CornellEngineering
Nancy E. and Peter C. Meinig School of Biomedical Engineering

BME

Newsletter
Fall 2016

ENGINEERING LIVING SYSTEMS: THE MEINIG SCHOOL UNDERGRADUATE MAJOR TAKES OFF

PAGE 4

BME MESSAGE

MESSAGE FROM THE DIRECTOR: MARJOLEIN C.H. VAN DER MEULEN

In 2015-16, after the Meinig family naming gift and New York state approval of our undergraduate major in the prior year, we focused on moving BME forward into a new era at Cornell.

Once the BME major was approved, the next critical task was implementing the undergraduate program. Professor Jonathan Butcher, our Associate Director and Director of Undergraduate Studies, continues to provide outstanding vision for the major. Now that the sophomore year classes have been developed and taught, our focus is on the junior year courses, including a new instrumentation lab required of all majors. After this fall, all majors will have completed the initial courses in each concentration, allowing them to focus on their concentration electives in the spring. For more detail on the undergraduate program, see our feature article on pg. 4.

Welcoming BME-focused undergraduate students into the fold has been an exciting and fulfilling program development. Our inaugural class of majors, the Class of 2018, was positioned to fulfill the BME affiliation requirements when the major was first announced in August 2015, and brought 19 majors who affiliated and began their coursework in January 2016. Last year's freshmen, the Class of 2019 and now sophomores, were admitted prior to the B.S. degree approval, but are expected to be nearly double the size of the first group. The current freshmen, Class of 2020, chose Cornell with the BME major in place and are expected to have healthy interest in the major. This growth rate is ideal as we stage our curriculum. Ryan Sauvé joined the staff last fall as our inaugural undergraduate coordinator and has been getting to know our majors (meet Sauvé on pg. 6).

One incredible statistic I'd like to highlight is the diversity of our incoming classes. Current and prior freshman College of Engineering classes are 48% female. In BME, we are thrilled to contribute our share to improving diversity representation, with our first class of majors comprised of 75% females and greater than 20% from underrepresented minorities. Indeed, our commitment to diversity is evidenced not only by the numbers but also in the form of awards recently bestowed upon our faculty and staff; Associate Professor Cynthia Reinhart-King was awarded the Zellman Warhaft Diversity Award last year for her efforts to increase participation of underrepresented students in engineering, and this year our Graduate Coordinator Belinda Floyd received a Diversity Programs in Engineering (DPE) Award.

Our faculty continue to have a strong interest in pedagogy and training experiences for our graduate students. We received a Department of Education Graduate Assistance in Areas of National Need (GAANN) award that will train our graduate students to be outstanding educators through teaching experiences in the undergraduate curriculum. The NIH support for our Ph.D. immersion term at Weill Cornell was renewed this summer through the leadership of Professor Yi Wang and the Department of Radiology (see pg. 13 for a program overview). Building on prior success with high school educators, we will soon be initiating a NYS Department of Health-funded Teacher-Scientist Partnership in stem cell biology. These large efforts all provide unique experiences for our graduate trainees.

We are excited to expand our faculty this year with unique expertise that nicely complements our current research areas. This summer we welcomed Ilana Brito who joined us as an assistant professor after her tenure as a postdoc at MIT. Ilana brings an exciting area of microbiome research to the school and curriculum. Next summer we look forward to welcoming Mert Sabuncu to the faculty as an assistant professor in Electrical and Computer Engineering, with a 25% appointment in BME. Mert's expertise in biomedical imaging applied to the brain will contribute unique insights to the newly established Cornell Neurotech program. With an ongoing search for the McAdam Professor of Heart Assist Technology and a junior faculty search being initiated this fall, we look forward to adding two new faculty to our team in the coming year.

We are fortunate to congratulate faculty member Newton de Faria as one of the first professors of practice in the College of Engineering, which recently established this new academic title. Newton initially joined us a year ago as a lecturer after a 20-year career at National Instruments. He leads the Master of Engineering (M.Eng.) program, which had several key individuals recently retire. Newton has brought tremendous energy, insight, and new ideas to the M.Eng. program, which you can read more about on pg. 7.

