

Joint Department of
**BIOMEDICAL
ENGINEERING**



UNC
CHAPEL HILL

NC STATE
UNIVERSITY

SPRING / SUMMER 2019



02

**ULTRASOUND RESEARCH WILL
BENEFIT DIVERS, OTHERS**

04

**RESEARCH IMPROVES HOW
PROSTHETICS ARE TUNED**

06

**BME SPINOFF RECEIVES
FEDERAL FUNDING**

IN THIS ISSUE

PAGE

02

RESEARCH TACKLES
DECOMPRESSION
SICKNESS

PAGE

04

REINFORCEMENT
LEARNING TUNES
PROSTHETICS

PAGE

06

NIH FUNDING WILL
BOOST RESEARCH

PAGE

07

THREE FACULTY
MEMBERS EARN
CAREER AWARDS

PAGE

08

FACULTY AND
STAFF NEWS

PAGE

13

STUDENT NEWS

LETTER FROM THE CHAIR



Nancy Allbritton

DEAR BME ALUMNI AND FRIENDS:

Welcome to the Spring / Summer 2019 edition of the UNC / NC State Biomedical Engineering Newsletter. In this edition, we share a number of exciting stories about the department but to begin I would like to share my decision to step down as chair / department head of the Joint Department on December 31, 2019.

To assist with a smooth transition, a search for my successor is expected to begin in the near future. After serving 10 years in this role I could not be more pleased with the Joint Department's progress and achievements or more satisfied with BME's faculty, staff, students, and alumni — whose extraordinary efforts collectively made the last decade of success possible.

A comprehensive summary of all these successes is not practical in the space available, but what follows is a summary of highlight achievements since 2009. In 2010 the Joint Department consolidated its NC State core space into 45,000 square feet of the just-constructed Engineering Building III; and in April 2019, BME consolidated its UNC-Chapel Hill core space into 24,000 square feet of the just fully renovated Mary Ellen Jones building. Thirty-two new faculty members were hired. Endowed chairs increased from zero to six. A development officer position was created and dedicated to raise funds for the Joint Department. UNC, NC State and BME adopted consensus branding for the Joint Department. The Bachelor of Science programs were totally made-over into a single joint UNC / NC State, ABET-accredited undergraduate degree. The Design Programs were completely overhauled sharpening their mission with the 21st Century view of training students to identify unmet human health improvement needs and translating them to patient care. The Master of Science program options were expanded from a traditional two-year MS thesis to now primarily offer a one-year entrepreneurial MS that also embraces the cutting-edge bench-to-bedside vision. This past May, the graduate program was externally reviewed to very positive preliminary feedback, in particular for the substantial increase in BME's jointness since the prior review in 2011. Perhaps most emblematic of UNC / NC State Biomedical Engineering's ever-strengthening jointness was the 2017 adoption of the "BME Charter," a document executed by the provosts and chancellors of both home institutions that codified "the principle of eliminating administrative boundaries that impede the unified, seamless operation of BME across the universities." The legacy of the Charter will be an administratively seamless BME for succeeding chair / department heads, as well as all Joint Department members, for the foreseeable future.

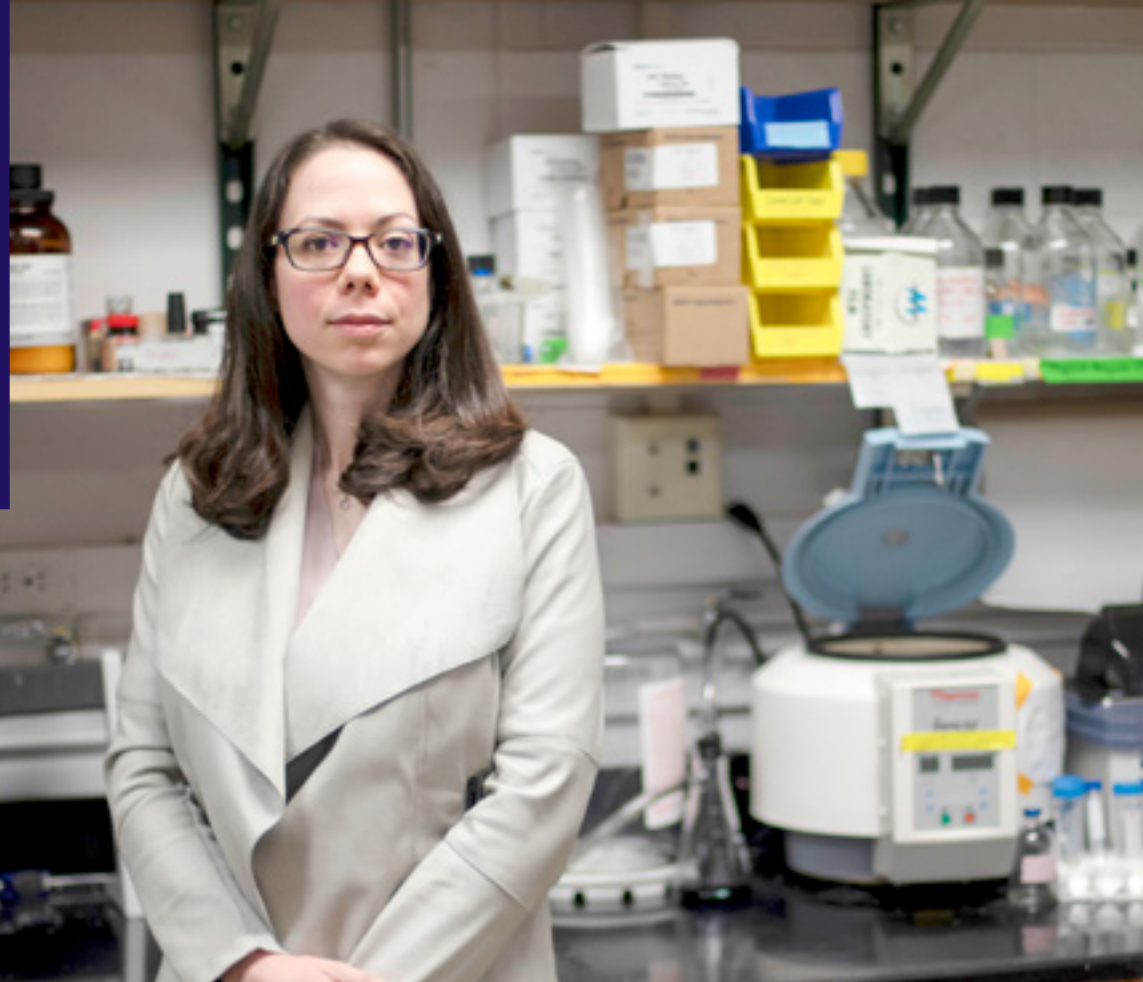
I close with profound acknowledgement and thanks to all of UNC / NC State Biomedical Engineering's institutional leaders as their administrative flexibility, support for crucial hires, and allocations of essential space were vital resources enabling our faculty, staff, students and alumni to make the last 10 years so successful. I end these correspondences one final time by again inviting you to explore the Joint Department's continuing story as documented within this newsletter, and see for yourself how UNC / NC State BME's ongoing work and results will be improving lives for decades to come.

