Joint Department of

BIOMEDICAL ENGINEERING

UNC CHAPEL HILL | NC STATE UNIVERSITY

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IN THIS ISSUE

LETTER FROM THE CHAIR

Paul Dayton

GREETINGS BME ALUMNI AND FRIENDS:

Iteration is well understood to be the path of progress by scientists, engineers and clinicians. In dealing with COVID-19, and the virus that causes it, the whole world's population finds itself in the front row watching as scientists, engineers and clinicians struggle to use the iterative scientific method to protect the healthy and treat the infected. What the general public is seeing firsthand is how scientific and healthcare innovation can be painstakingly slow and frustratingly indirect, and most of all that such progress is not always steady or forward. Setbacks are common. The power of the scientific method is that setbacks, and even failures, are not dead ends — such results are in fact additional knowledge to help solve the problem at hand. A year ago, there were numerous setbacks associated with returning to face-to-face education and laboratory research, and ultimately our home universities had to step back and reset. This past spring, applying additional knowledge gained by experience, some face-to-face teaching and laboratory mentoring returned and was sustained for the entire semester. This fall, applying a full 18 months of negative and positive results along with the advent of effective COVID-19 vaccines and high campus inoculation rates, our home universities return to full face-to-face education and laboratory research. We in the UNC / NC State Joint Department of Biomedical Engineering do so with great optimism and enthusiasm as we are anxious to once again fully undertake our mission, to unite engineering and medicine to improve lives.

As you read on you will find stories indicative of how our department returns to full-time in-person research and education with substantial momentum. In research, please note exciting reports of exosome-eluting stents for vascular healing, neural control technologies for bionic prosthetics, 3D-printed polymer-based biodegradable implant drug delivery systems, nanoparticles derived from human lung cells that can bind and neutralize SARS-CoV-2 and so protect from COVID-19 infection, a novel 3D dental X-ray device, and the use of nanodroplets and ultrasound to dissolve blood clots. We also announce substantial new research funding from NIH, NSF, the Male Contraceptive Initiative, Eshelman Institute for Innovation, American Heart Association and the NC State's Chancellor's Innovation Fund. In education, we proudly relay numerous NIH, NSF and other graduate student fellowships as well as prestigious student and faculty academic awards and honors from sponsors such as NAE Frontiers of Engineering, NC State (annual eGames, Mathews Medal, Outstanding Teaching Awards), UNC-Chapel Hill (Diversity Award, NC TraCS, TARC), Beckman, International Academy of Medical and Biological Engineering, International AIDS Society, Controlled Release Society, *Journal of Biomechanics* and Covintus Tech Tank pitch competition! The articles just referenced offer a wealth of information about our programs and who we are. I encourage you to contact us with questions or comments regarding these exciting educational and research opportunities as the Joint Department enthusiastically transitions them to be in person and on site!

Sincerely,

Paul A. Dayton, Ph.D.
William R. Kenan Jr. Professor and Interim Chair
UNC / NC State Joint Department of Biomedical Engineering

IMPROVING THE **LAB-TO-MARKET PIPELINE** AT UNC

By Megan May,

UNC Office of Research Communications

FOR THE PAST 30 YEARS, North Carolina's abundance of research universities and the Research Triangle Park have made the state a powerhouse in biopharmaceutical manufacturing. Regional participation in the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL) builds upon that asset, helping bring jobs to the area and strengthening the research-to-market pipeline.

Launched in 2017, NIIMBL is a nation-wide consortium aimed at accelerating innovations that make biopharmaceutical manufacturing faster, safer and at lower cost in order to increase accessibility to consumers. The consortium specifically focuses on the manufacturing of protein therapies like antibodies, gene therapies, cell therapies and vaccines.

"I think a lot of researchers don't typically think about manufacturing and manufacturing-related research," said Ralph House, the UNC representative for NIIMBL and associate chair for research in the UNC Department of Chemistry. "But it's another dimension that we, as an institution, can grow in and I think it would be upward growth."

While efficiently manufacturing biopharmaceuticals has always been the goal of NIIMBL, COVID-19 has made this enterprise more important than ever.

"Our goal is to do research that is at the interface between the findings of innovative companies and academics in the laboratory, and the implementation of technology in production," said Ruben Carbonell, NIIMBL's senior technology strategist, and faculty member of chemical and biomolecular engineering at NC State.

Initiated by funding from the U.S. Department of Commerce's National Institute of Standards and Technology, the organization is made up of about 150 partners ranging from large manufacturing firms to small companies, academic institutions and nonprofits like the Bill & Melinda Gates Foundation. Industry partners identify major needs or problems to focus on, and research partners provide the solutions.

"We joined NIIMBL because we want to identify research areas within UNC that are close to manufacturing that could benefit from this funding," House said. "We wanted to utilize this as a structure to connect those labs with the industrial partners."

One of NIIMBL's objectives is developing instruments that improve the efficiency of the manufacturing process. These include tools that can rapidly and accurately measure and verify the contents of bioreactors, which are essential to making biotherapeutics. Biotherapeutics are produced using genetically modified, live mammalian and microbial cells and require cell culture media for their development. Historically, these therapeutics have been made with batch-processing techniques. Think of it like brewing beer — but instead of alcohol, the cells create protein products like antibodies.

Because biotherapeutics are infused into the human body, they are FDA-regulated. Quality control during their manufacturing is paramount. Producing these therapies with the required characteristics and optimal yield requires careful monitoring of nutrients and growth factors inside the bioreactor during the entire process. Typically, samples from a bioreactor are sent to a separate facility, where analyses could take weeks, if not months — far too slow for precise control of the bioreactor.

"We're trying to introduce analytical techniques that are faster and can be done inline or at-line during manufacturing — decreasing manufacturing time and increasing the rate of product release," Carbonell said.

Enter Michael Ramsey, scientific founder of 908 Devices Inc. (MASS), and faculty member in the UNC Department of Chemistry, UNC Department of Applied Physical Sciences and the Joint Department.

Building upon inventions from the Ramsey Laboratory and supported with funding from NIIMBL, 908 Devices released in 2019 a product named the Rebel — the first at-line media analyzer that enables acquisition of comprehensive bioreactor data in minutes. The device can be used to rapidly monitor culture media for nutrients and supplements to improve product yield and quality.

The Rebel combines two technologies invented in the Ramsey Lab: a highly miniaturized mass spectrometer that led to the first ever commercial handheld mass spectrometer — developed and marketed by 908 Devices — and a micro-scaled separations platform.

"Two very important tools analytical and biological chemists use to characterize and quantify molecules are mass spectrometry and chemical separation technologies," Ramsey said. "It's much easier to characterize a mixture of materials if you can pull out all the separate components and look at them individually."

The Rebel allows pharmaceutical manufacturers to identify nearly three dozen important biochemical reactor components in about five minutes from a location adjacent to the bioreactor it monitors. It's simple and automated design enables technicians to use it after a short training period with no scientific or technical background, freeing up Ph.D. students and senior technical staff to focus on higher-priority tasks.

"So that's what the NIIMBL project was about — advancing the abilities of biomanufacturers to produce the best products possible," Ramsey said.

"908 Devices is a perfect example of a pioneering company that has developed a technology that the industry needs," Carbonell said.

"Mike Ramsey's NIIMBL project has been remarkable for the way it weaves together multiple threads of engaged research. It involved technology developed at UNC, a highly successful startup company, and it attracted additional industry funding from major pharmaceutical companies," said Don Hobart, UNC's associate vice chancellor for research. "On top of that, it's a textbook example of how UNC and NC State can combine our unique institutional strengths to support our state's economy."

Both UNC and NC State are members of NIIMBL. University participation is encouraged by matching funds provided by the North Carolina General Assembly. •

A PERFECT FIT

By Lisa Coston Hall,

NC State University Advancement Communications

WHEN IRA J. "JERRY" JACKSON III was a child in North Carolina's Vance County, there was little question where he would attend college. Following in the footsteps of his father, two uncles and other family members, he headed to NC State — so sure of that path that he never considered applying to other schools.

"I grew up loving this university," said Jackson, a member of the university's William Joseph Peele Lifetime Giving Society and a lifetime member of the Alumni Association. "As a kid, I loved listening to Ray Reeve, the sportscaster doing Wolfpack basketball games on the radio, and getting the chance to go to the Dixie Classic (men's basketball tournament) now and then. Those are wonderful memories."

Fast forward a few decades past his 1964 graduation, and NC State remains Jackson's perfect fit. He has become a dedicated volunteer, advocate and donor supporting a variety of areas at the university.

In 2019, in fact, Jackson received the NC State University Foundation's **Jerry and Elizabeth Godwin Red Torch Award**. The award recognizes extraordinary individuals or families who have volunteered with leadership, dedication and distinction to further the mission of NC State and the foundation, by sharing their expertise, counsel and resources.

Early in the university's current Think and Do the Extraordinary Campaign, Jackson and his wife, Nina, recognized one gap in their NC State giving: the STEM (science, technology, engineering and math) disciplines.

Increasing support for an outstanding faculty has been a key priority of the campaign; eventually, the Raleigh residents decided to endow a faculty position. Jerry Jackson described the commitment as a gratifying way to help advance NC State's purpose — doing work that matters.

In January 2020, Helen Huang was named the inaugural Jackson Family Distinguished Professor in Biomedical Engineering.