Among our current faculty we have had lots of good news, as featured in this newsletter (pg. 16), and a few

THE BME MISSION

To educate students to understand the human body as an integrated system and the mechanisms of disease through quantitative engineering analysis, and to use that understanding to design better therapeutic strategies, devices, and diagnostics to improve human health.

items that I'd like to highlight here:

Professor Claudia Fischbach-Teschl is leading the recently announced NIH-funded Center on the Physics of Cancer Metabolism. This Physical Sciences-Oncology Center will span the Ithaca and Weill Cornell Medicine campuses to advance our understanding of the regulation of tumor metastasis and function (read more about the center on pg. 8).

In March Professor Chris Schaffer was elected to a three-year term as the Associate Dean of the Faculty. This position follows on Chris's prior involvement with the Faculty Senate and University Faculty Committee. We look forward to his contributions to faculty governance at Cornell.

Please read further to get the full scope of the Meinig School faculty, staff, student, and alumni accomplishments in the past year. Beyond the newsletter, our webpage and social media sites are continually updated. Your thoughts and feedback are welcome, and we hope you will share your own good news with us. As always, please reach out if you or your family are back on campus.

Sincerely,

Marjolein C.H. van der Meulen

James M. and Marsha McCormick Director of Biomedical Engineering

Swanson Professor of Biomedical Engineering

ABOUT THE COVER
Undergraduate BME majors in the BME 3020 lab

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FROM ATOMS TO ORGANS: UNDERGRADUATE BME MAJOR UNDERWAY

Shivaun Archer, the John and Janet Swanson Senior Lecturer (far right), with undergraduate students in the BME 3020 laboratory workspace.

The 2015-16 academic year was a transformative one for biomedical engineering at Cornell, with a $50 million gift from the Meinig Family coming alongside N.Y. state approval to offer a four-year Bachelor of Science (B.S.) degree in the summer of 2015. The department was upgraded and renamed, and in January 2016 the Meinig School of Biomedical Engineering welcomed 19 affiliated sophomores to the inaugural class of BME majors. While at first glance the program may seem to be ramping up, in fact the idea for an undergraduate major in biomedical engineering has been over ten years in the making. And with focused program planning by Cornell's faculty leadership in the past two years, the Meinig School B.S. in biomedical engineering (as well as its majors) are indeed ready to fly.

Of particular note are the several progressive pedagogical features that distinguish this program from parallel programs at peer institutions. First is its

A COMMITMENT TO DIVERSTIY: INCOMING BME MAJORS ARE 75% FEMALE, 20% UNDERREPRESENTED MINORITIES

curricular platform, designed to develop a quantitative understanding of the human body as integrated, multi-scale systems. To establish this knowledge base, students pursue two parallel curricular streams: (1) a sequential series of four core laboratory-supported courses that present engineering analysis of disease mechanisms at molecular, cellular, tissue, and organ system levels, and (2) a concentration module of interdisciplinary engineering skills that fit key biomedical engineering career areas: molecular, cellular, and systems engineering; biomaterials and drug delivery, biomedical imaging and instrumentation; and biomechanics and mechanobiology. Each concentration module culminates in a unique laboratory practicum in which students gain real-world, practical expertise working with the latest technologies and processes in their chosen specialty. This schedule, says Jonathan Butcher, associate professor, associate director of BME, and director of undergraduate studies, "encompasses the variability and uncertainty of disease mechanisms that initiate and propagate across various scales, providing a strong platform from which students learn to engineer robust therapies, devices, and diagnostic procedures to improve human health."