Sincerely,

Nancy Allbritton, M.D., Ph.D.

Kenan Professor & Chair, UNC / NC State Joint Department of Biomedical Engineering

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RESEARCH USES ULTRASOUND TECHNOLOGY TO STUDY THE BODY IN EXTREME ENVIRONMENTS

NINETY FEET BELOW THE PACIFIC OCEAN, off the coast of the Galápagos Islands, Dr. Virginie Papadopoulou floats peacefully among hundreds of hammerhead sharks. She watches in wonder, taking easy, steadied breaths from her oxygen tank.

“It’s almost like you’re meditating and you can’t think of anything else apart from what you’re actually seeing at that moment,” she says. “You’re very present.”

Papadopoulou first learned to scuba dive during a family vacation in Jordan when she was 13 years old. After seeing advertisements across town for lessons and tours, she convinced her dad to take her and her brother on a dive. They were hooked, and have made countless dives since.

That passion has led Papadopoulou to the Dayton Lab in the Joint Department. She studies decompression sickness (DCS), which affects about 1,000 scuba divers per year.

DCS occurs when a diver’s body doesn’t properly expel gas built up due to pressure change. During a dive, the

body acts like a storage facility; the longer a diver spends at depth, the more gas is stored in their tissues. As long as a diver stays at depth there is no problem.

The issue comes when divers ascend. That gas needs to release back into the bloodstream and expel through the lungs. If divers come up too quickly, microbubbles can form in their blood, causing symptoms like joint and muscle pain, dizziness, fatigue, paralysis, and in some rare cases, death.

Despite about 100 years of research on the topic, according to Papadopoulou, few gains have been made. Scientists can create microbubbles with amazing precision, controlling the size, distribution, and quantity of the bubbles, the composition of gas and the bubbles’ shell, and what they target. When it comes to DCS though, researchers don’t understand where the bubbles form, how they form, how big they are, or how exactly they cause problems.

A STRONGER FOUNDATION

Papadopoulou joined the Dayton Lab at UNC Chapel Hill as a postdoctoral researcher in 2016. Now a research assistant professor, she continues to study decompression prevention by improving techniques in gathering data.

Papadopoulou uses ultrasound to assess divers' hearts before a deep dive, immediately after, and then every 20 minutes. For divers without DCS, bubble-filled blood is sent from the venous side of the heart to the lungs to be oxygenated, filtering out the gas, and then reentering the heart through the arterial side. Therefore, the ultrasound of a healthy diver typically shows bubbles on the left portion of the heart but none on the right.

Although this method isn't new, Papadopoulou says there are problems with previous findings, like insufficient data.

In many experiments, researchers create images at just a few timepoints: typically, immediately after the dive and a few hours later. If a diver has bubbles in their bloodstream it will decrease between these two measurements, but little is known about what happens in the meantime. In a 2018 experiment, Papadopoulou took eight ultrasounds per diver for more insight, and is currently still analyzing results.

The second issue is how this data is quantified. Based on images, researchers give a severity grade of zero through five. Most people are not well trained at this, though, and will give vastly different ratings upon reevaluation, according to Papadopoulou.

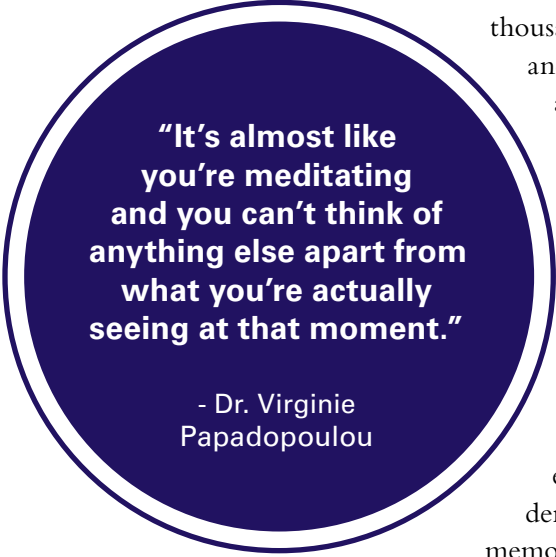
"So, you have the problem of a random grade, a timing that is not ideal, and then you wonder why we have no idea what's happening," she says while laughing.

During her Ph.D., Papadopoulou collaborated with a team to devise a more precise way to assess a diver's heart. The good news is they created a method that is not only more accurate, but also one that anyone — even those without ultrasound experience — can conduct. The bad news is it's time consuming.

With this technique it takes about 10 minutes to count bubbles, shown as bright spots, in the image of a

heart. This may not seem long, but considering her 2018 experiment generated over 1,300 videos, it adds up.

At the moment, Papadopoulou and her team are working to automate this process by training a computer algorithm. By collaborating with Divers Alert Network to recruit volunteers to manually analyze images, she hopes — over the course of the next two years — that thousands of videos will be correctly counted and serve as a solid foundation for the algorithm.



**"It's almost like
you're meditating
and you can't think of
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seeing at that moment."**

- Dr. Virginie
Papadopoulou

TINY BUBBLES, BIG SOLUTION

The study of microbubbles spans out far beyond examining decompression sickness. For decades, researchers have been analyzing the use of microbubbles for a variety of purposes like emergency lung function, cleaning dental plaque, and even restoring memory in Alzheimer's patients. In BME, Papadopoulou and her colleagues are exploring the use of ultrasound and microbubbles in detecting and treating cancer.

During an ultrasound, physicians can see large blood vessels but not blood flow. When microbubbles — which are a fraction of the size of a red blood cell — are injected into the bloodstream, though, they reflect and amplify the sound waves, allowing researchers and clinicians to see both the vessels and the flow.

The Dayton Lab is exploring this method by using the dense web of blood vessels surrounding a tumor to identify the mass.

"Pretty much all solid tumors have a very high vessel density because they're creating their own blood supply," Papadopoulou says. "They're using your body to grow."

Through microvascular imaging, the Dayton Lab can use ultrasound to create precise maps of this blood flow in the tumor, honing in on the mass in real time, and enabling doctors to detect cancer earlier, give a defined cancer diagnosis, and reduce the need for biopsies.

