNL professor of Electrical Engineering, and Matthew Dwyer, professor of Computer Science at UNL, are pursuing high priority research projects that directly impact the effectiveness of our nation's space program.

The funding has provided **Ned Ianno** with advanced instrumentation and student support for his research into thin-film contaminant deposition and characterization. Sunlight fuses thin layers of contaminants over satellite solar cells through photochemical deposition, darkening the cells and reducing the energy conversion efficiency. This leads to premature satellite malfunctions. Ianno's research programs determine the optical properties and growth characteristics of these nano-scale thin films of contaminant polymers. Ianno's facility is among a very few capable of directly measuring the optical constants of these contaminant polymers; results can be incorporated into the design and lifetime analysis of satellites.

Building on the success achieved from the NASA EPSCoR project, Ianno has forged research partnerships with Aerospace industry companies Eikos Inc., Ball Aerospace and Technology Corporation, Northrup Grumman, and the Aerospace Corporation.



**Matthew Dwyer's** NASA EPSCoR project focuses on developing an analytical tool for NASA to evaluate future changes in its software. The project began from the premise that useful software systems remain in operation for a very long time and undergo changes during their lifetimes. Bugs are fixed, performance enhancements are made, and new features are added in response to user needs. Dwyer's project leverages information about how the software has changed to calculate the influence that those changes would have on the behavior of the software. During the course of the research, Dwyer and his team have made a number of important conceptual and technical advances. Dwyer's work was the first to introduce the concept of a "differential" program analysis, i.e., an analysis that compares the operation of two different programs - in this case two program versions.



Working in these areas led Dwyer's team to become experts in a research area that was an integral part of a proposal funded by the Air Force Office of Scientific Research (AFOSR). This new \$4 million grant covers a wide range of topics, but two key elements - reasoning about system evolution and performing analysis using constraint solving techniques - are directly attributable to work performed in his NASA EPSCoR project.

## KIDS EXPLORE NEAR-SPACE

**E**mily Hernandez, Alexandria Green, and Matthew Okalebo prepare to launch a water rocket they constructed during the 2010 Young Nebraska Scientist summer camp at the University of Nebraska at Omaha. At the UNO camp, "The Sky's the Limit - The Science & Design of Near Space Exploration," participants were able to design and test several different kinds of rockets, participate in simulations of astronauts' working conditions, explore the history of the NASA space program and design team mission patches, witness a weather balloon launch, and take a field trip to the SAC Air and Space Museum. Dr. Dana Richter-Egger, the Director of the Math-Science Learning Center and Professor of Chemistry at UNO, is Nebraska EPSCoR's partner in developing YNS summer science camps at UNO.



YNS

## SCIENCE SUMMER CAMPS AT NEBRASKA EPSCoR MIX SCIENCE AND FUN

**T**he summer of 2010 was the third year for the Young Nebraska Scientists Initiative, a program that offers middle school and high school students enriched learning opportunities in science, technology, engineering and mathematics (STEM) while also familiarizing themselves with university campuses. The 2010 YNS portfolio included two one-week residential summer science camps for middle school students, one at the University of Nebraska—Lincoln with the theme "Energy for the 21st Century" and one at the University of Nebraska at Omaha with the theme "The Skys the Limit — the Science and Design of Near Space Exploration."

With a curriculum developed by certified teachers, students were engaged in active-learning activities in college classroom settings. Major highlights included the building and testing of wind turbines and solar cars for the Energy Camp and building and testing rockets and witnessing a weather balloon launch for the Near Space Camp. Students came from across the state — of the 57 total participants for the

two camps, 40% were from rural areas, 51% were from underrepresented minority groups, 42% were female, and 54% received financial aid.

For the second year in a row, Nebraska EPSCoR augmented the YNS portfolio with an \$80,000 grant from the Harris Foundation to support a 2-week residential camp at UNL for middle school students with the theme, "Extraordinary H<sub>2</sub>O." Fifty-two students participated in the camp from the Lincoln and Omaha areas. All expenses were paid for the participants, fully half of whom were female and/or underrepresented minority.

In addition to the summer science camps, for the third year in a row, Nebraska EPSCoR provided support for the science component of the Nebraska College Preparatory Academy (NCPA), which offers three-day summer camps for the program's 10th and 11th grade high school students. Participation in a summer science camp at the UNL campus is one component of a broader mentoring program designed to prepare a 9th-12th grade cadre of

students for the rigors of college coursework, particularly in the STEM fields. NCPA scholars are aiming to become first generation college students. This program has had strong success, as the first cohort of NCPA scholar-graduates entered college in the fall of 2010 with a 100% acceptance and attendance rate.