The professorship gift was a very personal one, rooted in family, in a long relationship with the university and even in a twist to Jackson's perfect Wolfpack fit. It is also one of the 100 distinguished professorships created as part of NC State's Think and Do the Extraordinary Campaign.

"I'm pleased to help the biomedical engineering department because it's a joint department with UNC-

Chapel Hill. Yes, they're the school that we love to hate, but I think it's absolutely beautiful to draw from the strengths of both schools to do something one couldn't do alone," he said.

Well-rounded and always jumping in

Jackson describes himself as "always a joiner and always curious." As an NC State student, he got involved in a range of activities, including Sigma Chi fraternity and the Interfraternity Council, ROTC and the Pershing rifle team, and the Men's Glee Club. He served as photography editor of the Technician and held a part-time job in the campus print shop as a proofreader.

While enjoying a variety of classes, he changed majors from chemical engineering to textile chemistry before earning a bachelor's degree in textile technology.

Jackson went on to a successful career, capped as chairman of FMI Corporation, the nation's largest provider of management consulting and investment banking to the worldwide construction industry. His book Financial Management for Contractors, published in 1981 by McGraw-Hill, remains in industry use after several reissues.

The path from textile technology to that career might seem indirect. It includes one class in cost accounting and inspiration from an NC State accounting professor, the late Emol "Doc" Fails. The journey also included key mentors and friendships, Jackson said, and invaluable lessons in expanding horizons, pursuing curiosity, thinking critically and turning ideas into reality — all originating at NC State.

"Once you realize that the university played a role in your ability to have some success in life, I think you really have a sense that you should give back," he added. "I had incredible mentors at NC State, and I want to make sure that this university continues to attract and support young talent. It's the way we become truly great."

Jackson reconnected with his alma mater several years after graduation because of the late Banks Talley, longtime university administrator. As a student, Jackson had gotten to know Talley and his wife, Louise, who worked in the financial aid office.

A phone call from Talley about his vision for expanded arts on campus led to Jackson's service as a charter member, then the chair, of the Arts NC State Board. While helping lead the campaign to renovate then-Thompson Theatre, Jerry and Nina gave a gift to name the building's main hall for their fathers (Nina's father graduated from NC State). Their university involvement continued to grow, linked to their broad interests.

The Jacksons co-chaired the campaign to renovate the historic chancellor's residence into the Gregg Museum of Art & Design — naming the formal garden there for their mothers and establishing an endowment to support outdoor programming. They received the university's Bowers Medal of Arts in 2011 for dedication to the mission of bringing the arts to NC State students and the community.

"If you've been away for a while, what you know about this university probably only scratches the surface," Jackson said. "The more involved that Nina and I became, the more passionate we became about the depth and breadth of extraordinary things happening. We became more aware of the limits of state funding and the need for corporate and personal donors to take NC State to the next level, along with the critical need to grow the endowment."

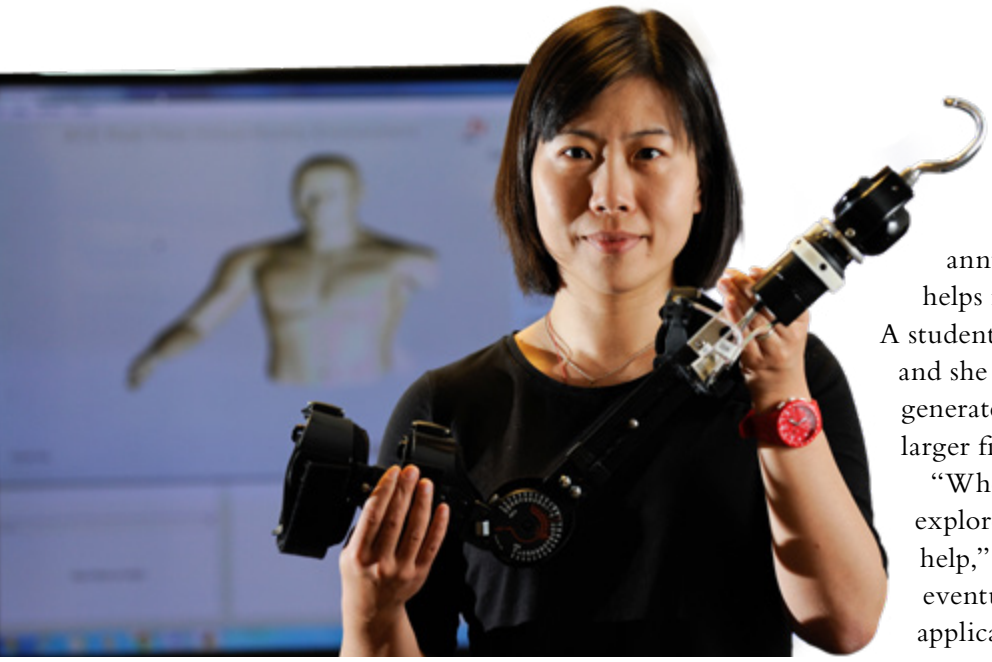
Jackson served on the NC State University Foundation Board from 2010 through 2017, including a term as its chair, and has been a lead volunteer for JC Raulston Arboretum. The couple has established an endowment to provide study abroad scholarships and has supported the Wolfpack Club, Student Emergency Fund, Our Three Winners Fund, Employee Dependent's Tuition Scholarship and Military and Veteran Services, among other areas.

When it came to a STEM gift, Jackson discovered the same kind of certainty he had felt as a teenager preparing for college.

A few years prior, he had been diagnosed with Type 2 diabetes. His and Nina's son, Jay, and daughter, Lane, were each diagnosed with Type 1 years before that. When Jackson began learning about the Joint Department of Biomedical Engineering's innovative work to integrate and harness engineering, math, medicine and science to enhance the health and quality of daily life for people with diabetes, cancer, disabilities and more, he soon found his philanthropic fit.

"It just popped off the page," he said. "Technology and knowledge have advanced so much in improving lives, and we want to see that continue.

"If you feel at all neutral about supporting NC State, I encourage you to get actively involved in an area that interests you. Find a faculty member or administrator in an area that matches your passions and strike up some conversations. I think you'll be impressed with what's going on and want to be part of it."



Fitting technology with human need

Huang, who earned her bachelor's degree from China's Xi'an Jiaotong University and her master's and doctorate from Arizona State University, joined NC State's faculty in 2013. She serves as director of the Closed-Loop Engineering for Advanced Rehabilitation (CLEAR) Core team.

A 2015-16 University Faculty Scholar, she has a list of honors that includes her induction as a member of the College of Fellows of the American Institute for Medical and Biological Engineering. The College of Fellows comprises the top 2 percent of medical and biological engineers, and she was chosen in recognition of outstanding contributions to rehabilitation engineering by developing breakthrough technology for assistive robotic prostheses and exoskeletons.

Being named the Jackson Family Distinguished Professor is certainly among her greatest honors, Huang said.

"Everyone doesn't get that opportunity to be a DP," she said. "You have to be doing innovative research of high importance. It means a lot to me and to the lab's students — it's affirmation that people recognize the hard work we're doing every week and are willing to provide additional funds."

Huang's cutting-edge research targets patients — such as amputees or those who have suffered strokes — with physical disabilities that leave them with limited or low mobility, and impaired daily functions.

"We are not medical doctors on my team," she explained. "We're learning how to use engineering approaches to build devices that can merge with the human body to help someone move or perform daily tasks, or be able to continue doing things they love to do. Our goal is restoring quality of life."

The additional funding that comes annually to a distinguished professor particularly helps fund graduate student research, Huang said. A student might have an innovative idea, for example, and she is able to provide funds for a pilot study to generate data that can then help the team apply for larger financial grants.

"Where does the money come from at first to explore an idea? A professorship is a tremendous help," she said. "These are the ideas that eventually may lead to tech transfer, real-world application and even spinoff companies. The research is not only impacting society and lives, but it can mean a lot for the economy too by translating into job opportunities locally and nationally."

In addition to providing additional opportunities for talented students, private support helps the department do more of what Huang called high-risk, high-reward research, and to build its reputation and competitiveness.

And while her team isn't made up of medical doctors, the Joint Department's partnership means that what happens in her engineering lab can be tested by UNC-Chapel Hill School of Medicine clinicians and with rehabilitation patients in areas like orthopedics and prosthetics.

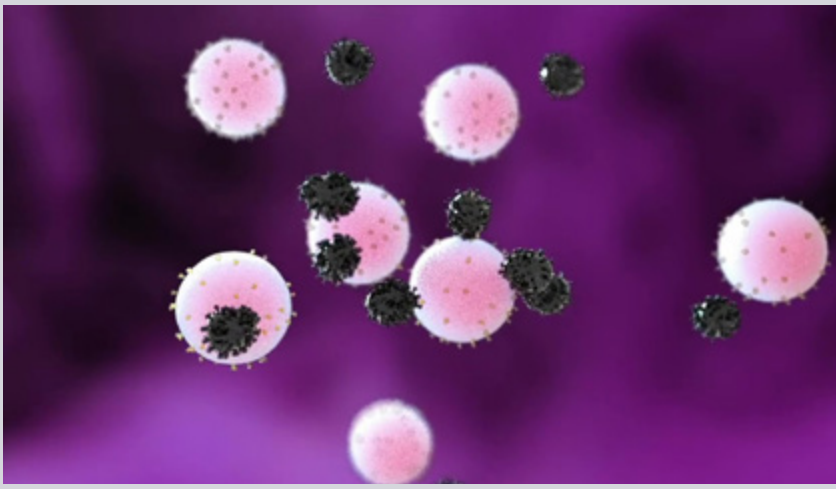
"It's a very, very unique collaboration," Huang said. "You have multiple faculty members in multiple departments working together, building bridges and connections. I'm excited to continue building up what we're doing and to make North Carolina one of the best-known leaders in the engineering and science of rehabilitation."

