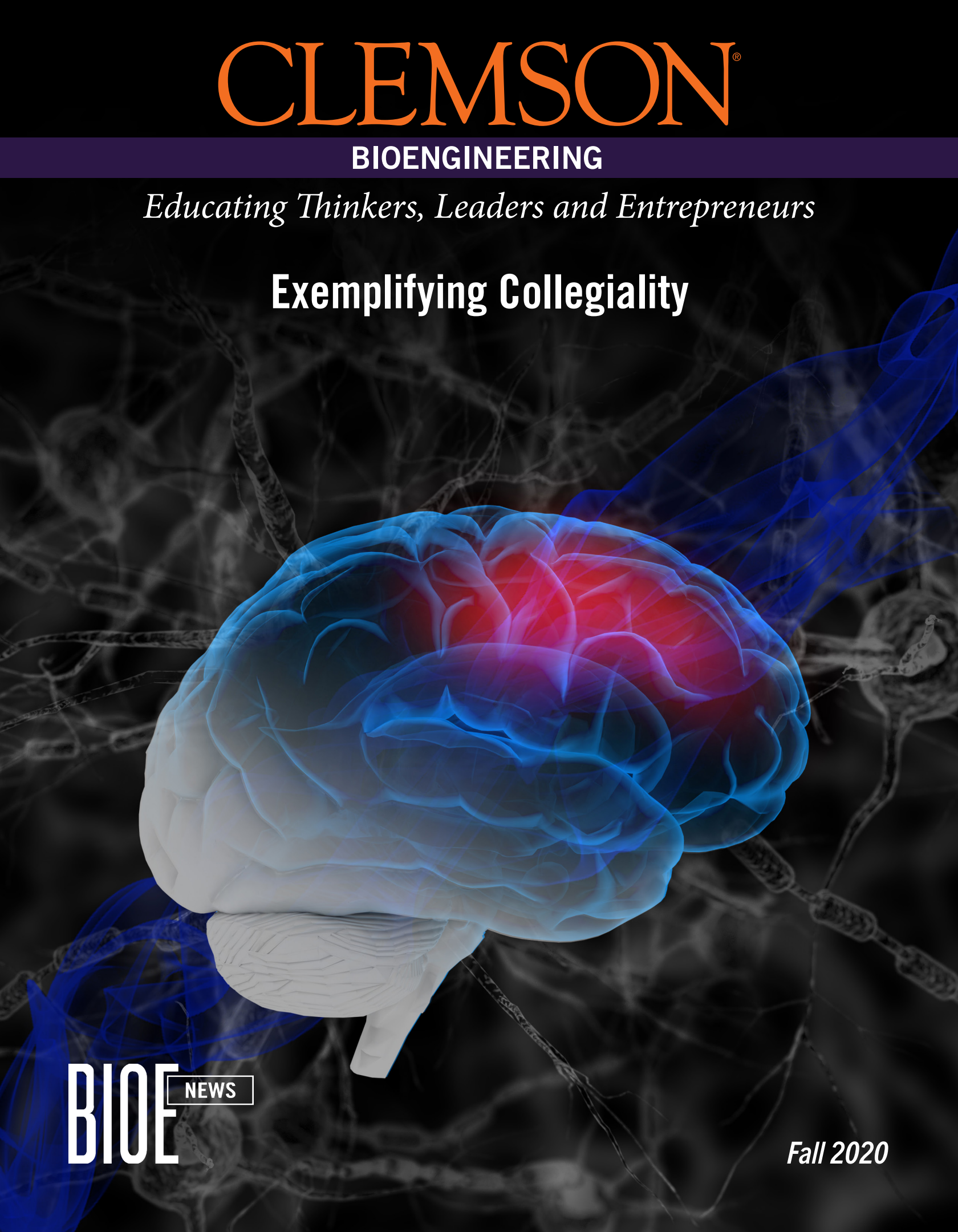
CLEMSON

BIOENGINEERING

Educating Thinkers, Leaders and Entrepreneurs

Exemplifying Collegiality



BIOE NEWS

Fall 2020

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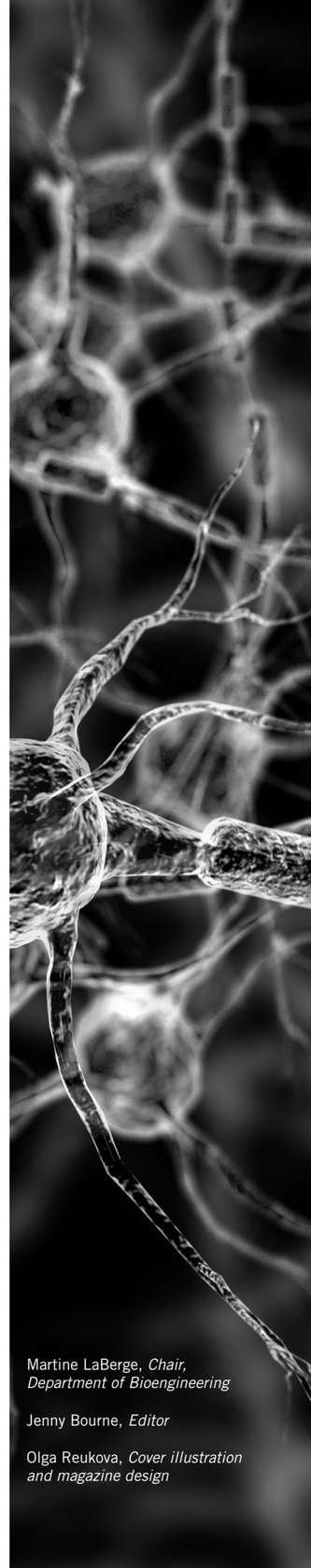
Cover illustration — *Traumatic Brain Injury (TBI). By quantifying performance of football helmets, John DesJardins aims to prevent TBI. One goal of Jeoung Soo Lee's research in drug delivery technology is TBI treatment.*



Martine LaBerge, *Chair, Department of Bioengineering*

Jenny Bourne, *Editor*

Olga Reukova, *Cover illustration and magazine design*

Clemson University researchers create cutting-edge solutions to COVID-19

Paul Alongi, College of Engineering, Computing and Applied Sciences
October 27, 2020

A new Clemson University lab that researchers are calling "a cutting-edge solution to help fight COVID-19" could be stocked with 13 sample-handling robots and have a staff of about 50 students fully trained as early as November. The COVID-19 Clinical Diagnostics Lab started off by testing the saliva of athletes and Tiger Band members and is now poised to broaden testing across campus. Once fully operational, the lab will be able to test 5,000 samples daily and return results the same day, with each test costing about $8.

"This is a clear example of Clemson's leadership through the efforts of its faculty, staff and students to take on the COVID-19 challenge," President James P. Clements said. "The lab reinforces what Coronavirus Response Coordinator Deborah Birx said when she visited campus: 'It was apparent from the moment we arrived the outstanding efforts Clemson has done to open the university and to keep it open. It's clear the students have taken a responsible approach to their return and the results have been encouraging.'"

The lab is overseen by Delphine Dean, the Ron and Jane Lindsay Professor of Bioengineering, with the help of Mark Blenner, the McQueen Quattlebaum Associate Professor of Chemical Engineering. "This is a multidisciplinary, University-wide effort to create a lab that is a cutting edge solution to help fight COVID-19," Dean said. "We're trying to ramp up quickly but safely."

The University received a commitment of $6.9 million through Gov. Henry McMaster and the state's Joint Bond Review Committee to assist in the development and expansion of the lab, according to a University press release. Angie Leidinger, Clemson's vice president for external affairs, said the lab is an example of the ingenuity that researchers are showing in the face of a global pandemic that is unprecedented in modern times. "This lab will foster research and innovation, not only for COVID-19 but also for other infectious diseases," she said. "We will be well-positioned to compete for federal grants that fund cutting-edge research."

Robert Donato, chief strategy officer for Clemson, said the lab underscores the unique solutions that have made the University a national leader in coronavirus response. "Multiple stakeholders from across campus have come together to make this new lab possible," he said. "The lab allows us to ramp up testing as part of our comprehensive effort to provide the safest possible environment for students, faculty, staff and visitors."

The lab, which employs the PCR testing technique, is based in Jordan Hall and has room to expand in Sirrine Hall. About 20 graduate students are serving as the lab's technicians, and about 30 undergraduates are helping with sample collection and are training in data handling and other tasks to assist the technicians. "They are getting amazing training right now in clinical lab sciences that otherwise would not be available to them at Clemson," Blenner said. "We're really excited about the fact that the lab gets to be this really wonderful educational tool as well as being able to serve our local community and the University." The lab is certified through the Clinical Laboratory Improvements Act.

The Athletics Department has provided key support for the creation of the lab, including the purchase of equipment and providing samples for research. Over the summer, student-athletes were tested with both nasal swabs and saliva tests, helping researchers validate that their saliva tests worked. "We appreciate the opportunity to support the research and teaching mission of the University, while helping enhance the mental and physical well being of our student-athletes through regular testing for COVID-19," said Athletics Director Dan Radakovich. "I very much appreciate the hard work that Clemson's faculty and students have put into helping keep our student-athletes safe. I thank them and congratulate them on the opening of the lab." The lab is processing samples from athletes for all fall and spring sports, except for game day tests. A third party chosen by the ACC conducts those tests.

Cynthia Young, dean of the College of Science, said that several faculty in biological sciences and in genetics and biochemistry have been involved in COVID testing, and that these faculty connected her with Dean. Young then invited Dean and Blenner to tour Jordan Hall, where it became immediately apparent that the space would work. "Our College of Science Outreach Center has two DNA labs that typically have 15,000-plus K-12 students and teachers discovering science throughout the year," Young said. "We were able to redeploy these two labs – one for virtual science labs and clubs to support K-12 teachers, parents and students; and the other for the COVID-19 Clincial Diagnostics Lab. We are thrilled that the lab in Jordan will enable expanded saliva-based testing capacity for our Clemson family and our state."

Corey Kalbaugh, an assistant professor of public health sciences, is among the collaborators on the project. "This lab is providing new opportunities for research, education and teaching," he said. "This 'all-in' approach is enabling our team to come up with the best possible outcome not only for faculty and students but for the broader community."

On a recent morning, six graduate students tested Tiger Band members' saliva with the help of a sample-handling robot that can work more quickly and is less prone to errors than human hands. Tubes containing the samples sat in a rack on the bottom of a glass case. A device inside the case took the saliva out of each tube and placed it in four separate wells, two to check for COVID-19 and two serving as controls.

Wells are arranged in rows on plates that go into a PCR machine where the samples are heated up and cooled down multiple times. The process turns RNA into DNA and copies it repeatedly. Results come out on a nearby computer screen. A sharp upward curve on a test primer means the sample is positive for COVID-19. "Even if you have a tiny amount of virus, we can detect it," Dean said.

Among the students training in the lab was Austin Smothers, who is pursuing his master's degree in bioengineering. The job is giving him valuable lab experience, he said. "I didn't consider anything like this while I was doing my research," Smothers said. "But now that I've been in here and I've experienced it, I feel like this is something I could do in the long run. I think after we get a certain amount of time in here with some certification, we can be supervisors."

The lab tested about 1,000 samples in its first seven days of operation. Accuracy so far is 100%, Dean and Blenner said. Starting with a relatively small population and two borrowed sample-handing robots is giving students an opportunity to train before ramping up. When the lab is fully operational, it will have capacity to process all on-campus screening tests and to offer to help with testing in the surrounding community, Dean and Blenner said.

COVID-19 SECTION

Even as the lab tests at greater scale, Dean and Blenner expect to be able to continue to return results on the same day. A quick turnaround can help give students peace of mind if they think they might have COVID-19, and it allows for a quick start for contact tracing if needed, Dean said.

Dean said the simplicity of the Clemson tests help keep the costs down. Students scan a QR code on the tube, take off a cap, spit in the tube, replace the cap and put it in a rack. There's no need for a trained professional to take the sample, which reduces the need for personal protective equipment. Dean and a student pick up the rack and deliver it to the lab, following hand-off protocols. The cost savings continue at the lab because saliva samples require fewer steps to extract RNA from the virus than nasal swabs, Dean said. Students receive an email when their test results are available and can check them online. Dean uploads each day's results to the state Department of Health and Environmental Control, which includes them in the statewide total.

The lab has also presented research opportunities for faculty and students, Dean said. "I've had a lot of people call to ask about adding the lab and protocols onto research proposals so they can validate some of the tests they are running on the research side," she said. "Before the lab, we didn't have that capacity at Clemson."

The lab's procedures are aimed at protecting students' privacy. As part of undergraduate training, students are learning about federal health information privacy rules. Once the tubes arrive in the lab, they have no identifying information apparent to those working in the lab.

Anand Gramopadhye, dean of the College of Engineering, Computing and Applied Sciences, said the lab is helping keep the community safe and providing valuable experience for students. "This is an example of the innovative ways that the college's faculty and students are working across disciplines and departments to respond to COVID-19," he said. "I thank Delphine and Mark for their hard work and dedication to combatting the virus and providing new learning and research opportunities. Their efforts will help us come out of COVID-19 stronger."

Watch the video about COVID-19 Clinical Diagnostics Lab at Clemson University

Clemson University's robust testing strategy has been supplemented this week by additional capacity through saliva-based testing. In the three days of expanded saliva testing, the University has processed 1,599 tests, with 95% of results being returned the same day of the test.