Another use is targeted drug delivery — bubbles containing drugs can be sent to tumors through the vascular system, seeking out parts of the mass that indicate blood-vessel growth. Once the bubbles attach to those biological markers, a high-pressured ultrasound can pop them and release the drug. •



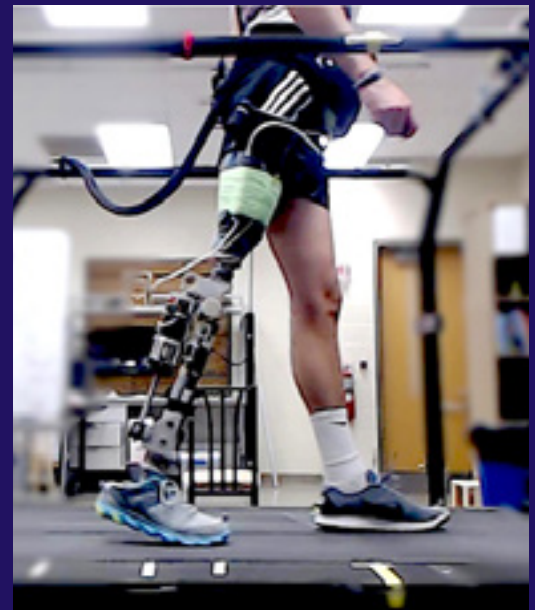
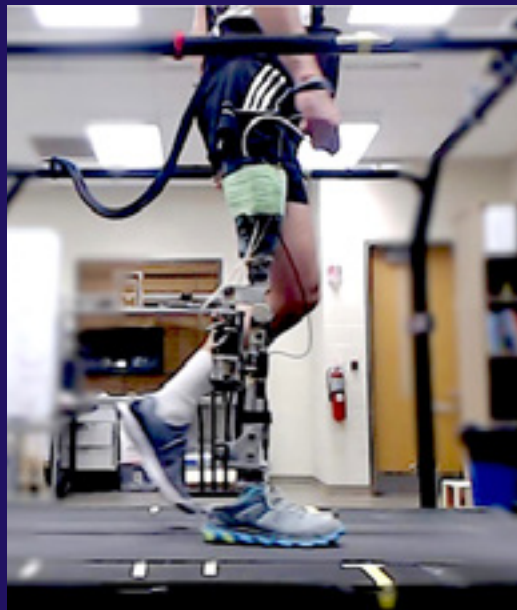
REINFORCEMENT LEARNING EXPEDITES “TUNING” OF ROBOTIC PROSTHETICS

RESEARCHERS FROM BME, the University of North Carolina at Chapel Hill and Arizona State University have developed an intelligent system for “tuning” powered prosthetic knees, allowing patients to walk comfortably with the prosthetic device in minutes, rather than the hours necessary if the device is tuned by a trained clinical practitioner. The system is the first to rely solely on reinforcement learning to tune the robotic prosthesis.

When a patient receives a robotic prosthetic knee, the device needs to be tuned to accommodate that specific patient. The new tuning system tweaks 12 different control parameters, addressing prosthesis dynamics, such as joint stiffness, throughout the entire gait cycle.

Normally, a human practitioner works with the patient to modify a handful of parameters. This can take hours. The new system relies on a computer program that makes use of reinforcement learning to modify all 12 parameters. It allows patients to use a powered prosthetic knee to walk on a level surface in about 10 minutes.

“We begin by giving a patient a powered prosthetic knee with a randomly selected set of parameters,” says



Helen Huang, co-author of a paper on the work and a professor in the Joint Department. “We then have the patient begin walking, under controlled circumstances. Data on the device and the patient’s gait are collected via a suite of sensors in the device,” Huang says. “A computer model adapts parameters on the device and compares the patient’s gait to the profile of a normal walking gait in real time. The model can tell which parameter settings improve performance and which settings impair performance. Using reinforcement learning, the computational model can quickly identify the set of parameters that allows the patient to walk normally. Existing approaches, relying on trained clinicians, can take half a day.”

While the work is currently done in a controlled, clinical setting, one goal would be to develop a wireless version of the system, which would allow users to continue fine-tuning the powered prosthesis parameters when being used in real-world environments.

“This work was done for scenarios in which a patient is walking on a level surface, but in principle, we could also develop reinforcement learning controllers for situations such as ascending or descending stairs,”

says Jennie Si, co-author of the paper and a professor of electrical, computer and energy engineering at ASU. “I have worked on reinforcement learning from the dynamic system control perspective, which takes into account sensor noise, interference from the environment, and the demand of system safety and stability,” Si says. “I recognized the unprecedented challenge of learning to control, in real time, a prosthetic device that is simultaneously affected by the human user. This is a co-adaptation problem that does not have a readily available solution from either classical control designs or the current, state-of-the-art reinforcement learning controlled robots. We are thrilled to find out that our reinforcement learning control algorithm actually did learn to make the prosthetic device work as part of a human body in such an exciting applications setting.”

Huang says researchers hope to make the process even more efficient. “For example, we think we may be able to improve the process by identifying combinations of parameters that are more or less likely to succeed, and training the model to focus first on the most promising parameter settings.” •



NIH AWARD TO CELL MICROSYSTEMS WILL BOOST BIOMEDICAL RESEARCH

CELL MICROSYSTEMS, INC. a company based in the Research Triangle Park, has received two federal Small Business Innovation and Research awards totaling \$1.9 million to automate distinct CRISPR workflows using its proprietary CellRaft Technology, which was created by the lab of Dr. Nancy Allbritton, Kenan Professor and chair of BME.

Nick Trotta, Ph.D., director of genomics programs, described the awards saying, “These grants will accelerate our ongoing work toward automating CRISPR workflows using the CellRaft AIR™ System that will provide a more efficient alternative to other cloning and sorting technologies.”

Cell Microsystems’ CellRaft AIR™ System is an automated platform employing an integrated fluorescent microscope to image, sort and isolate cells or small clonal colonies cultured on the CytoSort™ Array. Culturing viable, single cells after applying guide RNAs, then tracking clonal colony formation and other phenotypes for screening, gives the system tremendous value in CRISPR workflows.

Under a Phase II grant, the company will collaborate with two investigators to validate the AIR™ System in core laboratories: Dr. William Marzluff, Kenan Distinguished Professor of Biochemistry and Biophysics at the UNC School of Medicine, and Dr. Mike McConnell, of the University of Virginia.