Huang's work and that of her entire department, aimed at empowering people to be more active and productive, is a perfect fit for Jackson's philanthropic intentions, indeed.

"It's amazing to know that there's research going on at NC State that will mitigate the challenge of living with a chronic disease or disability," Jackson said. "We're so excited to support that kind of work — it's literally what 'Think and Do' is all about. To see a technology on one hand and to see a need on the other — to be able to fit those together in a way that can improve the human condition — that's inspiration.

"That's real talent. That's magic. That's extraordinary." •

"NANODECOY" THERAPY BINDS AND NEUTRALIZES SARS-COV-2 VIRUS



By Tracey Peake,

NC State News Services

NANODECOYS MADE FROM HUMAN LUNG SPHEROID CELLS (LSCs) can bind to and neutralize SARS-CoV-2, promoting viral clearance and reducing lung injury in a macaque model of COVID-19. By mimicking the receptor that the virus binds to rather than targeting the virus itself, nanodecoy therapy could remain effective against emerging variants of the virus.

SARS-CoV-2 enters a cell when its spike protein binds to the angiotensin-converting enzyme 2 (ACE2) receptor on the cell's surface. LSCs — a natural mixture of lung epithelial stem cells and mesenchymal cells — also express ACE2, making them a perfect vehicle for tricking the virus.

"If you think of the spike protein as a key and the cell's ACE2 receptor as a lock, then what we are doing with the nanodecoys is overwhelming the virus with fake locks so that it cannot find the ones that let it enter lung cells," said Ke Cheng, corresponding author of the research. "The fake locks bind and trap the virus, preventing it from infecting cells and replicating, and the body's immune system takes care of the rest."

Cheng is the Randall B. Terry Jr. Distinguished Professor in Regenerative Medicine at NC State and a professor in the Joint Department.

Cheng and colleagues from NC State and UNC converted individual LSCs into nanovesicles, or tiny cell membrane bubbles with ACE2 receptors and other lung cell-specific proteins on the surface.

They confirmed that the spike protein did bind to the ACE2 receptors on the decoys in vitro, then used a fabricated SARS-Co-V-2 mimic virus for in vivo testing in a mouse model. The decoys were delivered via inhalation therapy. In mice, the nanodecoys remained in the lungs for 72 hours after one dose and accelerated clearance of the mimic virus.

Finally, a contract research organization conducted a pilot study in a macaque model and found that inhalation therapy with the nanodecoys accelerated viral clearance, and reduced inflammation and fibrosis in the lungs. Although no toxicity was noted in either the mouse or macaque study, further study will be necessary to translate this therapy for human testing and determine exactly how the nanodecoys are cleared by the body.

"These nanodecoys are essentially cell 'ghosts,' and one LSC can generate around 11,000 of them," Cheng said. "Deploying millions of these decoys exponentially increases the surface area of fake binding sites for trapping the virus, and their small size basically turns them into little bite-sized snacks for macrophages, so they are cleared very efficiently."

The researchers point out three other benefits of the LSC nanodecoys. First, they can be delivered non-invasively to the lungs via inhalation therapy. Second, since the nanodecoys are acellular — there's nothing living inside — they can be easily preserved and remain stable longer, enabling off-the-shelf use. Finally, LSCs are already in use in other clinical trials, so there is an increased likelihood of being able to use them in the near future.

"By focusing on the body's defenses rather than a virus that will keep mutating we have the potential to create a therapy that will be useful long-term," Cheng said. "As long as the virus needs to enter the lung cell, we can keep tricking it."

The research appears in *Nature Nanotechnology* and was supported by the National Institutes of Health and the American Heart Association. Dr. Jason Lobo, pulmonologist at UNC, is co-author of the paper. •

Jump-starting startups

By DeLene Beeland,

UNC College of Arts & Sciences

WHILE MANY ESTABLISHED BUSINESSES slowed down at the onset of the pandemic in 2020, startup ideas at UNC-Chapel Hill got a boost from a new program called the KickStart Accelerator.

Two life sciences ventures recently founded by UNC faculty members, Perotech Corp. and Triangle Biotechnology, embody the university's culture of supporting faculty members who have ideas with the potential for commercialization.

Both companies have benefited from the accelerator, part of a pilot program for the Institute for Convergent Science in the Genome Sciences Building. The accelerator mobilizes diverse teams of researchers, designers, entrepreneurs and others.

Perotech seeks to develop a next-generation medical imaging device. Triangle Biotechnology is developing products and equipment that labs can integrate seamlessly to save time and costs for processing biological samples.

Founders from both startups say they never dreamed of starting their own businesses — until suddenly they saw no reason not to.

Revolutionizing DNA extraction

Triangle Biotechnology was born from scientists seeking a shortcut at the lab bench 10 years ago.

Samantha Pattenden, an associate professor in UNC's Eshelman School of Pharmacy, was experiencing a common problem: breaking up DNA. A necessary step to prepare samples for next-generation genomic sequencing, this is typically achieved with ultrasound or enzymes.

Next-gen sequencing is used for large numbers of samples containing genetic material — say, saliva collected in tubes from people curious about their ancestry — and these are processed en masse, by a sequencing instrument. But for this technology to work, the DNA in the samples must first be broken up into very short, uniform segments, a feat that has proved stubbornly hard.

One of the technicians in Pattenden's lab had heard that another UNC lab — run by Paul Dayton, a professor and interim department head in BME — used microbubbles for a similar problem. Dayton's work investigates ultrasound for clinical imaging and diagnostics, and microbubbles are frequently used as a contrast agent. The lipid-shelled, 1-micron gas-filled spheres wiggle and vibrate in the presence of high-energy acoustic waves.

"We were using the microbubbles therapeutically and for imaging of various body parts, but it turns out they can also, by the same mechanisms of vibration and mechanical agitation, help the problem that Sam was having," Dayton said.

The pair collaborated and improved the efficiency by miniaturizing the microbubbles into nanodroplets — five to seven times smaller and filled with a liquid core instead of a gas — that sheared DNA into short, uniform segments of a predictable length when exposed to high-energy sound waves. They eventually obtained two patents related to this technology.

"I was encouraged when one of Sam's colleagues at the university started using the nanodroplets, too," Dayton said. "I thought, 'Wait a second; others at UNC want this technology, so clearly there's a desire for it.'"

Though the pair were interested in launching a company, they did not have the expertise. They were connected to Joe McMahon, a businessman who had previously directed several biotech companies, and who became a co-founder and, later, Triangle Biotechnology's CEO.

Today, the company's main product is the nanodroplet reagent for biological samples, an innovation that simultaneously shreds 96 DNA samples in 10 minutes. Their biggest competitor takes two hours to process that number of samples.

The company's chief technology officer, Sunny Kasoji (B.A. '12, Ph.D. '18, biomedical engineering), said that their technology also costs less.

"Nanodroplets eventually ended up having a large market for us. Once we started doing customer interviews, we realized there were so many applications for this apart from just shearing the DNA," Kasoji said. Soon they were developing and marketing the nanodroplets to also break up tissues, bacteria and plants.

In early 2021, Triangle Biotechnology moved out of the KickStart Accelerator space that it had occupied for a year and into space in Research Triangle Park.

Kasoji, who was Dayton's graduate student and performed research on the nanodroplets, said that when he was a student, he thought startups were too risky for employment right after graduate school.

"But it's been a great experience for me to see my research through to the ultimate end," he reflected. "I consider myself very lucky and I've caught the bug. The startup space is where I want to be."

Transforming medical imaging devices

Imagine a portable medical imaging device that is flexible enough to wrap around injured limbs or brought to patients who can't be easily moved. Now imagine that the radiograph this device makes has an image quality that is 100 to 1,000 times better than what's currently on the market — all for a vastly lower cost.

That's the vision of Jinsong Huang, founder of Perotech. Huang has researched a special material structure called perovskite for the past eight years. While characterizing its properties for solar energy applications — it has good electronic properties — he and his team discovered that it also works well for detecting X-rays.

"Perovskite has a good stopping power; it has lead inside which can stop or absorb X-rays efficiently, and we can see the X-ray photons," said Huang, who is the Louis D. Rubin Jr. Distinguished Professor in UNC's Department of Applied Physical Sciences.

Perovskite is highly sensitive to detecting X-ray photons, which means it can make more detailed images from a comparatively lower dose of radiation.

"If we can make the detector more sensitive, then we can dramatically reduce the radiation dose to the patient," Huang said. "We can make X-ray imaging much safer for people."

The lightweight, portable nature of his concept has many different applications. Hospital patients who are too unstable, or too infectious, to be moved to a common radiography room can have the new imaging device brought to their bedside. Soldiers injured on a battlefield could be treated by a medic who unrolls the bendable, compact device to image injuries on the spot.

Perotech moved into the KickStart Accelerator in 2020, and Huang credits the incubator with providing not just lab space and equipment but also advice on grants and accounting. Perotech has established proof of its concept, and the company plans to produce a full-sized X-ray detector prototype by 2023.

