

ANNUAL REPORT

2021



IDEA
EPSCoR
NEBRASKA

Established Program to Stimulate Competitive Research

COVER IMAGE (and THIS PAGE): Models show nanohelices formed via glancing angle deposition of materials — in this case, silicon and silver — resulting in new hybrid dielectric and plasmonic metamaterials with extremely enhanced sensing capabilities. This research is part of FRG2, a Focused Research Group in the Emergent Quantum Materials and Technologies (EQUATE) project: awarded to Nebraska EPSCoR for five years of funding to total \$20 million from the National Science Foundation’s Established Program to Stimulate Competitive Research (EPSCoR). This collaborative project includes more than 20 researchers and engages six Nebraska colleges and universities. *Images source: Ufuk Kilic, Ph.D. – postdoc, E. Schubert Lab / Nebraska Center for Materials and Nanoscience, University of Nebraska-Lincoln*

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

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Nebraska’s Established Program to Stimulate Competitive Research (EPSCoR) office is funded by the National Science Foundation via OIA-1557417 and OIA-2044049. Any opinions, findings, and conclusions or recommendations expressed in this material do not necessarily reflect the view of the National Science Foundation.

DIRECTOR'S MESSAGE



DESPITE THE CHALLENGES OF an ongoing pandemic, 2021 was an excellent year for Nebraska EPSCoR. In early March, we were notified by the National Science Foundation (NSF) that our Research Infrastructure and Improvement Track-1 grant proposal titled Emergent Quantum Materials and Technologies (EQUATE) was funded for a total of \$20 million over five years. This great news was the culmination of nine months of project design, budget development, proposal writing and assembly. The EQUATE team successfully

met this challenge by working remotely and submitting their proposal in August 2020. EQUATE is now a statewide project involving six Nebraska institutions of higher learning and 20 senior investigators led by scientific director Dr. **Christian Binek** of the Department of Physics at University of Nebraska-Lincoln (UNL). You can read more about EQUATE in the following pages of this report.

Our other Track-1 project, the Center for Root and Rhizobiome Innovation (CRRI) that began in 2016, reached its final year. Due to pandemic-related delays in many of the research and education activities, NSF allowed the CRRI funding period to be extended through May 2022. The unprecedented overlap of two Track-1 projects (EQUATE and CRRI) for a full year provided the Nebraska STEM (Science, Technology, Engineering and Math) community with additional resources such as an expanded FIRST Award program for early-career researchers; a Nebraska STEM Education Conference attended by 65 middle school, high school, and higher education teachers in July; and a new Small College and University Teaching and Research Equipment program described in this report.

The Nebraska EPSCoR office has now resided on the Nebraska Innovation Campus for two years. In the past year our team had some personnel changes as our Outreach Coordinator Ms. **Nicole Busboom**

moved on to another opportunity, and our Accounting Technician Mr. **Fred Gartner** retired after serving Nebraska EPSCoR for ten years. We were very fortunate to fill both vacancies with excellent new colleagues. In the summer of 2021, Dr. **Jodi Sangster** and Mr. **Aaron An** joined our team--with Jodi filling the outreach and education position, and Aaron becoming our new accountant. With our new team and our new NSF Track-1 award in place, I am excited about the role that Nebraska EPSCoR will play in our state's future STEM education and research. ■

Meet Our New Hires



Accounting Technician **HOKWANG "AARON" AN** joined Nebraska EPSCoR after an internship with University of Nebraska Office of the President. Originally from Seoul, South Korea, he earned his B.S. in Accounting from the University of Nebraska-Lincoln (UNL), and is currently pursuing a master's degree in professional accountancy and studying to acquire CPA certification.



Outreach Coordinator **JODI SANGSTER** earned her Ph.D. and master's degrees in Civil Engineering from UNL. She has worked as a postdoctoral researcher with Nebraska Engineering and the US Department of Agriculture in Riverside, California. Earlier in her career, she was a zookeeper at Omaha's Henry Doorly Zoo; more recently, she managed citizen science initiatives in water quality for Nebraska.

STATE COMMITTEE

The Nebraska EPSCoR State Committee is a 19-member group, appointed by the governor, to oversee Nebraska EPSCoR's mission. In 2021, the committee noted several changes among its members:

THANK YOU



SUSAN FRITZ

AFTER 32 YEARS WITH the University of Nebraska—including roles as Provost, Executive Vice President, and Interim President—and 7 years on Nebraska EPSCoR's State Committee as Committee Vice-Chair, Dr. **Susan Fritz** retired in 2021. At the January 2021

State Committee meeting, Nebraska EPSCoR Director **Matt Andrews** commended her for being a thoughtful and competent force on behalf of our state. "Dr. Fritz has been a strong supporter of Nebraska EPSCoR, and played an important role in moving the Nebraska EPSCoR office into its new location on the Nebraska Innovation Campus."



THOMAS MURRAY

AFTER 13 YEARS ON Nebraska EPSCoR's State Committee, Dr. Murray departed from the group as he retired from work as Provost at Creighton University. Fellow State Committee member, Dr. **Juliane Strauss-Soukup**, was recently appointed CU's Vice Provost for Research and

Scholarship and will succeed him as Creighton's administrative representative on the committee. In 2021, Dr. Strauss-Soukup was also elected Vice Chair of the Nebraska EPSCoR State Committee.

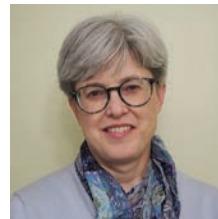
WELCOME



JEFFREY GOLD

JEFFREY GOLD, M.D. SERVES as chancellor of the University of Nebraska Medical Center (UNMC), Vice President of the University of Nebraska System and board chair of Nebraska Medicine Health System; he was also previously chancellor of the

University of Nebraska at Omaha. In July 2021 he succeeded **Susan Fritz** as NU's Provost.



JANET SEGER

DR. SEGER IS PROFESSOR and Chair with Creighton University's Department of Physics. Her research focus, with support from the U.S. Department of Energy and DoE-EPSCoR, is the study of ultra-peripheral heavy ion collisions. She is active in

engaging undergraduate students in her research.

TRACK-1

Nebraska Gains \$20 Million from NSF for Five Years of Quantum Materials Research

IN MAY OF 2021, a new research collaboration was announced for Nebraska. With National Science Foundation (NSF) funding for five years totaling \$20 million, the Emergent Quantum Materials and Technologies (“EQUATE”) project will study quantum properties of materials—potentially advancing technology, medical applications, national security, and more.

