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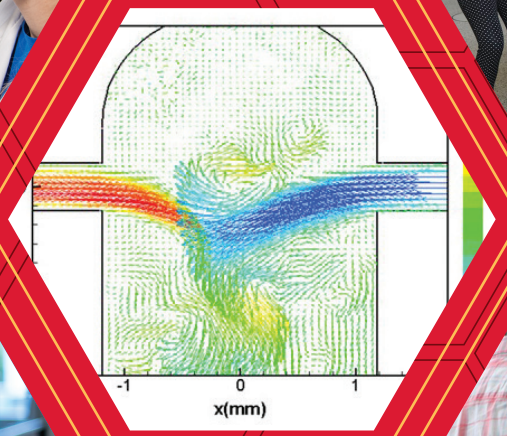
Iowa State University **Chemical and Biological Engineering** • Issue No. 32, Fall 2021

IOWA STATE UNIVERSITY
Department of Chemical and Biological Engineering



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Dear Alumni and Friends,

Hello to you all from the Department of Chemical and Biological Engineering at Iowa State University. We hope that you enjoy the 2021 edition of Active Site, our annual departmental newsletter.

2020 was indeed a very unusual year, and one that many of us will look forward to having behind us. Like many universities around the country, the pandemic had a major impact upon our operations and activities, including mask mandates, many courses taught remotely or in hybrid fashion and many events canceled or held virtually. The appearance of the COVID-19 Delta variant has created lingering uncertainty, but we have cautiously embarked on a new fall semester with students back on campus, but with safe practices still foremost in our routines.

We do have lots of good news to share. The department is doing very well. Our research and teaching activities have continued to grow and evolve. A few of the notable efforts and accomplishments are highlighted on the pages within. Our faculty productivity, student numbers, and student support in the form of scholarships and fellowships remains strong (**By the Numbers**). A number of research efforts are highlighted, including a cover page of Chemical Reviews (**Challenges – Tessonnier**), continued efforts to develop Iowa's biobased economy (**With state support – Shanks**), and development of new materials for cancer treatment (**Engineering hope – Mallapragada**). Read about the new home of our Nanovaccine Institute (**Dream to reality – Narasimhan and others**). Congratulations to Nigel Reuel on his recently awarded National Science Foundation CAREER Award (**Cell therapy manufacturing – Reuel**). Our graduate students have been busy with new projects and startup companies (**Research project paves the way**). Our undergraduates have been actively involved in AIChE, both competing in the national conference and hosting the first ever virtual Mid-America Regional student conference (**Stepping up and moving forward**). We are delighted to serve as host for the planned in-person Mid-America Regional conference on the Iowa State campus in spring of 2022 (**ISU AIChE chapter to host**).

Let me close by once again thanking all of you for your continued support of our program and people. Your friendship and generosity is critical to so many important efforts, including recruiting and retaining the very best students, staff and faculty, providing state of the art facilities for teaching and research, providing financial assistance to students through scholarships and fellowships, and supporting all sorts of new initiatives to support our mission of world leading research and education.

Please send me any comments, updates or suggestions you have for future issues of ActiveSite (hillier@iastate.edu). Let me also take this opportunity to invite you back to campus. I would be delighted to host you and give you a tour of our amazing facilities.

Warmest Regards and Go Cyclones!

Andrew C. Hillier

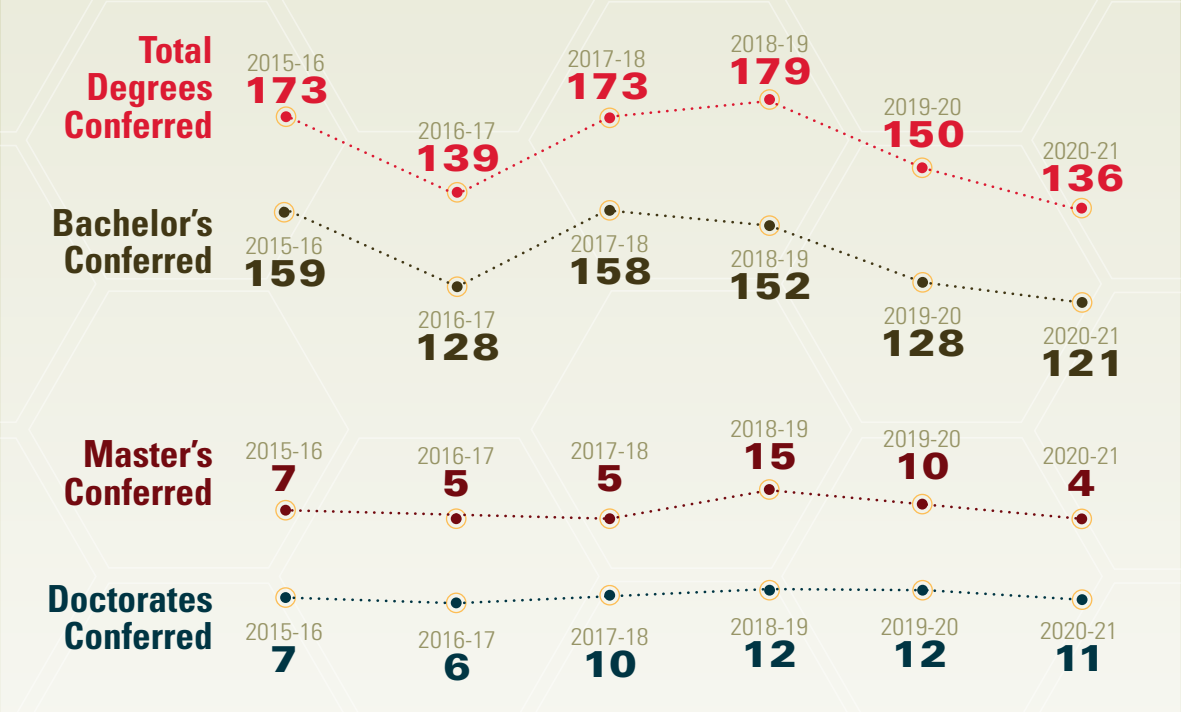
Andrew C. Hillier
Professor and Reginald R. Baxter Endowed Department Chair

166
Number of Faculty Publications

12,920
Number of Faculty Citations

$8M
Research Expenditures

$338,000
Average Faculty Research Expenditure



Fall 2021 Learning Communities

85
Total Students

16
Peer Mentors

CBE's fall 2021 peer mentors preparing to lend a hand to incoming students in the fall semester.

487
Undergraduates Fall 2021 Enrollment
36% Female

79
Graduates Fall 2021 Enrollment
33% Female

$533,000
Undergraduate Scholarships
146 Students Awarded

$287,000
Graduate Fellowships
15 Students Awarded

Challenges in electroorganic synthesis study led by Tessonnier is Chemical Reviews cover story

Metal corrosion is not only a nemesis for many surfaces found in everyday practical materials – it can also be a problem in chemical manufacturing for processes based on electrochemical transformations.

Electrochemical reactions are gaining increasing attention to make the chemical industry more sustainable. This approach uses (renewable) electricity to replace toxic chemical reagents, as well as water and air for reduction and oxidation reactions. However, corrosion of the metal electrodes over time can release environmentally hazardous metals like lead. This drawback is prominent for metal cathodes for reactions performed in aqueous media. It's been called "the dark side of electroorganic reduction."

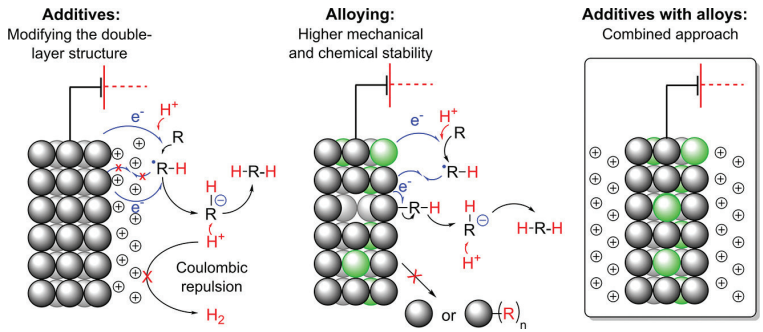
A research team led by Department of Chemical and Biological Engineering associate professor and Richard C. Seagrave Professor **Jean-Philippe Tessonnier** (pictured below) is looking at ways to address this corrosion concern, and their efforts have been profiled in a cover research story, Cathodic Corrosion of Metal Electrodes – How to Prevent it in Electroorganic Synthesis, in the journal *Chemical Reviews* 2021, 121 (17), 10241-10270.

Tessonnier points out that cathodic corrosion has been documented for almost as long as electrochemistry itself. As far back as the early 1800s researchers began to observe by-products of cathodic corrosion.

The paper presents a brief overview of the different mechanisms and reaction conditions that corrode the cathodes and, subsequently, discusses general concepts that can help to prevent the cathodic corrosion. It looks at reductive organic electrosynthetic processes that take advantage of these approaches to prevent the detrimental corrosion. A strong focus is maintained on lead cathodes as they are the most widely used cathodes in electroreductive industrial processes.

The occurrence of alloying with alkali metals, formation of metal hydrides, cathodic etching in anhydrous aprotic solvents, cathodic etching in acqueous media and formation of organometallics are all presented and analyzed for their roles in corrosive processes.