Each of these programs provides enhanced STEM education in positive, fun settings with the purpose of inspiring future STEM participation. The portfolio is designed so that students can layer YNS experiences as they get older, thereby nurturing the K-16 pipeline. In 2010, twenty of the participants in the summer camps also attended the previous year, three of the summer researchers were former camp participants, and one former high school researcher has continued to work in the same Plant Sciences lab now that he is in college. In the coming year, EPSCoR will develop and implement longitudinal studies to formally assess the long term impact of its programs.

## NEBRASKA EPSCoR HELPS ACADEMICS MEET BROADER IMPACTS GOALS

**N**ebbraska EPSCoR's most recent NSF awards will allow for the continuation of the highly successful Young Nebraska Scientists Initiative with its summer science camps and summer research experience for high school students. Moving into its fourth year, Nebraska EPSCoR's programs have been honed over the years, but we don't wish to hoard the expertise that we have acquired — instead, we offer support to researchers who wish to incorporate a summer science camp or research experience for high school students as a means of fulfilling the broader impacts requirements of NSF proposals.

Should a researcher wish to incorporate these elements into a proposal, Nebraska EPSCoR can provide a wide range of assistance. Nebraska EPSCoR can advise on the cost, planning and operation of camps. Curriculum from the YNS summer camps is available for adaptation by individual institutions. Nebraska EPSCoR's YNS website, <http://yns.nebraska.edu>, is available for promoting YNS summer camps and activities and allows online access to recruiting and applications.

Nebraska EPSCoR offers summer camp advertisements that can be adapted for new host institutions, and can assist in ensuring camp advertisements are disseminated across the state. NE EPSCoR can also assist in the recruitment of Nebraska science teachers for camp instruction.

Academics who have the funds to hire high school students as summer science researchers can use YNS's existing recruitment infrastructure to find qualified students. For example, in the summer of 2009, Dr. Wonyoung Choe, Assistant Professor in UNL's Department of Chemistry, used the YNS website recruitment to hire a former YNS participant for a summer internship with funding from the American Chemical Society.



Elizabeth Paulissian, now a high school senior, attended the YNS Summer Science Camps for two years, and then became a 2010 Summer Researcher in the metal-organic frameworks lab of Wonyoung Choe, Assistant Professor in UNL's Department of Chemistry.

Students from Pius X High School in Lincoln use gel electrophoresis to determine their genotype for a benign mutation at UNL's Beadle Center.



## EPSCoR BRINGS ADVANCED SCIENCE LABS TO HIGH SCHOOL STUDENTS

Advanced concepts in molecular biology become more than just words and pictures for the Nebraska high school students who participate in Nebraska EPSCoR's Molecular Biology for Secondary Classrooms (MBSC) program. The MBSC program demonstrates basic principles of genetics and genetic engineering through three portable laboratory experiments for use by 9th grade biology, 10th grade differentiated or honors biology, and advanced biology classrooms across the state. The program is in its 5th year and has reached over one-thousand students annually in the last four years.

Participating teachers report that students are engaged and excited about the real-world lab experiences. The experiments help the students retain what they learn, according to John Snoozy, 10th grade differentiated biology teacher at Northeast High School in Lincoln, Nebraska.

Three basic labs involving recombinant DNA technologies are offered:

- 1) students transform bacteria by inserting foreign DNA in order to make it produce a protein that glows under ultraviolet light;
- 2) students use restriction enzymes to cut harmless bacterial virus DNA into fragments and visualize the DNA fragments using gel electrophoresis;
- 3) students determine their genotype for a benign mutation on Chromosome 16 by using DNA obtained from cheek cells, and then use Polymerase Chain Reaction technology to amplify the target region on the chromosome.

"Without the program...my students would be missing out on a lot of microbiology experiences. I think [the labs] prepare them for college and makes them more aware of

some of the technology out there," says Krista Holliday, who teaches 10th grade Biology at Ewing Public School in Ewing, Nebraska.

Lesson plans, supplies and guidance are provided by Sarah Zulkoski-Benson, Outreach Coordinator for Nebraska EPSCoR. Participating classrooms do so at no expense — Nebraska EPSCoR ships the necessary supplies and equipment to the teachers and includes return postage, providing laboratory equipment valued at \$10,000 and additional classroom supplies that cost \$300 per class.

New participants are chosen on a first-come, first-serve basis and are incorporated based on availability of funds and equipment. Nebraska EPSCoR particularly encourages the participation of teachers or schools that serve traditionally underrepresented populations, including rural students.