Funded through NSF’s Established Program to Stimulate Competitive Research (EPSCoR), EQUATE will involve more than 20 scientists—including physicists, chemists, and engineers—at six Nebraska colleges and universities: University of Nebraska-Lincoln (UNL), University of Nebraska at Omaha (UNO), University of Nebraska at Kearney (UNK), Creighton University (CU), Nebraska Indian Community College, and Little Priest Tribal College.

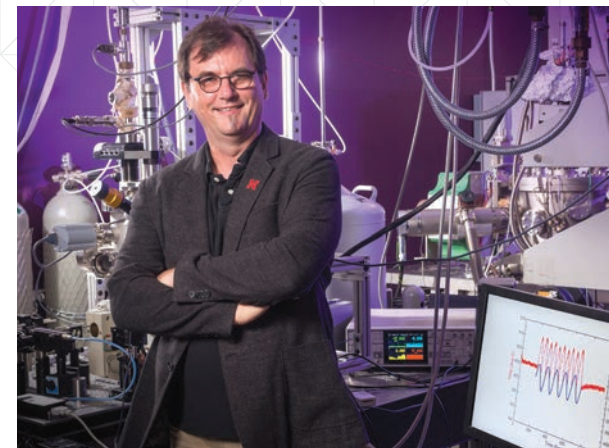
According to **José Colom-Ustáriz**, a program director with NSF EPSCoR: “This project (EQUATE) furthers Nebraska’s strategic priority to advance knowledge in quantum phenomena. It has the potential to benefit society through research outcomes, workforce development and STEM education and training, specifically in Native American and rural communities.”

As part of NSF EPSCoR’s Research Infrastructure Improvement (RII) resources, “Track-1” projects (such as EQUATE) are funded to study important basic science topics via the recipient states’ higher education sites—both large and small colleges/universities—and extend that benefit to the state’s people. EQUATE’s proposal aligns with one of NSF’s “10 Big Ideas,” Quantum Leap, described as: “Exploiting quantum mechanics to observe, manipulate, and control the behavior of particles and energy at atomic and subatomic scales, resulting in next-generation quantum-enabled science and technology for sensing, information processing, communicating, and computing.”

UNL’s **Christian Binek** (right), Charles Bessey Professor of Physics and EQUATE’s scientific director, said the project’s goal is to stimulate scientific discovery in how quantum materials and systems are designed and implemented, which has the potential to revolutionize technologies used in communication and information processing. He added the Nebraska Center for Materials and Nanoscience and the Materials Research Science and Engineering Center, both based at UNL, created a foundation for success and led to formation of the Nebraska Nanoscale Facility—all fundamental to EQUATE’s work.

According to a UNL news release, EQUATE aims “to grow the state’s economic competitiveness through a well-trained workforce; establish education and outreach programs to increase understanding of quantum science and technology, particularly among secondary and post-secondary students, underrepresented groups and rural populations; invest in new, cutting-edge equipment; make strategic faculty hires to increase research capacity and expertise; engage with local industry partners; and secure major research funding.”

“Thanks to our faculty, the University of Nebraska has built a proven record of success in quantum science. This new award, made possible by the collaborative power of our campuses and partners, will only grow the impact of our work,” said University of Nebraska System President **Ted Carter**. “EQUATE will significantly expand our state’s research and teaching capacity, make cutting-edge science accessible to more Nebraskans, and create economic growth.”



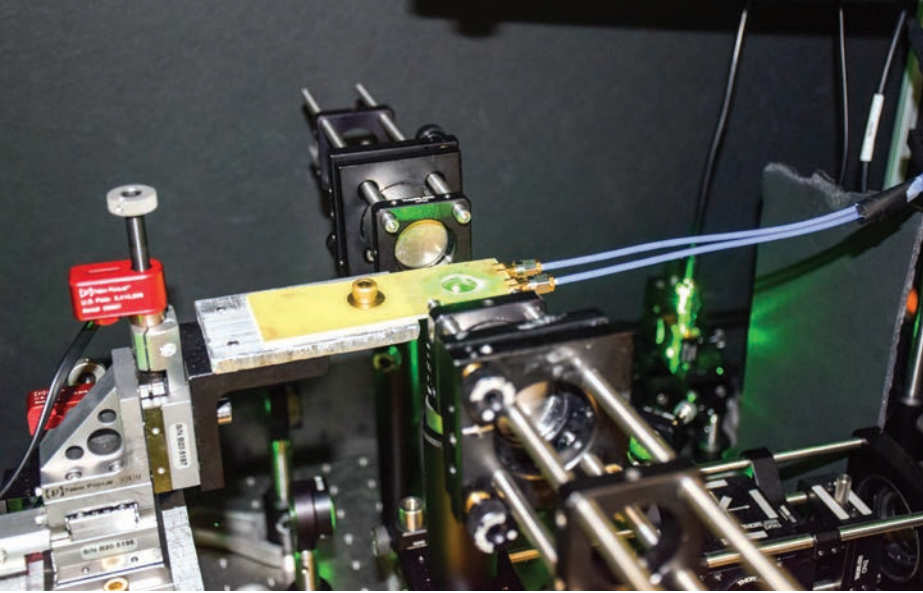
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ABOVE, Nebraska's Emergent Quantum Materials and Technologies (EQUATE) 2021-2026 group gathers for strategic planning in August 2021. From left to right are: *seated*—**Matt Andrews*** (PI, Nebraska EPSCoR), **Christian Binek*** (UNL, Research PI and Scientific Director), **Abdelghani Laraoui*** (UNL, FRG2 leader), **Jonathan Wrubel*** (Creighton University, FRG3 leader), **Xia Hong*** (UNL, FRG1 leader), and **Rebecca Lai*** (UNL, EQUATE Associate Director); *standing*: **Steve Wignall*** (UNL/NCMN Outreach), **Carole Allen** (NE EPSCoR), **Mathias Schubert** (UNL), **Christos Argyropoulos** (UNL); **Allison Teeter** (OEIE); **Renat Sabirianov** (UNL); **LeAnn Brosius** (OEIE-external evaluator); **Yinsheng Guo** (UNL); **Jeremy Armstrong** (UNK), **Alexey Kovalev** (UNL), **Xiaoshan Xu** (UNL); **Ralph Skomski** (UNL); **Sy-Hwang Liou** (UNL); **Mai-Ning Wei** (UNO); **Jodi Sangster*** (NE EPSCoR); **Wei Bao** (UNL); **Nancy Simnitt** (NE EPSCoR); **Mark Griep** (UNL); **Aaron An** (NE EPSCoR); **Peter Dowben** (UNL). *Not pictured: Eva Schubert* (UNL); **Evgeny Tsybmal** (UNL). * indicates project management team member (Photo: Nebraska EPSCoR)