Though the research acknowledges that great advances have been made in creating electrodes that are metal-free, it also recognizes that the effective qualities of metal electrodes will never be fully replaced. But ways to offset the issue of corrosion will pay dividends.



Different strategies including the clever use of alloys instead of soft neat heavy metals and the application of protective cationic additives have allowed researchers to successfully exploit these materials as cathodes. “The whole idea is to apply forms of protective materials on cathodes to stop corrosion – like rust protection for your car,” says Tessonnier.

“Inexpensive and abundant renewable electricity offers an attractive resource for these processes – electrosynthesis, using electric current as a reagentless way to produce chemicals is seen as the wave of the future,” says Tessonnier. “Electricity can be used as both an energy source and a green reagent for substitution of conventional harsh chemicals to avoid hazardous wastes and help mitigate the impact of chemical manufacturing on climate change.” This is seen as especially important in the realm of decarbonizing the chemical industry through transition from petroleum to biomass as a feedstock and for bolstering the use of electricity generated by wind.

For this project, Tessonnier joined forces with **Siegfried R. Waldvogel**, professor of Organic Chemistry at Johannes Gutenberg University Mainz in Germany; **Tom Wirtanen**, a postdoctoral researcher under Waldvogel; and **Tobias Prenzel**, a Ph.D. student in the Waldvogel group. A new Ph.D. student will join the Tessonnier group in fall 2021. As part of the project’s specifics, a chemical engineering graduate student exchange between Gutenberg University Mainz and Iowa State University will take place.

The source of information for this article is from Cathodic Corrosion of Metal Electrodes – How to Prevent it in Electroorganic Synthesis, with permission, ACS Publications https://pubs.acs.org/doi/10.1021/acs.chemrev.1c00148. Further permissions related to the material excerpted should be directed to ACS.

With state support, CBiRC advances biobased products in unique program

There's nothing unusual about state governments providing funding for university research projects.

But State of Iowa officials and researchers at Iowa State University envisioned a much more comprehensive partnership for the future of biobased products in an analysis led by the Iowa Economic Development Authority.

With initial funding through the State of Iowa's Bioscience Initiative, the State Department of Economic Development and the Iowa Innovation Corporation (now BioConnect Iowa), ISU embarked on a groundbreaking plan: a "full-scale menu" of not just funding and doing the research, but adding industry into the mix in a planned strategic alliance all the way to achieving full commercial development to get biobased products into the market more efficiently.

"Given the extended involvement of the Center for Biorenewable Chemicals (CBiRC) in advancing biobased products, we met with state officials to form a plan on how product innovation and development can more fully interface with Iowa State researchers – how to integrate research, development and commercialization of biobased products under a unified plan," says Mike and Jean Steffenson Chair and Anson Marston Distinguished Professor in Engineering **Brent Shanks** (pictured, right), CBiRC director.

But to do this right, a person well-versed in many different areas was needed to oversee the plan. Enter **Sundeep Vani**, a chemical engineer with more than 20 years of experience working in industry. He was hired as ISU's first chief technology officer for biobased products as he possessed an understanding of the coordination of research and development and how to interact with those who can commercialize and manufacture products.

"There are many people who hold the job of officer of technology transfer in universities," Vani said. "But the goal was to nurture and to channel and track where the investment is going through product development by talking to ISU faculty members to communicate and build toward commercialization. You help engage with the expertise needed to go that extra mile.

"There is a lot of engagement with where the investment is going, but when you play a more active role by talking to professors you can work to find the right commercial match."

This plan with the state helps CBiRC and ISU open up new avenues for funding in the future, including more opportunity for collaboration with industry to pursue federal grants.

A number of states have shown interest in what CBiRC is doing in this area. Iowa has a long history of research and development related to biobased products as well as being an important location for that industry. This level of innovation takes it to a whole new level.

New electrochemistry for a greener world

Wenzhen Li, Herbert L. Stiles Faculty Fellow, associate professor of chemical and biological engineering and an associate scientist at the U.S. Department of Energy's Ames Laboratory, is a high-impact researcher in the areas of fuel cells, electrochemistry, renewable energy, and catalysis.

With a unique core strength in design of electrochemical flow cells for continuous production of valuable chemicals, Li's interdisciplinary team is starting three new projects, two funded by the National Science Foundation and one by the U.S. Department of Agriculture, aimed at improving integration of renewable energy and resources into the chemical industries.

Nitrate wastes turned ecofriendly products

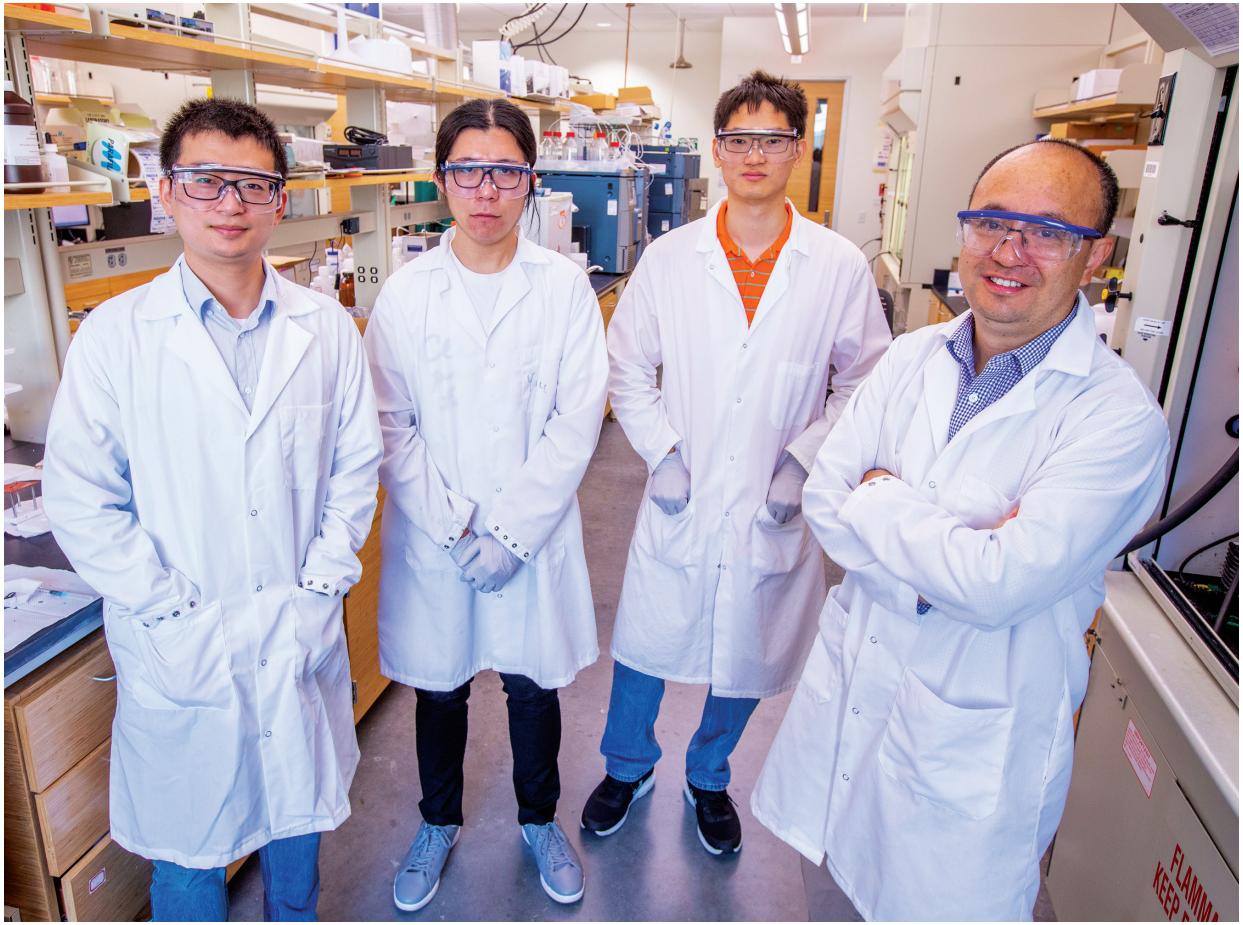
Li leads pioneering research on "electrochemical nitrate upcycling." Nitrogen-based compounds, manufactured from ammonia, require the use of fossil fuels and creates a high amount of greenhouse gas carbon dioxide emissions.

The goal of Li's research is to turn harmful nitrate wastes directly into useful, ecofriendly, nitrogen-based products powered by renewable electricity without the use of fossil fuels. Part of the project also includes workforce development in the field of advanced manufacturing.

Electrolyzers to store renewable electrons, convert carbon into valuable chemicals

In one of the NSF projects, Li's team is designing an innovative flow electrolyzer. The system uses electricity to directly create valuable monomers from biorenewable furanic feedstock at both cathode and anode. In the USDA project, Li's team is pairing electrochemical reduction of carbon dioxide to formate and oxidation of biodiesel byproduct glycerol to valuable carboxylic acids. Both the two electrolyzers suppress less valuable byproducts, such as hydrogen and oxygen gases.