Marzluff, who is also a member of the UNC Lineberger Comprehensive Cancer Center said, “The AIR™ System

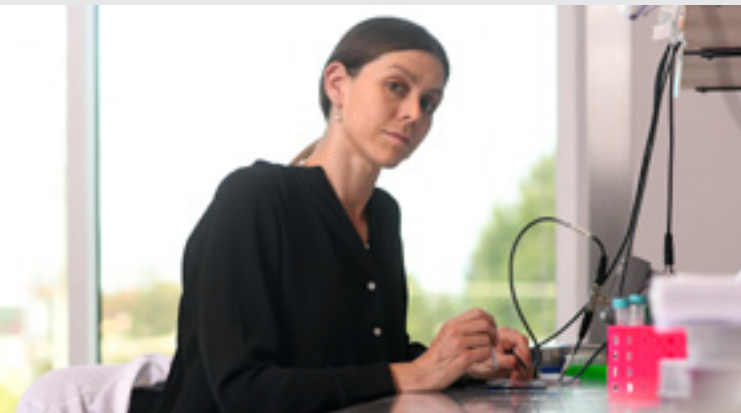
helps us identify a much larger number of viable clones for generating knockout cell lines, and large numbers of cloned cells can be identified and expanded much faster than with other approaches.”

McConnell’s laboratory will use the system to run a pooled CRISPR screen with time-course imaging. “With the AIR™ System now in the stem cell core, we can use it for some of the CellRaft applications we’ve already published in single cell and single nucleus sequencing, but we are doing a lot of CRISPR work with it now, too. It’s an easy way to track cells for your phenotype of interest, keep them alive, and then collect the cells you want for downstream molecular analysis,” McConnell said.

In a separate Phase I grant, the company will collaborate with Dr. William Buchser of Washington University in St. Louis to develop pooled CRISPR-mediated genome editing. “The AIR™ System gives us a great way to edit phenotypically interesting cells and track them for subtle functional changes we can only see under optimized culture conditions. We ran a few proof-of-concept studies with the system, and it is going to be an excellent platform for functional genomics experiments.”

The company also announced a new software release for the AIR™ System and a new HexaQuad™ Array. The new software automates cloning workflows using brightfield imaging to eliminate the need for fluorescent markers for sorting and confluency measurement. Another new feature automates cell sorting based on fluorescent signal intensities to characterize complex phenotypes. In 2010, Allbritton and two members of her lab — senior scientist Dr. Christopher Sims and research associate Dr. Yuli Wang — founded Cell Microsystems. Since then, the company has received federal research awards for areas in addition to CRISPR workflows, including single cell genomics, HIV latency reversal, cancer immunotherapy, and high-resolution imaging. •

THREE FROM DEPARTMENT RECEIVE PRESTIGIOUS NSF AWARDS



Dr. Ashley Brown, Dr. Michael Daniele and Dr. Xiaogang Hu.

THREE FACULTY MEMBERS from the Joint Department have received Faculty Early Career Development awards, also known as the CAREER Award, from the National Science Foundation (NSF).

Dr. Ashley Brown, assistant professor; Dr. Michael Daniele, assistant professor in the Joint Department and in the Department of Electrical and Computer Engineering at NC State; and Dr. Xiaogang Hu, assistant professor, will each receive \$500,000 in funding over five years to support their work.

The award is one of the highest honors given by NSF to young faculty members in science and engineering.

- Brown's project, "Dynamic microgels that mimic platelet behavior to promote healing," will focus on the development of a new material that mimics the ability of platelets to change shape in response to injury. The developed materials will be tested for their ability to change shape in response to injury signals and for their ability to stop bleeding and improve healing.

From an outreach standpoint, the goal of the project is to increase awareness and support for biomimetic materials engineering. Biomimetic materials are materials that mimic certain aspects of natural systems, such as the materials described in this proposal that mimic platelet function. This will be achieved by designing new materials for K-12 summer camps and day camps and by giving talks at local museum events.

- As part of Daniele's project, "Reconfigurable Microfluidic-Microbalance Sensors to Monitor and Optimize the Performance of Microphysiological Models," he will investigate and engineer a new generation of reconfigurable biosensor platforms that can be used to measure multiple circulating biomarkers and inform the development and analysis of microphysiological models. Because microphysiological models replicate human organ function, they are promising technologies for fundamental biological research and discovery of translatable biomarkers, pharmaceuticals and regenerative therapies.
- For his project, "Robust Decoding of Neural Command for Real Time Human Machine Interactions," Hu's research goal is to decode the descending neural command / drive that controls individual finger movement, by extracting spinal motoneuron discharge activities using source separation of high-density EMG signals.

The impact of this research will be profound on the general field of human-machine interaction and neural rehabilitation. Additionally, Hu will integrate his research with education through undergraduate and graduate level course development and aid in the expansion of current courses. •

FACULTY AND STAFF NEWS



Dr. Ashley Brown

Ashley Brown elected to serve on the ASMB Council

BME Assistant Professor Dr. Ashley Brown has been elected to serve on the Council for the American Society for Matrix Biology (ASMB).

The mission of the ASMB is to promote

basic, translational and clinical research on the extracellular matrix, as well as the application of this research for therapies and devices. The ASMB seeks to accomplish this mission by promoting interactions among academia, scientific societies, industry and government; facilitating dissemination of relevant knowledge and new findings; providing mentoring opportunities to junior scientists; and advocating sustained funding for research and education.

For more information, visit asmf.net/election.

2019 Biomaterials Science Emerging Investigator: Dr. Ashley Brown

Dr. Ashley Brown, assistant professor in the department, was recently nominated as a 2019 Biomaterials Science Emerging Investigator, in recognition of her potential to influence future directions in the field.

Biomaterials Science also presented the 2019 Emerging Investigators collection, which gathers the very best work from biomaterials scientists in the early stages of their independent careers.

Brown's article titled "Platelet-like particles dynamically stiffen fibrin matrices and improve wound healing outcomes" was published as part of this collection and can be found at rsc.li/2J7YRVi.



Dr. Fran Ligler

Ligler gives useful tech transfer tips

BME Lampe Distinguished Professor Dr. Fran Ligler offered some technology transfer tips as part of Pack Hacks for Faculty, a NC State News Services feature.

"NC State ranks No. 2 nationally in commercialization of

research among universities without a medical school," Ligler said. From her own journey as a scientist, engineer and inventor, Ligler shared invaluable lessons on: problem awareness, assessing value, getting from invention to product, understanding the process and realizing your vision.

For example, Ligler advised that the technology doesn't have to be entirely new, because an improvement can be as valuable if it adds a capability to the original patent that is really important for the user.

You can read all of her advice to make tech transfer successful at bit.ly/2IWYayK.