The 20 Senior Investigators from UNL, UNO, UNK and CU bring expertise in physics, chemistry, materials science, mechanical engineering, electrical engineering, and computer science. A particular strength is the well-established collaboration and feedback between theory and experiment, which promotes inter-institution exchange and based on past success expedites theory-guided discoveries. Theorists from UNO explore

platforms for a generalized quantum computer operator above millikelvin (mK) temperature, which can be experimentally realized through UNL's nanofabrication capabilities. Theoretical guidance from UNK informs EQUATE's powerful experimental platform allowing investigation of cold atoms for quantum emulation at CU. ■



In the lab of **Abdelghani Laraoui**, UNL assistant professor of Mechanical & Materials Engineering, this optically-detected magnetic resonance microscope studies diamond nitrogen vacancy (NV) color centers doped near the surface of a diamond chip. The diamond substrate is excited with green laser and the collected fluorescence is analyzed to detect weak magnetic signal from iron-contained biomolecules deposited on top of diamond. Laraoui leads Focused Research Group (FRG) 2 in the EQUATE project's focus on quantum materials research; in this particular work (quantum sensing of biomolecules), Laraoui collaborates with UNL Physics' Professor **Sy-Hwang Liou**.

“EQUATE furthers Nebraska’s strategic priority to advance knowledge in quantum phenomena. It has the potential to benefit society through research outcomes, workforce development and STEM education and training, throughout the state.”

— José Colom-Ustáriz

Learn About the Science of EQUATE

EQUATE's cooperative research enterprise comprises three focused research groups (FRGs) to facilitate a collective theoretical, experimental, and engineering effort. FRG1 (Quantum Materials) is led by UNL Associate Professor **XIA HONG** and creates the cluster's foundation through basic materials science. New quantum materials will be designed, nanofabricated, characterized, and modeled. FRG2 is led by UNL Assistant Professor **ABDELGHANI LARAoui** and focuses on sensing and precise measurements utilizing the extreme sensitivity of various quantum systems, and on quantum communication with special emphasis on photons as carriers of quantum information. FRG3 is led by Creighton University Associate Professor **JONATHAN WRUBEL** and is aimed at quantum information processing with the implementation of quantum emulation, which uses the laws of quantum mechanics to solve problems or demonstrate the physics of materials that cannot easily be calculated with a conventional computer. ■



Xia Hong
FRG1 Leader



Abdelghani Laraoui
FRG2 Leader



Jonathan Wrubel
FRG3 Leader

TRACK-1: CRRI *Center for Root and Rhizobiome Innovation Extends Project Term with Successes in Research, Outreach*

WITH AN EXTENSION YEAR (slated to end in mid-2022) due to the COVID-19 pandemic, Nebraska’s five-year, \$20 million CRRI project dug into culminating its research: understanding plants’ root microbiome. CRRI’s 20+ researchers—from UNL, Doane, UNK, UNMC—focused on four project aims:

- Root Metabolism: Integration of Natural Genetic Variation and Systems Biology
- Linking Natural Chemical Variation in Root Exudates to Rhizobiomes
- Root Synthetic Biology: Tool Development and Applications
- Plant Phenotypic Rhizobiome Abiotic Stress Responses to Variations in Root Exudates.

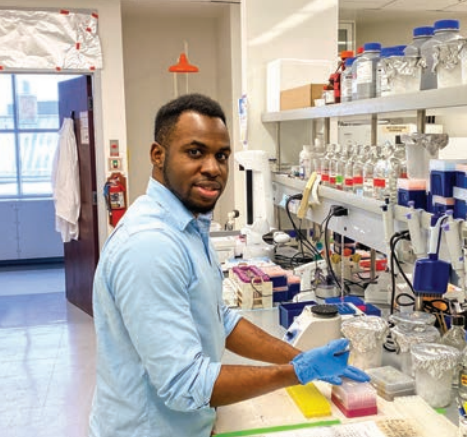
The project generated more than 75 journal publications (and still counting), and \$58+ million in related new funding via CRRI researchers’ efforts.

Through this EPSCoR project’s outreach, more than a dozen different youth STEM (science, technology, engineering and math) camps were offered at campuses around the state—via CRRI support to the Young Nebraska Scientists program. CRRI supported more than 5,000 Nebraska high school students’ use of YNS mobile labs in their classrooms to learn molecular biology methods, and CRRI plant science was shared at public events including Husker Harvest Days, the Nebraska State Fair, and Fascination of Plants Days. These activities helped Nebraskans understand plant science, including young people—especially those from underrepresented groups, such as racial and geographic minorities—seeking careers: via connecting to STEM (Science, Technology, Engineering, and Math) possibilities. ■



Nebraska Public Media featured CRRI research on its “What If ... ?” show, including visits to the project’s lab and field sites. The episode can be viewed at <https://go.unl.edu/whatifcrr>. During video production, Nebraska Public Media crew visited the University of Nebraska’s Eastern Nebraska Research, Extension and Education Center (ENREEC) in Mead, where they interviewed Geng “Frank” Bai (left) about test fields where CRRI employed SpiderCam equipment for crop research.

THANK YOU, CRRI PARTICIPANTS!



PROFILE: *Tross Makes Strides with CRRI*

MICHAEL TROSS CAME TO Nebraska as a sprinter with Doane University's track team, but he has stayed for the long haul. He earned his

bachelor's degree in Biological Sciences at Doane, then took master's level courses in Business Management. With his longterm interest in biology, plus mentoring from Doane Biology's Associate Professor **Tessa Durham Brooks**, he next focused on plant science. He had good timing: in 2016 Doane became part of Nebraska's Center for Root and Rhizobiome Innovation (CRRI), funded by the National Science Foundation's EPSCoR program.

Intrigued by plant genetics and data science, Tross entered the University of Nebraska-Lincoln's (UNL) Complex Biosystems PhD program with a series of lab rotations in Fall 2019. His second of three rotations was with UNL Agronomy and Horticulture Professor **James Schnable**; Tross joined the Schnable Lab in the summer of 2020, and his PhD is funded by a CRRI follow-on project that's led by Associate Professor **Yufeng Ge** (with UNL Biological Systems Engineering) in collaboration with Schnable. Again, great timing; Tross pursued research focused on leaf canopy architecture in sorghum, and the genes governing leaf angles (important as plants are placed closer together to increase yield per hectare). Growing a diverse panel of sorghum genotypes (366 plants from 236 genotypes at three different timepoints), Tross grew his research skills. After image processing, measurements, DNA sequencing, and statistical analysis, this "Genome-Wide Associated Study" (GWAS) supported a paper he authored with the lab team. His paper is now published at *Peer J.* (<https://peerj.com/articles/12628/>), and enhances his Ph.D. path toward a career in industry, where his Business Management background will also serve him well.