Designing such electrolyzers would make possible the storing of renewable electrons in chemical bonds. The work will help researchers better understand and design electrolytic systems that support power resilience and help decarbonize the chemical industry. Li's discoveries will also be incorporated into new and existing curricula for community college and university students across Iowa and the Midwest.



Wenzhen Li (right) is shown with graduate students (left to right) Hengzhou Liu, Yifu Chen and Ting-Han Lee.

Engineering hope for pancreatic cancer patients

Surya Mallapragada (pictured, right), Carol Vohs Johnson Chair and Anson Marston Distinguished Professor in Engineering, is a worldwide recognized innovator in developing new materials to cure illnesses and treat injuries. Over the last two decades in the lab, she's engineered nanocomposites for nerve regeneration, created nanopolymers to deliver vaccines, designed new materials for hip implants and more.

In her most recent project, Mallapragada is taking on one of the most lethal diagnoses: pancreatic cancer. With a five-year survival rate of just 10%, more effective treatment options for pancreatic cancer are badly needed – and new materials are the key to creating new therapies.

Dual-delivery therapy

With support from the National Institutes of Health, Mallapragada is teaming up with researchers at the University of Nebraska Medical Center to create a dual delivery nanoscale device (DDND) to carry both a tumor suppressant miRNA called miR-345 and gemcitabine, a chemotherapy drug.

"The novel DDND is based on temperature and pH-responsive pentablock copolymers, electrostatically complexed with miR-345. Then the particle is self-assembled with gemcitabine-encapsulated layers," says Mallapragada.

Attacks on multiple fronts

The design has many advantages: A DDND offers more stability than other delivery methods, like liposomes, and protects the miR-345. Using DDND also makes it possible to selectively target cancer cells, sparing normal cells, using pH differences, and may even allow for dose-sparing of chemotherapy drugs.

"Using DDND opens up new doors in pancreatic cancer therapies by concurrently targeting the tumor itself and the cancer stem cells to attack pancreatic cancer from multiple fronts, while minimizing side effects," said Mallapragada.

Nanomaterials, big impact

Mallapragada has been honored for her research innovation with election to Fellow of the National Academy of Inventors, the American Institute for Medical and Biological Engineering, and the American Association for the Advancement of Science – along with many other national awards.

On campus, Mallapragada is an interdisciplinary research leader, building research teams as an associate vice president for research, contributing her expertise to the Nanovaccine Institute, and teaching and mentoring the next generation of chemical and biological engineers.

"Solutions to many human health problems can – and will – be found at the interface of engineering and biology, and we'll see both current and future Cyclone Engineers making the kind of important discoveries in engineered medicine that will help so many people lead healthier lives," said Mallapragada.

Iowa State knowhow helped launch COVID vaccine mixing technology

An email with a link to a CNN news story was recently received by Department of Chemical and Biological Engineering faculty member **Rodney Fox**.

"Did you see this?" said an email from **Daniele Marchisio**, a former postdoctoral researcher under Fox, who is now on the faculty in the Department of Applied Science and Technology at Politecnico di Torino, in Italy.

The story involved a visit to a Pfizer pharmaceutical plant in Michigan and work to manufacture that company's COVID-19 vaccine. In the report a small device called an impinging jet mixer was discussed and hailed as key to quick and efficient production of the Pfizer vaccine.

Rodney Fox, Anson Marston Distinguished Professor and Hershel B. Whitney Professor, Global Initiatives

Research by Fox, Anson Marston Distinguished Professor and Hershel B. Whitney Professor, Global Initiatives, and others at Iowa State University that began more than ten years ago created technology to assist in the development of the device.

In the early 2000s work on confined impinging jet mixers was progressing and one application under study was using them to create vaccines composed of nanoparticles. Compounds are injected through small tubes at high velocities into a small mixing cavity to properly combine them.

One of the people involved in this research was Princeton University professor **Robert Prud'homme**. The process he used involved mixing solvents with anti-solvents in a Multi-Inlet Vortex Mixer (MIVM) in a process he calls FlashNano Precipitation (FNP). It creates particles of a tunable size that have great potential in various commercial processes. But physical handling of volatile chemicals in labs was needed to conduct the research. The danger and inconvenience posed to researchers was a serious matter.

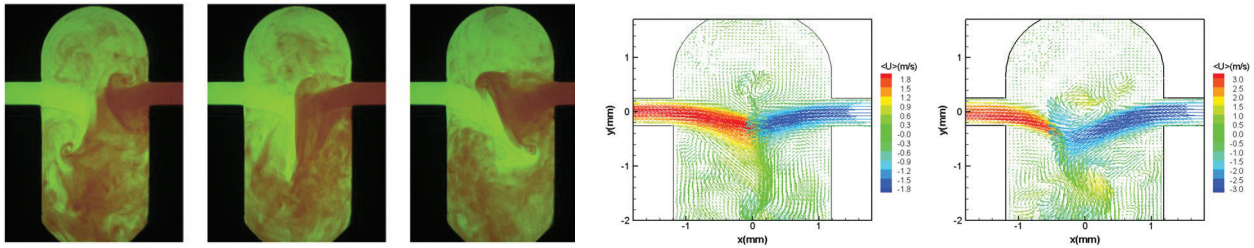
At Iowa State a research group led by Fox had been developing computer programs where computational fluid dynamics (CFD) equations could be used to predict the mixing uniformity in these types of mixing devices. This avoided having to physically handle the risky chemicals to run tests and improved the efficiency of process development.

"Prud'homme asked us if our CFD models could be used with his FNP," says Fox. They could. Work involved Fox and Department of Mechanical Engineering professor **Michael Olsen**, with contributions from CBE faculty members **James Hill** and **Dennis Vigil**, ISU graduate students and international collaboration with Marchisio's group in Torino.

"We did not actually manufacture the nanoparticles," says Fox. "We measured mixing and supplied him with validated CFD models for nanoparticle production in the MIVM. He took that technology and applied it to the vaccine-making process."

Iowa State researchers employed microscopic particle image velocimetry (microPIV) measurements - the first velocity measurements to be made inside a microscale reactor. They performed a statistical analysis of the velocity and used the results to develop and validate CFD models for the turbulent flow inside of the reactor.

"Those of us involved in the work here years ago were quite pleasantly surprised to learn this technology was being used to create the COVID vaccines," says Fox. Though the ISU work is not patented, Fox says it is very rewarding that the knowhow in early work on making the process safer and more efficient came from Iowa State.



MicroPIV imaging (left) and simulated flow fields (right) show the process for mixing inside an impinging jet device – technology that has been used to efficiently create COVID-19 vaccines.

Dream to reality: new all-inclusive lab

"This is what we have dreamed of. The realization of a goal."

Those are the proud words of Department of Chemical and Biological Engineering (CBE) Anson Marston Distinguished Professor and Vlasta Klima Balloun Chair **Balaji Narasimhan** (pictured, left), director of the Iowa State University-based Nanovaccine Institute.

The dream realization was moving the Nanovaccine Institute into an all-new laboratory space on the ISU campus, the top floor of the recently constructed Advanced Teaching and Research Building (ATRB). There, Narasimhan and a large group of researchers from many corners of the ISU campus have physically come together – not to mention the many other researchers from around the world who are also a virtual part of the group. Their mission is to launch a new chapter of alliance to produce nanovaccines and nanomedicines that will transform world health.

Nanovaccines represent the next era in dealing with many health threats, ranging from flu to totally unforeseen events such as the COVID-19 pandemic. Nanovaccines are administered via methods such as inhalation, with no needles, provide greater and more long-term stimulation of immune systems, targeted delivery to different tissues in the body, can eliminate the need for booster doses, and can be distributed and stored without the burden of requirements such as refrigeration.

The Nanovaccine Institute is made up of 75 research collaborators at 21 universities, research institutes, national laboratories and companies, representing such diverse disciplines as microbiology, virology, immunology, materials chemistry, entomology, medicine, economics, and more.

Twenty-six Iowa State faculty members from 14 departments and five colleges are part of the effort. And for the core group physically together in the new lab space, that work is now done even better.

"It was pretty hard to be efficient working out of seven different buildings on campus," says Narasimhan.

The new lab facilities opened in 2020. Scientists and staff work in new state-of-the-art laboratory facilities that are among the best in the world, with capabilities ranging from vaccine synthesis to animal studies that allow an unprecedented ease of follow-through on various types of research from beginning to end, all under one roof.

A virtual ribbon-cutting ceremony hosted by President Wendy Wintersteen was held last fall and Narasimhan says the facility has had some visitors, including some donors, faculty collaborators, and other scientists – and they look forward to hosting many more in the future.

facility for Nanovaccine Institute

Nanovaccine Institute continues its quest to be a game-changer in fighting disease

In their new lab facilities on the ISU campus, Nanovaccine Institute researchers are continually developing new and better ways for implementing life-changing vaccines.

Their work has made headlines and has garnered great support through grants and other funding, from sources such as the National Institutes of Health, the National Science Foundation, the Department of Defense, the U.S. Department of Agriculture and many others.

In 2020 the State of Iowa provided a $2 million grant through federal CARES Act funding to help develop a nanovaccine to fight COVID-19; Iowa State and University of Iowa researchers were awarded a $3.5 million grant to develop nanovaccines against influenza for older adults; and in total for fiscal year 2021 the Nanovaccine Institute received close to $9 million in new grant funding.