"I researched perovskite for eight years, and I was waiting for someone to commercialize my work," Huang said. "Then I received calls from big companies saying they wanted to buy a product, and some asked me to make a product, so that made me think about it."

Huang said he hesitated, but that he thought it was worth pursuing due to the big improvements of perovskite over existing materials. •

Rethinking drug delivery systems

By Mary Lide Parker,

UNC College of Arts & Sciences

LISTENING TO RAHIMA BENHABBOUR describe the research in her lab feels a bit like peering into the future of medicine. Are these things already possible?

Injectable HIV prevention, 3D-printed intravaginal rings, patented hydrogel, biodegradable implants — just to name a few.

"We focus on developing polymer-based devices that can go into the human body," Benhabbour said. "The challenge is to make them feasible and bio-compatible."

Take the patented hydrogel, for example. Made of all-natural polymers, this novel substance was developed by Benhabbour and her team to be used in regenerative medicine applications, from regrowing bones to treating cancer.

In April, the BME **researcher received $3.74 million to create an injectable technology** that will provide long-acting protection for women against sexually transmitted pathogens and prevent pregnancy, but is also removable.

Benhabbour, an assistant professor in BME, said her career in developing drug delivery systems stems from a lifelong love of chemistry.

In grade school, she enjoyed the problem-solving components of her math and science classes, but chemistry quickly became her favorite subject.

"I loved the making of chemistry," Benhabbour said. "It was all passion from day one."

Born and raised in Algeria, Benhabbour grew up listening to her father, a geologist, talk about earth science. After high school, she attended the Algerian Petroleum Institute, where she earned a degree in engineering. She came to the United States to pursue a master's degree in chemistry, completed her doctoral work in Canada and then joined the UNC Eshelman School of Pharmacy in 2011 as a postdoctoral fellow.

Going into pharmacy was a departure from the "traditional" career path for a Ph.D. chemist. But Benhabbour knew she was in the right place.

"They were experts in drug delivery — making platforms I hadn't used before, and I wanted to learn something different," she said. "I wanted to extend my knowledge beyond everything I knew at that stage."

She became a faculty member in the Joint Department in 2017 and holds an adjunct appointment in pharmacy. Her thirst for knowledge naturally evolved into a desire to help people — especially at-risk populations.

"As a woman from Africa, I wanted to find a way to help those women," Benhabbour said. "They are so vulnerable. I wanted to create a mechanism they could use to protect themselves."

Inspired by a project she worked on in her postdoctoral research, Benhabbour decided to make an intravaginal ring that could serve a variety of women's health needs — from infertility to HIV prevention — empowering marginalized women in Africa (and elsewhere) to take their healthcare into their own hands.

The challenge came in manufacturing the device. The time required made it impractical to help a large number of women.

After watching then-UNC professor Joseph DeSimone give his TED talk on faster 3D printing, Benhabbour wondered, "What if we could make an intravaginal ring with complex geometry at that speed? It would completely overcome all the manufacturing hurdles."

In collaboration with the DeSimone lab, Benhabbour developed prototypes, filed a patent and started thinking about forming a company.

In 2016, she officially founded AnelleO with a simple motto: "Where 3D printing meets women's health." In May 2017, AnelleO received its first seed funding from Carolina's KickStart Venture Services.

The motivation for starting a company, Benhabbour said, has always been philanthropic. By focusing on a for-profit product, the company can rapidly develop the technology, then direct needed resources into humanitarian causes.

Benhabbour considers the supportive, innovative environment at Carolina an essential component of her success — especially the direct access to clinicians.

"As a bench scientist, you really have to have that connection," she said. "If I don't know what their hurdles are, how can I design the right technology? Hearing about patients' experiences is what gets ideas going." •

INNOVATING AND INSPIRING: **MEET FADUMA OSMAN**

By Christy Sadler,

NC State University Communications

FADUMA OSMAN'S ROAD TO NC STATE started about 8,000 miles away.

When the NC State freshman was one year old, her family left the refugee camp in Kenya where she was born and boarded a plane bound for Charlotte, NC. They didn't know anyone in the United States — or much of anything about the country — but they had hope that it would be better than the camp or the home in war-torn Somalia they had fled on foot more than a decade before.

Though she doesn't remember her life before she came to North Carolina, Osman knows that what her parents went through during their harrowing journey out of Somalia and 12 difficult years in the refugee camp has shaped life for her and her eight siblings.

"Since I was little, my parents have told us stories of what they went through to get here because they wanted us to know our roots and appreciate every opportunity we have," Osman said. "We could have been living in a war zone instead of in a place where we have a chance for things like a college education."

Osman has seized that chance, earning a place in the Joint Department — and a full scholarship through the Pack Promise program, which offers financial support for students with demonstrated need.

Engineering a better future

From a young age, Osman has enjoyed learning.

"I always liked going to school and did pretty well, especially in math and science," she said.

No woman in Osman's family had attended college, but after one of her older brothers graduated from UNC-Charlotte, she knew she might be able to become the first.

"Seeing him go through college, graduate with a degree and get a job in his field showed me it was possible for me," Osman said.

She participated in the Carolina Youth Coalition, a college-prep program that helps high-achieving under-resourced students prepare to attend and succeed in college. "The mentors there were amazing in guiding us through the college admissions process since we didn't know much about it," she said.

Osman's interest in biomedical engineering was sparked during a career day in 10th grade. After her grandfather in Somalia contracted a tumor, she had wondered what role she could play in improving medicine in developing countries. She had considered becoming a doctor, but after she learned about careers in biomedical engineering, she realized she was more interested in how she could drive innovation in medical tools.

"My main goal is to make the tools that doctors use better and safer to improve patients' experiences," Osman said. "I'm hoping I can travel to Somalia frequently to help improve medical care there."

Part of the Pack

Though she applied to many colleges, she knew all along which one was her favorite.

"NC State always stood out to me because I loved the campus when I came to visit," Osman said. "And the College of Engineering seemed ideal because they offer a lot of opportunities to help you be successful. I feel like they really care about my future after I leave here."

While receiving her first college acceptance was an exciting moment, she was holding out for her dream school. She found out that NC State's admissions decisions had been released one day when she was working at her part-time job at Chick-Fil-A.

"I was scared to check because I was afraid I would start crying if I didn't get in," Osman said. "When I saw I was accepted, I freaked out and told everyone. I knew this was where I wanted to be."

And if she had any doubts, the Pack Promise scholarship sealed the deal.

"It was going to be hard for me to pay for college without working a lot," she said. "I'm so thankful for this scholarship because it allows me to be laser-focused on school and my college experience."

Osman wasted no time making the most of her new home, finding favorite spots on campus, enjoying Welcome Week events and sharing meals with new friends from her residence hall.

"It's been great to see how this big campus can still feel very homey," she said.

Though she misses her family, she's been bringing her younger siblings along on her adventure, sending them updates on her life around campus as she works out in the gym or eats in the dining hall. She hopes that seeing what college life is like will inspire them to reach for that goal, just like her parents' and older brothers' work ethics inspired her. One of her younger brothers already wants to pursue engineering, too.

"It means a lot to me to know that I'm in a place in my life where they can look up to me," Osman said. "There's no way my parents could have gone through what they went through for me not to do the best I could to succeed. And my brothers and sister can see what their future can be like if they work hard, too." •

"NC State always stood out to me because I loved the campus when I came to visit, and the College of Engineering seemed ideal because they offer a lot of opportunities to help you be successful. I feel like they really care about my future after I leave here."

Faduma Osman

FACULTY AND STAFF NEWS

Rahima Benhabbour

Benhabbour receives NIH grant

The lab of Rahima Benhabbour, assistant professor in the department, has received a $3.74 million grant over five years from the National Institute of Allergy and Infectious Diseases (NIAID) of the National Institutes of Health (NIH). The grant will fund the creation of an injectable that will provide long-acting protection for women against sexually transmitted pathogens and prevent pregnancy, but is also removable.

The work will be a collaboration amongst Benhabbour's lab and three researchers at the Centers for Disease Control and Prevention. They will develop a new, ultra-long-acting In-Situ Forming Implant (ISFI) drug delivery system as a multi-purpose prevention technology (MPT) for the prevention of HIV and unplanned pregnancy.

MPTs for the protection of women against sexually transmitted pathogens and prevention of pregnancy are in a phase of accelerated encouragement and development, with multiple drugs and delivery systems. Long-acting (LA) MPT formulations that provide sustained drug release over weeks or months can potentially enhance compliance to prophylactic therapies and reduce the incidence of new HIV infections and unintended pregnancy.

Currently, there are no LA injectable MPT formulations in development, mainly because of limitations of current LA injectable formulations utilizing nanoparticle suspensions like cabotegravir and rilpivirine. These limitations include inability to combine two drugs into one formulation, and once administered, nanoparticle formulated LA injectable drugs cannot be removed in the event of breakthrough infection, toxicity, allergic response or pregnancy.

Benhabbour and her collaborators will address these limitations by creating an ultra-LA ISFI formulation that is simple to prepare, biodegradable, can incorporate an antiretroviral and a contraceptive drug with an initial targeting of more than six months of sustained release, and can be removed to terminate the treatment regimen if required.

Benhabbour also received a Young Investigator Award from the Controlled Release Society (CRS), where she was invited to give a talk to the Transdermal and Mucosal Delivery (TMD) Focus Group. The CRS is a not-for-profit organization devoted to the science and technology of controlled delivery worldwide.