His time in Nebraska has "expanded my perspective," Tross says; when he arrived, he didn't see himself going beyond a bachelor's degree. He hopes Nebraska EPSCoR keeps building people's confidence, with opportunities that help more minorities in STEM (Science, Technology, Engineering and Math): to imagine the possibilities, join the endeavors, and grow capabilities—so they gain confidence in achieving their potential. ■

NRIC Gathers Nebraska's STEM Teachers, Equips with Modeling Tools

On July 23-24, 65 Nebraska middle and high school science teachers showed up for "summer school," led by computational biologists and NGSS (Next Generation Science Standards) leaders convened by Nebraska EPSCoR. gained professional development, networking contacts, and a set of classroom-focused tools.

Planned with partners including the Nebraska Association of Teachers of Science (NATS) and the Nebraska Department of Education (NDE), the event was co-chaired by Associate Professors **TESSA DURHAM BROOKS** (Doane University) and **TOMAS HELIKAR** (University of Nebraska-Lincoln)—both scientists with the EPSCoR Track-1 Center for Root and Rhizobiome Innovation.

With NSF funding, Nebraska EPSCoR conducts annual statewide gatherings—called NRICs, or Nebraska Research & Innovation Conferences—to advance topics in STEM (science, technology, engineering and math). The 2021 NRIC was the first in the event's two-decade history to focus on teachers; the gathering included a poster session with further resources shared by conference attendees, as well as hands-on workshops for deeper benefit with NGSS phenomena.

"Attending the (2021 NRIC) conference helped me to understand how to implement modeling and computational thinking into my classroom," one teacher commented, and said the event "gave me resources that will help to decrease barriers." ■





TRACK-2 *UNL's Corman Leads Multi-State Research*

Converged database tracks water systems

UNIVERSITY OF NEBRASKA-LINCOLN (UNL) aquatic ecologist **Jessica Corman** earned a four-year, \$6 million grant from the National Science Foundation's (NSF) Established Program to Stimulate Competitive Research (EPSCoR) program to lead a four-institution team. Together they are building a first-of-its-kind database with information from streams, lakes and other inland water systems across the nation.

The project—Stoichiometric Traits of Organisms in their Chemical Habitats, or STOICH—creates an open-source, publicly available database via Nebraska's School of Natural Resources Scientific Computing Center and the University of Arkansas-Little Rock's Midsouth Bioinformatics Core. In ecology, stoichiometry measures relationships between components of a chemical reaction and studies the related outcomes' data.

STOICH's Research Infrastructure Improvement (RII) Track-2 "Focused EPSCoR Collaborations" (FEC) project team studies a range of environmental patterns. The cohort of Nebraska researchers offers a variety of perspectives: **Jennifer Clarke**, professor of food science and technology; **Steven Thomas**, professor of natural resources; **Yawen Guan**, Department of Statistics, and **Katie Anania**, assistant professor of art history.

For a STEAM (Science, Technology, Engineering, Arts, and Math) approach, STOICH includes UNL's School of Art, Art History and Design—focusing on visual representation of data with multiple variables, aimed at scientists and the public. One outcome is a workshop series to help researchers improve their science communication.

Also collaborating on STOICH are the University of Wyoming, Central Arkansas University, and Middlebury College (Vermont). To help boost diversity in STEM across the four EPSCoR jurisdictions, another project partner is the Society of Freshwater Science's Instars and Emerge Program: a mentoring initiative supporting undergraduate students from underrepresented groups who are interested in freshwater science. Through research presentations and student training workshops at the society's

annual meeting, a wider group can gain data science knowledge and professional development skills.

Corman's team augments data from the National Ecological Observatory Network (NEON), which gathers ecological information throughout the United States. The STOICH database will include additional data from 34 aquatic sites nationwide, plus datasets from published and unpublished studies. With this combined database—publicly available during development—the team pursues three research topics:

- the link between phosphorous and nitrogen levels in water, potentially informing work against nitrate contamination of drinking water;
- effects of elemental mismatch in food webs—which can trigger further environmental imbalances; and
- factors of individual organisms, along with their environment's effect on characteristics such as behavior, physiology and other organismal traits.

"The EPSCoR program is really wedded to increasing inclusion and opportunity in the sciences, and building up careers from undergraduate to career faculty stages," Corman said, "and we've tried to embed that in this grant as well." ■





Zhang Earns NSF EPSCoR Track-4 Fellowship at CalTech

THIS YEAR LIMEI ZHANG, associate professor with the University of Nebraska-Lincoln's Department of Biochemistry, received National Science Foundation funding to pursue "Visualization of biomacromolecules at atomic resolutions" via NSF's EPSCoR Track-4 program.

With this \$215,821 award, Zhang develops single-particle cryo-electron microscopy (cryo-EM) expertise at the Cryo-EM Center of the California Institute of Technology—for applying the technique to the structural characterization of biomolecules at the atomic level.

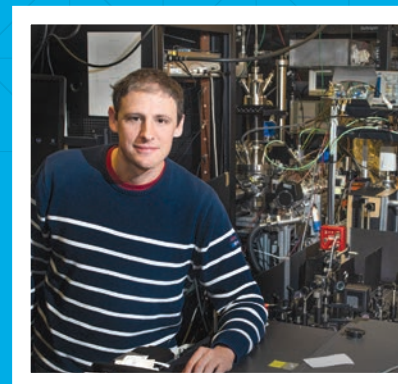
Cryo-EM is an advanced microscopy technique that has become a game-changer for molecular visualization. Traditionally, X-ray crystallography and nuclear magnetic resonance have been the only two available structural tools that can experimentally determine three-dimensional (3D) structures of biomacromolecules at atomic levels, Zhang said—and added that "cryo-EM has become the preferred technique for determining the 3D structure of large macromolecular complex or membrane proteins that have been dauntingly challenging to either of the two conventional structural techniques."

At Caltech, Zhang and her UNL lab colleague will receive comprehensive training on structural characterization of metalloproteins and assemblies by cryo-EM: from grid preparation and image collection to 3D map construction and model development. For Zhang, this enhances her research focus on the structural investigation of two families of interconnected metalloproteins involved in bacterial redox stress response and transition metal homeostasis, respectively.

Expertise she gains through this Track-4 experience will help fill critical gaps in fundamental structural principles for metalloproteins in the bacterial response to biotic and abiotic redox stresses and antibiotic resistance. This Track-4 funding also aligns to help Zhang extend the teaching and training activities from her 2019 NSF CAREER award, as she aims for a leading role in understanding structure-mechanism investigations of metalloproteins in redox biology with graduate students and postdocs via the cryo-EM technique. She further aims to facilitate new research explorations with cryo-EM techniques, and catalyze new collaborations to promote innovative research. ■

Congratulations To...