The recent development of a laboratory certified by the Clinical Laboratory Improvement Amendments – commonly called a CLIA Lab – based in Jordan Hall on the main university campus has facilitated the increase in capacity. The University received a commitment of $6.9 million through Governor Henry McMaster and the State's Joint Bond Review Committee to assist in the development and expansion of the CLIA Lab.

"This funding provides the additional high capacity lab facilities, testing support and reporting resources to help Clemson University meet its obligations to its students, faculty and staff and further its Land Grant Mission of helping the State of South Carolina," Clemson University President Jim Clements said. "Clemson's continued partnerships and collaborations with the other research universities across the state as well as its close working relationship with SC-DHEC will further the state and our community's response to this pandemic."

This is a multidisciplinary, University-wide effort to create a lab that is a cutting-edge solution to help fight COVID-19. We're trying to ramp up quickly but safely.
Delphine Dean

The goal of the CLIA labs is to 1) provide regular, rapid testing of Clemson faculty, staff, and students and 2) collaborate with DHEC to expand and facilitate rapid testing availability for the entire Upstate community and other institutions of higher education throughout the State.

Collaboration between Clemson's new CLIA labs and DHEC will help fight community spread through expanding availability of faster, less-invasive saliva-based tests to off-campus Clemson students, local school districts, and other members of the Upstate community.

Clemson Continues to Lead on COVID-19 Testing, Expands Saliva-Based Capacity

UNIVERSITY RECEIVED PORTION OF $16.7 MILLION COMMITMENT FROM STATE OF SOUTH CAROLINA

MEDIA RELEASE
October 22, 2020

Overseen by Delphine Dean, the Ron and Jane Lindsay Professor of Bioengineering, with the help of Mark Blenner, the McQueen Quattlebaum Associate Professor of Chemical Engineering, the lab employs 20 graduate students serving as the lab's technicians. Approximately 30 undergraduates are helping with sample collection and are training in data handling and other tasks to assist the technicians.

When fully operational, the lab will be able to test 5,000 samples daily and return results the same day. "This is a multidisciplinary, University-wide effort to create a lab that is a cutting-edge solution to help fight COVID-19," Dean said. "We're trying to ramp up quickly but safely."

Angie Leidinger, Clemson's vice president for External Affairs, said the lab is an example of the ingenuity that researchers are showing in the face of a global pandemic that is unprecedented in modern times. "We're grateful to Governor McMaster and the JBRC for this investment," Leidinger said. "This funding not only assists in the immediate needs related to COVID, but also positions Clemson and the State of South Carolina to be a leader in competitive health-related research grants in the future.

Melissa McCullough's COVID-19 Research funded by Booz Allen Foundation

Melissa McCullough
September 17, 2020

I was awarded a grant from the Booz Allen Foundation Innovation Fund for a project I pitched to address a social issue or community resilience challenge created by COVID-19. The Urinall COVID-19 Wastewater Detection System is our effort to reduce community spread of the virus by making wastewater testing without the need for external lab support an option for communities of all sizes. The system, a sensor platform in development, is designed to be portable for point of care use, rugged ready for field deployment and low-cost for communities.

Monitoring sewage for the coronavirus's genetic material could create up to a week of warning before cases of COVID-19 peak in an area. Such a system could be put into service close to the population, allowing community health managers to identify residents for health screenings and testing, thereby preventing asymptomatic individuals unknowingly spreading the virus. We envision utility and municipal workers employing our testing solution by accessing sewage systems through existing maintenance holes and pipe cleanouts.

Routine wastewater monitoring with the Urinall sensor platform in housing facilities where strict social distancing measures are not possible such as nursing homes, high rise apartments and dormitories will help protect vulnerable populations from outbreaks of COVID-19. By isolating a potential outbreak to a residential community, the system will allow provision of medical attention and resources to people directly affected by the virus. Critical resources, staff-hours and lives can be saved with the Urinall Covid19 Detection System.

Critical resources, staff-hours and lives will be saved with the Urinall Covid-19 Detection System.

The Booz Allen Foundation Innovation Fund awarded $10,000 for the Urinall's development. With the ambitious goal of having a prototype platform ready for field trials by Summer 2021, we have a lot of work to do!

Simulated heart attacks could help researchers screen drugs

Paul Alongi, College of Engineering, Computing and Applied Sciences
May 4, 2020

Researchers have developed a new way of simulating heart attacks in a lab and then using the engineered tissue to screen drugs that show promise for treating patients with heart damage, according to a new article in the journal Nature Biomedical Engineering. Corresponding author Ying Mei, an associate professor of bioengineering at Clemson, said that when specific human heart cells were placed in a culture they self-assembled into a tissue called an "organoid" that mimicked the heart. Researchers then reduced oxygen to a defined level to resemble the conditions that occur in a heart attack. The resulting tissue can be used as a model to screen drugs that are designed to treat heart damage, Mei said. It could also be used to screen chemotherapy drugs that are toxic to the heart and could be harmful to patients with heart conditions, he said.

The drugs that researchers used to demonstrate how screening could work were JQ1, a bromodomain inhibitor currently in clinical trials, and the chemotherapy drug doxorubicin. "We've designed a very useful model for pharmaceutical companies to screen new drugs or to repurpose drugs already on the market," Mei said. "I think this is ready for large-scale testing. This is a platform technology, and we would like to extend it to different applications."

Researchers, who conducted their study prior to the COVID-19 pandemic, are starting to think about how the organoids could be deployed in the fight against the novel coronavirus, Mei said. They are exploring whether the organoids could be used to test drugs that treat COVID-19, or to learn more about COVID-19's effects on the heart, he said. It could also be possible to use the organoids to investigate the genetic factors that leave some people more susceptible to heart attack than others, Mei said.

A heart attack, also called a myocardial infarction, is caused when the coronary artery becomes blocked, resulting in a loss of oxygen that damages heart muscle. Heart attacks are a common cause of heart failure. Heart-failure clinical trials have had limited success in recent years, partly because several studies have involved tests on rodents, Mei said. "Part of the problem is that when you optimize drugs for mice or rats, they just don't work in humans," he said. The organoids provide new hope, though, because they allow researchers to conduct tests on human tissue, Mei said.

The title of the paper is, "Human cardiac organoids for the modeling of myocardial infarction and drug cardiotoxicity." As of April 28, it was the fourth most-viewed article on Nature Biomedical Engineering's website with 7,300 unique page views.

Martine LaBerge, chair of the Department of Bioengineering, said the team is well positioned for global impact. "I congratulate the team on publishing these important findings," she said. "The number of times the article has been viewed is a testament to the high level of interest and its potential impact."

Article co-authors affiliated with Clemson University's Department of Bioengineering were: Dylan J. Richards, Yang Li, Jenny Yao, Robert C. Coyle, Xun Chen, Jia Jia, Brooke Damon, Hai Yao, Tong Ye and Ying Mei.Co-authors affiliated with the Medical University of South Carolina were: Charles M. Kerr, Gyda C. Beeson, Robert Wilson, E. Starr Hazard, Gary Hardiman, Donald R. Menick and Craig C. Beeson.

STUDENTS DESIGN
COVID-19 PROTECTION DEVICE
FOR LESS THAN $100

Paul Alongi, College of Engineering, Computing and Applied Sciences
May 14, 2020

A few supplies available at just about any hardware store for less than $100 can be assembled into a device that helps keep COVID-19 patients from infecting the healthcare providers who take care of them, a group of Clemson University researchers said. The student-led group is designing and building prototypes of a "negative pressure" device that would fit over patients' heads. If they sneeze or cough, the device would keep the novel coronavirus from spreading to others in the room, researchers said.

The device is built with fans, air filters, PVC pipe and plastic sheeting that you can get from the hardware store. Air inside the device is passed through the filter to prevent the virus from escaping into the room. Healthcare providers could place the device over COVID-19 patients while intubating them or transporting them through areas with uninfected patients, researchers said.

For the group, the idea is to design a device that can be built inexpensively with readily available parts so that it can be quickly replicated at hospitals around the world. The group has made seven prototypes, some for as little as $15, and is working with doctors from Prisma Health to refine the designs. The project underscores how students and faculty are turning the pandemic into an opportunity to conduct unique research and stay connected to the University while campus is closed to promote social distancing.

Diego Nigoa, a senior who graduated in May, is building a frame and trying different fan configurations at his apartment in Central. "Working on this has helped me stay connected to the professors in my department and made sure I'm constantly thinking about the pandemic in terms of 'what can I do to make things smoother' instead of in a doom-and-gloom 'there's nothing I can do to help' sort of way," said Nigoa, who plans to pursue a Ph.D. in bioengineering.

Nigoa is working on the project with fellow bioengineering students Amanda LeMatty and Robert Falconer, as well as Delphine Dean, the Ron and Jane Lindsay Family Innovation Professor, and John DesJardins, the Robert B. and Susan B. Hambright Leadership Professor.

LeMatty, a rising senior, said the device they are creating could be used in any hospital setting. "Our structure is meant to fit on any standard hospital bed," she said. "We're expecting it to be used in transporting patients and for intubation. We have holes built into the structure that will allow doctors to intubate."

DesJardins said the device would be put on patients when they take off their medical masks, a precarious time because without precautions a single sneeze could contaminate the entire room. "This is basically a helmet of sorts that patients wear and that allows doctors and nurses to get inside and perform procedures on them," he said. "It could be used for intubation or ventilation. This could also be used for dental procedures or for asthma treatments. It's basically a space that isolates your head and sucks air out of that space and through a filter before it's expelled into the room."

> It's basically a space that isolates your head and sucks air out of that space and through a filter before it's expelled into the room.
> *John DesJardins*

Martine LaBerge, chair of the Department of Bioengineering, said COVID-19 is providing students and faculty a unique opportunity to innovate and advance their studies, even with campus closed. "Our students and faculty are rising to meet the unprecedented challenges presented by the COVID-19 situation," she said. "Their perseverance and determination are inspiring and will help ensure they come out stronger on the other end. They are well positioned for global impact."

Dean said she is drawing on her experience with the project to help organize Summer 2020's Clemson Covid Challenge. Teams of undergraduates from throughout the University were challenged to work on problems related to the COVID-19 situation and potential future pandemics.

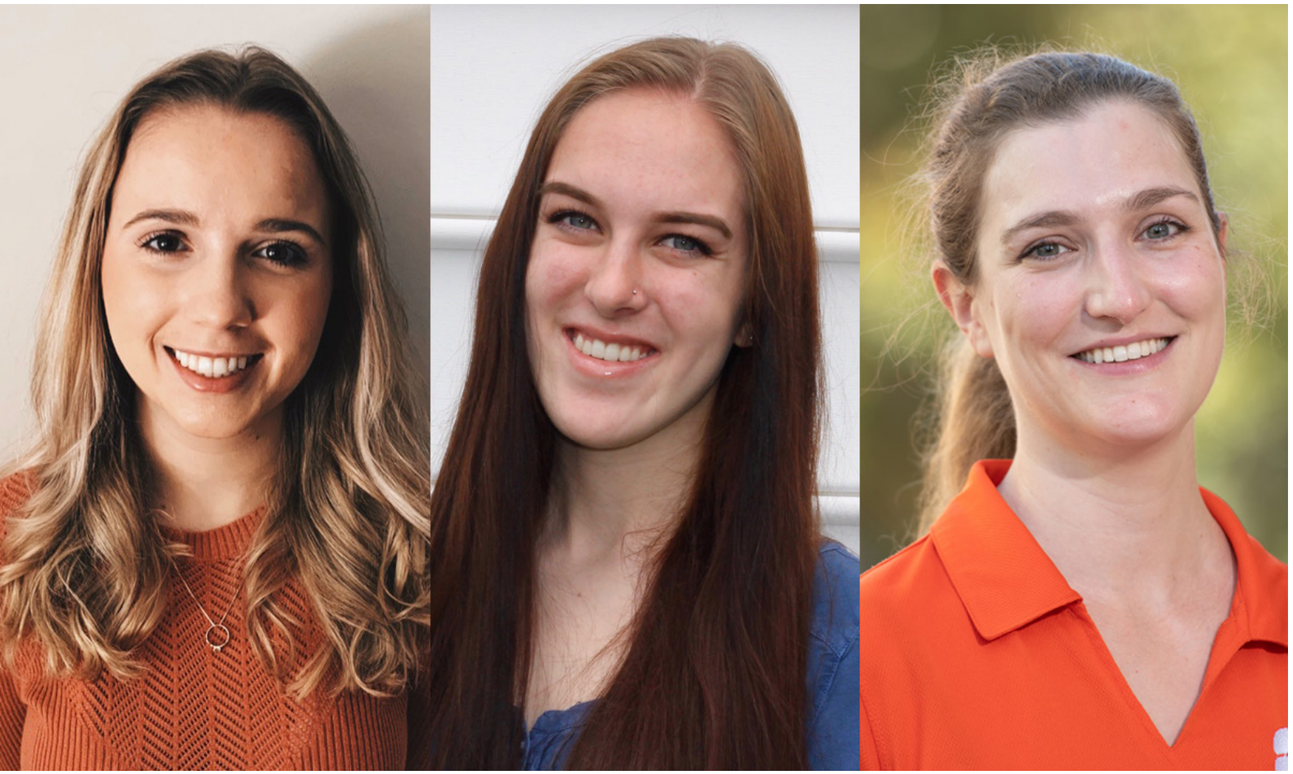
Creating medical devices during a pandemic presents some unique challenges, but the group working on the negative-pressure device is uniquely qualified to overcome them. Dean and DesJardins have led trips to Tanzania, where students assess healthcare needs in rural areas. When they return to Clemson, they create devices that take into account the special challenges that come with providing medical care to areas where materials can be hard to get. "The key is that we're not all that different," Dean said.