Protection against COVID in an all-new way

With the onset of the COVID-19 pandemic, the Nanovaccine Institute shifted gears to provide expedited research to develop a way to combat the disease, and variants of it.

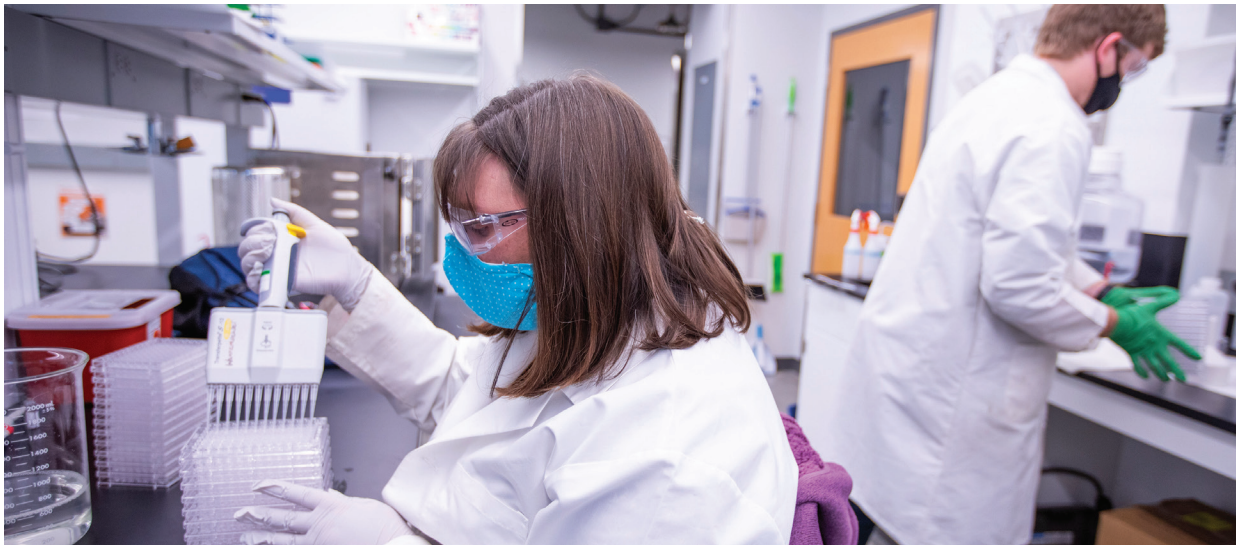
"The problem of COVID is not going to immediately go away," says Narasimhan. "The first generation vaccines we've become so accustomed to have done their job in getting the spread under control, but next generation vaccines will likely be needed. The vaccine we've been developing will protect the world in the long haul. It can be stored up to a year at room temperature, which greatly enhances distribution and administration of it. It's administered nasally, so it's needle-free and requires just one dose."

Because the vaccine goes straight to work in the lungs, it will actually station sentry cells in the lungs, which will act as guardians to repel any invaders. Narasimhan says clinical trials for the vaccine are about a year away, pending FDA approval.

A game-changer against flu

Work on all-new types of flu vaccines through nanotechnology is also in full swing. "Flu has been a lethal worldwide problem for a very long time, and we're flipping the script on how to deal with it through nanotechnology. We're developing a novel form of universal flu vaccine that removes the guesswork," Narasimhan says.

Development of a vaccine to protect older adults is also progressing in a project co-led by Narasimhan and the ISU Department of Kinesiology's **Marian Kohut**. It addresses the shortcomings of current flu vaccinations for that age group, which often simply relies on a larger dose in a "one size fits all" strategy. The new research looks at ways to tailor flu vaccine for older adults using nanotechnology. Narasimhan says major steps in rolling out the vaccine, including clinical trials, are expected to happen within the next year, pending FDA approval.



The state-of-the-art laboratory facilities of the Nanovaccine Institute offer scientists and students alike ample opportunity and space to conduct research.

Cell therapy manufacturing nets CAREER Award for Nigel Reuel

"Manufacturing" is the key word in Jack R. and Carol A. Johnson Faculty Fellow and associate professor **Nigel Reuel**'s research that has earned him a 2021 National Science Foundation (NSF) CAREER Award.

But it's not hard goods in a supply chain. This research involves the manufacture of cell therapies that will help attack the health challenges of cancers, along with autoimmune and infectious diseases. But, as any good manufacturer will do, he's also addressing how to produce those cell therapies with a reduced cost and more effective process control.

The CAREER Award recognizes and supports junior faculty members at U.S. higher learning institutions who exemplify the role of teacher-scholars through research and education, and the integration of these endeavors in the context of their organizations' missions.

Reuel was chosen for his research entitled "Real-Time Control of Cell Differentation Using Reinforcement Learning." It addresses the challenge of therapeutic cells showing promise as a new treatment option for chronic illness, but carrying with it the fact that advances must be made in manufacturing reproducibility to get therapeutic cells out of clinical trials and into widespread use.

With a research background in the use of contact-free sensors as a tool for real-time measurements and readings in processes, the research will develop a real-time, adaptive control strategy for cell differentiation to improve cost and quality of cell therapy manufacturing.

To do this he will build a reinforcement learning (RL) control framework which will actively learn using custom, parallelizable culture environments that will also be developed as part of this work. These environmental modules will leverage Reuel's expertise in design of contact-free sensors that will report the real-time cell state information to the RL agent. The dynamic RL control framework will be benchmarked against static recipes using model mouse and human cell lines.

"Cell therapies are the next wave of therapeutic innovation, demonstrating incredible outcomes and ability to tailor specifically to each patient. In order to realize their full impact, they need to be made more efficiently and safely. Our work will be a part of this effort," says Reuel.

Nigel Reuel (left) has been a trendsetter in using various techniques and therapies to address health challenges and his work has been rewarded with numerous recognitions, including the NSF CAREER Award.

Powerhouse of the cell, key to new treatments

If you remember just one thing from high-school biology, it's that the mitochondria are the powerhouses of the cell. But could mitochondria also hold the key to gene therapy and new tailored drug development for diseases and disorders?

Zengyi Shao, Vernon Guse Faculty Fellow and associate professor of chemical and biological engineering, and her team are developing a comprehensive mitochondrial genetic toolkit in a new project funded by the National Institutes of Health.

The toolkit will be used to untangle the complex nature of mitochondrial genetics and the impact mitochondrial DNA (mtDNA) mutations have on health disorders like type 2 diabetes, cancers and neurological disorders.

Model yeast mirrors human energy generation

Drawing on previous research on tailoring microbial platforms for specific purposes, Shao and **Deon Ploessl**, a Ph.D. student and National Science Foundation Graduate Research Fellow (GRF) in chemical and biological engineering, first plan to develop a new model yeast system to gain insights on mtDNA dysfunctions and how those connect to diseases.

"The previously well-studied model yeast is too dissimilar to human physiology, so we need a new option. We aim to establish a simple testbed that more closely mirrors human energy generation and offers practicality in terms of cost and timescale of genetic manipulations," says Shao.

Bringing CRISPR to mtDNA

The lack of an extensive mtDNA manipulation toolkit represents a major challenge in investigating the role of mtDNA and its mutations in eukaryotes, including humans.

"Our work aims to follow the development path of the CRISPR technology, which is currently capable of effectively editing nuclear DNA. We hope that labs can easily edit mtDNA in the same manner they edit nuclear DNA. This ability holds exciting potential across many disciplines," says Ploessl.

Tailored treatments, broad applications

Shao's team will use the genetic mtDNA toolkit to study specific mtDNA-associated diseases, such as obesity-related human illnesses. They plan to zero in on how modulating fluidity of inner mitochondrial membranes might change mitochondrial physiology, offering new customized drug development possibilities.

And the potential for mtDNA editing reaches far beyond biomedical applications to many other areas such as agriculture.

"The possible avenues made accessible by an extensive mitochondrial manipulation toolkit seem limited only by one's ingenuity. For example, producing livestock with increased body weights using the same amounts of feed. The strategies developed for mitochondrial manipulation could also mediate similar issues faced in chloroplast DNA engineering, potentially enhancing plant photosynthesis and biomass yields," says Shao.

ISU's Bailey Research Award

In 2021 Shao received the Bailey Research Career Development award from Iowa State's Office of Vice President for Research. It is given each year to faculty whose work is high-risk, high-reward and addresses emerging scientific, technical, or societal problems.

Shao (right) and NSF GRF chemical engineering graduate student Deon Ploessl at work in the Shao laboratory.

Recent Faculty Publications

Rizia Bardhan
X. Wen, Y-C. Ou, G. Bogatcheva, G. Thomas, A. Mahadevan-Jansen, B. Singh, E. C. Lin, R. Bardhan, Probing Metabolic Alterations in Breast Cancer in Response to Molecular Inhibitors with Raman Spectroscopy and Validated With Mass Spectrometry, *Chemical Science*, 2020, 11, 9863-9874.

Eric Cochran
S. Goyal, F. Lin, M. Forrester, W. Henrichsen, G. Murphy, L. Shen, T. Wang, E.W. Cochran, Glycerol Ketals as Building Blocks for a New Class of Biobased (meth) acrylate Polymers, *ACS Sustainable Chemistry & Engineering*, 2021, 9(31), 10620-10629.