University of Nebraska-Lincoln Physics and Astronomy Professor **MARTIN CENTURION**, who received a DOE EPSCoR Implementation Award renewal grant of \$2,940,000 for August 2021 to August 2023 for his research: developing and applying new experimental and computational tools to understand dynamics of chemical reactions in organic molecules. This project also involves researchers from Kansas State University, Louisiana State University and Brown University.



This research investigates a series of ultrafast photo-triggered ring-opening and ring-closing reactions with the goal of developing general rules that can be applied to understand and predict the outcome of a large class of reactions. Because electrocyclic reactions play an important role in nature and have many commercial applications (for example, in the synthesis of pharmaceuticals), knowledge gained via this project has significant potential impact for both basic and applied chemical research.

This renewal project explores in greater detail the reactions targeted in the first project period and investigates additional ring-changing reactions. The project includes theory and multiple complementary experimental methods focusing on a single problem to capture a complete picture of the chemical dynamics. The project enables the participating graduate students and postdocs to gain broad expertise. ■

SMALL COLLEGE AWARDS

Nebraska EPSCoR aligns funding from the National Science Foundation to help the state's smaller colleges and universities augment undergraduate research experiences. Funded participants report their project outcomes, and undergraduates present their research in scientific publications and at conferences. Faculty recipients in 2021 were:

Dane Bowder – Doane University, Dept. of Biology | *Investigation of MxB and APOBEC3C as Restriction Factors of Cyprinid Herpesvirus-3*

Haishi Cao – University of Nebraska at Kearney, Dept. of Biology | *Investigating the role of H2S in cancer cells by using nanoparticle based fluorescence sensors*

Dirk Charlson – Central Community College, Dept. of Agricultural Sciences | *Utilizing Unmanned Aerial System-Acquired Aerial Imagery in Urban Forestry*

Blake Colclasure – Doane University, Dept. of Environmental and Earth Sciences | *Voices in Graduate School and the Workforce: A Qualitative Study on the Value of the Undergraduate Research Experience in STEM at a PUI*

Stacie Turnbull – York College, Department of Biology | *Areas of the Upper Big Blue River and the Issue of Excess Nitrogen (and Other Pollutants) in Groundwater*

TEACHING AND RESEARCH EQUIPMENT FUNDING FOR NEBRASKA'S SMALL COLLEGES

To help improve this state's research capacity, the following items were approved for support by Nebraska EPSCoR's State Committee:

Chadron State College – Acquisition of a Handheld X-Ray Fluorescence Analyzer to Improve STEM Research and Teaching

Doane University – GCMS Instrument Upgrade at Doane University

Midland University – Infrared Spectrometer and Autoclave

Nebraska Wesleyan University – Western Blot Experiment for Undergraduate Learning in Chemistry

Southeast Community College – Expanding CUREs at SCC to Ensure Biotechnology Career Readiness

FIRST Awards

NEBRASKA EPSCoR'S FIRST AWARDS have a 17-year history of helping our state's early-career scientists to pursue major initial research funding, specifically the prestigious NSF CAREER Award.

In 2021, two cohorts of FIRST Award Recipients—one set funded in January by the NSF EPSCoR Research Infrastructure Improvement program's Track-1 Center for Root and Rhizobiome Innovation (CRRRI), and another group in November that was funded by Nebraska's new Track-1 Emergent Quantum Materials and Technologies, EQUATE—were designated.

The Nebraska EPSCoR State Committee approves FIRST Award Recipients, who each receive \$25,000 (an amount which must be matched by each Recipient's department) and expert peer reviews that are provided to all FIRST Award Finalists. This year, a total of 14 FIRST Award Recipients were approved:

— Funded by CRRRI —

DR. WEI BAO

Department of Electrical and Computer Engineering, University of Nebraska-Lincoln (UNL)

DR. MARIA BECKER

Department of Physics, Nebraska Wesleyan University

DR. JOEL DESTINO

Department of Chemistry, Creighton University

DR. KATARZYNA GLOWACKA

Department of Biochemistry, UNL

DR. KEEGAN MOORE

Department of Mechanical and Materials Engineering, UNL

DR. ROBERT STREUBEL

Department of Physics and Astronomy, UNL

DR. JOSEPH YESSELMAN

Department of Chemistry, UNL

— Funded by EQUATE —

DR. JENNIFER AUCHTUNG

Department of Food Science and Technology, UNL

DR. BENJAMIN BRANDSEN

Department of Chemistry and Biochemistry, Creighton University

DR. LEAH BUTLER

School of Criminology and Criminal Justice, University of Nebraska at Omaha (UNO)

DR. JORGE FANDINNO

Computer Science Department, UNO

DR. AMY NAPOLI

Department of Child, Youth and Family Studies, UNL

DR. SHUAI NIE

School of Computing, UNL

DR. DUNG TRAN

School of Computing, UNL



Chemist Dieckman Gains Creighton's First NSF CAREER Award

STUDENTS JOIN IN MAPPING PROTEIN INTERACTIONS THAT LINK DNA REPLICATION AND NUCLEOSOME ASSEMBLY

LYNNE DIECKMAN, PH.D.—an associate professor with Creighton University's Department of Chemistry—earned a five-year, \$680,500 Faculty Early Career Development Program (CAREER) award from the National Science Foundation (NSF). Her project aims to gain a better understanding of how improper DNA replication and compaction can cause changes in gene expression in offspring, which can play a role in the onset of diseases such as cancer, cell death or developmental issues. With this award she's also creating a comprehensive learning environment for aspiring high school-aged and undergraduate scientists to have significant roles in the research.

Dieckman is the first Creighton faculty member to receive the highly competitive NSF CAREER award, and she credits Nebraska EPSCoR's FIRST Award program for helping her prepare her successful proposal. Dieckman not only benefited from her experience as a FIRST Award recipient, which included reviews of her draft proposal by expert scientists in her field (coordinated by Nebraska EPSCoR), but she also helped give back to the FIRST Award program by serving on a Nebraska EPSCoR review panel for succeeding years' submissions.

In her lab, a key part of Dieckman's CAREER Award project is engaging student researchers in examining protein-protein interactions that regulate DNA replication and the subsequent packaging of DNA into the nucleus of cells. Creighton students are involved in performing all experimentation, as the NSF grant covers stipends for three undergraduate students each summer.

Dieckman's award also includes funding for six students from local high schools to participate in research projects each summer in a collaboration with the Haddix STEM Corridor program. Students in the program attend weekly scientific development workshops on campus and present research results to other scientists and the public.