It took about a week to round up all the materials for the negative-pressure prototypes, a task that might have been handled in one trip to Walmart prior to the pandemic, she said. Students couldn't go to the store in person, because they were complying with social distancing guidelines. When they tried to order the parts online, some took a while to ship. Researchers also didn't have access to some of the more sophisticated facilities available on campus.

"You have to do a lot of the construction outside of sophisticated manufacturing or 3D printing spaces," DesJardins said. "You have to use what tools you have." It's a challenge that Falconer, a rising senior who is majoring in bioengineering, has tackled from his parents' home in Downers Grove, Illinois. "We've been able to communicate and work remotely and still develop our prototypes," he said. "We're creating something that will have a real impact in helping people in the U.S. and beyond."

Students think 'outside the box' to protect grocery shoppers from COVID-19

Paul Alongi, College of Engineering, Computing and Applied Sciences
May 11, 2020



Two Clemson University freshmen are thinking outside the box– and shining a light inside it– to combat COVID-19 at the grocery store. Carleigh Coffin and Ashlyn Soule said they are designing a device that would be located at supermarket checkout lanes. Groceries would be placed on the conveyor belt and then pass through an enclosed box where they would be exposed to UVC light. UVC is a type of ultraviolet light that destroys genetic material inside viruses and other microbes, according to The National Academies of Sciences, Engineering, and Medicine.

Running groceries through the device help could kill off the novel coronavirus, preventing its spread, during the pandemic, the students said. When it's over, the device could still be useful, helping kill viruses that cause the flu and preventing contamination from pathogens, such as salmonella, they said. "Everyone needs to shop, and a lot of essential workers work in those grocery stores," Soule said. "We thought that this would be really helpful to a wide variety of people."

The project is one of many examples of how students and faculty members are stepping up to meet COVID-19's unique challenges, even with campus closed and research groups working remotely to prevent the novel coronavirus from spreading. Coffin and Soule are designing a prototype under the direction of Delphine Dean, the Ron and Jane Lindsay Family Innovation Professor of bioengineering. Their work is part of Creative Inquiry, a program that encourages undergraduates to conduct research. "This is not something a professor would come up with," Dean said. "As much as they are making a box, they are thinking outside the box. That's what I enjoy about Creative Inquiry– you get freshmen and other undergraduates who are early in their careers and flexible in their thinking. They come up with some cool ideas."

For Coffin, the new realities of grocery shopping are thrown into sharp relief every time she goes to work. When she isn't studying or conducting research at Clemson, Coffin is a cashier for a major grocery store chain, giving her a unique, first-hand perspective on the UVC-light project. "I want to create a way to decontaminate groceries so that I'm not passing germs and so that I'm protecting myself," she said. Coffin and Soule said the box they are designing will stand about 1 ½-2 feet so that it can fit tall items, such as cereal boxes. The students think they can make each device for about $100 in parts. The UVC lamp is the most expensive piece at about $50 each.

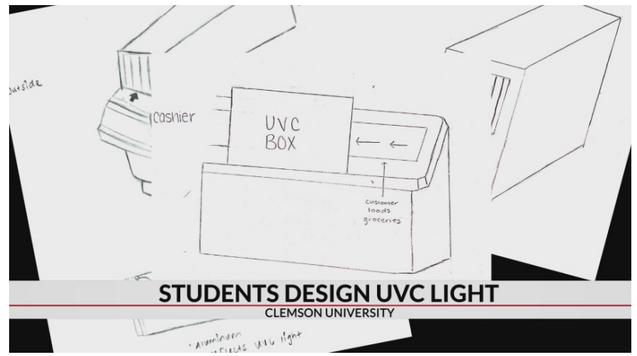
The National Academies has reported that UVC probably kills the novel coronavirus that causes COVID-19, while cautioning that more study is needed. UVC destroys related coronaviruses, including the one that causes the disease MERS, the National Academies reported. Coffin and Soule estimated that UVC kills about 99 percent of bacteria and viruses. "Our research showed that after 10 seconds UVC tends to kill bacteria and viruses that are about six inches away," Coffin said.

The box that Coffin and Soule are creating would be lined with aluminum to reflect light onto the groceries and to keep the light inside the box, protecting cashiers, customers and others in the area. UVC has the potential to damage human skin and should be used only on objects and surfaces, according to the National Academies. "We want to assure people that if this is in their grocery store, this is safe and they are going to be protected," Soule said. "The UVC light stays inside the box, similar to the X-ray machines at the airport."

Coffin, of Irmo, is a General Engineering student who plans to major in bioengineering. Soule, of Summerville, is a biochemistry major. Their device is one of the projects that helped inspire the Clemson COVID Challenge, organized by Dean. Teams of undergraduates from throughout the University are being challenged to work on problems related to the COVID-19 situation and potential future pandemics. (Learn how to join here.)

Martine LaBerge, chair of the Department of Bioengineering, said that COVID-19 research empowers students to come up with their own solutions to some of the new challenges that society and individuals face. "They have an opportunity to conduct highly relevant research while gaining valuable skills and experience," she said. "I am continuously inspired by the unique solutions that students are able to find, and their determination to continue their work in the face of the COVID-19 situation."

Everyone needs to shop, and a lot of essential workers work in those grocery stores. We thought that this would be really helpful to a wide variety of people.
Ashlyn Soule

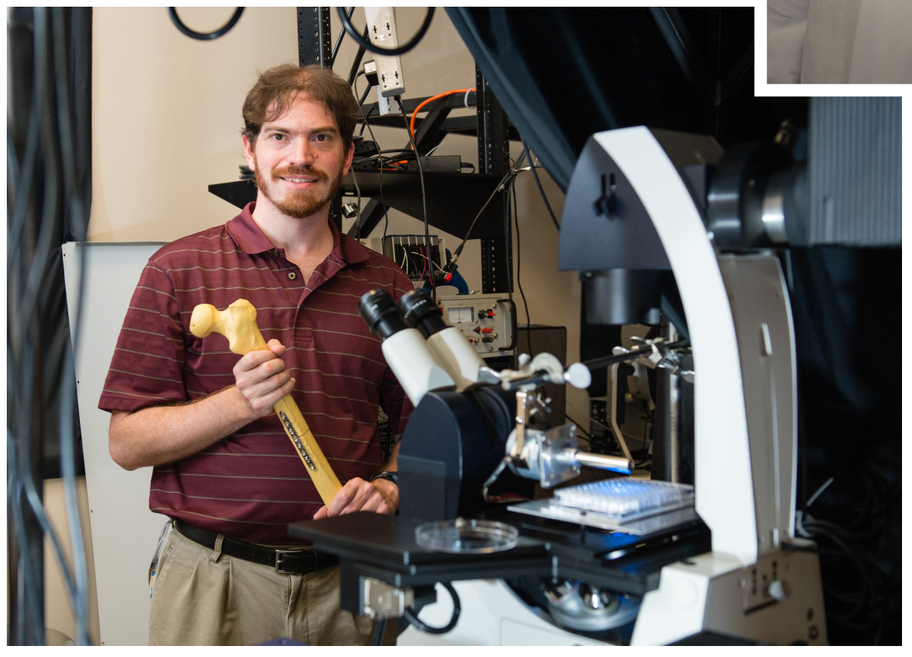


COVID-19 SECTION

Clemson University startup company earning rave reviews for improving implant sensors

Chris Worthy, Special to the College of Science
October 15, 2020

When innovation and expertise meet practicality, the result is not quite magic, but it sure is close. This is the strength behind Aravis BioTech, a startup headed in part by Jeffrey Anker of the College of Science and John DesJardins of the College of Engineering, Computing and Applied Sciences, as well as Dr. Caleb Behrend, an orthopedic surgeon in Arizona specializing in the spine. The team is developing screws used in orthopedic surgery that employ easy-to-use sensors to determine the status of fracture healing. This, in turn, helps physicians know when patients can safely apply weight to their healing fracture.



Aravis BioTech is one of three finalists for the InnoVision Technology Development Award. InnoVision is a non-profit organization that fosters the growth of South Carolina's innovation economy and recognizes leadership, innovation and technological excellence. "My background is in analytical chemistry – which means I make sensors," said Anker, a professor in the Department of Chemistry.

Anker and DesJardins, a professor in the Department of Bioengineering, met on a bus at a student NASA project at the Marshall Space Flight Center in 2010. The pair decided to bring their work together to develop a medical implant that would change color as a fracture healed. Through a grant from SC BioCRAFT (Bioengineering Center for Regeneration and Formation of Tissues) and an NIH grant, they developed screws that changed color based on how tight they were.

But Dr. Behrend, a spine surgeon and longtime friend and collaborator of Anker's, said that such a sensor would be more practical if surgeons could see it on an X-ray. "Most Americans will break a couple of bones, on average, in their lifetime," Anker said. "If it's a bad break and you can't just put a cast on it, they need to put in hardware. That's where those screws come in."

An X-ray doesn't show how well a bone is healing. Between the break and full healing, there is an intermediate phase where the repaired fracture can and should bear weight – the question is how much. "Maybe it can take your weight for a bit, but it will eventually fatigue and fail," Anker said. "Similar to a paper clip, I can bend it a lot, but if I go back and forth, back and forth, eventually it will fail. The same thing happens with these implants. That's a huge problem."

Consider a hip fracture. Anker said one in 10 Americans will break hips. Rather than replacing the hip, the most common repair is to secure the ball back to the femur with a simple screw. "People are encouraged to bear weight immediately, but if it's not healing, the screw will probably eventually cut out of the bone or there will be other mechanical failures," Anker said. "That happens rarely, but when it happens, it's devastating."

The screw is positioned into the bone repair with a wire guided through its hollow core. Aravis BioTech's implanted device enhances the screw. "We add a straight piece to the bottom of the hollow screw so that when it bends, this straight piece moves relative to the screw casing," Anker said. "We make that straight piece out of a material that is dark on X-rays. You can see how much the screw is bending, quantify how much load is on it and be able to track the patient's progress."

The implant can help surgeons determine whether the device has been tightened sufficiently during surgery. And because load can lead to postoperative failure, it can help determine whether the patient is at an optimum activity level or if activity needs to be reduced until further healing takes place. Once the bone has healed, the hardware typically stays in and becomes superfluous.

A technology translation grant from the National Science Foundation's Innovation Corps (ICORPS) program to Clemson University allowed the Aravis team to interview a variety of stakeholders, including physicians, patients, physical therapists, insurance executives and hospital administrators to determine if the team is making a device that best meets the needs of patients. A South Carolina Research Authority (SCRA) Acceleration Grant helped fund prototypes. The team is expanding the idea to plates and other devices, as well as to sensors that can track infection based on chemical changes.

COVID-19 SECTION

Researchers respond to urgent call for COVID-19 testing

Paul Alongi, College of Engineering, Computing and Applied Sciences
April 21, 2020

Clemson University researchers are volunteering their time and resources as part of a statewide effort to develop serologic tests that could play a key role in reigniting South Carolina's economy and protecting healthcare professionals on the frontlines of the COVID-19 pandemic. A test on track to be ready this week would be aimed at detecting antibodies that form in the bloodstream when someone has been exposed to the novel coronavirus and is therefore thought to have a lowered chance of re-infection. Commercial labs are also developing the tests, but some South Carolinians are concerned that the tests will be in short supply and that the lion's share will go to larger states with more purchasing power and more cases of COVID-19.

Clemson researchers are developing the South Carolina tests with colleagues from the University of South Carolina, Prisma Health and the Medical University of South Carolina. Delphine Dean is overseeing the Clemson portion of the work as the Clemson lead for the state's Serological Testing and Diagnostic Working Group. "We're all working on it together," said Dean, who is the Ron and Jane Lindsay Family Innovation Professor of bioengineering. "Many of the barriers between institutions that sometimes slow down collaboration have been removed. Everyone has been working around the clock to make these things go much faster than typically happens."

Before any test is deployed, it would need to be validated for effectiveness to meet Food and Drug Administration regulations. The test that will be available this week is aimed at checking healthcare professionals for antibodies. The idea is that those who test positive for the antibodies could be cleared to re-enter public life, allowing them to work with minimal concern they could come down with COVID-19 or infect others. About 500-1,000 tests could be ready as early as this week, less than a month since the project started, researchers said. The two Clemson researchers working on the test are Mark Blenner, the McQueen Quattlebaum Associate Professor of chemical and biomolecular engineering, and Sarah Harcum, professor of bioengineering. Blood samples would need to be tested in a lab, which limits how many can be done.

In a parallel effort, Clemson researchers are working to create tests that could take saliva, urine or blood and show results with a color change in as little as 15 minutes, similar to a home pregnancy test. Researchers involved in developing those tests are: Blenner, Terri Bruce, research assistant professor of bioengineering and director of the Clemson Light Imaging Facility; Dean; Harcum; and R. Kenneth Marcus, University Professor of chemistry. The tests would be an improvement on current methods. Antibody tests that check for immunity require a blood draw and are inaccurate and scarce, Blenner said. Testing directly for the virus itself requires an uncomfortable nasal swab and puts healthcare workers at a heightened risk of catching the virus, he said.