Jacqueline Cole

Cole receives two Outstanding Teaching Awards

Jacqueline Cole, associate professor, received two 2021 Outstanding Teaching Awards. In 2021, NC State honored more than 30 faculty members for their commitment to educational excellence. As a recipient of the Outstanding Teacher Award, Cole becomes a member of the Academy of Outstanding Teachers for as long as she remains NC State faculty.

Cole also received a 2021 Outstanding Teacher Award from the NC State Alumni Association, which since 1968 has been recognizing top-flight faculty members with stipends. This year, the Association awarded 25 faculty members a total of $70,000. Nominations were made by deans, department heads, peers and students.

BME team shares first place in NC State eGames

Ross Petrella, BME teaching assistant professor, and Michael Sano, BME assistant professor, and their team shared first place in this year's eGames, NC State's annual startup competition that awards over $100k in cash prizes. The team's project, "Gradient Medical: ACE (Algorithmically Controlled Electrotherapy) to target and eliminate cancerous tumor cells," won $25,000, which can be used for critical early-stage business expenses. The team also included BME student Chris Fesmire.

George Ligler

Ligler invited to join board

George Ligler, dean's eminent professor of the practice in biomedical engineering, has been invited to join the Board of Aeronautics and Space Engineering (ASEB) of the National Academies of Sciences, Engineering, and Medicine for a three-year term ending on Dec. 31, 2023.

The ASEB was established in 1967 "to focus talents and energies of the engineering community on significant aerospace policies and programs." The board oversees ad hoc committees that recommend priorities and procedures for achieving aerospace engineering objectives and offers a way to bring engineering and other related expertise to bear on aerospace issues of national importance. Over the last three years, Ligler has participated in two studies done under the aegis of this board, chairing one of them.

Brown wins Therapeutics People's Choice Award

BME Associate Professor Ashley Brown won the Therapeutics People's Choice Award for her pitch at Equalize 2021, the only pitch competition for women in academia, hosted by Washington University in St. Louis. Brown gave a pitch about a new synthetic platelet technology to stop bleeding and promote healing after injury that is being developed by her startup company, Selsym Biotech, Inc.

Selsym Biotech, Inc. is an early-stage biotechnology company, started in cooperation with the Office of Technology Commercialization and New Ventures at NC State, with the goal of developing novel hemostatic materials for treating bleeding. Brown's long-term research goals are to understand mechanisms involved in coagulation and develop novel therapies that augment the body's native clotting and subsequent healing processes.

Equalize is a virtual mentor program and pitch competition designed to take national action around the disparity of women academic inventors forming university startups.

Ashley Brown

Donald Freytes

Brown and Freytes selected as Goodnight Early Career Innovators

Ashley Brown and Donald "Danny" Freytes, BME associate professors, were selected to the 2020-21 inaugural class of NC State's Goodnight Early Career Innovators.

The award supports early career faculty excellence and advancement in STEM or STEM education. The program is part of NC State's strategic efforts to invest in and retain top faculty members. Chancellor Randy Woodson noted that "the Goodnights' investment in our faculty helps us recruit and retain innovative minds, and ensures they have the resources they need to address our world's grand challenges."

The 24 faculty members selected will receive $22,000 for each of the next three years to support their scholarship and research endeavors. Faculty recipients were nominated by their colleges and selected by a committee of senior leaders in the Office of the Executive Vice Chancellor and the Provost and the Office for Research and Innovation.

Kennita Johnson

Johnson wins 2021 Diversity Award

Kennita Johnson, BME assistant professor and director of diversity and equity, is one of the two faculty winners of the 13th annual Diversity Awards, which recognize individuals

and groups who have given their time and effort to further diversity, equity and inclusion at UNC and in the surrounding community.

Provost Bob Blouin recognized the impact of the awards, especially during such difficult times, stating, "… The pandemic, as well as political tensions and calls for social and racial justice across our nation, continue to present significant challenges. Despite these hurdles, our award recipients have demonstrated in extraordinary ways that their tireless efforts and commitment to diversity, equity and inclusion are integrally connected to all aspects of the University's strategic plan, Carolina Next: Innovations for Public Good."

This year's winners were chosen from a record number of nominations.

Lianne Cartee

Cartee named Alumni Association Distinguished Undergraduate Professor

Lianne Cartee, BME teaching professor, was named a Distinguished Undergraduate Professor by the NC State Alumni Association.

This group recognizes faculty members who excel in the classroom, laboratory and in the field. For more than 50 years, the NC State Alumni Association has recognized top faculty members with stipends that today range from $1,000 to $4,000. This year, the Association awarded 25 faculty members a total of $70,000. Nominations were made by deans, department heads, peers and students.

Helen Huang

Huang receives Alcoa Foundation Engineering Research Award

Helen Huang, the Jackson Family Distinguished Professor in Biomedical Engineering, received the Alcoa Foundation Distinguished Engineering Research Award, which is given to a senior faculty member for research achievements made over a period of at least five years in NC State's College of Engineering. Recognized internationally for her work in rehabilitation engineering, Huang is the director of the Closed-Loop Engineering for Advanced Rehabilitation (CLEAR) core, which studies human-machine interactions and develops advanced wearable rehabilitation technologies. She has led the way in research of neural control of robotic upper- and lower-limb prostheses and she is published widely in the top journals in the fields of biomedical engineering, rehabilitation engineering, neural engineering, biomechanics and robotics.

Nancy Allbritton

Allbritton receives Pritzker Distinguished Lecture Award

Nancy Allbritton, current University of Washington College of Engineering dean and professor of bioengineering and 2009-19 Joint Department chair, received the 2021 Robert A. Pritzker Distinguished Lecture Award, the premier recognition by the Biomedical Engineering Society (BMES) for outstanding achievements and leadership in the science and practice of biomedical engineering. She accepted the award at the BMES annual meeting on Oct. 7 in Orlando, Fla.

Allbritton's research focuses on biomedical microdevice development. She is an international expert on multiplexed single-cell assays, microfabricated platforms for high-content cytometry combined with cell sorting, and microengineered stem-cell-based systems for re-creating human organ-level function. Her work has resulted in 45 issued and pending patents and led to 15 commercial products. She has co-founded four start-up companies based on her research discoveries: Protein Simple (acquired by Bio-Techne in 2014), Intellego, Cell Microsystems and Altis Biosystems.

She has been nationally recognized for her research and is a Fellow of the American Association for the Advancement of Science, the American Institute for Medical & Biological Engineering and the National Academy of Inventors.

Allbritton delivered a plenary lecture on her research in designing biomedical microdevices for simplicity and reliability during the BMES meeting.

Hubbard wins 2021 College of Engineering Award for Excellence

BME's NC State undergraduate

Lesley Hubbard

student services administrator Lesley Hubbard is one of the College of Engineering's two SHRA winners of the 2021 Awards for Excellence.

Hubbard's recognition as a COE Awards for Excellence recipient was announced at a virtual ceremony held in late April. An Award for Excellence is the most prestigious honor bestowed upon nonfaculty employees. This award recognizes the outstanding accomplishments and contributions of individual employees who do not hold faculty rank, and who go above and beyond an employee's normal job responsibilities.

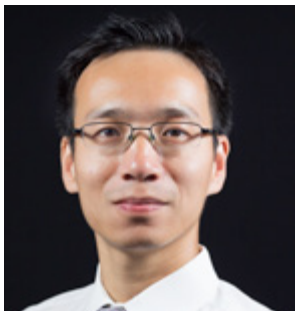
Awards are given in two employment categories: those exempt from the Human Resources Act (EHRA) and State Human Resources Act (SHRA) employees, who carry out a wide range of activities in support of NC State's mission. Hubbard's selection for one of this year's awards was based on her excellence in assigned tasks and also her outstanding support of BME students, often being instrumental in their successful completion of our demanding program. Hubbard exemplifies outstanding overall service, and in particular is the essential link for students, alumni, prospective students and parents.

Pégard named Beckman Young Investigator

Nicolas C. Pégard, assistant professor in UNC's Department of Applied Physical Sciences and adjunct assistant professor of biomedical engineering, has been selected as a 2021 Beckman Young Investigator (BYI), with a grant award of $600,000 to support his proposed research, "Bidirectional Neuroprosthetics with Miniature Optical Brain Machine Interfaces."

Pégard's optical brain machine interfaces use light to monitor and manipulate neural activity. His BYI project seeks to develop a large area interface to communicate with multiple brain regions and address tens of thousands of neurons in parallel, and also to develop a miniature interface to perform read-write operations in real time with single-cell specificity in unrestrained mice. The Arnold and Mabel Beckman Foundation selected Pégard from a pool of over 300 applicants after a three-part review led by a panel of scientific experts.

The Beckman Young Investigator Program was established in 1991 with the mission of supporting the most promising young faculty members in the early stages of their academic careers in the chemical and life sciences particularly to foster the invention of methods, instruments and materials that will open up new avenues of research in science.



Ke Cheng

Cheng and Gu elected Fellows of International Academy of Medical and Biological Engineering

Current BME faculty member Ke Cheng and former professor Zhen Gu were welcomed and elected as two of the 26 Fellows to the 2021 class of The International Academy of Medical and Biological Engineering (IAMBE).

Cheng, Randall B. Terry, Jr. Distinguished Professor of Regenerative Medicine, was elected "for contributions in developing novel biomaterials and cell therapies for tissue engineering and regenerative medicine and apply them in clinical trials." Gu, now Qiushi Distinguished Professor and Dean of College of Pharmaceutical Sciences at Zhejiang University, China, was elected "for outstanding contributions to advancing fundamental and technological innovations in the field of drug delivery."