Dieckman's project is jointly funded by the Genetic Mechanisms program of the Molecular and Cellular Biosciences Division in the Biological Sciences Directorate and the Established Program to Stimulate Competitive Research (EPSCoR). ■

WITH CAREER AWARD, UNL'S NEJATI STUDIES MOLECULAR ENGINEERING

SIAMAK NEJATI, Ph.D., assistant professor of chemical and biomolecular engineering at the University of Nebraska-Lincoln, received a five-year, \$593,240 Faculty Early Career Development Program grant from the National Science Foundation (NSF).

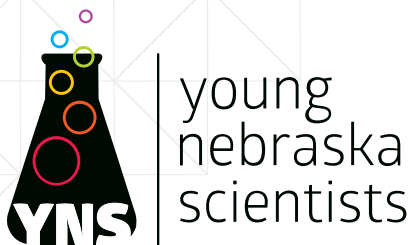
Nejati had earned a FIRST Award from Nebraska EPSCoR in 2018, which helped him refine his proposal for the highly competitive NSF CAREER Award.

His CAREER project explores a new green pathway to enable high-precision deposition of ultra-thin porous and covalent organic frameworks. Using molecular layer deposition, Nejati constructs films with a wide and tunable range of porosity in a solvent-free coating process.

In efforts to control the synthesis and growth of molecular materials, Nejati's vapor-phase approach can help form porous organic frameworks, or POFs: more versatile and easily assembled than earlier versions synthesized with a liquid-based process. The frameworks—including carbon, nitrogen and oxygen—offer “different ways of arranging networks of materials,” he said.

The three-dimensional molecular structures Nejati builds could improve electronics, medicine and more. With his CAREER award, Nejati's education and outreach activities aim to engage underrepresented groups with summer opportunities leading to molecular engineering research. ■





New YNS Camp: Bellevue University Explores Small But Mighty Viruses

DURING THE COVID-19 PANDEMIC, Young Nebraska Scientists debuted a camp called “Small but Mighty: A Hands-on Investigation of Viruses and Bacteria.” Leading this camp for high schoolers were scientists from Bellevue University’s College of Science and Technology—**John Kyndt**, Ph.D., Associate Professor of Microbiology, Nutrition and Sustainability, and **Tyler Moore**, Ph.D., Assistant Professor of Biology.

Kyndt and Moore planned for high school students to combine field excursions with modern laboratory techniques to examine the biology of microscopic organisms. Campers collected soil samples from a never-plowed tallgrass prairie and analyzed soil microbe composition through next generation sequencing. Back at Bellevue University’s R. Joe Dennis Learning Center, the group used cell culture approaches to study how immune cells recognize and respond to virus infections. ■



YNS High School Researcher Gains Hands-On STEM Experience

by Lana Koepke Johnson, UNL Agronomy and Horticulture

RYLEIGH GROVE, A SENIOR at Lincoln’s North Star High School, could’ve spent her summer relaxing with friends but instead conducted science research in a lab at the University of Nebraska-Lincoln (UNL).

Through Nebraska EPSCoR’s Young Nebraska Scientists program, Grove spent her summer months working with **James Schnable**, who is a Department of Agronomy and Horticulture associate professor and the Dr. Charles O. Gardner Professor of Agronomy, and her mentor **Michael Tross**, a doctoral student studying Integrated Plant Biology (see story in the Track-1/CRRRI section of this publication).

YNS provides STEM (science, technology, engineering and math) summer internships in university laboratories for high school students—for an extended, paid taste of the camaraderie and focus of a university research team. High school researchers work alongside mentors and other members of a lab team to accomplish their research tasks.

Before this summer, Grove had interest in science but favored music; thanks to prompting from her high school’s science department chair, **Floyd Doughty**, she applied to YNS.

“When I first started, the scientific terms went right over my head,” Grove said. After working with the lab team all summer, she added, “I started to understand what they were talking about.”

She also arrived with no knowledge of computer coding—but by summer’s end, she was proficient at programming, reading error messages, and fixing the errors herself. On the Schnable Lab team, if she needed help with coding or visualizing data, she could access team members with those talents.

Biotechnology has advanced from past methods with researchers using protractors in the field to measure leaf angles of hundreds or thousands of individual plants. The Schnable Lab uses computers to measure leaf angles using photos of a sorghum plant, like those collected by UNL's Greenhouse Innovation Center automated phenotyping facility.



With the Schnable Lab, Grove helped to identify the specific genes that control how erect or relaxed the leaves of different sorghum varieties are. If the leaves are too close together, they block each other's light and can't photosynthesize properly, reducing yield. However, different arrangements of leaves in 3D space can maximize how much light all the plants in the field can capture, allowing them to produce more grain from the same sized field.

Grove's summer involved writing, testing and running computer code to measure the angles of sorghum leaves from two-dimensional photographs. To accomplish this, she had to learn to write Python code and use ImageCV software. By the end of the summer, she was able to perform her own genome wide association study (GWAS) using measurements her code extracted from photos.

Grove developed skills in scientific research and teamwork, and gained experience in presenting her research at the Nebraska Summer Research Program Symposium (view her poster presentation at mediahub.unl.edu/media/17549). Her work was also incorporated into a paper both she and Tross are authors on, which was published in the journal *Peer J*. (<https://peerj.com/articles/12628/>).

"In my experience, it is quite uncommon for YNS students to get all the way to authorship on a paper in a summer research project," Schnable said.

For her future, Grove said she has more interest in a STEM-related field now and has added three AP science classes to her senior schedule; she plans to pursue a STEM major in college.

"Turns out I loved it," Grove said of her YNS lab experience. "It pushed me outside the bubble of what I am comfortable with ... I also learned what it is like to work full-time." ■

EPSCoR Funds STEM Career Fair at Nebraska Tribal Communities

THE INAUGURAL NEBRASKA TRIBAL STEM Career Fair took place October 8 in South Sioux City, with 35-40 attendees, including 13 exhibitors who ran eight booths. Organizer Mark Griep (professor with the University of Nebraska-Lincoln's Chemistry Department) said, "the students who talked to me were energized and all exhibitors said they would come back next year." Griep said the planning group may also try bringing portions of this event to tribal area high schools in the future.

Three presenters gave local, national, and state perspectives. Denise Jensen from Winnebago Environmental Dept gave an overview of her department's community activities; her organization had three internships to offer. Sandra Begay from Sandia National Labs in New Mexico gave an inspiring summary (via Zoom) of her life's journey from community college to member of the SNL strategic planning committee. Siobhan Wescott from UNMC Public Health talked about COVID-19 challenges in Indian communities, while also noting that American Indians have the vaccination highest rates when considering race. Jodi Sangster, outreach coordinator, represented Nebraska EPSCoR at the event.