Martine LaBerge, the chair of Clemson's bioengineering department, said all the researchers are volunteering their time, efforts and resources to help the state, as it faces the unprecedented challenges posed by the COVID-19 pandemic. "They are working tirelessly to protect the health and safety of South Carolina's healthcare professionals and the general public," said LaBerge, who is playing a central role in coordinating Clemson's research response to the pandemic. "Institutional barriers are coming down so that we can work together as one South Carolina. I offer all those sacrificing sleep and time with family my deepest gratitude."

The process to develop the tests starts with Blenner, who is making spike proteins, which give the novel coronavirus its distinguishing feature and is believed to be how the viral infection is mediated. In his lab, Blenner puts the DNA for the spike proteins inside of human or hamster cells. When the cells grow, they produce the spike proteins, which will ultimately serve as the key reagent in the antibody tests. "Our group is going to make a stable cell line that we can scale up," Blenner said. "Right now the procedure is not meant to make a lot of protein. It's meant for quick protein production. I'm going to make a productive cell line and work with Sarah Harcum to get that in larger bioreactors."

Harcum said she will put the cells in computer-controlled bioreactors that can sense oxygen and pH levels. Pumps carefully control the nutrients that feed the cells. "I grow cells to make them happier so they make more protein," Harcum said. "Normally, I look at how to make pharmaceuticals, but the pharmaceuticals I make are proteins, which makes this COVID-19 work a good fit for what I do." Once she has the protein grown, Harcum will then purify it so that it can be used in the diagnostic tests.

Meanwhile, Bruce, Marcus and Dean are starting to lay the groundwork for simple tests that could reach large numbers of people. "What we really need is something simple that's a colorimetric test that can be done in under 15 minutes at the point of care," Bruce said. The team is working to improve upon a commercially-developed enzyme-linked immunoabsorbent assay, or ELISA, that checks blood samples for antibodies.

Antibodies are plentiful in blood but less so in saliva. One of the challenges in developing a saliva-based test is isolating the antibodies. To do so, Marcus and Bruce are turning to capillary-channeled polymer fiber-based films, a technology they have been researching for years. "Antibodies exist in this tremendously complex soup, and what you would like to be able to do is pull them out of the soup selectively in a fairly high-throughput fashion," Marcus said. "We can modify our fibers so that the only things that stick are the antibodies." Clemson researchers are working to make a prototype, but a manufacturer would be needed to produce large quantities of the test, Bruce said.

Dean, who is helping develop the optical portion of the test, said it could also be possible to use the fibers to capture the virus itself from urine. There is evidence that the virus comes out in urine after it is no longer detectable in blood, she said. "Patients could maybe test themselves at home," Dean said. "The same principle could be used to test waste streams. If you wanted to do population monitoring, you might be able to get a sense for what percent of the population has the virus."

Researchers said they are finding ways to pay for the development of the tests with existing funds but that eventually they will need financial support, particularly when the semester ends next month. "We are going to need lab supplies and graduate student salaries, and we could accelerate development by outsourcing some of the work," Dean said. "Typically, when we launch big projects, we apply for federal funding, a process that normally takes months, if not a year or more. But time is of the essence, and we are finding ways to quickly ramp up work. What we need most now is the funds to help keep the work going."

Finding a solution to the N95 mask shortage

Paul Alongi, College of Engineering, Computing and Applied Sciences
April 20, 2020

Melinda Harman is volunteering her time to explore how hospitals could wash and sanitize medical masks without having to ship them elsewhere or buy an expensive piece of equipment. A device that Harman designed to hold multiple N95 masks is central to her idea. It would help ensure the masks maintain their shape while being washed so that they continue to fit securely around the mouth and nose, said Harman, associate professor and director of Clemson University's Medical Device Recycling and Reprocessing program, or GreenMD.

The masks help prevent healthcare workers from inhaling the novel coronavirus that causes COVID-19 and have been in short supply since the pandemic began. As part of her work, Harman said she has engaged three leading healthcare companies that offer expertise in detergents and decontamination. She is testing different kinds of detergents to find the best solution for cleaning mucus and proteins from the masks. The detergents are commercially available and already used by hospitals to clean other types of medical equipment.

Harman said that her goal is "to validate a cleaning process that is compatible with existing capabilities and equipment commonly available at hospitals in South Carolina and worldwide." The challenge is "to avoid interfering with mask performance, while effectively cleaning the masks without degrading their filtering capacity," she said. Harman added, "Working with innovative industry partners is a considerable advantage, with everyone on the team willing to contribute a potential solution. They are providing reliable products that are already proven to meet routine reprocessing challenges in healthcare delivery."

Harman said one of the advantages to her approach is that many hospitals already have the ability to clean medical equipment, even if they aren't yet applying it to the masks. That means hospitals wouldn't need to buy any capital equipment, she said. Further, the masks would stay at the hospital, reducing travel time, the risk of spreading contamination outside of the hospital and the additional burden on an already-stressed logistics system, Harman said.

"The technology I'm working on is meant to be used broadly, compatible with existing reprocessing practices that are already in hospitals," Harman said. "It's intended for rapid deployment in health care settings, and it's meant to be compatible with any sterilization system." Harman added, "Cleaning masks before sterilization enables more masks to be reused Right now, guidelines for sterilization require N95 masks to be inspected and discarded if they are 'soiled.' My idea is to reliably clean masks to remove both the visible and 'invisible' soils, making the entire reuse process safer."

Martine LaBerge, chair of the Department of Bioengineering, said that Harman is well qualified to lead the work. "Dr. Harman has built a career on developing innovative ways to reprocess and reuse medical equipment that is normally disposable, which uniquely positions her to have a global impact," LaBerge said. "I thank her for her service to South Carolina, the nation and the globe as we join together in the face of the unprecedented challenges posed by COVID-19."

Harman has conducted extensive research into reuse and reprocessing of medical equipment. As director of GreenMD, she engages students in industry-driven research targeting healthcare needs in South Carolina and broader global health challenges. GreenMD is the nation's only engineering-focused program for medical device design targeted for reprocessing and reuse.

Harman said that if her idea works, used masks would be sent to central sterilization facilities within hospitals. The device she designed would hold the masks while they are cleaned. After cleaning, the masks would go through a separate sterilization process to get rid of any lingering microorganisms, including coronavirus.

The mask-holder that Harman designed could be 3D-printed, she said. However, she is focusing on more rapid manufacturing approaches using common acrylic materials. The technology could be readily adapted in hospitals from South Carolina to India, Harman said. She recently disclosed the technology to the Clemson University Research Foundation, setting it on the path to commercialization and raising the potential for widespread use.

Harman said what's been most interesting to her is that her previous work with resource-poor countries has come home to the United States, with disrupted supply chains and inadequate supplies at the point of need. "That's exactly the situation we've been working on with other countries," Harman said. "For me that's just been a startling change. It's been amazing to see how many people have become interested in the topic of safe and sustainable reuse and how many unique solutions they come up with. I hope that creative energy continues, because it can solve a lot of global health problems."

It's been amazing to see how many people have become interested in the topic of safe and sustainable reuse and how many unique solutions they come up with.
Melinda Harman

Precision Genetics

Emily Sawvell and Noah P. Wright, co-op students

Precision Genetics is a start-up healthcare technology company and genomic testing laboratory that has expanded to Clemson University's Bioengineering Innovation Center (CUBEInC) in Greenville, S.C. Precision Genetics offers healthcare organizations, employer groups, and other laboratories the resources necessary to implement solutions for both patient and employee health.

Precision Genetics uses advanced scientific technologies to allow development of individualized treatment and prevention plans. With a single noninvasive cheek swab, a patient's genetic risk factors can be identified. Thus, a personalized treatment plan can be developed to ensure that proper medications and regimens are being used for individual patient therapies. For example, Precision's Perioperative Medication Risk Solution (PPMRS) is designed to evaluate a number of known genetic pathways that are related to surgical medications, their appropriateness based on patient risk and genetics, and any mutations that can cause complications both during and after surgery.

The Journey

Precision Genetics started in 2014 when CEO Nate Wilbourne purchased the start-up Pinpoint Genetics. The main facility has since been located at 1 Marcus Drive, Greenville, S.C. When the COVID-19 outbreak began in the spring of 2020, the company expanded its facilities to allow testing of the SARS-CoV-2 virus. At that time, the company moved into a lab space at CUBEInC, which has been beneficial on many levels.

The People Behind Precision Genetics

Nate Wilbourne, founder and CEO of Precision Genetics, was employed in business operations at large healthcare companies over the last 20 years. His experiences in the healthcare industry created relationships with major health institutions and provided the opportunity to develop companies like Precision Genetics.

John Wrangle, M.D., chief medical officer, is a thoracic medical oncologist with day-to-day experience in pharmacogenomics. In addition to his practice, Wrangle has spent the past two decades in research in lung cancer and novel immunotherapies for treating solid tumor malignancies. Jeremy Stuart, a Ph.D. in Genetics and Complex Diseases, chief science officer, specializes in developing genomic sequencing technology, including being a co-developer of SOLiD next-generation sequencing. Stuart's experience includes validating laboratory--developed tests and managing start-up genomics companies.

Steve Enkemann, a Ph.D. in molecular virology, is director of lab operations. His early research involved organizing the human genome and regulating gene expression; he holds patents on transcriptome analysis of cancer and numerous techniques for classification of tumors. He previously directed the development of new genome-based assays and was the director of the Molecular Genomics Laboratory at the H. Lee Moffitt Cancer Center in Tampa, Florida. Jay Spencer, chief strategy officer and SVP of finance, received a Master of Health Care Management and a Master of Business Administration at the University of Michigan prior to 16 years of experience in healthcare management and business development. His background includes years of work on the corporate and financial side of the healthcare business, where he has proven ability to accelerate company growth.

Precision Genetics Upholds the Vision of CUBEInC

Precision Genetics fulfils CUBEInC's mission and goals by participating in a collaborative environment for clinically driven medical technologies and increasing and innovating biomedical technology and research in South Carolina. Like other laboratories at CUBEInC, Precision Genetics provides services to outside groups. In addition, the company seeks to further the number of affordable options for genetic testing and to provide services directly to patients and clinicians. At CUBEInC, researchers can work directly with both patients and clinicians.

COVID-19 Response

Since the pandemic's beginning in the United States, Precision Genetics has worked with healthcare organizations, employers, and academic institutions to help create a safe environment, both locally and nationwide.

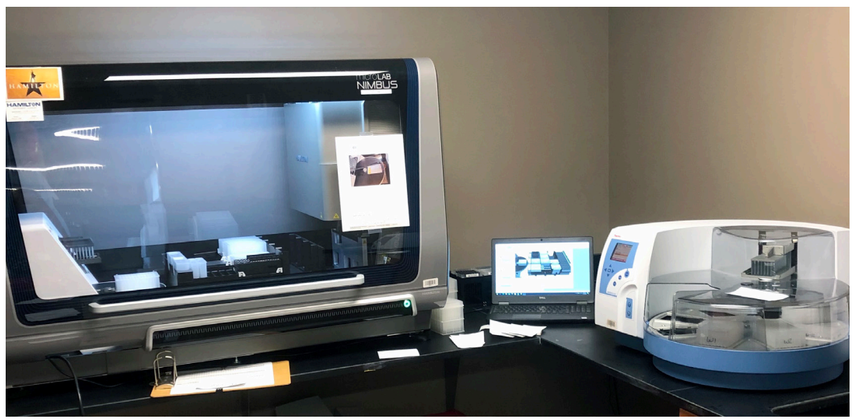
On April 3, 2020, Precision Genetics was given Emergency Use Authorization (EUA) by the FDA to process real-time RT-polymerase chain reaction (RT-PCR) kits to test for the SARS-CoV-2 virus. With the ability to process more than 1,000 COVID-19 tests per day at a turnaround time of less than 24 hours, Precision Genetics COVID-19 services have been critically important. As of October 21, 2020, Precision Genetics was approved to add saliva collection to its validated COVID-19 testing options under EUA. Precision Genetics' most recent COVID-19 innovation is a new test that can detect the presence of both COVID-19 and Influenza A and B from just one sample, which will make it easier for healthcare providers to differentiate between these two viruses.

It is nice being a part of the Prisma clinical campus; we feel it gives clinicians confidence in our work since the lab is located in the hospital.
Jeremy Stuart, CSO, Precision Genetics

At CUBEInC, Precision Genetics has 4 laminar flow hoods that are used for transferring samples from their collection tubes into 96-well plates. After being transferred into 96-well plates, the samples undergo a purification process to isolate RNA from other substances in the sample. This extracted RNA is a mix of an individual's own genetic material and, if present, the virus's RNA. The RNA samples are then converted into DNA and amplified using real time RT-PCR. The team at Precision Genetics evaluates the RT-PCR results, and based on certain criteria, can determine if the sample is positive or negative for COVID-19 and/or Influenza A and B.

The Precision Genetics team at CUBEInC

Saliva collection not only reduces exposure to the healthcare professionals that will supervise the collection process, but as importantly, offers a less invasive and comfortable alternative for groups that might require this option.
Nate Wilbourne, CEO, Precision Genetics



COVID-19 SECTION

BIOE-Related Startups Address COVID-19

Elastrin Therapeutics, Inc.