Additionally, in their final year, all BME students pursue a year-long design sequence ideating and building solutions to real-world, open-ended problems from the biomedical industry and the clinic. These team-based projects are designed to reflect the irreducible working units in today's biomedical industry. Students are trained to recognize where and how to add value to a product, and then to utilize their complementary skills to innovate a solution confidently. "This environment creates essential training in professional skills necessary for long-term career progression," says Butcher. Students can further broaden their education by pursuing tailored course paths within Cornell's renowned liberal arts tradition, including pre-medicine, public policy, study abroad, and entrepreneurship.

"A SIGNATURE OF THE MAJOR CURRICULUM IS AN EMPHASIS ON EXPERIENTIAL LEARNING, DESIGNED TO CONNECT COURSEWORK WITH REAL-WORLD EXPERIENCE"
—Jonathan Butcher, Director of Undergraduate Studies

Another unique program feature is its "flipped curriculum" whereby students first explore the applications landscape before digging into intellectual and technical content. "Traditionally, content is presented the other way around," says Professor Lawrence Bonassar, who was integrally involved in designing the major's program with Butcher. This unique twist, he says, "primes students with the challenges and opportunities inherent to biomedical engineering so that they are motivated to pursue the necessary deeper expertise to meet those needs."

A highlight of the Meinig School major's curriculum is an emphasis on experiential learning, facilitated by an Engaged Curriculum Grant from Cornell's Office of Engagement Initiatives. All BME majors embark on extracurricular, long-term, student-driven projects, and participate in experiential learning seminars designed to connect coursework with real-world experience. They choose from a variety of individual and team-based opportunities such as serving as research assistants in faculty laboratories, participating in design team projects, or engaging in community outreach. Flexibility in their project choices means students can build knowledge specific to their own interests and career goals. In addition to a richer experience for students, this program also builds direct ties between the Meinig School and various community members as diverse as local hospitals, the public, and industry. Juxtaposition of coursework with these unpredictable, real-world situations provides continually varying engineering contexts and develops students' capacity to adapt to an uncertain and changing professional biomedical terrain.

A BME undergraduate student pipetting samples in the BME 3020 lab.

Within seminars and in more traditional courses, the curriculum incorporates exercises that blend material from lectures, textbooks, and the student's real world experiences. In this way, students take engineering concepts from the classroom into the communities within which they work; in other words, they put theory into practice, and bring practice into discussions of theory. The experiential learning seminar also provides

(continued next page)

UNDERGRADUATE PROFILE: JORDAN HARROD

Jordan Harrod hails from Montclair, N.J., and is excited to be a part of Cornell's first class of undergraduate BME students. Cornell didn't have a biomedical engineering undergraduate major when Harrod arrived on campus in 2014 as a freshman, but that didn't stop her from getting involved. She's worked on research in both the Bonassar (BME) and the Estroff (MSE) groups since her freshman year. "It has been amazing," says Harrod, "to see how the research that I work on connects back to the classes that I now have the opportunity to take." Harrod has also been happily surprised to develop her research interests further through classes that focus on skills and topics that do not relate to her research (specifically, biomedical signals and systems with Professor Steven Adie), alerting her to additional research topics for graduate studies. Harrod looks forward to the opportunity to work with other professors in the Meinig School, and to the skills she will gain through the experiential learning classes she has yet to take.

complimentary training in soft skills such as teamwork, communication, and leadership. As an example, BME has partnered with Poppy Mcleod, associate professor in Cornell's Department of Communication, to assess and develop students' teamwork skills and to guide them in how to apply these skills to their real-world and class projects.

With the curriculum in place and a stream of incoming freshman interested in BME, the Meinig School's future looks bright. "We expect healthy growth for the BME majors program in the next few years," confirms Marjolein van der Meulen, the James M. and Marsha McCormick Director of Biomedical Engineering and Swanson Professor of Biomedical Engineering at the Meinig School. "This is due in part to a global need for qualified BME engineers in industries from healthcare and pharmaceuticals to medical devices and consulting, but also because of the strength of our program vision and our faculty." Within this growth, the program is thrilled to see increasing diversity. In 2015, 75% percent of affiliating BME majors were women and 20% were underrepresented minorities. Compared to the national average for all undergraduate engineering students, which is 18% and 13% respectively (source: American Society for Engineering Education), these numbers demonstrate Cornell Engineering's (and the Meinig School in particular) commitment to diversity in the STEM fields.