Polacheck's article featured on journal cover

A recent cover of Nature Protocols features the latest work of BME Assistant Professor Dr. William J. Polacheck, a collaboration with his former colleagues at The Wyss Institute, Harvard University and Biomedical Engineering at Boston University.

"Microfabricated blood vessels for modeling the vascular transport barrier" is about understanding the molecular pathways



Dr. William J. Polacheck

and mechanisms that regulate the permeability of blood vessels, which is of critical importance for developing therapies for cardiovascular dysfunction and disease.

Polacheck and his team recently developed a novel microfluidic human engineered microvessel (hEMV) platform to

enable controlled blood flow through a human endothelial lumen within a physiologic 3D extracellular matrix (ECM) into which pericytes and other stromal cells can be introduced to recapitulate tissue-specific microvascular physiology. The published protocol describes how to design and fabricate the silicon hEMV device master molds (takes ~1 week) and elastomeric substrates (takes 3 d); how to seed, culture, and apply calibrated fluid shear stress to hEMVs (takes 1–7 d); and how to assess vascular barrier function (takes 1 d) and perform immunofluorescence imaging (takes 3 d).

You can read the publication in full at go.nature.com/30CajPd.

George Ligler serves NC State and National Academy of Engineering



Dr. George Ligler

Dr. George Ligler, Dean's Eminent Professor of the Practice in Biomedical Engineering, is quickly filling his advisory dance card with four recent demanding committee appointments by the NC State Chancellor's office and the National Academy of Engineering (NAE).

Ligler was appointed by Chancellor Randy Woodson to be on the NC State Intellectual Property Committee for a two-year term ending July 31, 2020. The committee meets twice a year to review, discuss and make recommendations related to intellectual property issues to the vice chancellor for

research and innovation and the Office of Technology Commercialization and New Ventures.

Not an entity to underuse a valuable resource, the NAE has called Ligler to serve on three committees. He was elected to the Executive Committee of the Special Fields and Interdisciplinary Engineering Section (Section 12). In this capacity, he will be second vice chair of the section in 2018–2019, first vice chair of the section in 2019–2020 and chair of the section from July 1, 2020 to June 30, 2021. The NAE Council further appointed Ligler to a three-year term as a member of the Section 12 Peer Committee. This committee assists with vetting nominees who are directed to Section 12 for Academy membership. Ligler also remains a member of the Academy's 2019 Nominating Committee. On Sept. 7, this committee recommended a nominee to be the next President of the Academy. The Nominating Committee is additionally making recommendations for several candidates for the NAE Council as well as one of the other officers of the Academy.

Five recognized at Faculty Excellence event

BME professors Ashley Brown, Michael Daniele, Xiaogang Hu, Roger Narayan and Koji Sode were recently recognized at the Celebration for Faculty Excellence Event in NC State's College of Engineering. They received the following recognitions: Narayan as part of NC State's inaugural class of Provost Faculty Fellows, Sode for his induction into the National Academy of Inventors; and Brown, Daniele and Hu for their NSF CAREER awards.

NC State annually honors faculty members who have won prestigious state, national and international awards and created new knowledge and advancements in their respective disciplines.

Open-source software tracks neural activity in real time

BME Assistant Professor Dr. Andrea Giovannucci and his former colleague Eftychios Pnevmatikakis at the Flatiron Institute in New York have spent three years developing CalmAn, an open-source calcium imaging analysis software.

The tool replaces the process of manually tracking the location and activity of neurons, which has already proved invaluable to the calcium imaging community, with more than 100 labs using the software internationally.

“My lab is excited about being able to use a tool like this,” said Duke University neuroscientist John Pearson in a recent article published on *eHealthNews.eu*.

Giovannucci explains that “existing analysis tools were not powerful enough to disentangle the activity of this population of neurons and implied that they were all doing the same thing.” For more information, read the full article at bit.ly/2Vb2L75.

BME featured in the Think and Do the Extraordinary TV commercial



Dr. Helen Huang

BME Professor Dr. Helen Huang is featured in a Think and Do the Extraordinary NC State University TV commercial, which is aired during NC State sporting events.

In the 30-second video promoting the University’s fundraising campaign, students and faculty members at NC

State explain how the school encourages them to dream big and empowers them to work on real-world projects. Halfway through the advertisement, Huang states “we make something impossible possible,” while her robotic prosthetic leg appears in action in a short clip. See the video at bit.ly/2wTTUYN.

Legant named Searle Scholar



Dr. Wesley Legant

Dr. Wesley Legant, assistant professor in the Department of Pharmacology at UNC and in BME, was one of 15 exceptional young faculty members from across the United States to be named 2019 Searle Scholars for their pursuit of fundamental, groundbreaking research in chemistry and the

biomedical sciences. Each scientist will receive an award of \$300,000 in flexible funding to support their work over the next three years.

Legant’s lab creates fluorescence microscopes for rapid 3-D imaging to improve current observations of living organisms and push forward new research in cell biology.

The Searle Scholars Program makes grants to selected universities and research centers to support the independent research of exceptional young faculty in the biomedical sciences and chemistry who have recently been appointed as assistant professors on a tenure-track appointment. The program’s scientific director appoints an advisory board of eminent scientists who choose the Scholars based on rigorous standards aimed at finding the most creative talent interested in pursuing an academic research career. This year, 195 applications were considered from nominations by 137 universities and research institutions.

Since 1981, 617 scientists have been named Searle Scholars. Including this year, the program has awarded more than \$174 million.

Narayan named 2019-20 RTI University Scholar



Dr. Roger Narayan

BME Professor Dr. Roger Narayan is part of the new 2019-20 cohort of RTI University Scholars. Narayan will be working on a joint research project in collaboration with Dr. Dave Dausch, RTI director of engineered systems, to evaluate microneedle-based devices as wearable sensors for health monitoring.

The RTI University Scholars Program provides support for distinguished academic researchers to spend scholarly leave time at RTI, actively collaborating with experts. This program is open to faculty members from Duke University and the University of North Carolina’s 16 university campuses. The goal of the program is to foster collaboration and catalyze opportunities for strategic, joint research projects.

Narayan named to Provost Faculty Fellows Program

BME Professor Dr. Roger Narayan has been selected to participate in the first cohort of the Provost Faculty Fellows Program, a new

leadership development program for mid-career and senior NC State faculty members.

Narayan has been invited to participate in two or three meetings focused on leadership development as well as a dinner meeting with the provost during the spring semester. As a Fellow, he is also eligible to request individual coaching sessions from the vice provosts and senior vice provosts involved.