Naren Vyavahare, Hunter Endowed Chair and Professor and Director of the NIH Center of Biomedical Research Excellence SC Biocraft, cofounded Elastrin Therapeutics. He noted, “Our biotech startup develops technologies to restore hardened and damaged arteries and tissue by targeting the elastic fiber that makes them work. Now, Elastrin Therapeutics has verified a previously untested approach to preventing the most severe outcomes of lung diseases, including COVID-19. The approach is based on targeting damaged elastic fibers that lead to impairment of lung function. Previously, our company developed the world’s first humanized antibody that specifically targets only exposed elastin fiber; we are currently pursuing investment to advance further development of a therapy.”

Kiyatec

Alumnus Matthew R. Gevaert, Ph.D., is CEO and co-founder of Kiyatec. He stated, “Although KIYATEC traditionally serves the oncology community exclusively, we quickly determined that our existing technical infrastructure and capabilities in RNA extraction were ideally aligned to address this critical pressure point in the COVID-19 test process. Following discussions with public health thought leaders and COVID-19 testing laboratories, we realized that offering RNA extraction services could provide immediate help to these laboratories in overcoming possible supply chain challenges and optimizing their volume and turnaround time potential. At a time when COVID-19 testing volume and turnaround times are surging, Kiyatec’s 24-hour turnaround time per RNA extraction could provide a cost-effective efficiency boost to laboratories performing these tests. Making RNA extraction services available to COVID-19 testing laboratories is consistent with KIYATEC’s core goals of improving patient care and outcomes.”

Delphine Dean named recipient of Class of ’39 Award for Excellence

December 2, 2020

Clemson University faculty have named Delphine Dean one of the very best among them by awarding her the Class of ’39 Award for Excellence. The award, endowed by the Class of 1939 to commemorate its 50th anniversary in 1989, is presented annually to one distinguished faculty member whose outstanding contributions for a five-year period have been judged by peers to represent the highest achievement of service to the student body, university and community, state or nation.

Dean is currently the Ron and Jane Lindsay Family Innovation Professor of Bioengineering at Clemson University. During the COVID-19 pandemic, Dean set up Clemson’s first high complexity clinical diagnostics (CLIA) lab on campus to run all of the University’s COVID-19 screening tests. The lab runs over 3,000 tests a day, which includes all of Clemson’s COVID-19 surveillance testing as well as testing for the community.

Her nomination letter, which was penned by Terri Bruce, academic program director of the Clemson Light Imaging Facility, and Windsor Westbrook Sherrill, associate vice president for health research, states: “[Dean] has been a critical faculty leader in Clemson’s response to the COVID pandemic, informing Clemson’s reopening plans. She has been at the forefront of the science related to testing, and this talent and scholarship has been critical to Clemson. Dr. Dean has led a team of faculty who have accomplished the near impossible at Clemson. They opened a lab at Clemson in a few short months to enable saliva testing for our employees and students, something that continues to be very rare in the nation. Dr. Dean is at the forefront on international scientific trends in COVID saliva testing, a skill which has benefitted Clemson University students, faculty and the community.”

Bruce and Sherrill go on to describe how Dean has spent her career working on education, research and national service that maintains the highest ideals of service before self.

Dean earned her Ph.D. in Electrical Engineering and Computer Science from the Massachusetts Institute of Technology (MIT). Her lab leads a wide range of studies focused on understanding mechanics and interactions of biological systems. Her expertise is in nano- to micro-scale characterization of biological tissues including experimental techniques such as atomic force microscopy and mathematical modeling such as finite element analysis. In addition to the basic science work in the lab, Dean works on several applied translational design projects primarily aimed at enabling healthcare in low-resource areas in the U.S., Tanzania and India.

Dean is the recipient of the 2011 Phil and Mary Bradley Award for Mentoring in Creative Inquiry for her work in mentoring undergraduates at Clemson, where she currently mentors over 50 undergraduate students in creative inquiry research and design teams. These student teams work on a variety of projects, from understanding the effect of ionizing radiation on tissue to developing medical technology for the developing world.

“I am honored to be a part of the Class of ’39,” said Dean. “It’s amazing to be a part of such an illustrious group! The fact that service to the university and beyond is encouraged and celebrated at Clemson is part of the reason I’m always proud to say that I’m part of the Clemson family.”

Bruce and Sherrill concluded Dean’s nomination letter by summing up her life and career at Clemson:

“Dr. Dean’s passion and compassion have and will continue to benefit students, staff and faculty at Clemson University, and she is an incredible representative and ambassador for Clemson University. In so many ways, Dr. Dean’s research and scholarship exemplifies service to state and nation, and her work has impacted thousands. She represents the interest of faculty and students with focus, service and passion. We can think of no other faculty better representing the ideals of the Great Class of 1939.”

The award recipient also becomes an honorary member of the Class of 1939 and receives a monetary award equal to the value of $5,000 in 1989 dollars.

Team receives $6 million for research that could lower drug prices

Paul Alongi, College of Engineering, Computing and Applied Sciences
August 2, 2017

Sarah W. Harcum of Clemson University is leading a team that has received $6 million for research that could help lower the cost of several drugs that run into the thousands of dollars per treatment and fight some of the world's most debilitating ailments. The team brings together researchers from three states to seek better ways of engineering Chinese hamster ovary cells, which are used to manufacture more than half of biopharmaceuticals. The potential impact is immense. Products from these cells represent more than $70 billion in sales each year and include drugs for Crohn's disease, severe anemia, breast cancer and multiple sclerosis.

The focus for Harcum and her team will be on the Chinese hamster ovary "cell line." A cell line is developed from a single cell culture and starts with uniform genetic composition that would ideally remain unchanged. But that genetic composition drifts as the cells reproduce, and they become less effective at creating the drug they have been engineered to create.

As a result, manufacturing becomes more expensive, said Harcum, a professor of bioengineering. "We expect by the end of the study we will have identified some genes that cause the instability," she said. "What would be even better is if we can prove by modifying those genes we can make a genome that is more stable. With success, the Chinese hamster ovary cell line will stay more stable during the manufacturing. We hope to get that drift to be reduced; that's the ultimate goal."

The four-year grant was among eight awards totaling $41.7 million announced Wednesday by the National Science Foundation's Established Program to Stimulate Competitive Research, or EPSCoR. The Harcum-led research strikes at the heart of one of the toughest challenges in manufacturing biopharmaceuticals.

Biopharmaceuticals are different from more conventional drugs, such as ibuprofen and acetaminophen, which are based on what researchers call "small molecules" and are relatively easy to manufacture. Biopharmaceuticals, however, are 1,000 times larger than the small molecules and have structures that are more complicated. While biopharmaceuticals can treat disease that small-molecule drugs cannot, manufacturing these large-molecule drugs are more difficult. They require more monitoring, control and analysis throughout the manufacturing process.

Harcum and her team are aiming to improve the process not for a single drug, but for a wide range of biopharmaceuticals. The project is expected to increase patient access to expensive medicines, while helping educate the professionals headed for the advanced biomanufacturing workforce.

As part of the project, researchers are planning to promote diversity on the research team by including several undergraduate and graduate students who are from groups underrepresented in engineering. Also, three tenure-track faculty members from underrepresented groups will be mentored by more senior researchers.

Harcum is the principal investigator on the grant, and she is collaborating with researchers from the University of Delaware, Tulane University and Delaware State University. They are calling the project "Advanced Biomanufacturing: Catalyzing Improved Host Development and High Quality Medicines through Genome to Phenome Predictions." Co-principal investigators are Kelvin H. Lee, the Gore Professor of Chemical Engineering at the University of Delaware, and Anne S. Robinson, chair of the chemical and biomolecular engineering department at Tulane University.

Robert Jones, executive vice president for academic affairs and provost at Clemson, said the project underscores the value of collaboration. "The grant is helping build a sustainable research infrastructure in three EPSCoR-eligible states, enabling each of the four institutions involved to build on each other's strengths," he said. "Further, the grant helps prepare a diverse talent pool for

NSF EPSCoR

The mission of National Science Foundation (NSF) Experimental Program to Stimulate Competitive Research (NSF EPSCoR) is to advance excellence in science and engineering research and education in order to achieve sustainable increases in research, education, and training capacity and competitiveness that will enable EPSCoR jurisdictions to have increased engagement in areas supported by the NSF. The National Science Foundation supports EPSCoR projects within South Carolina through the Research Infrastructure Improvement Grant program and Co-Funding.

About South Carolina EPSCoR/IDeA

South Carolina EPSCoR/IDeA leverages federal resources with support from the state General Assembly to build research infrastructure; infuse research into education; provide opportunities for diverse groups of institutions, students, faculty and disciplines in science and technology; and increase collaboration among key stakeholders of the state's science and technology enterprise. Since 1990, S.C. EPSCoR/IDeA funds have enabled the hire of 95 junior tenure-track faculty members in science and technology at five South Carolina colleges and universities.

South Carolina EPSCoR/IDeA has supported research in such disciplines as biomedical engineering; neuroscience; alternative energy; nanomaterials; structural, chemical, and cellular biology; and environmental science, bringing more than $185 million in federal research funding to the state.

the biomanufacturing industry. We are well positioned for lasting impact."

Each project in the latest round of EPSCoR awards is focused on understanding the genome-to-phenome relationship. The projects are under EPSCoR's Track-2, which promotes collaboration across jurisdictions.

Chinese hamster ovary, or CHO, cells are used to manufacture biopharmaceuticals because these cells are highly adaptable to growth in different environments, bear no human viruses and are capable of high-level production, Harcum said. "However, the ability to continually adapt is also a negative attribute because clones may lose the desirable cellular and product phenotype even during during short-term culture," she said. "This is known as cell line instability and is rooted in a relatively unstable genome. Here, we will develop approaches to relate CHO cell genome stability to the phenome and apply this knowledge to improve control over instability of the CHO genome."

By seeking to engineering better medicines, Dr. Harcum and her team are focused on one of the 21st century's grand challenges. They are also using this project to enhance diversity in the talent pipeline. The size of the award attests to its crucial importance. *Anand Gramopadhye, dean of the College of Engineering, Computing and Applied Sciences*

Martine LaBerge, chair of the bioengineering department at Clemson, said Harcum's extensive work with CHO cells uniquely qualifies her to lead the project. "Dr. Harcum has 20 years' experience working with CHO cells and has used genomic approaches to study CHO cells for quite some time," LaBerge said. "She is very well aware of the industrial issues that affect CHO cells."

Anand Gramopadhye, dean of the College of Engineering, Computing and Applied Sciences, said the project addresses some of the nation's most critical needs, while building research infrastructure in three states, with Clemson taking the lead for South Carolina. "By seeking to engineering better medicines, Dr. Harcum and her team are focused on one of the 21st century's grand challenges," he said. "They are also using this project to enhance diversity in the talent pipeline. The size of the award attests to its crucial importance."

Lee said the grant will help accelerate biopharmaceutical manufacturing in the United States.

"This project will help us address the challenges we face in making these medicines more widely available, which could prove transformational for thousands of patients," he said. "This is a natural extension of the work we are doing as part of NIIMBL."

Watch the video "Clemson-led team receives $6 million from the National Science Foundation" on YouTube

Lee leads NIIMBL, which is short for the National Institute for Innovation in Manufacturing Biopharmaceuticals. The institute was established in March with a $70-million grant from the National Institute of Standards and Technology in the U.S. Department of Commerce and with support from more than 150 collaborators, including Clemson, Tulane and Delaware State.

Robinson said the EPSCoR project will help create a more diverse workforce in biopharmaceutical manufacturing. "This team has deep experience in supporting underrepresented groups and is well-suited to mentor diverse junior faculty members and students," she said. "The grant will help support programs that deepen our commitment to creating a more diverse workforce."

Douglas Hirt, associate dean for research and graduate studies in the College of Engineering, Computing and Applied Sciences, said the project helps lay the foundation for a sustainable research enterprise.
"This project strengthens existing collaborations among academics and provides mentoring and development for students and tenure-track faculty at four institutions in South Carolina, Delaware and Louisiana," he said. "The work that Dr. Harcum and her team have initiated has set the stage for success and is to be commended."

Tanju Karanfil, the vice president for research at Clemson, said the grant helps build Clemson's reputation as a world-class research university. "This EPSCoR grant underscores that the University's researchers continue their pursuit of bold ideas and innovative answers, while affirming Clemson's role as a leader in health innovation," he said. "I congratulate Dr. Harcum and her team on a job well done."

SC INBRE Receives $18.9 million award from the National Institutes of Health

SC INBRE
September 7, 2020

Columbia, SC — The National Institutes of Health (NIH) through the National Institute of General Medical Sciences (NIGMS) has awarded $18.9 million for the renewal of the South Carolina IDeA Networks of Biomedical Research Excellence (SC INBRE) to support biomedical research and infrastructure in South Carolina. The grant will fund the program for five years beginning September 1, 2020 and is the fourth consecutive renewal of SC INBRE.

With this renewal, the SC INBRE Program grows to a statewide network of 14 member institutions, two outreach institutions and two alumni institutions. Member and outreach/alumni institutions incorporate South Carolina's three Comprehensive Research Universities (CRUs) and 15 of the state's Primarily Undergraduate Institutions (PUIs), including three Historically Black Colleges and Universities (HBCUs).

Other SC INBRE member institutions include CRUs: **Clemson University** and Medical University of South Carolina, as well as PUIs: **Benedict College** (new in this INBRE renewal, HBCU), **Coastal Carolina University**, **College of Charleston**, **Columbia College** (new in this INBRE renewal), **Converse College**, **Francis Marion University**, **Furman University**, **Presbyterian College**, **University of South Carolina Aiken**, **University of South Carolina Upstate** (new in this INBRE renewal), and **Winthrop University**. Graduating as members from SC INBRE, but remaining a part of the network as alumni institutions, are **Claflin University** (HBCU) and **South Carolina State University** (HBCU). The two Outreach Institutions in the network are **Anderson University** and **The Citadel** (new to this INBRE renewal).