Van der Meulen expects the program to double enrollment year-to-year, with a graduating class of around 80 by the time the first BME majors graduate in 2018. With all this curricular muscle behind them, Meinig School graduates are ideally positioned for careers or further education in the engineering and life science industries.

MEET UNDERGRADUATE COORDINATOR RYAN SAUVÉ

"I LOVE THE COMMUNITY FEEL AT CORNELL BME"

Ryan Sauvé grew up not too far from Ithaca in Solvay, N.Y. After earning B.S. and M.A.T degrees from Northeastern University in Boston, Mass., he worked doing professional development for math and science educators, expanding the program to direct STEM education outreach with teachers, students, and schools. Prior to Cornell, Ryan was at the University of Houston providing academic scholarships and support to STEM majors.

Sauvé is glad to be back in upstate New York and at the Meinig School as undergraduate coordinator for the new major in biomedical engineering. He serves as both an academic and personal resource for students. Whether it's helping a student plan out their schedule, connecting them with research opportunities, or providing a space to vent, his door is always open! His goal is to help make the path through the BME degree as smooth and rewarding as possible.

Sauvé's favorite thing about Cornell is its community; both the university as a whole, as well as at the Meinig School. "It's a great feeling to come in every day and see so many hard working students, faculty and staff, all supporting each other and working towards the same goals."

Besides being the proud (and often tired) father of a four-year-old boy and two-year-old girl, he is proud of having survived six summers of Texas heat. Having been born and raised in Syracuse, N.Y., he sees this as quite an accomplishment.

Jonathan Butcher (standing), associate professor, Meinig School associate director, and director of undergraduate studies, working with BME majors in the Experiental Learning Seminar.

M.ENG. PROGRAM UPDATE

Newton de Faria

Improving upon something already great is always a challenge, but Newton de Faria, the Meinig School's professor of practice and Master of Engineering (M. Eng.) program director, is focused on just such a task. Specifically, in a quest to make the program the best of its kind, de Faria has been working this past year to strengthen the program's three P's: People (incoming students), Process (program), and Product (graduates).

"We are not only looking for the best and brightest," de Faria says of the improved processes for recruiting and selecting new students into the program, "but also for individuals with diverse academic and cultural backgrounds who are capable of fulfilling the needs of a broad and diverse healthcare industry."

Part of recruiting these top-level individuals includes presenting them with an engaging and inspiring curriculum. Center to the Meinig School's M.Eng. program is a design project—typically sponsored by academic and clinical institutions. De Faria's outreach efforts have focused on bringing in sponsors from industry, humanitarian, and community outreach organizations. These projects offer students depth in learning principles of sciences and engineering, as well as unparalleled opportunities to design products with real-world impact and develop professional leadership skills. "The goal of the design project," says de Faria, "is to provide students a rich academic and professional exercise as well as deliver value to the project sponsors." Improvements to this part of the program include streamlined processes for soliciting and selecting projects and sponsors, as well as targeted placement of students within teams addressing these projects.

Incoming students also benefit from another program development supporting these design projects, that of a newly-enhanced infrastructure including the addition of multiple collaborative environments including a student lounge, a design studio, dry and wet laboratories, and a fabrication laboratory. Each space is designed specifically to catalyze team-building and creativity, as well as cross-fertilization of ideas. The program has also acquired many different hardware and software technologies, such as high-performance computers, multiple design-enabling software platforms, 3-D printers, a CNC machine, a surface mounted electronic circuit station, and many other tools for building prototype products.

Professor of Practice Newton de Faria (blue hood) celebrates with graduating biomedical M.Eng. students at the May 2016 ceremony.

Finally, all of these improvements to the M.Eng. program at the Meinig School culminate in graduates with real-world problem-solving skills specific to the biomedical field. "By training students to understand and communicate their acquired marketable skills," says de Faria, "they are best able to inform potential employers about the quality and value our M.Eng. graduates bring, enhancing the student placement overall."