The IAMBE, affiliated with the International Federation of Medical and Biological Engineering (IFMBE), is made up of Fellows who are recognized for their outstanding contributions to the profession of medical and biological engineering. Election to the Academy is highly selective, initiated by nominations which are involved with at least three current Fellows and screened by the Membership Committee of the Academy. The election is conducted by a vote of all Fellows of the Academy. There are currently fewer than 250 Fellows worldwide.

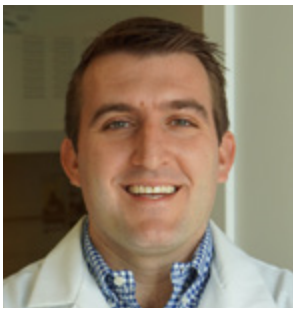
BME faculty members lead training grant

NC State's Comparative Medicine Institute (CMI) was recently awarded two National Institutes of Health T32 Training grant awards to support interdisciplinary team science training of graduate students. One of the grants, on the topic of comparative molecular medicine, is a significant collaboration with numerous BME faculty members.

This grant is titled "Training Grant in Comparative Molecular Medicine" and is co-led by BME faculty members Ke Cheng and Matt Fisher as well as April Kedrowicz and Jorge Piedrahita. This training grant is a collaboration between the Comparative Biomedical Sciences, BME and Cellular & Biomolecular Engineering graduate programs. In addition, it has faculty mentors from both UNC Chapel Hill and Duke University Medical Schools. BME's other mentors include faculty members Ashley Brown, Jacque Cole, Michael Daniele, Danny Freytes, Alon Greenbaum and David Zaharoff.

The second T32 award is led by Joshua Pierce and Gavin Williams, and is based in the Chemistry of Life Program. This award will focus on the interface of chemistry and the life sciences, and bridges molecular focused researchers from across NC State. This program is the result of a multi-year collaboration between CMI and the Department of Chemistry, now expanding to include five graduate programs from four colleges.

Combined, both grants involve over 60 faculty mentors distributed across multiple NC State colleges. They will directly impact nine to 10 new Ph.D. students per year as well as a much greater number indirectly through the creation of new courses and related minors.



Bill Polacheck

Polacheck receives AHA Career Development Award

Bill Polacheck, BME assistant professor, has received an American Heart Association (AHA) Career Development Award for his research project, "The Role of the Notch Mechanosensory Complex in the Vascular Endothelium." The AHA Career Development awards are given for three-year periods to promising investigators to support training and development to enhance future success as independent research scientists.

The total award of $231,000 may be used for salary and fringe benefits of the principal investigator, collaborating investigator(s), mentoring team members and other participants and for project-related expenses. Polacheck's laboratory is an interdisciplinary team of scientists and engineers who build microfluidic models of human tissues. They use these human microtissue models to study how cells interact with their environment and how these interactions are disrupted in diseases, with the long-term objective of building tissue engineered therapies for organ replacement and regenerative medicine.

Jason Franz

David Lalush

Franz, Lalush awarded UNC research grants

Jason Franz and David Lalush, BME associate professors, have each been awarded a one-year Pilot & Feasibility Research Grant of up to $25,000 in funding by UNC's Thurston Arthritis Core Center for Clinical Research (CCCR).

Franz said of the award, "So very thankful to have the support of UNC Thurston Arthritis Research Center to accelerate our new interdisciplinary line of research into the association between muscle action, inflammatory biomarkers, and cartilage loading during walking in people with osteoarthritis." Lalush's research focuses on identifying biomechanics phenotypes at risk for post traumatic osteoarthritis.

The objective of the pilot and feasibility research grant program is to provide seed money to initiate new and innovative projects in the areas of phenotyping and precision medicine that will enhance work being done in the UNC CCCR, and generate preliminary data needed to develop projects that will successfully compete for extramural support.

Bandodkar makes *Tech Review* list of top young innovators

Amay J. Bandodkar, an assistant professor of electrical and computer engineering at NC State, has been named one of the *MIT Technology Review* "Innovators Under 35" for his work on developing wearable biochemical sensors.

The annual list, which Tech Review has issued since 1999, was created to highlight exceptionally talented young innovators from around the world in a variety of fields. Previous winners include Mark Zuckerberg, Larry Page, Sergey Brin and Vivian Chu.

Bandodkar works at the interface of electronics, materials science and biology to create next-generation wearable sensors with biomedical applications such as disease monitoring.

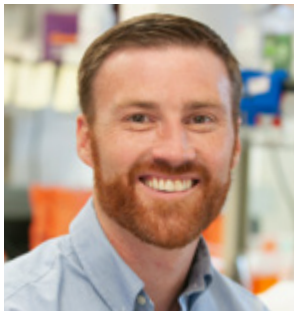
Bandodkar is part of the university's National Science Foundation-funded ASSIST Center and is an affiliated faculty member with BME.

Collaboration co-led by Franz selected for funding

After an extensive review and live pitch to their industry advisory board, the Eshelman Institute for Innovation has selected co-principal investigators Jason Franz, BME associate professor, and Brian Pietrosimone, UNC Exercise and Sport Science associate professor, for funding designed to drive cutting-edge technologies that solve the most pressing healthcare challenges.

Their proposal is the first in the history of the Eshelman Institute for Innovation from outside the School of Pharmacy to be selected for funding. Franz and Pietrosimone will leverage wearable sensors and machine learning techniques, complete proof-of-concept testing and develop a market hypothesis and initial business case for a novel technology to restore normal joint loading following lower extremity joint injury or surgery for the purpose of maintaining long-term joint health.

They will also work with Adam Kiefer, exercise and sport science assistant professor, and, through the NC State ASSIST Center, Michael Daniele, BME associate professor, and Edgar Lobaton, associate professor in the Department of Electrical and Computer Engineering.



Brian Diekman

Diekman Lab awarded two grants for osteoarthritis research

Brian Diekman, BME assistant professor, and his team have been awarded two National Institutes of Health grants totaling more than $400,000 for osteoarthritis research (OA). An R21 grant provides two years of funding for "high risk / high reward" projects. Diekman's lab will study a small genetic change that encodes an extra-cellular matrix protein known as chondroadherin-like. While rare, those with this genetic risk factor are nearly eight times more likely to have a total hip replacement due to OA. Understanding how this change accelerates the aging of cartilage will lead to a better understanding of this process across patients of all genetic backgrounds.

An R56 grant provides one year of funding to enable a project to begin while applying for long-term R01 funding. Diekman has teamed up with Richard Loeser, a leading rheumatologist and director of the UNC Thurston Arthritis Research Center, and Jeremy Purvis, associate professor in the UNC Department of Genetics, to study how chondrocytes change during aging. Chondrocytes that become senescent are thought to contribute to the loss of cartilage, but more work is needed in order to selectively eliminate these cells as a treatment for OA.

These grants will support the overall goal of the Diekman lab, which is to elucidate the biology of aging as a way to catalyze new therapeutic strategies for osteoarthritis.

Two faculty members received NC State Chancellor's Innovation Fund awards

Two of six 2021 NC State Chancellor's Innovation Fund awards were given to BME faculty projects. The Chancellor's Innovation Fund (CIF) provides seed funding to a select few NC State research projects each year that have promise for market success.

"The goal is to provide the critical funding needed to translate technologies to a point where a startup can be formed for commercialization or a license can be executed with an existing company," said Wade Fulghum, assistant vice chancellor of the Office of Research Commercialization.

Yevgeny Brudno and Michael Williams have developed a biomaterial that could shorten the production of CAR-T cells, which are genetically engineered to recognize and destroy cancerous cells. They will use CIF support to determine if their algae-based, dime-sized scaffolds could be implanted in animal trials to look for undesired side effects.

Michael Daniele, associate professor, has developed a microfluidic device that might be able to mimic the blood-brain barrier much more closely than current testing models can. Daniele's 3D chip contains two engineered-tissue components forming an interface that fits in the palm of your hand. CIF support will be used to validate that the technology can simulate the blood-brain barrier function continuously for multiple days during drug screening.

Fran Ligler

Ligler receives ACS National Award in Analytical Chemistry

The 2022 American Chemical Society (ACS) National Award in Analytical Chemistry, sponsored by Battelle Memorial Institute, will go to BME Ross Lampe Distinguished Professor Fran Ligler. She will be honored at the awards ceremony March 2022, in conjunction with ACS spring meeting in San Diego, Calif.

The ACS National Awards program is designed to encourage the advancement of chemistry in all its branches, to support research in chemical science and industry and to promote the careers of chemists. Ligler has more than 400 publications, including 35 U.S. patents and four books, and has served on editorial boards for nine journals. Her inventions have been directly commercialized in 11 biosensor products used in food production plants, clinics in developing countries, pollution cleanup sites and areas of concern for military and homeland security.

Nitin Sharma

Sharma wins NIBIB Trailblazer R21 Award

Nitin Sharma, BME associate professor, and his collaborators have been awarded a National Institutes of Health Trailblazer R21 Award for research on data-driven modeling and ultrasound-based control of afferent nerve stimulation for tremor suppression. The Trailblazer R21 Award is an opportunity for early stage investigators to pursue research programs of high interest to the National Institute of Biomedical Imaging and Bioengineering (NIBIB) at the interface of the life sciences with engineering and the physical sciences.