"We are excited to continue the mission of enhancing biomedical research throughout South Carolina," said Dr. Edie Goldsmith, UofSC SOMC professor of Cell Biology & Anatomy and SC INBRE Program Director. "This renewal will allow us to continue to train students, support faculty research and provide additional support for infrastructure and education/pipeline development. This is the largest our network has been in our almost 20 year history. We are

ABOUT SC INBRE

Cyndy Buckhaults
SC INBRE

The National Institutes of Health established the IDeA Networks of Biomedical Research Excellence (INBRE) to increase research capacity by programmatic expansion and networking of research activities of faculty and students at academic institutions in targeted states.

SC INBRE is achieving that goal by supporting career development of faculty and hands-on research training of students at network institutions through annual faculty and student workshops focusing on career development, mentoring and other relevant topics and funding opportunities available to any faculty or student at a network institutions. SC INBRE is administered at the University of South Carolina School of Medicine Columbia.

SC INBRE Cycle IV began September 1, 2020; it includes a statewide network of 14 member institutions, two outreach institutions and two alumni institutions. Member and outreach/alumni institutions incorporate South Carolina's three Comprehensive Research Universities and 15 of the state's Primarily Undergraduate Institutions, including three Historically Black Colleges and Universities.

proud of our previous accomplishments and are looking forward to having an even greater impact on the state's biomedical and biosciences community."

"SC INBRE had a huge impact on biomedical research in South Carolina during INBRE Cycle III (2015-2020). At the time we submitted our renewal in Spring of 2019, our data from the first four years of INBRE III showed that from 2015-2019, 415 students were trained in biomedical research labs in the SC INBRE network," continued Goldsmith. "For the students who completed their undergraduate education in INBRE Cycle III, 44% enrolled in graduate school, 17% went to medical/health professional school, and 39% obtained a job in industry. SC INBRE faculty and students produced over 100 publications and gave over 600 presentations. Their work led to over $9 million dollars in extramural funding from a variety of federal and non-federal sources. Fostering inter-institutional collaborations and promoting a research culture at PUIs, SC INBRE contributed to a collaborative NIH U54 award which brought in $12.5 million in research dollars to South Carolina."

With this renewal, SC INBRE will expand training capacity at five PUIs through renovation of existing space/facilities. Career and professional development activities will be provided to SC INBRE faculty and students, as well as opportunities to network and develop collaborations with SC INBRE colleagues.

Outreach programs developed at selected SC INBRE institutions will continue to engage high school teachers and students, strengthening the pipeline of future college students interested in biomedical research careers and actively encouraging participation by underrepresented minority students and those from underserved areas in South Carolina. SC INBRE's teacher outreach initiative, the Research Experiences for Teachers (RET) Program, is coordinated by Dr. John Kaup from Furman University. The RET program enables teachers to engage in a six-week in-depth research experience at an SC INBRE institution in their local area, exposing teachers to modern research methods and allowing them to link their research activities to classroom activities designed to increase student knowledge and awareness of science.

Bringing together colleges and universities from across South Carolina, over the next five years SC INBRE will continue to advance biomedical research by addressing the need for increased understanding of, and treatment options for, many human diseases while training the next generation of biomedical scientists. SC INBRE will continue to create research training opportunities for undergraduate students at institutions across South Carolina and promote increased diversity in the biomedical workforce. Concluded Goldsmith, "With the changing demographics in our state and country, engaging a diverse undergraduate student population in biomedical research through the SC INBRE program will ensure a well-educated workforce of physicians, scientists, healthcare providers and other professionals prepared to address the current and future health care problems in America."

SC INBRE is supported by an Institutional Development Award (IDeA) from the National Institute of General Medical Sciences of the NIH, number P20GM103499-20.

The South Carolina IDeA Networks of Biomedical Research Excellence: Capping Phase III, Proposing Phase IV

Lucia Pirisi-Creek
University of South Carolina at Columbia

The SC INBRE is a network of three comprehensive research universities (CRU) and seven predominantly undergraduate institutions (PUI) that have been working together during the past funding periods in pursuit of their common goals: to build biomedical research infrastructure and strengthen undergraduate research training in South Carolina, and to promote access to health research careers for all students, particularly underrepresented minorities and economically disadvantaged groups.

The thematic areas of SC INBRE are currently Bioengineering/Regenerative Medicine (primarily at the CRUs) and Cell and Molecular Biology (mostly at the PUI). In addition, Neuroscience has emerged as an additional area of strength upon which to build in the next phase. We have also seen much growth in the utilization of Bioinformatics within the research thematic areas and in student training, thanks to the efforts of the Bioinformatics Core.

SC INBRE enjoyed tremendous success during the current funding period. Of the 387 students that received research training since 2009, 172 were males, 215 females, and over 33% were underrepresented minorities. Of the 196 students who are well into their postgraduate careers, 46% went to graduate school, 22% to medical/professional school, and 27% hold industry jobs. In the current funding period, SC INBRE faculty and students produced over 170 publications and over 300 presentations and generated additional grant support for a total of over $36 million from a variety of funding sources including the NIH and the NSF.

SC INBRE paved the way for and supported the preparation of applications for large institutional (HHMI) and Center grants (COBRE) that (all together) brought over $13 Million in research funds to the state. PUIs that have been long-time members of SC INBRE serve as role models to new institutions in the network.

In the new funding period, we propose to extend the reach of SC INBRE's support to faculty and students across the state by including new PUIs in the network and by further increasing network activities and connections across institutions. To this end, we will implement the Developmental Research Project (DRP) complemented by strong mentoring and training and career development opportunities for the DRP target faculty; we will expand research training of students at each network PUI through the Institutional SC INBRE Undergraduate Research Programs; and we will increment the activities of the Bioinformatics Core with an expanded Pilot Projects program. We will renovate research facilities at three PUIs. Outreach to high school teachers and students at selected sites will help, strengthen SC INBRE's pipeline to research careers that actively encourages and supports underrepresented minority students and students from underserved areas to pursue a college education and engage in biomedical research.

Public Health Relevance

The Universities and Colleges that participate in SC INBRE have joined forces to promote biomedical research not only for its undeniable value as a conduit to better approaches to preventing and treating human disease, but also as an indispensable component of modern undergraduate education. SC INBRE strives to bring research training within reach of URM and underprivileged undergraduate students, in order to promote diversity in the scientific, medical and professional workforce. As the composition of the USA population changes, a diverse and well-educated body of scientists, physicians, health care workers, and other professionals is tantamount to solving the pressing health problems facing modern Americans, and ultimately indispensable for economic growth and development nationwide.

Building a Pipeline

The department's growth, from 7 primary tenure-track faculty members in 2002 to 28 in 2020, is remarkable for both quantity and quality. One scaffold of that growth is the new-investigator funding provided by NIH (through IDeA Networks of Biomedical Research Excellence [INBRE] and Centers of Biomedical Research Excellence [COBRE]) and NSF (through the Established Program to Stimulate Competitive Research [EPSCoR]. Each of these programs is designed to enhance the caliber of scientific faculty at research institutions and undergraduate schools who can attract more talented students to augment the science and technology knowledge of the state's workforce (INBRE) and enhance research competitiveness of targeted jurisdictions by strengthening capacity and capability in science, technology, engineering and mathematics (EPSCoR). We think the department continues to return excellent value for this timely and highly suitable investment. Below are comments from several investigators who have either watched or participated along the way.

Brian Booth, Assistant Professor

My INBRE research has been funded since 2019, and Dabo's All In Team Foundation has repeatedly funded my work. INBRE funding has allowed my research group to obtain exciting preliminary data that will be included in subsequent grant proposals that will submitted to NIH for consideration. The SC INBRE network has also presented new opportunities for scientific collaborations which I am currently pursuing."

Regarding biochemicals involved in cancer cell redirection, signals that originate in the normal mammary microenvironment influence the behavior of normal mammary cells and tumor-derived cells. When grown together with normal mammary epithelial cells (MECs) tumor-derived cells adopt normal, non-tumorigenic phenotypes in vivo and in vitro. When co-transplanted this combination results in new mammary outgrowths comprised of MECs and cancer cell progeny displaying a normal phenotype. The tumor-derived cells proliferate and differentiate into normal mammary luminal epithelial and myoepithelial cells. The normal mammary microenvironment induces the tumorigenic cells to either differentiate or undergo apoptosis via biochemical and/or biophysical cues. We have named this phenomenon "cancer cell redirection.

The long-term objective is to identify intracellular biochemical and biophysical signal pathways that can be targeted in order to drive the tumor cells down a differentiation/apoptosis pathway instead of the preferred tumor formation pathway. This will be accomplished using in vitro and in vivo models, RNAseq analyses, breast cancer cell lines, and primary breast cancer cells. These new targets will help in the fight against cancer, not only breast cancer, but all forms of cancer, as tumor growth is suppressed, and tumor cells are terminally differentiated leading to their demise.

Ann Foley, Assistant Professor

Funding through the SCBioCRAFT COBRE has allowed me to expand my research portfolio beyond my previous focus on the role that intracellular signaling plays in differentiation of heart muscle. With TRIMH COBRE funding and the scientific interactions that COBRE membership encourages, I have begun new projects that extend my findings from SCBioCraft. First, in collaboration with Susan Duckett, Ph.D., my group is working to understand how signaling mediates the growth of skeletal muscle with an eye to understanding muscle wasting diseases. I have also initiated a project with a researcher at MUSC, Dieter Haemmerich, Ph.D., to develop techniques for delivery of therapeutics to skeletal muscle.

Sarah Harcum, Professor

Early on, I was awarded an NSF CAREER: Stress Response in Recombinant Eschericia coli: A Research and Educational Tool. Later, my COBRE pilot project funded my student Arthur Brodsky's initial work on stem cells, which progressed into metabolic flux analysis using stable isotopes in breast cancer cells and most recently, the work by Daniel Odenwelder with induced pluripotent stem cells. Although the COBRE funding covered only the initial work by Arthur, it laid the groundwork for five journal articles in this area, including one this year. Two Ph.D. students graduated because of this funded research.

Currently, I lead a team of scientists from four universities (Clemson University, University of Delaware, Tulane University and Delaware State University), which was recently awarded a $6 million NSF EPSCoR grant. The CHO g20 project aims to develop new biological approaches to better understand the Chinese hamster ovary (CHO) cell line, which is used to manufacture most biopharmaceuticals. This EPSCoR grant, CHOg2p, as we call it, has been great. Leading a four-university project has been challenging and rewarding.

Jessica Larsen, Assistant Professor of Chemical and Biomolecular Engineering and Bioengineering

My INBRE IV Directed Research Project, funded since 2019, is Towards Theranostic Technology: Elucidation and Utilization of Neural Enzyme Upregulation. The goal is to develop a diagnostic nanoparticle tool for neurodegenerative conditions by leveraging a common thread in multiple neurodegenerative diseases, lysosomal hydrolase upregulation. The focus is on an incurable, neuropathic lysosomal storage disorder, GM1 gangliosidosis, lacking one lysosomal hydrolase with others upregulated.

Progression of neurodegeneration is less established because it is difficult to probe in situ and can vary dramatically patient to patient in order of symptom presentation and severity. Although variations occur, similarities among these disorders are present in lysosomal behavior. Lysosomal hydrolases are upregulated in early stages of disease in animal models, with data suggesting that increased hydrolase activity may indicate increased severity. If pathophysiology were better understood, in situ diagnostic options for neurodegenerative conditions, currently limited due to the blood-brain barrier, could be enhanced by selecting materials that respond correctly to levels of neurodegeneration.

This project will contribute to a better understanding of lysosomal storage disease-associated neurodegeneration through development of reliable assays and diagnostic tests that probe cellular- and molecular-level processes earlier in disease progression without the need for invasive (or sacrificial) sampling and a pharmacological tool that modulates relevant enzyme activities in the proper direction at the right time. After completion of this project, we will have highlighted potential biomarkers, with a measure of likelihood, to be scanned in vivo.

I was funded by SC EPSCoR GEAR Program in 2018 and was recently funded by SCBIOCRAFT, a Clemson University NIH COBRE. Through the Clemson Core Incentivized Access program, I have been funded twice, with my first funded proposal leading to an ACS Biomaterials Science & Engineering cover article. I was recently funded along with undergraduate student Christopher Pierce through the Student Initiated Research Projects Program.

Being a part of the INBRE pipeline has helped me form successful mentoring relationships with well-established NIH colleagues. I have also had the opportunity to participate in INBRE conferences, which has helped me with grant writing and establishing new collaborations.

Jeoung Soo Lee, Associate Professor

The objective of my research is to develop polymeric nanocarriers for combinatorial drugs that can simultaneously target multiple mechanisms underlying disease/trauma pathology. Toward this end, we have created a novel, amphiphilic copolymer, poly (lactide-co-glycolide)-g-polyethylenimine (PgP) that forms micelles with a hydrophobic core for drug loading and a cationic shell for electrostatic complexation of therapeutic nucleic acids. PgP offers a platform technology that we are applying towards treatment of central nervous system trauma such as spinal cord injury and traumatic brain injury, as well as cancer and cardiovascular diseases.

I have received two NIH R01 grants (one as a PI and the other as a Co-I), one DoD intramural grant with Walter Reed Army Institute of Research (WRAIR) as a PI and two NIH R21 grants as a Co-I.