The Provost Faculty Fellows program is designed for current, full-time NC State faculty members who are interested in learning more about academic affairs administration, developing their skills as faculty leaders, and working closely with Provost Office staff on projects that are meaningful to them and to the university.

Department hires new support staff

The BME department has welcomed two new support staff members: Lindsay Castret and Ana Estrades.

As the new administrative support associate, Lindsay Castret will be the staff point of contact for the i4 program and the BME Senior Design symposium. She will also be involved in scheduling yearly faculty annual reviews with the department chair. Castret's prior employments include a 6th grade public school science teacher, laboratory technician, research assistant and office aide. As part of her educational experiences, she worked with faculty members at many levels. Castret received her bachelor's degree, summa cum laude, from Florida Gulf Coast University.

With the new year, Ana Estrades began to work part-time as a communications officer. In coordination with Jack O'Daly, she is updating information on the BME website, in particular the news stories, calendar of events and faculty publications. She is also helping to enhance BME's presence on social media, including the Twitter account and a new Instagram account. More recently, she is coordinating the launch of the new Joint BME website with third party website developers. Estrades is fluent in several languages, including Spanish, Italian and English. With a B.A. in translation from Granada University in Spain, and an M.A. in decorative arts from the Bard Graduate Center in New York, Estrades is currently curator in residence at the Gregg Museum of Art and Design on NC State's campus.

New faculty member Dr. Andrea Giovannucci: the Neural Engineering Laboratory



Dr. Andrea Giovannucci

Dr. Andrea Giovannucci, who recently joined the Joint Department, is building a Neural Engineering Laboratory (NEL Lab) on the Chapel Hill campus.

The lab is both computational and experimental, with strong emphasis on optical brain imaging and machine

learning applied to data analysis. Through the study of how different learning and sensing mechanisms interact within the brain, the lab's final goal is to develop neural prostheses that replace learning and motor functions in the nervous system.

Giovannucci currently welcomes post-doctoral researchers and graduate students, who will have the opportunity to closely interact with experts in computing, optics and neuroscience. For more details, visit nel.bme.unc.edu/category/news/positions.

Sode wins Diabetes Technology Society Leadership Award



Dr. Koji Sode

Dr. Koji Sode, William R. Kenan Jr. Distinguished Professor in BME, recently attended the 18th Annual Diabetes Technology Meeting in Bethesda, Md. The Diabetes Technology Society (DTS) is a nonprofit organization committed to promoting development and use of technology in the fight against diabetes.

At the opening of the meeting, Sode was awarded the society's prestigious Leadership Award in recognition of significant leadership, vision and research. The award was presented to Sode by the president of the Diabetes Technology Society, Dr. David Klonoff.

Sode named to National Academy of Inventors



Dr. Koji Sode

Dr. Koji Sode, William R. Kenan Jr. Distinguished Professor in BME, has been named a Fellow of the National Academy of Inventors (NAI).

The academic inventors elected to the rank of NAI Fellow are named for their demonstration of prolific spirit of innovation in creating or facilitating

outstanding inventions that have made a tangible impact on quality of life, economic development and the welfare of society. It is the highest professional distinction accorded to an academic inventor.

During his graduate student period, Sode engaged as a research fellow at Swiss Federal Institute of Technology, Zürich Biotechnology Institute. He started his academic appointment as research associate (assistant professor) at Tokyo Institute of Technology, following at the Research Center for Advanced Science and Technology, The University of Tokyo. In 1990, he was promoted as an associated professor at the Department of Biotechnology and Life Science, Tokyo University of Agriculture and Technology. In 2000, he was promoted as full professor in the Department of Biotechnology and Life Science.

He has been engaged in a variety of research projects with many prominent international industrial partners in the field of novel biosensors, especially for glucose monitoring. He also launched a start-up company, Ultizyme International Ltd., and is serving as the science and technology advisor.

He is the author of more than 290 peer-reviewed papers and holds numerous international patents relating to biosensing technologies.

Three professors inducted into AIMBE

The American Institute for Medical and Biological Engineering (AIMBE) has inducted one former and two current professors in the Joint Department to its College of Fellows. The Joint Department's inductees include: Dr. Koji Sode, William R. Kenan Jr. Distinguished Professor, elected for "engineering enzymes and devices that have improved the quality of life for millions of diabetics worldwide;" Dr. Ke Cheng, professor, elected



From left, Zhen Gu, Koji Sode and Ke Cheng

for "engineering and medicine research, practice or education" and "the pioneering of new and developing fields of technology, making major advancements in traditional fields of medical and biological engineering, or developing / implementing innovative approaches to bioengineering education;" and Dr. Zhen Gu, formerly a professor in BME and now a member of the faculty of the Department of Bioengineering at UCLA, elected for "engineering and medicine research, practice or education" and "the pioneering of new and developing fields of technology, making major advancements in traditional fields of medical and biological engineering, or developing/implementing innovative approaches to bioengineering education."

A formal induction ceremony was held during the AIMBE Annual Meeting at the National Academy of Sciences in Washington, DC on March 25, 2019. This election is among the highest professional distinctions accorded to medical and biological engineers. AIMBE College of Fellows is comprised of the top two percent of medical and biological engineers. Fellows include two Nobel Prize laureates. Seventeen fellows have received the Presidential Medal of Science and/or Technology and Innovation, and 158 have also been inducted to the National Academy of Engineering, 72 to the National Academy of Medicine and 31 to the National Academy of Sciences. •

STUDENT NEWS

Conway, Sullivan earn Dissertation Completion Awards



Katie Conway



Lindsay Sullivan

BME Ph.D. students Katie Conway and Lindsay Sullivan have each been awarded a Dissertation Completion Fellowship for academic year 2019–2020. The faculty reviewers on the Fellowship Committee of The Graduate School were impressed with the quality of their research and with the progress they have been making toward completion of their degree and dissertation.

Conway is working with Dr. Jason Franz on research that focuses on the biomechanics of elderly gait and investigation of mobility impairment in our aging population. Currently, she is developing and using novel approaches for the functional assessment of neuromuscular capacity in walking.

Sullivan is mentored by Dr. Ted Bateman and Dr.

Jacqueline Cole. She is a co-founder of OpenGait Prosthetics, a start-up company that creates affordable above-knee prosthetic kits to help amputees in developing countries. In fact, this initiative recently won several prizes in the

categories of New Venture and Audience Choice at the 2019 Lulu eGames.

The Dissertation Completion Fellowship will provide each student with a stipend of \$18,000 for the academic year 2019–2020. It also includes health insurance, tuition and fees and a scholarship for three hours of doctoral dissertation credit.