With these improvements and more to come, de Faria expects the program will continue to meet and exceed its goal to train and place students as professional biomedical engineers who can both identify unmet clinical needs and apply that knowledge to invent, design, develop, and deploy innovative medical technologies for the benefit of the organizations they serve and humanity in general.

THE BME M.ENG. PROGRAM

The Meinig School's Master of Engineering (M.Eng.) program focuses on engineering practice and design. Our goal is to prepare students for professional practice in BME For outstanding students who are interested in entrepreneurship and engineering, Our M.Eng. students acquire a broad perspective of the biomedical engineering discipline that complements their undergraduate training in engineering or science, and an in-depth knowledge of an essential area in biomedical engineering. In addition to coursework, students complete a collaborative design project.

Graduates are equipped to design biomedical devices and develop therapeutic strategies within the bounds of health care economics, the needs of patients and physicians, the regulatory environment for medical devices and pharmaceuticals, and stringent ethical standards of biomedical engineering practice. Our M.Eng. program incorporates industry-oriented training using a design-centric approach to prepare students for a wide range of careers in medicine, academia, and industry from large pharmaceutical firms to entrepreneurial startups.

GRANT LAUNCHES CENTER ON THE PHYSICS OF CANCER METABOLISM

by Syl Kacapyr

Prof. Claudia Fischbach-Teschl (left) with Ph.D. students Peter DelNero and Young Hye Song in her Weill Hall Lab at the Meinig School.

The mechanisms controlling how breast cancer develops, spreads to other parts of the body and responds to therapy remain poorly understood, but researchers from Cornell Engineering and Weill Cornell Medicine hope to change that through the Center on the Physics of Cancer Metabolism—a new multi-institutional translational research unit to be established with a National Cancer Institute grant.

On Aug. 25 New York Senators Kirsten Gillibrand and Charles Schumer announced first-year funding for the center of $1.9 million. The grant could total $9.3 million over five years.

Led by Claudia Fischbach-Teschl, associate professor of biomedical engineering at Cornell University, and Dr. Lewis Cantley, the Meyer Director of the Sandra and Edward Meyer Cancer Center at Weill Cornell Medicine in New York City, other partners include researchers from Memorial Sloan Kettering Cancer Center, the University of Texas MD Anderson Cancer Center and the University of California, San Francisco. The partnership will also foster collaborations across the Ithaca campus among researchers from the College of Engineering, the College of Arts and Sciences and the College of Veterinary Medicine.

“THE PHYSICAL SCIENTISTS IN ITHACA ARE BRINGING TECHNOLOGIES THAT DON’T EXIST HERE AT WEILL CORNELL.”
—Dr. Lewis Cantley, Weill Cornell Medicine

The goal of the center is to combine the strengths of different interdisciplinary research groups to gain unprecedented understanding of the biological and physical mechanisms regulating how tumors function and metastasize, or spread, in the human body’s microenvironment.

Cantley’s expertise in cancer metabolism, which has led to several breakthroughs in the field, dovetails with Fischbach-Teschl’s acumen in engineering of cancer models to enable the team to explore tumor development, progression and metastasis from a completely new perspective. Complemented by other investigators’ expertise in micro- and nanofabrication, imaging and computational approaches, they can monitor and predict tumor metabolism and cell migration, and test drugs or other therapies in a patient-specific manner.

“The physical scientists in Ithaca are bringing technologies that don’t exist here at Weill Cornell,” Cantley said.

Fischbach-Teschl said teams in Ithaca will also benefit from access to patient samples and clinical knowledge that will be provided by Weill Cornell Medicine and other partners. The ultimate goal, she said, is to develop new therapeutic approaches to breast cancer, and eventually other types such as prostate and pancreatic cancer.

“Doing validation studies with patient-derived cells is always the end goal and we've done that, but we haven't done it as extensively because the resources are not there," Fischbach-Teschl added.