Given today's intensely competitive environment, a young investigator must either be extremely successful in obtaining funding very quickly or obtain additional support. I can say without hesitation that the access to funding, core facilities, and mentorship as a COBRE-supported targeted PI has had an incalculable impact in establishing my own scientific career. These resources have allowed me to acquire equipment, hire senior personnel such as postdoctoral fellows and initiate animal studies much more quickly than would have been possible without this support.

Jeff Anker, Wallace R. Roy Distinguished Professor of Chemistry and Bioengineering

I have received numerous grants including the NSF CAREER and an NIH R01. In recent InnoVision and X-Prize competitions, our student teams were finalists in Innovision Technology Development and COVID-19 categories and in the X-Prize COVID-19 category. The SCBioCRAFT COBRE was key to my career progress. I entered the program as an assistant professor with an interesting idea for a pilot project and needed help formulating clear applications. Thereafter, I became a targeted investigator and finally gained independence with an R01 ($1.5M grant). Through the program's support and mentorship, I learned how to better formulate and pitch my ideas and received several NIH grants. I am now a full professor. COBRE's peer review of proposals was especially helpful: It provided practice reviewing others' proposals, examples of how senior investigators reviewed proposals, and feedback on my own work. The COBRE program was immensely successful for my whole cohort, and I remain involved as a mentor.

Bruce Gao, Professor and The South Carolina SmartState Endowed Chair in Biofabrication Engineering

In 2003, I was recruited by the SC INBRE program as an assistant professor. Because my educational background is in physics, I was assigned a biomedical mentor, Dr. Thomas Borg, then department chair of Cell and Developmental Biology and Anatomy at University of South Carolina's School of Medicine. Dr. Borg's dedicated mentoring helped me receive the NIH Mentored Research Scientist Career Development Award and my first R01 grant, which laid a solid foundation for my academic career. I now enjoy mentoring new faculty through a variety of programs designed to create a pipeline of investigators and students for academia and industry in South Carolina.

Ying Mei, Associate Professor

My COBRE project is to leverage my expertise in polymer microarray technology to develop substrates for directed cardiac differentiation of human pluripotent stem cells (hPSCs). Being a COBRE targeted faculty member has greatly accelerated my career development. It nurtured a supportive environment for junior faculty to advance their careers. Through periodic NIH study section-style meetings, being targeted provided constructive critiques to develop my NIH projects and refine my proposals. It also offered the critically needed financial support to enable the collection of strong preliminary data for my NIH proposals. In addition, it provided crucial accesses to research facilities to develop my project. This has eventually led to a successful NIH R01 award (NIH R01HL133308).

NIH COBRE support helped lay the groundwork for my present research projects. Our current research focuses on bio/nanomaterials and human cardiac organoid technology for clinically applicable regenerative therapies and disease modeling. To this end, we have leveraged diffusion limitations in 3D microtissues to develop human cardiac infarct organoids and create a "heart attack in a dish" model. This platform technology was published in Nature Biomedical Engineering (PMID: 32284552). In addition, our lab has pioneered the use of electrically conductive silicon nanowires

to create an electrically conductive microenvironment and promote functionality of human cardiac microtissues. This led to two papers in Nano Letters (PMID: 27328393, PMID: 25826336). Lastly, we have been leveraging the recent advances in data science and machine learning to accelerate the development of biomaterials. We utilized bioinformatic data mining to identify a novel laminin-derived peptide to prepare peptide-functionalized alginates for therapeutic vascularization. This has led to a paper in Science Advances (PMID: 32923589).

INBRE and NSF Pipeline SECTION

William Richardson, Assistant Professor

My research focus is matrix systems mechanobiology. In other words, my lab studies how mechanical and biochemical signals regulate tissue matrix remodeling and how we can control that complex regulatory system to improve patient care. After a heart attack, for example, part of the heart muscle dies and gets replaced by scar tissue made of collagen fibers. The structure of those fibers is a huge determinant of the heart's ability to function after the injury. The difficulty in controlling the structural remodeling process is that it involves a complex system of cell and matrix interactions that depend on mechanical and chemical signals with multiscale layers of crosstalk and feedback loops. My Systems Mechanobiology Lab is developing systems-level computer models to identify cell and matrix processes dominating collagen structure regulation; this is conducted alongside high-throughput in vitro experimental platforms to test model predictions and engineer designs for fibrotic control in vivo.

Since starting my group at Clemson in 2016, we have been fortunate to participate in two of Clemson's NIH-funded Centers of Biomedical Research Excellence (COBRE). We first joined SCBioCRAFT with a pilot project focused on cardiac fibroblast systems biology modeling to identify mechano-adaptive cardiac drug targets. We subsequently joined SC-TRIMH with a target-investigator project (and now as a core codirector) focused on patient-specific collagen degradation predictions for tendon healing after injury. Perhaps more valuable than the COBRE funds to support these projects, the centers' infrastructures have provided incredibly beneficial relationships with diverse faculty across South Carolina. These relationships with engineers, biologists, clinicians, statisticians, and others have enriched and expanded my work in exciting directions I would never have designed or accomplished on my own. In particular, my newfound collaborations arising through the COBREs have hatched two new project directions and major funding awards: a $250,000 Scientist Development Grant from the American Heart Association and an $1,800,000 R01 from the National Institutes of Health. The review panelists for both these grants highlighted our multidisciplinary, collaborative teams as major strengths of the proposals — clear evidence that the South Carolina research network and COBREs are reaping rewards for the state, for Clemson, and for early investigators like me.

Bob Latour, McQueen Quattlebaum Professor

The SC INBRE initiative has provided an exceptional platform to support the integration of biomedical research programs for universities and colleges throughout South Carolina. In addition to helping to stimulate new research endeavors by students, postdoctoral fellows, and faculty, SC INBRE continues to provide excellent opportunities for training, networking, and collaboration.

Taking the B.S. to M.S. to Europe

For many students, undergraduate years are exploratory: Choices of classes, internships, co-ops and Creative Inquiry projects inform decisions about a career path and personalize its outcome. Mario Krussig intends to receive a Clemson Ph.D.; recently, he talked about his choice of the B.S. to M.S. program and the outcome to date. Ed.

"My professional goals are to complete my PhD and work in research and development in an orthopaedic firm. Ideally, I would like to design and help identify the next cutting-edge tendon/ligament grafts or augmentations for improved osseointegration of orthopaedic devices. Finally, super-long term, I would potentially like to run a consulting company. I would love to be a liaison between an American lab with the original research and an orthopaedic company in Austria, Switzerland, or Germany moving the research to market. I would love to run a company facilitating that or maybe do troubleshooting for medical device companies. I speak English and German fluently and have dual citizenship; I could work anywhere in the EU without needing a work visa.

When I entered the B.S. to M.S. program, the biggest benefit I saw was that it was a time-saving way for me to complete one of my academic goals at a top university. Since entering the program, I have realized another major benefit: The faculty already knew me and the quality of my work throughout my undergraduate years. This gives me a more impactful relationship with them, and when I come to them with a research idea, I am building on the trust we have. That is much easier than changing universities and starting from nothing. B.S. to M.S. allowed me an easier transition from the undergraduate classroom to the graduate research laboratory: I have been able to truly make the most of both my undergrad and grad time here at Clemson.

I came to Clemson through a summer internship at CU-ICAR. I thought about Pre-Med and then realized I wanted more hands-on problems as an undergraduate. With Dr. Dean's help, I got a two-month cardiovascular research internship at Universitäts Herzzentrum, Freiburg, Germany, with Dr. Remi Peyronnet. That is when I knew I wanted to go the research track. I have always loved tinkering, which is one reason I decided to study engineering rather than medicine. I enjoy the perspective of working toward an unknown.

The department has a good mix of seasoned professors and newer faculty. Being in Dr. Mercuri's lab is great because he really knows the game from his time in industry. Clemson and the department really do a good job of being a family. Although people across campus are doing different research, everyone is always open to intercommunity communication. In our department, you can run into things that normally would be a roadblock at other schools and could cost you another year of school. Here, you are able to communicate with faculty to solve the problem at hand, collaboratively. So many students stay here as undergraduates because the department has so many programs to facilitate academic as well as individual growth.

My biggest hobby outside the program is waterskiing. At Clemson, I am part of a stellar competitive Waterski Club Team that gets to travel across the nation. This has truly been something passionate that I spend a lot of my time doing. When it gets too cold to ski, I like to hike in the mountains or trails surrounding Clemson. Outside of my hobbies, I am what many call a coral reef enthusiast and even maintain a small reef ecosystem in my apartment. This allows me to tinker and apply many of the biological and chemical skills learned at Clemson to the principles of reef husbandry."

Here, you are able to communicate with faculty to solve the problem at hand, collaboratively.

In Collaboration with the Department of Marketing, Clemson Bioengineering Launches the Orthopaedic Medical Device Product Specialist Certificate

Martine LaBerge, Ph.D.

At its October 2020 quarterly meeting, the Clemson University Board of Trustees approved a new undergraduate certificate proposal submitted by the Department of Bioengineering in collaboration with the Department of Marketing aimed at providing undergraduate students with core competencies within various aspects of the orthopaedic medical device industry. The target audience for this certificate is undergraduate students in the College of Engineering, Computing and Applied Science; College of Science; College of Behavioral, Social and Health Sciences; and College of Business. This unique certificate provides a strong platform for workforce development and readiness for the orthopaedic medical device industry for health allied professionals and sales professionals.

With a focus on managing a product throughout its life cycle, the certificate also addresses product development and performance relevant to clinical use and communication of its commercial value. The certificate comprises four courses (12 credits), of which nine credits form the certificate core: Fundamentals of Orthopaedic Device Science and Engineering or Orthopaedic Engineering and Pathology, Technical Selling, and Developing and Selling Medical Devices. Students select a fourth course from an approved list of health-related courses in their respective major.

Students who graduate from the program will be able to: demonstrate an understanding of selected orthopaedic devices, their use, development, and function; understand clinical needs critical to bringing new biomedical technologies to market; and demonstrate communication skills for advocating orthopaedic medical device development, design and function for successful outcomes.

Clemson, one of the nation's leading research institutions in medical device technology, is distinguished by its groundbreaking research and discoveries that have significantly and positively impacted health care delivery and outcomes for the past 60 years. As healthcare is an economy priority in the United States, there is an increasing demand for cost-effective quality medical technology made available to all healthcare providers. The role of Product Specialists is to assure communication. As South Carolina's land grant university , Clemson University is dedicated to developing a workforce that meets needs of growing economy sectors. The orthopaedic medical device industry has taken a pivotal role in the economic landscape of South Carolina in the past decade, with major companies and start-up companies establishing bases in Pickens, Greenville, Dorchester and Charleston counties, to name a few. The certificate targets economic development by focusing on the marketability of translational research directly associated with clinical applicability.

This unique certificate bridging science, engineering and marketing will fill the existing gap between biomedical device product sales and and healthcare providers by increasing product awareness and knowledge, communication skills and marketability of highly skilled students. Those students will fuel the local economy or carry that knowledge to businesses across the U.S. and beyond.

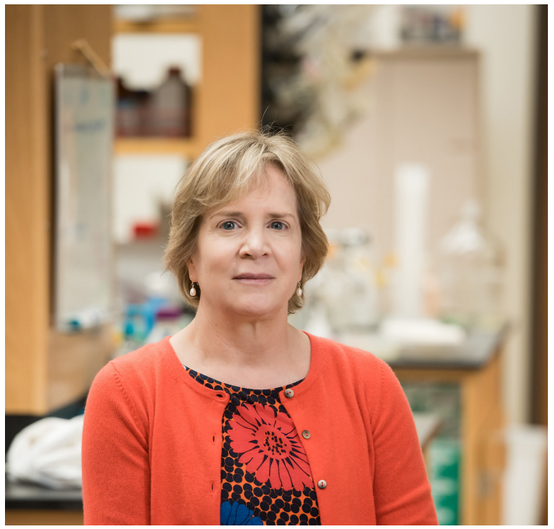
Jessica Larsen receives Phil and Mary Bradley Faculty Award for Mentoring in Creative Inquiry

Larsen, whose research interests include drug delivery, biomaterials and nanotechnology, is assistant professor of chemical and biomolecular engineering and bioengineering. The Phil and Mary Bradley Award for Mentoring in Creative Inquiry is presented each spring in recognition of outstanding work with undergraduate students. Nominations are accepted from student participants in Creative Inquiry. The award, made possible by generous gifts from Phil and Mary Bradley, consists of a plaque and a salary supplement. Previous awardees in bioengineering are:

2017 — Vladimir Reukov, Research Assistant Professor, Bioengineering

2012 — John DesJardins, Assistant Professor, Bioengineering

2011 — Delphine Dean, Assistant Professor, Bioengineering



Sarah Harcum receives University Research, Scholarship and Artistic Achievement Award

Harcum, a professor of bioengineering, was recognized for her fiscal-year research expenditures, which exceeded $1 million. The University Research, Scholarship and Artistic Achievement Awards were created in 2018 to recognize Clemson University faculty who have achieved rare career milestones, such as:

• Receiving the highest level of national or international recognition in their field;

• Authoring a paper that has received more than 1,000 citations;

• Expending more than $1 million on research in a fiscal year.

Those earning the URSAAA designation are lifetime members who will be invited to an annual gathering to celebrate scholarship and discovery at Clemson University.