Ph.D. students are winners at Lulu eGames 2019

BME doctoral students Aaron Fleming and Lindsay Sullivan, co-founders of OpenGait Prosthetics, took home several prizes at the NC State Entrepreneurship Initiative's Lulu eGames. The pair received a total of \$19,000 – including first prize in the categories of New Venture and Audience Choice.

In 2017, Fleming and Sullivan took a product innovation course at NC State, where they came up with the idea of manufacturing affordable prosthetic kits for above-knee amputees in developing countries. With the money prize, the two are planning to develop the product and travel to Guatemala later this year to test it.



Fleming, Center, and Sullivan, right, receive the Audience Choice award.

“We’re hoping to have about 10 kits to put together, so this (prize) will go toward the kits and also funding the testing that we need to do in Guatemala,” Sullivan explained. Fleming’s Ph.D. advisor, BME Professor Dr. He Huang, stated “We could not be prouder of the work they are doing to help amputees around the world.”

Lulu eGames is run by NC State’s Entrepreneurship Initiative with the goal of helping start-ups coming out of NC State with early-stage capital. This year, officials handed out more than \$100,000 in prize money as part of the competition. Around 35 finalists were selected out of 148 entries to compete across five categories: Arts Venture, Built on Cloud, Social and Environmental Impact, Design and Prototype and New Venture.

Students enjoy Summer Research Experience in Prague

BME undergraduates Emily Fomin and Sarah Kubik spent the summer after their sophomore year doing research at the Institute of Photonics and Electronics in the Czech Academy of Science in Prague. Here is what they reported.

Emily Fomin: Dobrý den! This past summer, I was given the opportunity to assist in an Alzheimer’s Disease research project. The lab focused on an optical biosensing technology called surface plasmon resonance (SPR), which measures the adsorption of a substance on a conductive chip by capturing and recording the acute changes of electromagnetic wave oscillations. My research project involved me using SPR to analyze and understand amyloid beta interactions happening on the intracellular level, knowing that those amino acids are abundantly present in Alzheimer’s patients. Living in Prague was a novel and challenging experience with a language barrier, but it has become my favorite city in the world. From the hearty meat-inspired dishes, to the historic bridges, to the picturesque sunsets on the Vltava, Prague holds a special place in my heart and I cannot wait to return and explore more of Europe.

Sarah Kubik: Spending the summer in Prague doing research was an amazing experience. It was a chance to experience a new culture, while gaining some practical lab skills. The research I worked on was a part of the Alzheimer’s research project. The specific project I worked on involved detection of small concentrations of the proteins amyloid β -40, amyloid β -42 and Tau-ladder. The ability to detect these proteins at this concentration

would aid in early diagnosis of Alzheimer’s disease. These experiments were conducted using Surface Plasmon Resonance (SPR), which involves the angle of light changing in response to different substances and different concentrations binding to a chip. I spent many of my afternoons wandering the city and learning the culture. The architecture of the city was beautiful, and the history of the city felt very present, especially with the Prague Castle. The food was very rich and filling with an abundance of meats, sauces and potato dumplings. I thoroughly enjoyed spending time in Prague and definitely plan to return one day.

Visiting Ph.D. student awarded Silver Prize of the Diabetes Technology Society



Inyoung Lee

Inyoung Lee, a visiting Ph.D. student from Japan in Dr. Koji Sode’s lab in BME, won the student Silver Prize of the Diabetes Technology Society (DTS).

She received the award from Dr. David C. Klonoff, founder and president of DTS, at the 18th Annual Diabetes Technology Meeting in November

2018 in Bethesda, Md. The planning committee voted her abstract, “Direct Electron Transfer Type Open Circuit Potential Based Continuous Glucose Monitoring System,” the second-best abstract first-authored by a student.

Lee was also invited to submit an original article on her abstract topic for the September 2019 issue of the Journal of Diabetes Science and Technology, which is indexed by PubMed.

Department awards Abrams Scholarships for 2018-19

The Joint Department received an unprecedented amount of funding from the College of Engineering Research Experience for Undergraduates program and was able to fund 32 Abrams Scholars for 2018-19.

BME undergraduate students who will work on research projects this year are: Ziad Ali, Sindhoor Ambati, Carly Britt, Ryan Chen, Sara Chopra, Suma Dasari, Erin Dowell, Mary Erb, Ariana Frey, Nuran Golbasi, Marwan Hawari, Alexei Kouminov, Alex Kyu, Veronica Lee, Ciku Makumi, Eric Markley, Erica McCune, Alyssa Merante, Joshua Milligan, Sophia Navarre, Dianna Pham, James Ranta, Asa Rogerson, Megan Sandry, Marci Sessions, Josh Smith, Nicole Spencer, Brandon Sweet, Maggie Tamburro, Steven Vargas, Graham Whitehouse and Nick Williamson.

BME undergraduate wins first place at NSBE technical poster exhibition

Undergraduate student Leroy Arthur, who has been working directly under the supervision of Dr. Kennita Johnson in the Dayton Lab in BME, won a first-place award for his poster at the National Society of Black Engineers in Maryland in November 2018.

Arthur has been studying the physiological changes of rats while under anesthesia.



Leroy Arthur

Undergraduate featured for work at ABL

BME senior undergraduate Jackson Richards has been working as a research assistant at the Applied Biomechanics Laboratory, investigating balance impairment and fall risks in adults due to aging and neurological disease or injury.

Richards saw this research as a way for him to apply what he had learned in class to work in the lab.

He said that the clinical applications were interesting:



Jackson Richards

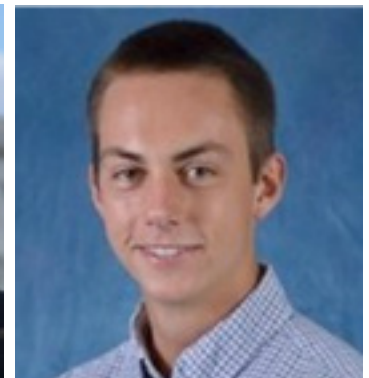
“... I could see that some of the research directly led into applications that could better other peoples’ lives.”

The lab’s goal is to introduce new rehabilitative approaches for preserving mobility and preventing falls. For more information see the article in UNC’s Endeavors magazine at unc.live/2DNwcS1.

Two students receive travel awards



Judith Rivera



Connor Puett

Two BME students were awarded travel awards to attend scientific conferences. Judith Rivera received a travel award from the American Institute for Medical and Biological Engineering to attend the AIMBE Public Policy Institute for Rising Leaders workshop, held in late October in Washington, DC. The program explored how proposed regulatory and policy initiatives shape medical and biological engineering.