The center will focus on three main research areas over the next five years: the mechanisms that regulate tumor metabolism and how obesity affects the process; how membrane-surrounded vesicles produced by tumor cells affect their behavior; and the physical and metabolic constraints influencing tumor cell migration.

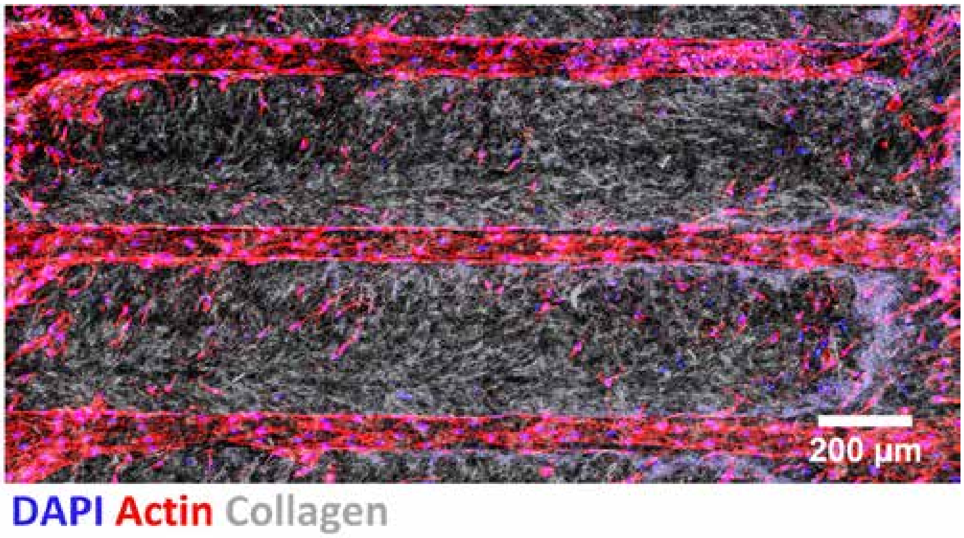
"DESPITE ADVANCES IN BREAST CANCER TREATMENT, METASTATIC DISEASE REMAINS INCURABLE. USING PHYSICAL SCIENCES APPROACHES MAY HELP US TO BETTER UNDERSTAND THE UNDERLYING MECHANISMS."
—Claudia Fischbach-Teschl, Cornell Meinig School of BME

The center will also provide an opportunity for next-generation scientists to receive unique interdisciplinary training, Fischbach-Teschl said.

"Students and postdocs in Ithaca are going to be trained in applying oncology principles to their engineering-focused study of cancer, and clinical trainees in New York City are getting exposed to the technologies and ideas that we develop here," she said.

Patients will benefit in another way as well: the inclusion of a patient advocacy component will link researchers directly to cancer patients and survivors to share emerging information about the disease with the people it is affecting. And adding the perspectives of patients will inform research approaches, ultimately leading to a more complete understanding of the disease.

"There's an opportunity to understand how to prevent metastasis from occurring, but even if we don't cure cancer, we're going to learn a lot from each other," Cantley said.



Endothelial cell-coated vessels embedded within microfluidic collagen scaffolds like this one will be used at the center to look at the role of oxygen and nutrient transport in regulating cancer metabolism.

MORE ON CANCER RESEARCH

Despite advances in breast cancer treatment, metastatic disease remains incurable and is of particular concern in patients with triple negative breast cancer. Both aberrant metabolic signaling and physical properties of the microenvironment have been independently defined as hallmarks of cancers, and experimental evidence suggests that they may be functionally linked.