The communities of both Little Priest Tribal College and Nebraska Indian Community College had incidences of COVID-19 affecting their operations in the week before this event; several attendees told Griep that conducting this event in years ahead would likely bring increased attendance. ■



NASA Nebraska EPSCoR Project Earns National Support

A NEBRASKA TEAM EARNED NASA EPSCoR funding for a total of \$1,125,000 for Development and Testing of Recyclable Antimicrobial Materials for In-Space Manufacturing of Medical Devices. The Principal Investigator for this research is **Jorge Zuniga**, Ph.D.—a professor with the University of Nebraska at Omaha Department of Biomechanics, where students will help the project’s work.

In space, astronauts remain at risk of illness yet are distant from fully-equipped medical facilities. The UNO team’s proposal stated that since medical devices are critical to proper and effective treatment in healthcare, it is important that medical items aboard the International Space Station (ISS) be free of bacteria and other fomites (objects or materials likely to carry infection). Advances in 3D printing polymers could allow astronauts the capability to generate medical device components in space.

To produce sterile medical items rapidly and self-sufficiently aboard the ISS, the UNO team (in collaboration with Copper3D, a Chilean-American company) seeks to develop antimicrobial polymer materials. In conjunction with Made In Space and NASA, the UNO team will send materials to space for in-space manufacturing of medical devices. The goal is to equip astronauts with versatile resources including preventative countermeasures embedded in antimicrobial polymers, for advancing the safety and efficiency of personnel during long duration space flight. ■



COBRE Creighton’s Translational Hearing Center COBRE Award is Largest NIH Grant in University’s History



IN 2021, CREIGHTON’S TRANSLATIONAL Hearing Center was awarded a \$10.8 million grant, payable over five years and competitively renewable up to 15 years, by the NIH-affiliated Centers of Biomedical Research Excellence (COBRE). The partnership includes Omaha’s Translational Hearing Center, Boys Town National Research Hospital, and the University of Nebraska Medical Center.

Led by **Jian Zuo**, PhD, chair of the Department of Biomedical Sciences at Creighton, and **Peter Steyger**, PhD, professor of biomedical sciences at Creighton and director of the Translational Hearing Center (pictured above), the partnership builds a corps of academic researchers battling hearing loss resulting from numerous causes: from hearing loss in children whose hearing is compromised by antibiotics or other medical treatments, to individuals suffering hearing loss in the wake of cancer therapies, those who suffer deafness due to such infections as meningitis, and hearing loss caused by aging.

“As the largest grant ever awarded to the University, it will be transformative for Creighton’s research,” said **Laura Hansen**, PhD, associate dean for research at the Creighton University School of Medicine.

In the grant application, Steyger said, “The Transitional Hearing Center will work to improve hearing loss by speeding the translation of research to clinical trials and from there into clinical practice.”

The COBRE grant enables the Transitional Hearing Center to create a unique cohort of junior investigators conducting basic research, and an “administrative core” of experienced professionals who coordinate projects with an external advisory committee—all intended to develop new therapies and methods of assessing their effectiveness. ■

Great Plains CTR Earns Funding Renewal

THE NATIONAL INSTITUTE OF General Medical Sciences (NIGMS) has given the University of Nebraska Medical Center (UNMC) its largest research grant in the university's history.

In September, the **Great Plains Institutional Development Award program for Clinical and Translational Research (IDeA-CTR)** received the five-year, \$20.3 million award—renewing a then-record \$20 million National Institutes of Health (NIH) funding award from 2016. At \$4.3 million during year one and \$4 million for years two through five, this renewal award will enhance clinical and translational science across the region.

Matthew Rizzo, MD, Frances & Edgar Reynolds Chair and professor in the UNMC Department of Neurological Sciences, is leading the group representing all IDeA-CTR awardees.

"It's a privilege to have won the federal support we need to launch great, new scientific teams, plans, and partnerships—to advance national biomedical science and health for all the communities we serve," Rizzo said. "We are excited to be launching innovative programs in technology spanning medicine and engineering, an academic public-private board, a community-engaged clinical and translational research incubator, team science and other initiatives."

"This grant mechanism was very effective in building new infrastructure and collaborative research teams across the region," said **Jennifer Larsen**, MD, UNMC vice chancellor for research. "Dr. Rizzo is well poised to advance our collaborative clinical-translational research and resources over the next five years."

With this renewal, UNMC leads a regional consortium of partners, including University of Nebraska-Lincoln; University of Nebraska at Omaha; University of Nebraska at Kearney; Boys Town National Research Hospital; Children's Hospital & Medical Center; Creighton University; Omaha VA Medical Center; and the Practice Based Research Network (PBRN) spanning 68 clinical sites across the Great Plains. ■

Congratulations to the **CENTER FOR INTEGRATED BIOMOLECULAR COMMUNICATION (CIBC)**—led by **JAMES TAKACS**, Ph.D., Emeritus Professor Charles Mach University Professor, UNL Department of Chemistry—on NIH renewal of this Phase 2 COBRE project.

Nebraska INBRE Gathers Online

NEBRASKA INBRE HOSTED A Central Region IDeA Conference—including Kansas, Oklahoma, North Dakota, and South Dakota—in July via Zoom. Keynote speakers included National Institute of General Medical Sciences (NIGMS) Director **Jon Lorsch**, **Ali Khan** (Dean, College of Public Health, UNMC), and **Sheritta Strong** (Director of Inclusion, UNMC). Nebraska INBRE Director **Paul Sorgen**, Ph.D. (UNMC) said the speakers did an amazing job and helped the conference succeed. Also important were the 448 registrations, from 17 states and 83 different research institutions; the event had 122 abstracts submitted, yielding 41 talks and 81 poster presentations.

A \$17.2 million multi-year National Institutes of Health grant supports Nebraska's Institutional Development Award Program (IDeA) Networks of Biomedical Research Excellence (INBRE) program. NE INBRE creates a biomedical research infrastructure with research opportunities for undergraduate students and serves as a pipeline for those students to continue into graduate research. ■

2021 NSF EPSCoR Co-Funding for Nebraska

NATIONAL SCIENCE FOUNDATION (NSF) EPSCoR co-funds specific NSF units in support of meritorious proposals from individual investigators and teams in EPSCoR jurisdictions. These proposals have been peer-reviewed and recommended for award, but could not be funded without the combined, leveraged support of NSF EPSCoR and the corresponding directorates. Co-Funding leverages EPSCoR investment and facilitates participation of EPSCoR scientists and engineers in NSF-wide programs and initiatives.