Sharma's Trailblazer project proposes ultrasound-based control of afferent nerve stimulation for tremor suppression in people with Parkinson's Disease, which affects more than 11 million people in the United States. Individuals experiencing tremors in the hands and arms face difficulty performing activities of daily living. Electrical stimulation that works by stimulating motor nerves of antagonistic muscles is a potential wearable option for tremor suppression when medication is ineffective, but prior to pursuit of effective yet invasive (and costly) brain surgery. However, there is a wide performance variability in existing stimulation-driven tremor suppression methods. Measurements of muscle tremors with ultrasound can help create a data-driven model of stimulation and help design individual-specific afferent stimulation parameters. However, ultrasound has never been used for tremor suppression control. Real-time algorithms and models that map ultrasound-derived muscle activity to oscillating limb displacement are yet unestablished.

Sharma's research collaborators include Caterina Gallippi, BME professor; Xiaoning Jiang, Dean F. Duncan Distinguished Professor in the Department of Mechanical and Aerospace Engineering at NC State; Daniel Roque in the Department of Neurology at UNC; and Tanya Garcia in the Department of Biostatistics at UNC.

Julia Rao

Rao receives Pride of the Wolfpack Award

The department's academic advisor Julia Rao is among the 2021 Pride of the Wolfpack award winners.

Rao joined the department in 2020, following more than two years as a manufacturing and process engineer at Corning Incorporated. She graduated from NC State as a mechanical engineer in 2017. As an academic advisor, Rao advises current students, transfer students and first-year students to stay on track, pick specializations within the field, understand requirements to graduate and participate in out-of-classroom opportunities. She also works with prospective students/parents about requirements for acceptance, credit transfer, department opportunities, etc.

Each quarter, EHRA non-faculty & SHRA employees may be nominated for the Pride of the Wolfpack Award. It recognizes individuals who demonstrate university values, and recipients receive a certificate and mug sponsored by NC State Bookstores and designed exclusively for Pride of the Wolfpack winners. •

STUDENT NEWS

Three receive NSF Graduate Research Fellowships

Three students with BME ties have received National Science Foundation Graduate Research Fellowships.

Emily Lambeth is an undergraduate alumna of the department. Siena Mantooth is a current BME graduate student, mentored by David Zaharoff. Isabella Young, UNC School of Pharmacy graduate student, is mentored by Rahima Benhabbour.

Fellows benefit from a three-year annual stipend along with an allowance for tuition and fees, opportunities for international research and the ability to conduct research at any U.S. institution they select.

Kodikara named a 2021 Beckman Scholar

Seth Kodikara

BME undergraduate student Seth Kodikara has been named a 2021 Beckman Scholar in NC State's Chemistry of Life Program.

The Beckman Scholars Program is a 15-month mentored research experience for exceptional undergraduate students in chemistry, biological sciences or interdisciplinary combinations thereof. Kodikara will be working jointly with Balaji Rao and Albert Keung in the Department of Chemical and Biomolecular Engineering on an epigenetics project with the goals of eventual presentation and publication. Two undergraduates were selected at NC State this year and two more will be selected in each of the next two years.

Traenkle wins 2021 Mathews Medal

Matt Traenkle

Matt Traenkle, a Park Scholar and BME undergrad student, was recognized for his legacy of leadership with the Mathews Medal, which recognizes graduating students who made NC State a better place.

As co-chair of the Park Philanthropy Council, Traenkle helped raise $765,000 for the Park Scholars Program during the 2019 and 2020 NC State Day of Giving campaigns. He managed one of NC State's signature traditions, the Krispy Kreme Challenge, raising $175,000 for UNC Children's Hospital. As vice president and engagement manager for NC State's Consult Your Community, Traenkle helped select and manage diverse student teams to solve problems for local businesses.

Traenkle served as an ambassador for Parks Scholars and the College of Engineering, as well as philanthropy chair for Beta Theta Pi, a fraternity dedicated to mutual assistance, intellectual growth, trust, responsible conduct and integrity.

Ph.D. student Mandy Munsch receives service award

Mandy Munsch, a third-year BME Ph.D. candidate,

received a National Research Service Award from the National Institute of Arthritis and Musculoskeletal and Skin Diseases that will fund her project titled "Effects of anterior cruciate ligament reconstruction on the association between quadriceps muscle dynamics, knee joint biomechanics, and articular cartilage loading during walking."

The research will evaluate how systematic changes in quadriceps activation and knee joint biomechanics affect cartilage contact forces and will improve our understanding of osteoarthritis development following knee joint injuries. Munsch will be advised by Jason Franz, associate professor in BME, and co-advised by Brian Pietrosimone, associate professor from UNC's Department of Exercise and Sports Science.

Applied Biomechanics Lab receives award

Two lab members in the Applied Biomechanics Laboratory led by Jason Franz, associate professor, were selected as the two finalists for the 2021 Journal of Biomechanics Award at the annual American Society of Biomechanics (ASB) meeting. Both finalists, BME senior Callum J. Funk ("Exploring the functional boundaries and metabolism of triceps surae force-length relations during walking") and UNC medical student Shawn Ahuja ("The metabolic cost of walking balance control and adaptation in young adults") were invited to deliver a podium presentation at the annual virtual meeting in August. In the conference's closing ceremony, it was announced that Funk had won the prestigious award.

Funk's co-authors include BME post-doctoral researcher Dr. Rebecca Krupenevich, Georgia Tech and former BME faculty member Gregory Sawicki and senior author Jason Franz.

Aryssa Simpson

Simpson awarded Witherspoon Graduate Fellowship

Aryssa Simpson, a first-year BME graduate student in the lab of Associate Professor Ashley Brown, has been awarded a Witherspoon Graduate Fellowship. This year seven graduate students out of 23 nominations were selected by representatives from the Black Alumni Society and the Graduate School.

Funded through an endowment given to NC State, this $2,000 award is offered to those who have demonstrated a commitment to supporting Black communities within and beyond campus.

Young awarded 2021 IAS Prize

Ph.D. candidate Isabella Young, who is a student in the BME lab of Rahima Benhabbour within the UNC Eshelman School of Pharmacy, has received the International AIDS Society (IAS) Prize for Research in HIV Prevention.

Her abstract entitled "Next generation 3D-printed intravaginal rings for prevention of HIV and unplanned pregnancy" won one of four $10,000 IAS/MSD Prizes for Research in HIV Prevention to outstanding researchers who demonstrate innovation, originality and quality in their research in the field of HIV prevention.

Student startup LiRA takes home top prize in Covintus Tech Tank Pitch Competition

LiRA, a technology company created by UNC students, won the first-place prize in the Covintus Tech Tank pitch competition, securing $25,000 for the startup. LiRA started in E(I) Lab — an entrepreneurship education program in the UNC School of Pharmacy — and originated from the experience that founder and CEO Andrew Prince, MD, had as a UNC otolaryngology / head & neck surgery resident working with voiceless patients.

For people who have lost their ability to speak, methods like writing notes are slow and often frustrating. By developing easy-to-use lip-reading communication, LiRA is working to restore communication between aphonic or voiceless patients and their providers and caregivers.

LiRA's leadership also includes Chief Design Officer Dina Yamaleyeva, also a UNC BME Ph.D. candidate, and Chief Operating Officer Nga Nguyen, a UNC medical and public health student. •

ALUMNI AND INDUSTRY **NEWS**

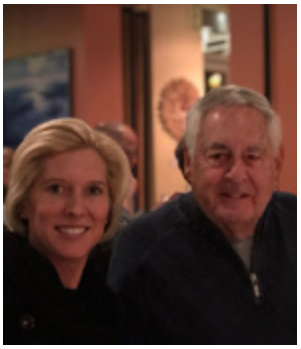
Caroline Greiner and Max Dowdle

ALUMNA TEAMS UP WITH **ARTS EVERYWHERE** TO BRIGHTEN UP PHILLIPS HALL

BME alumna **CAROLINE GREINER** '21 led an effort to brighten up the stairwell going down to the department's design labs in Phillips Hall on the UNC-Chapel Hill campus. Her idea was a big one, and she received support from the UNC administration and Arts Everywhere to fund a mural that was commissioned to local artist Max Dowdle. This arts and science collaboration resulted in a colorful mural titled *THINK!*. Dowdle created a bright and eye-catching geometric repeating pattern interlaced with biomedical engineering, physics and astronomy, and math iconography.

Greiner explained "I am drawn to murals and public art so I thought a mural would be a great way to bring color and life to the space. I also wanted the mural to be a creative representation of the often technical concepts of math, physics and BME to remind students that creativity and engineering go hand-in-hand." She also had the full support of her advisor, BME Teaching Associate Professor Devin Hubbard, who says that the mural is an "incredible demonstration of the awesome power of collaboration — the mural represents the passions, work and education of BME, math, physics and astronomy, and art" and is a reflection of "the community that occupies the building."

The Joint BME Department applauds Greiner's initiative, Dowdle's mural and Arts Everywhere for their support to make the BME community a little bit brighter and more cheerful. Watch the process of painting the basement stairwell of Phillips Hall by visiting **bit.ly/3BdtMXR**.