Our Inaugural Student Advisory Committee

Ken Webb, Ph.D.

In Spring 2020, the bioengineering department welcomed its inaugural Student Advisory Committee (SAC). This new student organization that serves as a liaison between the department's administration and faculty and the student body. One of the SAC's primary roles is to facilitate communication, particularly to provide student feedback on programmatic initiatives. For example, one of the group's first projects was providing student input to Drs. Martine LaBerge and Ken Webb about proposed changes to the department's professional development course sequence. Our new B.S. curricula incorporating the new course design is now progressing through the University's curriculum approval process. The SAC fills a previously unmet need: The department's leadership has always worked closely with the student professional organization, Clemson Bioengineering Organization; however, this group represents only students who choose to become members. In contrast, the SAC represents all bioengineering students. Although the first SAC group is composed entirely of undergraduate students, graduate-student members will be added in the future. Thus, from our incoming sophomores to our Ph.D. candidates, our students will be represented in departmental deliberations.

The BIOE Professional Development Program for Doctoral Students: Assuring Post-Ph.D. Career Preparedness

Martine LaBerge, Ph.D.

In 1963, Clemson University established its first graduate program in bioengineering, conferring the Ph.D. in bioengineering shortly thereafter. Consistently, our graduates have led the biomedical research and technological enterprise in academic and nonacademic career paths. Our platform for educating these leaders has been a culture focused on discovery and innovation. Graduates serve the biomedical technology field through seminal scholarship, novel research outcomes, national awards, patents and licenses. Over the years, our education and research partnerships with the Medical University of South Carolina and Prisma Health have led to the development of vigorous, innovative education models in bioengineering at the interfaces of patient care and innovation. Clemson bioengineering doctoral students acquire traditional research and technical skills to confront any challenge in an ever-evolving healthcare industry and biomedical research. Through the BIOE Professional Development Program (PDP), doctoral students are further prepared to enter the workforce with leadership core competencies needed for successful academic and nonacademic post-Ph.D. careers.

Through participation in experiential learning, interactive courses, leadership-building skills opportunities and individual mentoring, doctoral students will demonstrate confidence and assertiveness in team building, communication, strategic planning, emotional intelligence, project management, budget management, conflict resolution and entrepreneurship among others. Knowledge of research compliance, regulatory science, globalization, ethics and equity/inclusion in the workplace is also expected of Clemson BIOE Ph.D. candidates.

The BIOE PDP includes enrollment in mandatory courses as well as a mentored teaching/lab assistant practicum for a minimum of two semesters after qualifier defense. At the completion of their doctoral studies, students present an e-portfolio of core competencies demonstrating their leadership skills to facilitate a successful transition into professional careers. The program is offered at our three campuses — Clemson, Greenville (CUBEInC) and Charleston (Clemson-MUSC Bioengineering Program).

BIOE at InnoVision Awards!

November 17, 2020

In a field that included entries from across South Carolina, BIOE faculty-led student teams excelled in this year's InnoVision Awards, taking winner or finalist status in several categories. Dedicated to fostering growth in South Carolina's innovation economy, InnoVision annually showcases the world-class capabilities and accomplishments of South Carolina innovators.

Describing the BIOE winners, Delphine Dean, Ph.D., said, "I'm so impressed with all that the teams and students have accomplished. Several have filed invention disclosures (even filed patents!), worked on papers, started CIs, submitted grants/awards and presented at (virtual) conferences. I'm going to try to organize the program again this coming May with hopefully, a different topic than COVID. The MUSC Center for Global Health was interested in doing something a bit more 'global' in flavor so we'll see! It's all very exciting!"

The Ibrahim Janajreh Young Innovators Award went to the Clemson COVID Challenge Program led by Delphine Dean. Aravis Biotech, a startup headed in part by Jeffrey Anker, Ph.D., of the departments of chemistry and bioengineering and John DesJardins, Ph.D., was a finalist for the Technology Development Award sponsored by Fluor. The VR Mondi team (through the Clemson COVID Challenge summer research program created by Dean, won the Education Award sponsored by Techtronic Industries Power Equipment. LANCR Health Technologies, led by Dean and Endre Takacs, Ph.D., of Clemson's astronomy and physics department, was a finalist for the COVID-19 Response – Technology Deployment award. For the COVID-19 Response – Technology Research category, BIOE's Negative Pressure Chamber Project led by DesJardins and Phillip Moschella, M.D., was the winner. Finalists included the COVID Microbead Screening Project led by Anker and the COVID Biomarker Detection Test Project led by Dean and Melissa McCullough, Ph.D. candidate.

TEAMS

COVID Biomarker Detection Test Project

Izabella Kamieniecki
Grace Joyner
Melinda Busman
Habib Rafka
Jake Steiniger

Negative Pressure Chamber Project

Amanda LeMatty
Robert Falconer
Emily Andriello
Bowen Griffith
J.P. Paul
Noah Ashley

COVID Microbead Screening Project

Unaiza Uzair
Madison Motes
Mandolin Lucier
Symphanie Key
Ryan Hernandez
Alessia Keane
Shrey Patel
Mohammad Arifuzzaman

LANCR Health Technologies

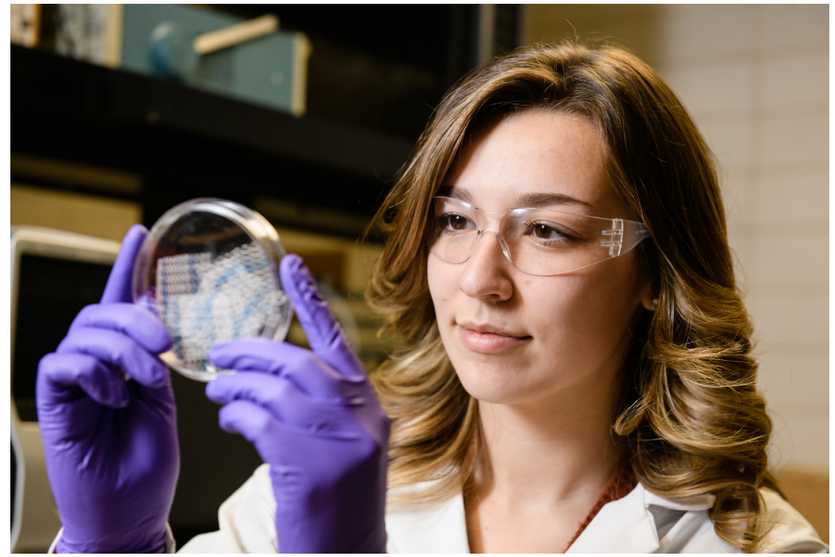
Andrew Rifkin
Justin Napolitano
Razzan Alam
Danny Lazega
Victor Carera

VR MONDI

Kyle Anderson
Maggie Ayala
Madelyn Stafford
Gavin Vasquez
Nayoung Kim
Michael O'Brien

Watch the awards celebration!

Lauren Davis, 2020 Beckman Scholar



In 2019, Clemson University was selected by the Arnold and Mabel Beckman Foundation as one of 13 institutions in the U. S. to receive a three-year Beckman Scholars Program Award. This summer, undergraduate Lauren Davis began her journey as a Clemson University Beckman Scholar, joining an elite group of students. From Lakeville, Minnesota, Davis began her Beckman Scholars research remotely this past summer studying analysis of chemical and mechanical structural changes in hernia mesh following explantation.

Davis' mentor, Melinda Harman, noted, "Recognition as a Clemson University Beckman Scholar is a tremendous honor, and Lauren certainly exemplifies the value of engaging undergraduate students in research. In keeping with the spirit of the Beckman Scholars Program, she has defined a stimulating two-year research project that challenges her to both higher technical achievement and professional development. Lauren has consistently pursued opportunities to gain technical skills necessary for success in biomedical engineering and embraced increased responsibilities for experimental research and project leadership."

This Beckman Scholars award speaks volumes about Clemson's successful Creative Inquiry program and the structure it provides for mentoring undergraduate students in research.
Melinda Harman

Davis is a recipient of the Jungaleers Memorial Grant, Rauch Saxophone Grant in Aid, and a two-year recipient of the Delta Award for Excellence Scholarship. She received the department's Larry S. Bowman Outstanding Bioengineering Junior Award. Davis is a member of Omicron Delta Kappa, a national leadership honors society, and Alpha Omega Epsilon, a professional sorority for women in engineering and technical sciences.

Harman said, "This Beckman Scholars award speaks volumes about Clemson's successful Creative Inquiry program and the structure it provides for mentoring undergraduate students in research."

Clemson-Claflin Program

Clemson's bioengineering department is partnering with Claflin University, a top 10 Historically Black College and University (HBCU, U.S. News and World Report) located in Orangeburg, South Carolina, to offer a combined B.S./M.S. program. Juniors and seniors in Claflin biochemistry, biology, biotechnology, chemistry, computer engineering, and mathematics departments with a cumulative GPA of 3.2 or greater will be eligible to dual-enroll in a selection of seven graduate-level elective courses in BIOE for a maximum of 12 credit hours that may be counted towards their M.S. in bioengineering. In conjunction with the program, BIOE has launched a Claflin-Clemson Summer Match Program to allow students pursuing the B.S./M.S. the opportunity to conduct mentored research with faculty in BIOE that may contribute to their master's thesis project. Through this program, we aim to strengthen our connection with HBCUs in South Carolina and build a pipeline to increase diversity in our graduate programs. We currently have one Claflin alumnus pursuing a Ph.D. in our program and one Claflin student who participated in a research experience in summer 2020.

Emily Ongstad Society of Women Engineers Distinguished New Engineer

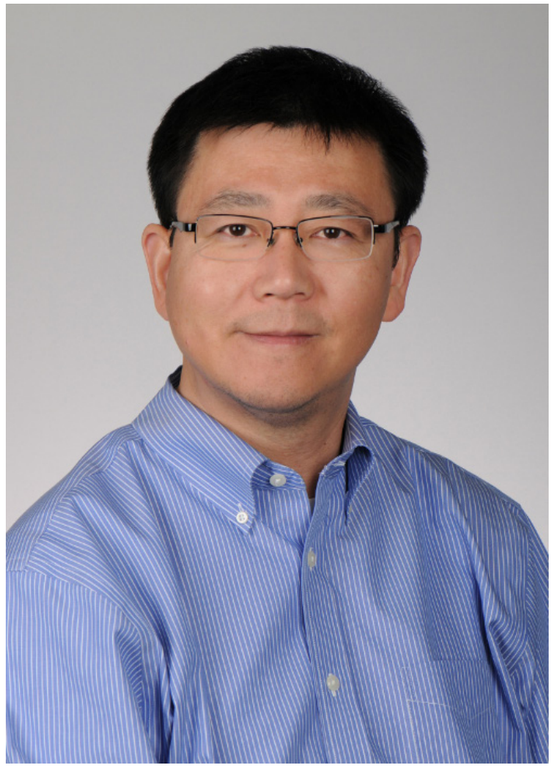
Senior Scientist at AstraZeneca; MAL President-Society of Women Engineers; Editorial Board-SWE Magazine

I am humbled and honored to have been selected by the Society of Women Engineers as an SWE Distinguished New Engineer award recipient this year. In the very strange world we are living in now, SWE did a fantastic job of finding meaningful ways to recognize the many award recipients at an entirely virtual WE20 conference. Congratulations to all of this year's award recipients!

Hai Yao chosen for funding by National Institute of General Medical Sciences and Xlerator Network

Clarissa Austin, Clemson University Research Foundation
May 26, 2020

A Clemson University researcher has received funding to develop a novel technique to correct spinal deformities without anchoring rods to the spine with screws. Hai Yao, the Ernest R. Norville Endowed Chair and Professor in the Department of Bioengineering and one of six faculty members in the Clemson University-Medical University of South Carolina (MUSC) Joint Bioengineering Program, has been awarded $40,000 from the National Institutes of Health (NIH) to advance his research on spinal deformities.



"Spinal deformity, an abnormal curvature of the spine, affects a substantial number of patients around the world," Yao said. "Surgical treatment usually involves implanting rods to straighten the spine; however, complication rates are extremely high."

Yao 's research is focused on combatting the challenges associated with improving spinal deformities. "My lab is developing a novel surgical system for correcting spinal deformities without anchoring rods to the spine with screws," he said. "With this new approach, which we have called the R-FIXation system, rods will be anchored to the ribs using a series of hooks instead of to the spine." According to Yao, this technology is a paradigm shift in approaching spinal deformity with a new focus on the thorax as the primary structure for manipulation to secondarily reposition the spine, rather than solely focusing on the spine itself.

Yao is one of seven researchers to receive funding through the XLerator Network's "Ideas to Products" (I2P) program that seeks to accelerate the commercialization of healthcare technologies across the southeast Regional Technology Transfer hub—a virtual hub comprised of 24 institutional partners. XLerateHealth (XLH) and its affiliate, the Southeast XLerator Network (XLN), recently announced that NIH will provide proof-of-concept funding for the continued development of a number of biomedical innovations that represent various sectors of technology, from medical devices, to diagnostics and therapeutics. The XLN received 55 proposals, scoring them based on a number of criteria, with a total amount of $200,000 available for this round of funding.

"I am honored to have been one of seven innovators to receive an I2P award," said Yao. "The funding will allow me to further develop the R-FIXation system to provide safer, more effective, and versatile spine correction in patients with spinal deformities."

With this new approach, which we have called the R-FIXation system, rods will be anchored to the ribs using a series of hooks instead of to the spine

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