Rodney Fox
A. Ilgun, A. Passalacqua, R.O. Fox, Solution of the Conditional Moment Closure for Multiphase Reacting Flows Using Quadrature-Based Moment Methods, *Chemical Engineering Journal*, 2021, 405, 127020.

Andrew Hillier
M.M. Islam, M.M. Hossen, T. Koschny, A.C. Hillier, Shape- and Orientation-Dependent Scattering of Isolated Gold Nanostructures Using Polarized Dark-Field Microscopy, *The Journal of Physical Chemistry C,* 2021, 125, (21), 11478-11488.

Laura Jarboe
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Monica Lamm
S. Yan, J.M. Peck, M. Ilgu, M. Nilsen-Hamilton, M.H. Lamm, Sampling Performance of Multiple Independent Molecular Dynamics Simulations of an RNA Aptamer, *ACS Omega*, 2020, 5(32), 20187-20201.

Wenzhen Li
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Surya Mallapragada
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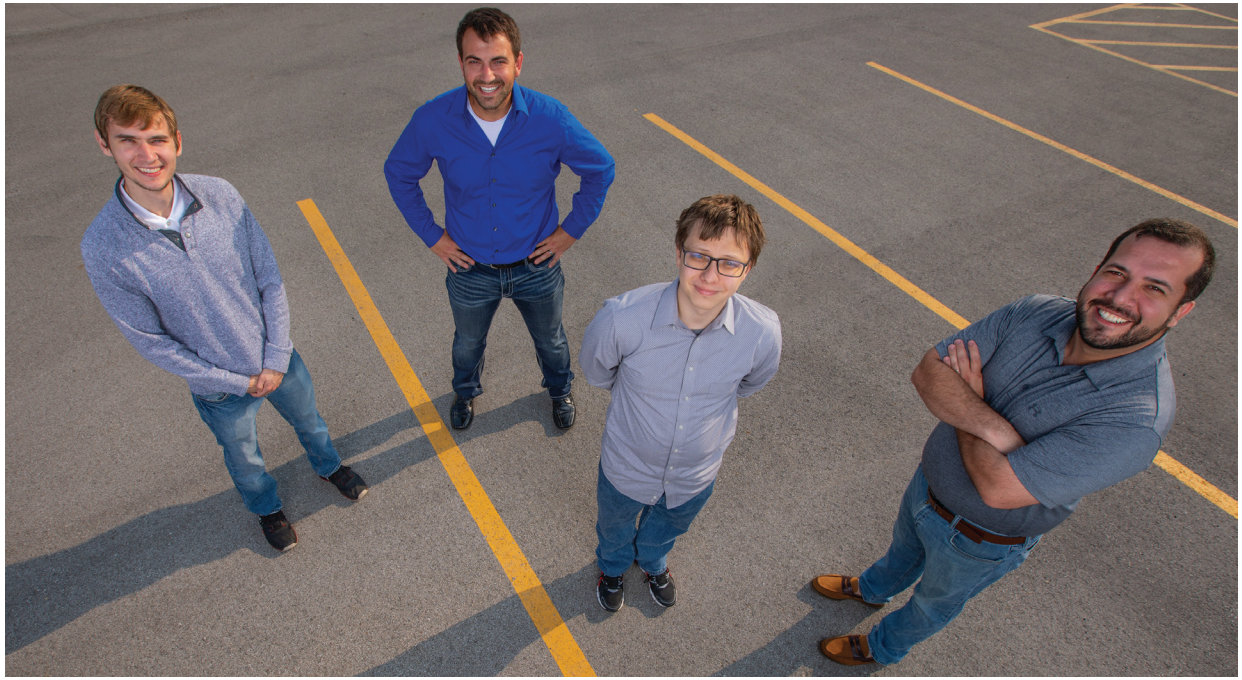
Research project paves the way for grad students commercial success with startup



From left, chemical engineering graduate student Baker Kuehl, scientist and graduate student Austin Hohmann and research scientists Michael Forrester and Nacu Hernandez stand atop a parking lot that was paved with their product.

The old saying discusses "where the rubber meets the road" in terms of success of a plan or idea. And where the rubber literally meets the road on asphalt surfaces, new life for those surfaces is being created with work of a group of Iowa State University chemical and biological engineering graduate students and researchers who have come together to form a promising startup business.

Invigorate Rejuvenator™ is a product developed by SoyLei Innovations™, a business headed by **Nacu Hernandez**, who received a Ph.D. in chemical engineering from Iowa State in 2012. He's joined by current department graduate students **Austin Hohmann** and **Baker Kuehl** and research scientist **Michael Forrester** (Ph.D. chemical engineering, Iowa State University, 2018) in their mission to improve the asphalt pavements you walk and drive on – not by promoting the expensive process of laying new asphalt, but how to prolong the life of existing asphalt.

All the members of the group participated in graduate-level work at Iowa State in the research group of Mary Jane Skogen Hagenson and Randy L. Hagenson Professor **Eric Cochran**. He, along with Gerald and Audrey Olson Professor **R. Christopher Williams** of ISU's Department of Civil, Construction and Environmental Engineering, are advisors to the startup.

"Our technology is about applying chemically modified soybean oil to old asphalt," says Hernandez.

It's done through polymer science, and how their soy-based product impacts the old asphalt molecules found in recycled asphalt pavements. It's not just a short-term change that is found in many products. "There's a lot of 'snake oil' out there when it comes to asphalt rejuvenators," says Hohmann. "Invigorate was specially formulated to react at the molecular level and attack and rejuvenate old, worn-out asphalt materials."

The use of soybean-based products in this realm is not new, but how Invigorate does it is. "This all came about by accident, with a misunderstanding during a lab experiment," says Hernandez. Hohmann explains, "I was giving out some instructions to some students on how to perform an experiment within the lab. I told one person to try one process and another person a different process. One of them did only part of the process, but it unexpectedly gave us a good result we weren't expecting."

Starting with small batches produced in Iowa State University labs, the group is now working with a company in Indiana to produce commercial quantities of their material. Testing has been carried out at 15 different sites around the U.S. Many sales have been made, with many more expected, and a new phase of the business is in the works.

Anyone will tell you: In business, it's all about filling a customer's needs.

Iowa State chemical and biological engineering graduate students **Jared Dopp** (pictured, left) and **Adam Carr** see immense potential in advanced cell free expression – a technique that is used for rapid discovery of new biotherapies and as an engine of new diagnostics (like their recent SARS-CoV-2 mailable sensor). As they talk to end-users, the need is clear: reduce variability in reagents and make it inexpensively in large batches. In a word, needs to be frugal.

Enter Frugi Biotechnology Inc. and a different way of doing this work. "There are many companies that are wanting these reagents," says Dopp. "But they are more focused on the end use. They're developing machine learning and AI (artificial intelligence) systems that rely on consistency of cell free experiments." Frugi has cast their attention upstream of all the exciting end uses, for now, to address the pressing problems of cell extract preparation and packaging for consistent use in drug discovery and diagnostics. After solving this problem, they also plan to develop frugal diagnostics of their own, especially for animal health.

"This idea [of robust cell free components] is a continuation of what I've been working on in obtaining my Ph.D," Dopp explains. And it hasn't been accomplished without some important support, including a Partnership for Innovation grant while as a student and a recently funded Small Business Innovation Research (SBIR) Grant to Frugi, both through the National Science Foundation; Jared and Adam also work with Iowa State's Startup Factory, a yearlong program where participants receive formal training, resources, and access to a network of business mentors, advisors, counselors, and investors.

Another key co-founder who has helped put Frugi's wheels in motion is Department of Chemical and Biological Engineering associate professor and Jack R. and Carol A. Johnson Faculty Fellow **Nigel Reuel**. "I am eager to share my experience on incorporating, building efficient processes for small companies, and obtaining critical non-dilutive funding from federal sources to our students that embark on the entrepreneurial path."

BioMaP program returns with important research opportunities

A summer of expanded horizons – personally and scientifically – was offered to ten undergraduate researchers in the Department of Chemical and Biological Engineering (CBE) in 2021.

The Biological Materials and Processes Research Experience for Undergraduates (BioMaP REU) program, funded by a grant from the National Science Foundation, returned to Iowa State after a one-year hiatus due to the COVID-19 pandemic.

The experience provides mentored research for students who are pursuing bachelor's degrees in chemical engineering or a related curriculum. Each student is paired with one ISU CBE faculty member, along with a designated graduate student. It's coordinated by CBE faculty members **Monica Lamm** and **Ian Schneider**. Iowa State chemical engineering graduate student **Alma Vela Ramirez** served as the program's overall graduate student mentor.

The students also interact with other department graduate students, post-doctoral researchers, and faculty and participate in seminars, meetings, professional development workshops and social events.

Comments about the program included:

"This experience will definitely help me be more competitive in searching for graduate school."

"The collaboration and input from graduate students involved has been very important."

"The idea generation involved has really motivated me to continue expanding my research."