## SUPPORT CONTINUES FOR TRIBAL COLLEGE STEM PROGRAMS

In 2010, key support from Nebraska EPSCoR enabled Little Priest Tribal College to complete an upgrade of its chemistry and computer laboratories. The renovation of LPTC's Legacy Building was completed in August of 2009, but the renovations had not included monies for chairs, tables, computers and audio visual material for its chemistry and computer laboratories. Nebraska EPSCoR stepped in with funds to support the replacement of an old asbestos fume hood, purchase six student workstations and one instructor workstation in the computer laboratory that has GIS/GPS capability, and purchase a SmartBoard for the science classroom to complete the project. The new science labs allow for better access to and resources for LPTC students, broadening their exposure to science and science-related experiments.

Also with support from Nebraska EPSCoR, Little Priest Tribal College initiated a Science Laboratory program intended to provide culturally sensitive, hands-on experiments for 11th and 12th grade high school

students and the community. LPTC hosted five laboratories over the course of the year, offering topics in a workshop-style atmosphere, including a chemistry/physics demonstration, a solar workshop, a hands-on rocket building project, a meteorite workshop, and a star party. The rocket workshop resulted in a successful launch of a rocket with a payload on it — a small video camera with audio — that recorded its flight over Winnebago. The video from the flight can be found at [youtube nasa rocket launch, little priest tribal college](#).

"We remain convinced that it is important to provide hands-on science experiments for junior and senior high school students. This will help to increase high school students' interest in science, helping them to see the relevance of science in their lives and in their community, and to increase the number of students entering LPTC and other area colleges with the intent of majoring in science," says Brigid Quinn, Assistant Chair of the Science Department.

## BRIGHT LIGHTS SUMMER LEARNING ADVENTURES: A PLAYFUL WAY TO TEACH STEM



During the Bright Lights Healthcare Explorers camp at BryanLGH East Hospital in Lincoln, students get to perform laser surgery on fruit, tour a helicopter ambulance, and learn from the epidemics response team.

In 2010, Nebraska EPSCoR expanded its commitment to providing opportunities for low-income elementary and middle school students from underrepresented groups in the sciences through the non-profit Bright Lights (BL) Summer Learning Adventures program. Nebraska EPSCoR sponsored 50 need-based scholarship students, up from 31 in 2009.

With almost half of the program's offerings in math, science, and technology, Bright Lights' mission is to promote life-long learning, which it does by offering summer school classes with an eye to enticing children to learn through "hands-on, minds-on" activities. Summer classes that involve science, technology, engineering or mathematics include "Engineering a Better World," "Crime Scene Investigation," "Healthcare Explorers," "Games, Patterns & Puzzles," and "Robotics: Lego Mindstorms NXT."

## COLLEGIATE COMPUTER PROGRAMMERS COMPETE AGAINST EACH OTHER AND THE WORLD

Logic, speed, and strategy must be employed in the battle of wits between the college participants of the Association for Computing Machinery's annual Regional Programming Contest. Held simultaneously via the web across multiple sites, Nebraska EPSCoR supported UNL in hosting the largest regional contest in the North Central North American Region, with 32 teams from 10 different schools solving problems in Pascal, C, C++, and Java. The North Central North American region includes Minnesota, Wisconsin, Western Ontario, Manitoba, Iowa, North Dakota, South Dakota, Nebraska, Kansas, and the upper peninsula of Michigan.

At the November event, the UNL team Phelpsians — John Benes, Justin Hicks and Dylan Douglas — placed 1st at the UNL competition and 6th in the Region. Last February, a UNL team, the Incendiary Pigs, attended the World Finals in Harbin, China, and earned an Honorable Mention. Nebraska EPSCoR is a proud supporter of this competition, as it plays a key role in engaging youth to become competent, skilled members of the STEM workforce.

## WOMEN IN SCIENCE CONFERENCE INSPIRES PARTICIPANTS

In February 19-20, 2010, Nebraska EPSCoR co-sponsored the 12th Women in Science Conference with the UNL Center for Science, Mathematics and Computer Education. The conference provides career information and talks by prominent female scientists to high school students with an ability and interest in exploring a future in science. Eighty-seven high school women, along with their teachers, attended from 24 high schools in Nebraska and 2 in Kansas. UNL faculty and students assisted with the conference by providing displays, serving as panelists, and conducting tours and workshops.



High School students watch a demonstration at the Dentistry Workshop during the 2010 Women in Science Conference at UNL.

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