In 2021, NSF EPSCoR Co-Funded projects brought \$3,012,708 to Nebraska; \$1,794,617 of this total was from NSF EPSCoR. Recipients were:

GREGORY BASHFORD (PI) and **ERIC MARKVICKA** (co-PI); Dept. of Biological Systems Engineering, University of Nebraska-Lincoln (UNL) | REU Site: Undergraduate Research Opportunities in Biomedical Engineering Devices at the University of Nebraska-Lincoln

LYNNE DIECKMAN, Dept. of Chemistry, Creighton University | CAREER: Mapping Protein Interactions that Link DNA Replication and Nucleosome Assembly

CATHERINE EICHHORN, Dept. of Chemistry, UNL | CAREER: Molecular Mechanisms of Ribonucleoprotein Assembly

NICOLAS LALONE, Dept. of Information Systems & Quantitative Analysis, University of Nebraska at Omaha (UNO) | CRII: HCC: Practical Steps Toward Integrating the Tools of Emergency Management with Crisis Informatics Techniques

ERIC MARKVICKA, Dept. of Mechanical & Materials Engineering, UNL | Collaborative Research: Designer Microstructures by Additive Manufacturing of Functional Emulsions

SPYRIDON MASTORAKIS, Dept. of Computer Science, UNO | CRII: CNS: A Hybrid Software Defined Networking-Information Centric Networking Framework for the Reuse of Computation at the Network Edge

PETRONELA RADU (PI) and **MIKIL FOSS** (co-PI), Dept. of Mathematics, UNL | Higher Order Nonlocal Models in Continuum Mechanics

PETRONELA RADU (PI) and **MIKIL FOSS** (co-PI), Dept. of Mathematics, UNL | Nonlocality in Continuum Mechanics, Population Dynamics, and Neural Networks

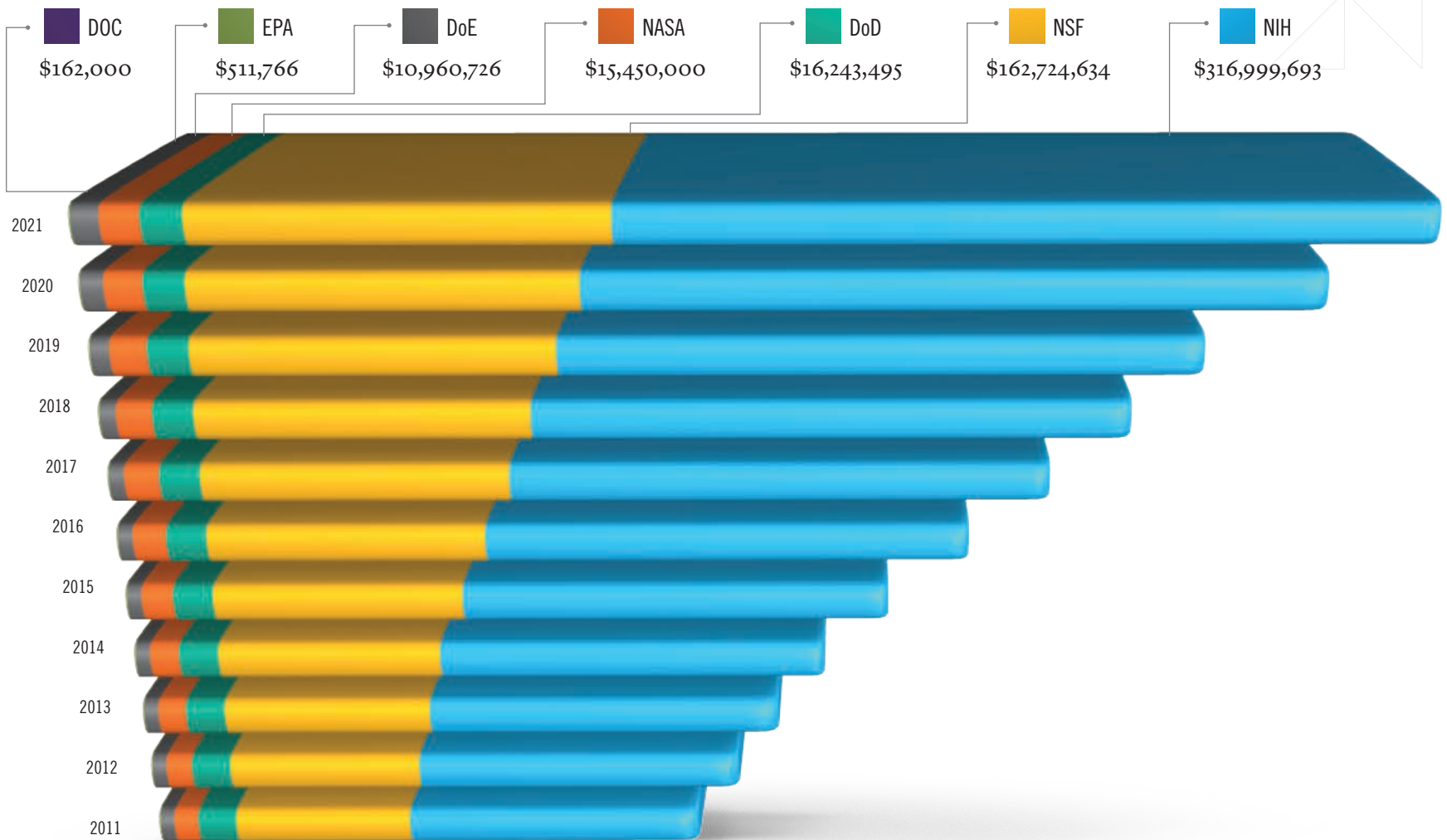
NICK STERGIU (PI), **AARON LIKENS** and **SPYRIDON MASTORAKIS** (co-PIs), Dept. of Biomechanics, UNO | Gaitprints as Predictors of Disease and Disability for Effective Rehabilitation Engineering

CORNELIS UITERWAAL, Dept. of Physics & Astronomy, UNL | REU Site: Lasers and Optics

ALEXANDER ZUPAN, Dept. of Mathematics, UNL | Interactions of 3- and 4-Dimensional Topology

Cumulative Federal EPSCoR/IDeA Funding in Nebraska

NEBRASKA BECAME AN EPSCOR state in 1991 and has successfully competed for more than \$523 million in federal research funding. This chart shows funding by agency and the cumulative growth of funding over time for the most recent decade: 2011 – 2021.



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Mr. Phil Kozyra, *CEO*, MatMaCorp

Dr. Jennifer Larsen, *Vice Chancellor for Research*,
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