This year's participants, their research projects and their faculty mentors were:

- **Walid Abuhashim**, The University of Akron: Polymer Properties That Selectively Target Tumor Associated Macrophages, **Katie Bratlie**
- **Nareen Anwar**, The University of Texas at Dallas: Resonant Biosensors for Enzyme Activity, Protein Binding, and Ion Detection, **Nigel Reuel**
- **Maple Chen**, Cornell University: Probiotic Engineering, **Thomas Mansell**
- **Ryan Godin**, Cleveland State University: Understanding the Relation Between Aptamer Structure and Function for Sensors and Synthetic Biology, **Monica Lamm**
- **Liam Herbst**, Iowa State University: Lignin-Based Engineering Thermoplastics, **Eric Cochran**
- **Kendra Kreienbrink**, University of Wisconsin-La Crosse: The Artificial Pancreas Project, **Derrick Rollins**
- **Grace Matassa**, The College of New Jersey: Immunomodulatory Nanovaccines Against Infectious Diseases, **Balaji Narasimhan**
- **Tyler Price**, University of Tulsa: Controlling Structure and Mechanical Properties to Understand and Guide Cell Migration, **Ian Schneider**
- **Megan Raszler**, Dordt University: Contribution of Membrane Proteins to Microbial Robustness, **Laura Jarboe**
- **Derrick Sanders**, University of Maryland, College Park: Hyperspectral Imaging of DNA and Protein-Linked Metal Nanoparticles, **Andrew Hillier**

Stepping up and moving forward: AIChE chapter navigates 2020 with strong results

Despite COVID-19 pandemic challenges, a whirlwind of virtual activity netted some significant experience, respect and honors for the Department of Chemical and Biological Engineering's American Institute of Chemical Engineers (AIChE) student chapter.

Strong leadership was established by the Iowa State chapter in 2020 after members stepped up to fill a void when another school's chapter was unable to meet the timeline required for a virtual hosting of the 2020 MidAmerican Regional Student Conference.

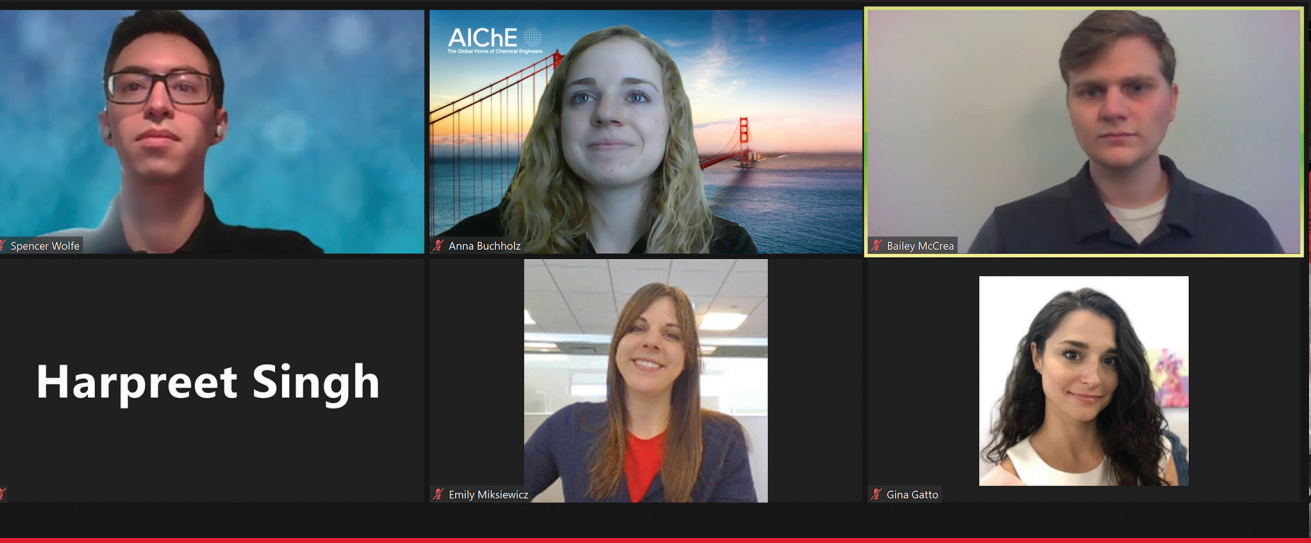
The AIChE Annual Student Conference was held virtually November 13-16, 2020, with the Iowa State chapter in action in the Chem-E-Car competition, and several group members, along with the entire chapter, receiving awards.

Other notable achievements for Iowa State's chapter surrounded the execution of the annual conference, with the ISU contingent kicking off the entire event with a live seminar about engaging students and staying connected with chapter members in a virtual environment. The group was also selected to provide a pre-recorded seminar about running a safe and effective Chem-E-Car program. "Being selected for two seminars was an honor, especially to be the only chapter to give a live seminar - all the rest were pre-recorded," said teaching professor Stephanie Loveland, the faculty adviser for ISU's AIChE group.

For the first time in the chapter's history it was named an Outstanding Student Chapter and was recognized at the annual event. Another significant first was achieved by the chapter in the K-12 Outreach Competition, taking top honors in their first time as an entrant. The ISU committee, led by CBE undergrad Hailey Bates, was honored for a proposal for a program in the K-12 division called "Putting a Stop to Viruses," which teaches how soap binds to viruses and kills them as it cleans our hands.

In the Chem-E-Car competition Iowa State's Ninetails With Attitude team, which took first place in the regional competition in October, took 13th place out of 47 entries in the national competition.

At the 2020 AIChE annual student conference Iowa State's chapter played a significant role in engaging students and maintaining connection nationally when it was invited to host a virtual presentation.



The Iowa State chapter was invited to host a pre-recorded seminar for the opening of the 2020 national student conference about running a safe and effective Chem-E-Car team. The Ninetails With Attitude team is shown here.

ISU AIChE chapter to host 2022 Mid-America Regional conference

The members of Iowa State's AIChE chapter will add yet another feather to their collective cap when they host the organization's next Mid-America Regional conference in the spring of 2022 on the Iowa State University campus.

There are 13 schools in AIChE's Mid-America Region, and hosting the conference is done on a rotating basis. This will mark Iowa State's first time hosting the conference in more than 10 years.

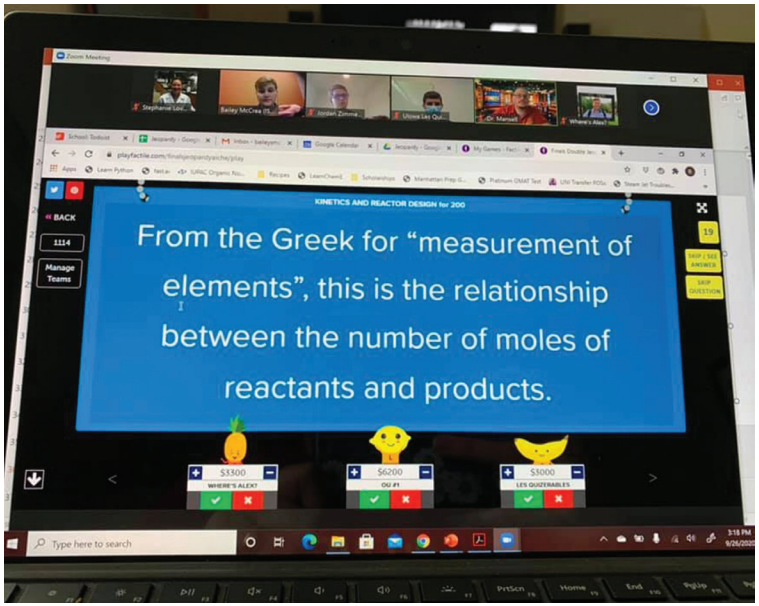
The conference includes competitions, such as the Chem-E-Car, technical presentations, and Chem-E Jeopardy along with research presentations and research posters designed by students. There are also events for networking and socializing with chemical engineering students from other schools and with company representatives, offering AIChE members the chance to connect and showcase their work.

Two Iowa State CBE students will step into the conference spotlight in co-chair roles: **Garrison Pierce** and **Maggie Toepfer**. **Spencer Wolfe** is ISU's AIChE chapter president for the 2021-2022 school year.

Help support the continued success of the ISU AICHE chapter as it hosts the 2022 AIChE Mid-America Student Regional Conference on Iowa State University's campus in April of 2022. See the donation link on the home page of Department of Chemical and Biological Engineering web site at cbe.iastate.edu.

ABOVE:
The Ninetails With Attitude Chem-E-Car team makes a run on its way to winning the 2021 regional competition.

RIGHT:
The popular "Chem-E-Jeopardy" contest was successfully planned and executed by the ISU chapter in the 2021 regional conference, and students will be set to do the same when they host the event in 2022.



CBE alumnus Mark Lashier named Phillips 66 president, COO

Department of Chemical and Biological Engineering (CBE) alumnus **Mark Lashier** was named president and chief operating officer of Phillips 66 effective April 1, 2021. He had served as president and CEO of Chevron Phillips Chemical Company since August, 2017.

Lashier received his B.S. and Ph.D. in chemical engineering from Iowa State University in 1985 and 1989, respectively. He serves on the Iowa State University College of Engineering Industrial Advisory Council and has also served on CBE's Advisory Council.

Mark Lashier, BS ChE '85, PhD ChE '89

In his new position he is responsible for operational execution across all of Phillips 66 businesses — which include refining, midstream, and marketing & specialties — and also for the company's health, safety and environmental efforts. He will be based in Houston, Texas.