Connor Puett received an award from the BME department to attend the Radiological Society of North America 104th Scientific Assembly and Annual Meeting in late November. He presented a talk during a session titled “Digital Breast Tomosynthesis: Screening and Diagnostic Indications.”

SECC Award to BME for most participation: student scholarship

In February, the Joint Department received an award for most participation in the North Carolina State Employees Combined Campaign (SECC). A scholarship was



Candace Burgin

awarded to Candace Burgin, a junior in the department.

Burgin defines herself as a “committed and imaginative student focused on improving and developing the biological devices in the medical sciences.” She is not only a full-time scholar student, but also a Women in Science and Engineering learning village ambassador.

Two receive graduate research fellowships



Murad Hossain



Gabriela Torres

Two graduate students in the Joint Department, Charlotte DeVol and Emily Fawcett, have received prestigious graduate research fellowships from the National Science Foundation (NSF).

The fellowship program recognizes outstanding graduate students in NSF-supported science, technology, engineering and mathematics disciplines who are pursuing research-based master’s and doctoral degrees.

Fellows benefit from an annual stipend of \$34,000 for three years, a \$12,000 allowance for tuition and fees, opportunities for international research and professional development, and the freedom to conduct their own research at any accredited U.S. institution of graduate education they choose.

Graduate students receive travel awards

Four BME graduate students, Emily Fawcett, Murad Hossain, Connor Puett and Gabriela Torres are the proud recipients of travel awards to participate in scientific conferences.



Connor Puett

Fawcett, Hossain and Puett attended the annual meeting of SPIE, the society for optics and photonics, in California. Science and industry connect at SPIE, and the greatest minds showcase the latest innovations across a wide range of technologies in medical imaging, optics and photonics.

Torres used her travel award to attend the American Institute of Ultrasound in Medicine conference.

Undergrad featured in *The Daily Tar Heel*

BME undergraduate student Morgan Goetz was the star in a recent story appearing in the UNC student newspaper, *The Daily Tar Heel*.

Goetz spoke about her success in her coursework as well as her role as a defender on the 2018 NCAA National Championship UNC field hockey team. Goetz graduated in spring 2019 with a B.S. in biomedical engineering from the Joint Department, and will pursue a Ph.D. at Harvard in BME. To read more about Goetz and her accomplishments and inspirations, check out the story at bit.ly/2EuPImt.

Student honored at Undergraduate Research and Creativity Symposium

Ariana Frey, a junior BME student doing research in Dr. Donald Freytes’ lab, was recently awarded an Outstanding Poster Presentation at the 28th Annual Spring Undergraduate Research & Creativity Symposium.

Sponsored by the Office of Undergraduate Research the Undergraduate Research Club, and the Division of Academic and Student Affairs at NC State, the symposium took place April 24 in the Talley Student Union Ballrooms. More than 200 posters were presented, representing the research work of more than 400 students in each of the nine colleges at NC State. Including Frey, only 23 other students were awarded with Outstanding Poster Presentations and have been invited to join Sigma Xi, The Scientific Research Honor Society.

Frey is also a 2018–19 Abrams Scholar and was awarded an Office of Undergraduate Research grant for the 2018–2019 school year. Her research in collaboration with Dr. Freytes and Dr. Glenn Cruse of the College of Veterinary Medicine focuses on the development of in vitro models for human and canine mastocytosis.

Graduate is motivated to help niece, others, with prosthetics



Ryan Hobbs

Ryan Hobbs graduated from the Joint Department with a bachelor's degree in spring 2019. During his academic career, Hobbs served as president of the Helping Hand Project, which creates usable prosthetic devices for children across the country. During summer 2018, Hobbs spent two months in Tanzania repairing medical equipment.

Hobbs posted on his Instagram account after graduation about his motivations for pursuing a degree in biomedical engineering:

“Junior year of high school I decided to pursue a degree in Biomedical Engineering after my niece Hannah was born.

A few weeks ago I graduated from NC State with a degree in Biomedical Engineering and have had a blast giving kids like Hannah recreational prosthetic hands and arms that have changed their lives (Hannah's is coming soon)! In August I will be moving down to Birmingham, Alabama as a Venture for America Fellow to work for

a Healthcare startup that is striving to improve outcomes for both patients and providers!

Big thanks to everyone who helped me get here today, but the largest praise and all the Glory to the Father above!”

BME Ph.D. student introduces Science Day in Dominican Republic

In December, first-year BME Ph.D. student Maura Vrabel, in collaboration with graduate student Franklin Mejia at the University of Notre Dame, travelled to the Dominican Republic to lead the first annual Dia de Ciencia (Science Day) at local high school Colegio Loyola.

The pair had planned and organized the science outreach event at Mejia's former high school because they saw a need for greater awareness about STEM careers, especially in developing countries where careers in science are often underappreciated. The objective was to introduce students to various STEM disciplines and to encourage them to pursue careers in those fields. Throughout the day, students were introduced to basic concepts of biology, chemistry and physics by appealing to their curiosity and using interactive examples.

The first Science Day benefitted 40 students and was supported by 15 volunteers, most of whom were young STEM professionals and alumni of Colegio Loyola themselves. In addition, the event was partly funded by the Institute for Latino Studies at Notre Dame. Vrabel said of the event: “After months of planning and coordination, the event was incredibly successful and I look forward to expanding Science Day to offer more activities to students at other high schools next year.”

If you would like to be updated on future plans for Science Day or would like to donate, contact Vrabel at mrvrabel@ncsu.edu. •



Franklin Mejia, left, and Maura Vrabel

Joint Department of
**BIOMEDICAL
ENGINEERING**



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BME Graduation and New Beginnings

The Carolina Theater was filled to the balconies with family and friends celebrating the 2019 graduating class of the Joint Department of Biomedical Engineering. Do you remember how exciting it was to reach that milestone and celebrate your accomplishment of earning your degree?

What have you been doing with your BME degree? What job opportunity has presented you with new challenges and achievements? We would like to be able to highlight our alumni on the department's website, in social media and in this newsletter. Send us your stories and highlights and share your success with your fellow alumni and BME students.

Our current and future students depend on the support of BME alumni like you for a variety of initiatives including unrestricted support for students to travel to competitions and conferences, resources for design projects and community events that help bring students from both campuses together. Your success and support will inspire our students and help BME to thrive. We look forward to recognizing you as a donor to BME in future issues.

For more information about supporting the Joint Department of Biomedical Engineering and our mission to unite engineering and medicine to improve lives, please contact Laura Schranz at lschranz@unc.edu or **919.962.6212** or visit www.bme.unc.edu/give-to-bme (BME 21st Century Fund at UNC or Biomedical Engineering Enhancement Fund at NC State).

Thank you!