Amy DeWinter and Arthur Noel DeWinter

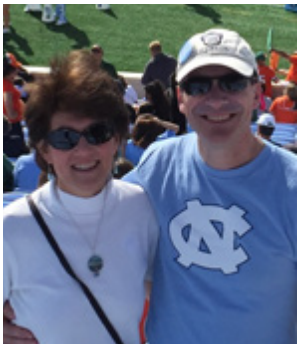
SCHOLARSHIP HONORS **FATHER'S LOVE OF EDUCATION**

The Joint Department would like to announce a new endowed scholarship established on behalf of **ARTHUR NOEL DEWINTER** by his daughter, **AMY DEWINTER**. "Noel" passed away in January of 2020 at the age of 80 and led a very full life, punctuated by his strong belief in education. He held a bachelor's degree from Carleton College and a master's in business administration from The Wharton School. He always encouraged his children to pursue their education and believed strongly in the power of a college degree. In addition to a standard education, DeWinter believed in serving his country and entered Officer Candidate School with the United States Marine Corps, being honorably discharged as a First Lieutenant.

Amy DeWinter, his oldest daughter, has more than 20 years of experience in medical device marketing. She has worked with BME for several years as a guest lecturer at

UNC and NC State and as a judge in the i4 competition. When her father passed, Amy DeWinter felt strongly about carrying on his legacy while pairing her passion for the field of biomedical engineering. She initiated the Arthur Noel DeWinter scholarship endowment to support students in biomedical engineering. "I feel so blessed that my father both encouraged and financially supported my college education, leading to my professional success," she said. "Creating this scholarship will allow his passion to endure and will help BME students thrive in their educational endeavors."

DeWinter plans to remain involved with the BME department and looks forward to meeting recipients of this scholarship, perhaps even working with them on future innovations that will realize BME's mission to unite engineering and medicine to improve lives. Her company, Ascenda Medical Marketing, works with medical technologies in all phases of development and commercialization. For more information on Amy DeWinter's company and background, please visit **ascendamed.com**.



Karen Randall and Daniel Wasser

CREATING OPPORTUNITY THROUGH **PHILANTHROPIC GIVING**

Through the generosity of BME alumni **KAREN RANDALL** and **DANIEL WASSER**, BME undergraduate students will have the opportunity to spend their summer conducting research alongside BME faculty members, graduate students and post-doctoral researchers. These internships will provide students with practical research experience that can help confirm their interest in pursuing a specific area of research, choosing to further their academic career with a graduate degree and even to recognize that research may not be the path of choice for them. Research internships also afford an opportunity to present at conferences and poster sessions and broaden personal and professional networks.

Randall ('87 biomedical engineering and mathematics) and Wasser ('90 biomedical engineering and mathematics) know from their own careers that each experience may lead to a new direction. Building on their industry experiences at Spyrus and AT&T for Randall and Bristol Myers Squibb for Wasser, they now have two consulting companies, Randall Consulting and Dry Ridge Data Analytics, LLC.

Thank you Dan and Karen for your generous gift to support BME undergraduate research and creating opportunities for continued innovation.

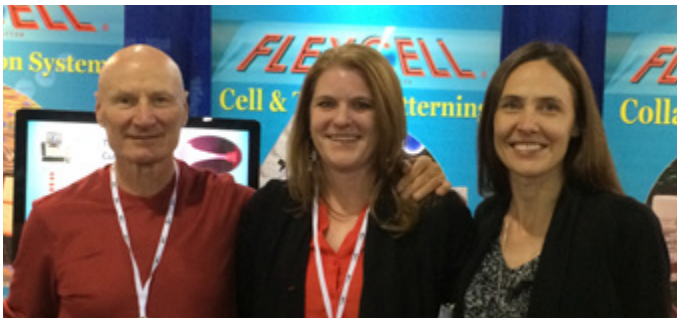
RECENT BME ALUM WORKS WITH **HELPING HAND PROJECT**

Recent BME graduate **EDDIE NERI** has worked with the Helping Hand Project (HHP), designing and building 3D-printed prosthetic hands for children with limb differences, while studying biomedical engineering. Neri joined HHP so that he could learn to design prosthetics and have his work be an impactful service to the community. During an interview with Innovate Carolina that can be viewed at **bit.ly/3nshOo6**, he discusses how the HHP provides prosthetic devices to children in need and how he hopes this initiative will eventually expand to his home country of Mexico.

Innovate Carolina is UNC-Chapel Hill's initiative for innovation and entrepreneurship. The Helping Hand Project traces its origins back to the summer of 2014 in the Joint BME Department at the UNC-Chapel Hill campus, and has since grown with chapters in Charlotte, Durham-Tech and NC State, which specializes in custom designs for recipients who would not benefit from a standard 3D printed device.

MECHANOBIOLOGY, THE BANES' LAB, **FLEXCELL** AND THE RECENT NOBEL PRIZE IN PHYSIOLOGY OR MEDICINE

ALBERT BANES, BME emeritus faculty member and founder and president of Flexcell International Corporation, recently checked in with the Joint Department to update us about his company and share his pride in Flexcell's role supporting student training and scientific discovery in mechanobiology.



Albert Banes with BME alumni Robin Queen and Michelle Wall Frakes

How did you come to found Flexcell International?

My road to mechanobiology began with a lecture from Dr. Itzhak Binderman on stretching osteoblasts on a polystyrene dish and a discussion of stretching cells in 1976. Immediately after, I hatched a plan to build a cell-stretching device using an elastomer membrane and vacuum deformation of the membrane from below to avoid interfering E and B fields. From this device, Flexcell was eventually born. In fact, I was one of the early faculty successful start-ups. Forty years later, I am still at it in labs at Flexcell's 30k-square-foot headquarters in Burlington, NC, and the company is a global supplier of this technology. During that interval my lab experienced many "firsts," including: first papers on stretching vascular endothelial cells, smooth muscle cells, osteoblasts, tenocytes, etc.

Speaking of firsts, you shared with us that Flexcell equipment was used to perform experiments in the research just awarded the 2021 Nobel Prize in Physiology or Medicine, is this a first?

Congratulations to Dr. David Julius and Dr. Ardem Patapoutian of the Scripps Institute for their recent Nobel award in Physiology or Medicine for the elucidation of Piezo 1,2 and Trp channels and their roles in mechanobiology in health and disease. Both researchers utilized the Flexcell International Corporation's flexible bottom culture plates and control unit on the way to their discoveries of mechanosensitive ion channels. This is a first and we're proud of Flexcell's role supporting scientific discovery in mechanobiology.

Have Flexcell's products always been well received?

Many researchers and journals were skeptical of this "new technology" and the importance of "stretching cells." I recall a visit from Dr. Judah Folkman in the late 1980s. Intended as a brief visit, Dr. Folkman stayed for some time, opening the incubator door to closely observe the endothelial cells moving up and down on custom cast, soft silicone elastomer membranes derivatized with collagen. He remarked that he couldn't believe this new development. Other leaders in the field felt the same way. At first, the research was phenomenological. How did cells look when they were subjected to applied strain (which was, at first, unconstrained deformation in 2D, then equibiaxial, uniaxial and finally in 3D, fabricating engineered tendons, ligaments and cardiac trabeculae in vitro).

Has Flexcell been a resource for training the next generation of mechanobiology researchers?

Students help Flexcell to prosper, and Flexcell helps students to grow in their research and technical skills. Many dental and medical students, residents, fellows and post-docs have flowed through Flexcell's labs. In the early 2000s, I started teaching a tissue engineering course in the CAMS program. Dr. Michelle Elfervig Wall, BME alumna, was one of the students who worked with me. Her work on connexins and calcium signaling showed the need for cell-cell signaling in response to ligands and applied load. Dr. Bertina Jones, BME alumna, also worked with me and Sean Washburn in the CAMS program, to show how ligament cells in microfabricated grooves cross-talked with each other. Our work was in pursuit of the basic mechanisms underlying how cells respond to mechanical strain. There were many BME interns in the lab as well as other students to thank for their participation and contributions along the way.

What else would you like to share?

It is gratifying at this stage in life to know the many students who participated in mechanobiology in my lab have gone on to successful careers in different roles and industries. I am proud to congratulate the recent Nobels for elucidating the specific ion channels involved in mechanosensation. I offer special thanks to Dr. Eddie Grant and son David who has been with Flexcell as an engineer for seven years. And thanks to all the students who have worked in my lab and the company for contributing to the mechanobiology field. I will continue to welcome BME students and alumni for internship and employment opportunities and support the growth of the Joint BME Department and its network of collaborators and industry partners. More information is posted on the **flexcellint.com** website, in particular news about Flexcell's 35th anniversary in mechanobiology in 2022. •

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BIOMEDICAL ENGINEERING

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SUPPORT THE DEPARTMENT

Thank you to all our donors this past year who helped support students, faculty members and programs in the BME department. As the newsletter illustrates, there are so many ways that philanthropy has helped BME thrive, succeed and grow.

Helen Huang, Jackson Family Distinguished Professor, states that "the additional funding that comes annually to a distinguished professor particularly helps fund graduate student research." Undergraduate research internships can be life changing. As one student explained, "This experience has helped solidify my desire to pursue an M.D. Ph.D. after my undergraduate studies and one day become a medical researcher." Innovation and entrepreneurship are fostered through the senior design program. Philanthropic support helps provide resources for students to research, design and build their dreams and innovative devices.

With your support, we can continue to realize the mission of uniting engineering and medicine to improve lives. You can make a year-end gift to support BME through the **UNC 21st Century Fund** or the **NC State BME Enhancement Fund**.

If you would like to learn more about specific ways to support the Joint Department, please reach out to Laura Schranz, **lschranz@unc.edu** or **lschran@ncsu.edu**.