The latest promotion for Lashier came after a long history with Chevron Phillips and Phillips 66. At the onset of the Chevron Phillips Chemical joint venture in 2000, Lashier was named Asia region general manager, located in Singapore. He has held several different international management posts with locations including Singapore and Saudi Arabia. Lashier started his career at Phillips in 1989 as an associate research engineer in Phillips' chemicals group of research and development. By 1997 he had been named olefins manager in chemicals and plastics.

James L. and Katherine S. Melsa Dean of Engineering **W. Samuel Easterling** said, "On behalf of the Iowa State University College of Engineering, I want to extend my heartfelt congratulations to Mark Lashier on his continued success. We are indeed proud of the many accomplishments of our graduates, and Mark's appointment as president and COO of Phillips 66 is a shining example."

ISU Chemical and Biological Engineering

With Harvard law degree, Andrew Mettry sets sights on legal side of chemical engineering

Not every Iowa State University chemical and biological engineering (CBE) graduate works in a laboratory and wears a white coat. Some use lessons and the global perspectives learned to lead them to occupations that find them in very different settings.

Meet ISU CBE alumnus **Andrew Mettry**, who earned a B.S. in chemical engineering in the spring of 2018. He's now embarking on a career in law after recently completing a juris doctorate program at Harvard Law School after spending one year at the University of Illinois College of Law.

Andrew Mettry, BS ChE '18

Undergraduate research experience at Iowa State

"I worked for Dr. Hillier (CBE's Reginald R. Baxter Endowed Department Chair **Andrew Hillier**) for two years, first with independent study and then through the Griswold internship program, with focus on colloidal crystal formation.

I was also a teaching assistant for Dr. Heinen (teaching professor and director of undergraduate education **Jennifer Heinen**) answering student questions about in-class activity."

Deciding to attend law school

"I realized that what excited me most about chemical engineering was high-level strategic thinking. I've always loved the intersection of tech, law and business. I knew I wanted to do something different with my degree. We had a guest lecturer in a class – **Gary Griswold** (Chemical Engineering '67), who is involved with the field of intellectual property, and with his wife, Mickie, is the founder of the Griswold internship program at Iowa State. He talked about the legal rights of people who conduct research and patent scientific discoveries. I really wanted to develop that skill set."

Benefits of a CBE education

"Engineering gives you an ability to analyze seemingly large problems in a logical, systematic way. I relied on that skill set constantly throughout law school and imagine I will do the same as I begin practicing law. CBE helped me develop that."

Future plans

"I'm going to a law firm in Chicago after taking the bar exam, where I'll be doing corporate work on behalf of small, emerging companies that are backed by venture capital."

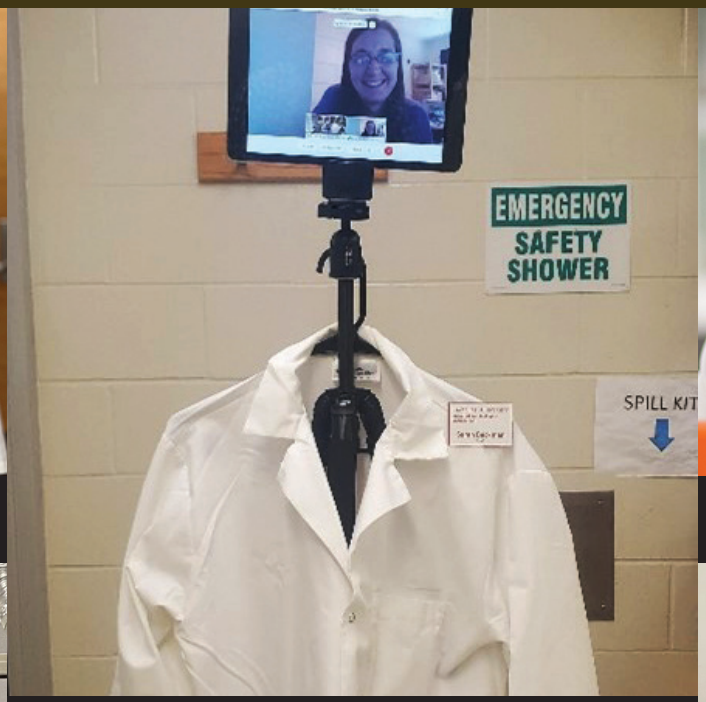
Advice to CBE undergraduates

"Never underestimate the power of your network. At ISU CBE, you're surrounded by many smart people who are going to go on to do wonderful things and who have gone on to do wonderful things already. Reach out to them to hear more about what they do. Surround yourself with smart, interesting people outside of class. They will be your friends for a long time."

"Never underestimate the power of your network."

Andrew Mettry, BS ChE '18

Graduate students (from left) Prerana Carter, Andrew Kohler and Daniel Vincent Sahayaraj discuss research in a CBiRC laboratory.

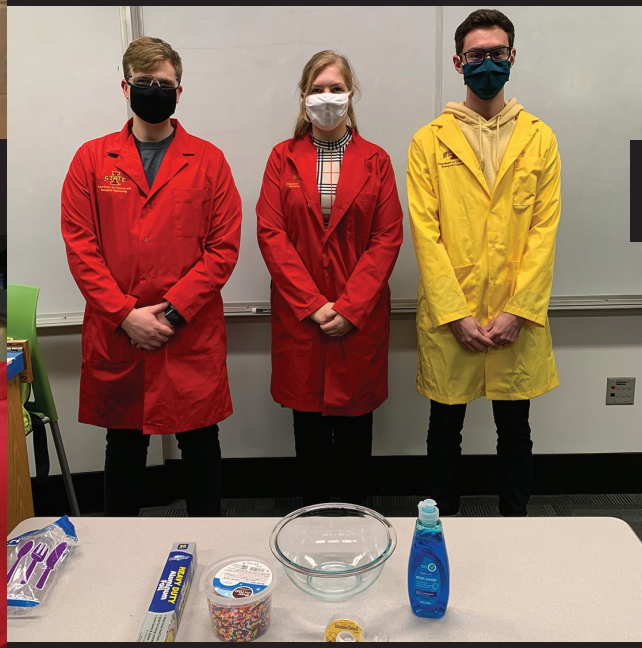


During the COVID-19 pandemic remote access to the teaching laboratories was provided in creative and fun ways.

CBE associate professor Rizia Bardhan collects research data in the new facilities of Iowa State's Nanovaccine Institute.

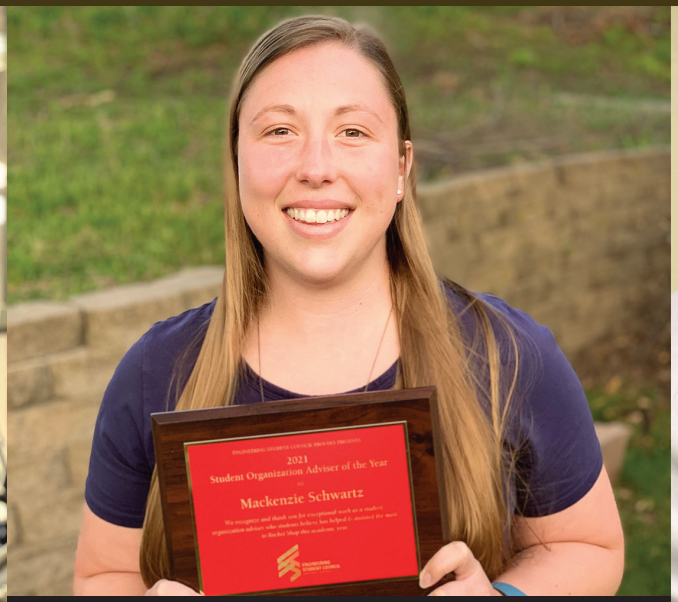
This spray dryer, purchased with alumni funds to support teaching and research experiments, aids in forming powders and particles.

BioMaP REU student Megan Raszler (left) discusses her work at the program-ending poster session.



The American Institute of Chemical Engineers (AIChE) ISU student chapter took first place in the 2020 Annual Student Conference in its first venture into the K-12 Outreach Competition. The committee, led by Hailey Bates, was honored for a proposal for a program called "Putting a Stop to Viruses," which teaches how soap binds to viruses and kills them as it cleans our hands.

Graduate student Dhananjay Dileep at work in a department research lab.



CBE advisor Mackenzie Schwartz was named College of Engineering Student Organization Advisor of the Year in 2021. The nominated award recognizes exceptional student support through her five years of assisting the ISU chapter of the Society of Women Engineers.

BioMaP REU student Derrick Sanders works on his summer research project in a Sweeney Hall lab.

CBE students are all smiles at the department ice cream social at the start of the fall 2021 semester. It featured a variety of campus-created flavors from the Iowa State University Creamery.

BioMap participant Maple Chen discusses her research at the summer-ending poster session.

CBE Honors & Awards 2020-2021

FACULTY

Karen Burt
Promoted to associate teaching professor

Eric Cochran
Mary Jane Skogen Hagenson and Randy L. Hagenson Professor

American Chemical Society Cooperative Research Award in Polymer Science & Engineering

Laura Jarboe
Cargill Professor in Chemical Engineering

College of Engineering Mid-Career Achievement in Research Award

Wenzhen Li
Herbert L. Stiles Faculty Fellow

Surya Mallapragada
American Institute of Chemical Engineers Fellow

Balaji Narasimhan
American Institute of Chemical Engineers Fellow

Nigel Reuel
Promoted to associate professor

Jack R. and Carol A. Johnson Faculty Fellow

Engineering Entrepreneurship Faculty Fellowship in Chemical & Biological Engineering

National Science Foundation CAREER Award

Iowa State University Early Achievement in Research Award

Iowa State University Achievement in Intellectual Property Award

Luke Roling
Black and Veatch Building a World of Difference Faculty Fellow in Engineering

Zengyi Shao
Vernon Guse Faculty Fellow

Iowa State University Bailey Career Research Development Award

Jean-Philippe Tessonnier
Richard C. Seagrave Professor

College of Engineering Mid-Career Achievement in Research Award

STAFF

Ryan Arndorfer
ISU Exceptional Effort Excellence in Instructional Support Award

Mackenzie Schwartz
College of Engineering Student Organization Adviser of the Year

ALUMNI

Lori Ryerkerk, B.S. '83,
College of Engineering Anson Marston Medal

Edward Maginn, B.S. '87
College of Engineering Professional Achievement in Engineering (PACE) Award

STUDENTS

Conor Smith, Lawrence E. Burkhart Outstanding Senior Award, Fall 2020

Austin Angel, CBE senior marshal nominee, Fall 2020

Divyesh Kumar, CBE senior marshal nominee, Spring 2021

Graduate student **Shailja Goyal** was selected as the 2020 Department of Chemical and Biological Engineering nominee for the prestigious Brown Graduate Fellowship.




The Fall 2020 graduate students Research Excellence Awards were presented to **Nathaniel Kallmyer** (first) and **Alireza Saraeian** (second), while **Prerana Carter** (third) and **Geet Gupta** (fourth) claimed the Teaching Excellence honors.

Chemical engineering graduate student **Hamed Bateni** received the highly competitive Iowa State University Graduate and Professional Senate Teaching Award in 2021.



Benjamin Schlichtmann (first), **Bradley Ryan** (second) and **Sean Rollag** (third) took top honors in CBE's annual Perfect Pitch competition, where graduate students have a strict time limit for presenting a synopsis of their research.

James Trettin (left) and **Alex Kauffmann** (right) were dual recipients of the Lawrence E. Burkhart Outstanding Senior Award for Spring 2021. Shown with Reginald R. Baxter Endowed Department Chair **Andrew Hillier**.

Advisory Council

The department relies on the expertise, experience and advice of its advisory council, a group of chemical engineering professionals who are alumni of the department. The council plays a key role in helping to shape department policies and procedures in many areas, including curriculum development, accreditation, undergraduate and graduate student affairs, industry engagement, budget and more.

Amy Determan
B.S, 2001; Ph.D., 2006
Advanced Product Development Specialist
3M

Tess Duckett
B.S., 2002
Principal Systems Engineer
General Mills

Christian Edmiston
B.S., 1998 (double major with Econ.)
Vice President, Procurement
Land O'Lakes

Christopher Ellison
B.S., 2000
George T. Piercy Professor, Department of Chemical Engineering and Materials Science
University of Minnesota

Edward Maginn
B.S., 1987
Keough-Hesburgh Professor, Department of Chemical and Biomolecular Engineering,
University of Notre Dame

Jane Newman-Ford
B.S., 1991
Associate Project Engineer
Burns & McDonnell

W. Mark Saltzman
B.S., 1981
Head of College, Goizueta Foundation Professor of Chemical and Biomedical Engineering
Yale University

Jack Starr
B.S., 1987
Director of Engineering R&D
Cargill

Jeff Underwood
B.S., 1994
Vice President, Enterprise Innovation
Kent Corporation

Meghan Watt
B.S., 2002
Program Director
Dow Chemical Company

Derek Winkel
B.S., 1998; MBA, 2015
Vice President, Manufacturing Operations
Renewable Energy Group

SCHOLARSHIPS

3M Endowed Scholarship in Engineering
Gloria Youngbear

A. Douglas and Helen F. Steffenson Memorial Endowed Scholarship
Maxwell McLain
Huy Nguyen

Alpha Chi Sigma Chemical Engineering Scholarship
Jack Bonde

Ana and Ed McCracken Engineering Scholarship
Jared Greiner

Barbara L. Feroe Scholarship
Elena Knops

BASF STEM Scholarship
India Cavazos
Jessica Hammel
Adriana Patino
Dejuan Roberson

Beisner Scholar Award in the Department of Chemical Engineering
Brett Deconinck
Ian Gandhi
Matthew Laws
Sydney Williams

Bob Kaiser Memorial Scholarship
Madison Rubin

Building a World of Difference Renewable Energy and Sustainable Water Scholarship in Engineering
Allyson Ehlers
Holly Jacobs
Vittal Kamath

Burton H. Friar Scholarship in Chemical Engineering
Taylor Schlagel

Chemical Engineering Scholarship
Joshua Analitis
Matthew Baker
Maija Beckwith
Ashley Behrendt
Jack Bonde
Maria Brown
Nicholas Carber
Cameron Cimino
Jacob Davis
Mackenzie Donald
Robert Downs
Mason Dyess
Blake Eder
Caroline Franciskato
Ian Gandhi
Luke Geis
Jessica Hammel
William Henrichsen
Liam Herbst
Kaitlyn Holtz
Holly Jacobs
Yeongran Jo
Vittal Kamath
Elena Knops
Luke Koeneman
John Kokkin
Victoria Kyveryga
Violet Lapke
Margaret Lashier
Matthew Laws
Joyee Leong
Nicole Lorang
Ashley Marker
Natalie McAninch
Maxwell McLain
Anna Meerschaert
Aline Milach Teixeira
Mattea Miller
Katelyn Nelson

Chemical Engineering Scholarship
Huy Nguyen
Mya O'Connell
Darshit Patel
Abigail Petheram
Addisen Popp
Justin Pottorff
Jack Raffaelle
Finlan Rhodes
Dejuan Roberson
Madison Rubin
Daniel Sauer
Taylor Schlagel
Josef Schmitz
Christopher Schnitzler
Connor Schroeder
Marion Schultz
Emma Schwarck
Megan Sherman
Ryan Shustrin
Jaclyn Simons
Cole Smith
Nathan Smith
Raven Stevens
Kaitlin Steward
Laura Stowater
Sophia Vaughan
Cassandra Volpe
Carter Wachholtz
Caden Washburn
Emma Williams
Spencer Wolfe

Conrad N. Muzzy Scholarship Fund
Mya O'Connell

Dr. Owen A. Heng Chemical and Biological Engineering Scholarship
Megan Wolfe

Dr. Peter Reilly Memorial Scholarship
Adriana Patino

Dr. Susan Heller Scholarship for Engineers
Madison Karamagianis

Dr. Thomas D. Wheelock Scholarship
Lauren Burton

Edward W. and Joyce C. Backhaus Scholarship in Chemical and Biological Engineering
Emily Aube
Liam Herbst
Violet Lapke
Grace Ledvina
Tyler Naughtrip
Raven Stevens
Kaleb Still
Delaney Eaheart
Sean Kelly
Leigh Ozsalar

Edwin John Hull Endowed Scholarship
Maria Brown
Natalie McAninch

Engineering College Scholarship
Matthew Baker
Cameron Cimino
Jessica Hammel
Logan Keller
Ritwesh Kumar
Ashley Marker
Elias Pickit

Engineering Incoming Freshman Merit Scholarship
Delaney Eaheart
Jessica Fuertes-De Arcos
Isabel Furness
Mariella Vitelli

Engineering Student Leadership Development Scholarship
Mason Dyess
Caden Washburn
Spencer Wolfe

Engineering Student Program Support - Freshman Applied Merit
Jaden Brand
Jaya Davis
Brandon Deahl
Tyler DeBlieck
Delaney Eaheart
Isabel Furness
Michael Galvin
Jack Girton
Jonathan Greene
Kaelie Hainlin
Nathan Harding
Rachel Leholm
Carter McCann
Morgan Meaney
Kaitlyn Quinn
Callan Randall
Cameron Smith
Sydney Williams

Engineering Student Program Support - Incoming International Merit
Yassin Ashraf Abushanab
Ee Jie Tai

Erwin and DeLoris Whitney Scholarship in Chemical Engrineering
Josephine Trager

Eugene Devere Travis Scholarship
Vittal Kamath
Darshit Patel

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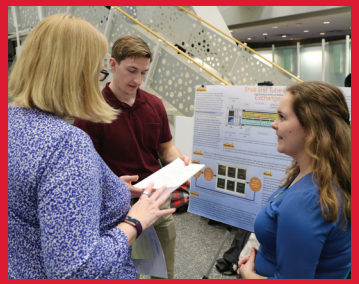

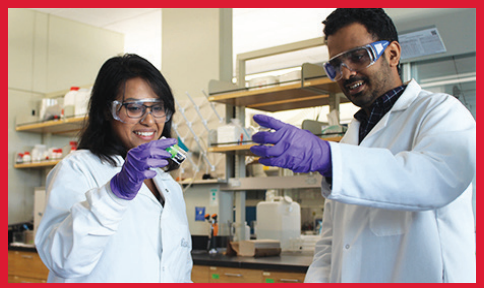

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