Cell culture models are powerful tools in cancer research because they enable control over experimental parameters. In addition, culture models can be based on patient samples, enabling rapid translation of basic science to the clinic. However, traditional cell culture consisted of a thin layer of cells growing on a flat petri dish. This geometry and mechanical environment is so different from what is found in patients, so that these models do not behave the same as cancers in patients. The current lack of physiologically relevant culture models that capture important physical details prevents studying the specific mechanisms that link metabolic reprogramming, the physical microenvironment, and clinical outcomes of malignancy. With the development of novel, three-dimensional models that more accurately recreate the true environment of tumors, the Center on the Physics of Cancer Metabolism will study how the physical microenvironment can contribute to the reprogramming of cancer cell metabolism and vice versa. Understanding how cancer cells produce and use energy is vital to developing new therapies that can target tumors while minimizing the side effects on patients. In addition the center will address how cancer cells can communicate with each other and normal cells through the release of soluble signals and microvesicles carried in the fluids around cells. Such signals may render distant organs vulnerable to colonization by migrating tumor cells, increasing metastasis and cancer malignancy.

In 2009, Cornell became one of the initial National Institutes of Health Physical Sciences Oncology Centers. This grant continues Cornell's participation in this nation-wide network of investigators exploring the contribution of physical sciences to cancer biology.

BRITO WENT TO FIJI TO STUDY MOBILE GENES IN HUMAN MICROBIOME

by Tom Fleischman


Ilana Brito

How far will a scientist travel in pursuit of answers? In the case of Ilana Brito, new assistant professor in the Meinig School of Biomedical Engineering, the answer is: one-third of the way around the globe.

Brito, the Mong Family Sesquicentennial Faculty Fellow in Biomedical Engineering, co-authored a report with Massachusetts Institute of Technology professor Eric Alm on "mobile genes" and the role they play in the human microbiome. Mobile genes are genetic material that, unlike that passed from parent to child, moves between organisms by horizontal gene transfer.

In early 2011, Brito—then a postdoctoral researcher working in Alm's lab at MIT—traveled more than 8,000 miles from Boston to the South Pacific islands of Fiji to study remote, isolated populations and compare the mobile genes within the microbiomes to those of people living in metropolitan North America. The information on North Americans was gathered in 2008 in the Human Microbiome Project of the National Institutes of Health.

The Brito group's work, "Mobile genes in the human microbiome are structured from global to individual scales," was published July 21 in *Nature*.

The study of 172 Fijian islanders—called the Fiji Community Microbiome Project (FijiCOMP)—represents the first terabase-scale metagenomic view of the microbiome in the developing world. Brito was in Fiji for six weeks, living with local families and conducting an extensive survey of villagers she met. She mapped out family trees and social networks, noted what medications they took, and recorded exact locations of their homes and drinking water supplies. She also sampled their water and identified who touched livestock, and took samples from those livestock.

She was also "basically going door to door, asking for stool samples," she said with a laugh, eventually returning home with more than 1,000 genetic samples. The group's exhaustive research combined both single-cell sequencing of nearly 200 genomes derived from seven FijiCOMP participants and metagenomics from all of the samples, to identify more than 22,000 mobile genes. It required, to some extent, inventing as they went along. "About 200 single cells, that's quite a large study by today's standards," Brito said. "The technology to be able to do sequencing on one cell is fairly new and required some new engineering on our part."

The *Nature* paper describes the new method that uniquely combines two approaches—shotgun metagenomic sequencing with single cell sequencing. Her study uses a new method that she and colleagues at the Broad Institute developed in which cells are encapsulated in a hydrogel matrix and isothermally amplified in situ, improving the fidelity of single-cell sequencing. By examining these genomes, she determined which genes were transferred between cells and then looked into over 500 individuals' microbiomes to determine who harbored this set of mobile genes. Her work uncovered tiered structure to the mobile gene pool, with some portion of genes capable of sweeping the globe, but others more local. Interestingly, these local pools of mobile genes were reflective of different cultural practices, including diet and antibiotic use.

Among their findings, the team reported large differences in mobile gene content between the Fijian and North American microbiomes, with variations consistent with known dietary and behavioral differences between the populations. Those findings support the hypothesis that human activities provide selective pressures that shape mobile gene pools, and that acquisition of mobile genes is important for colonizing specific human populations.

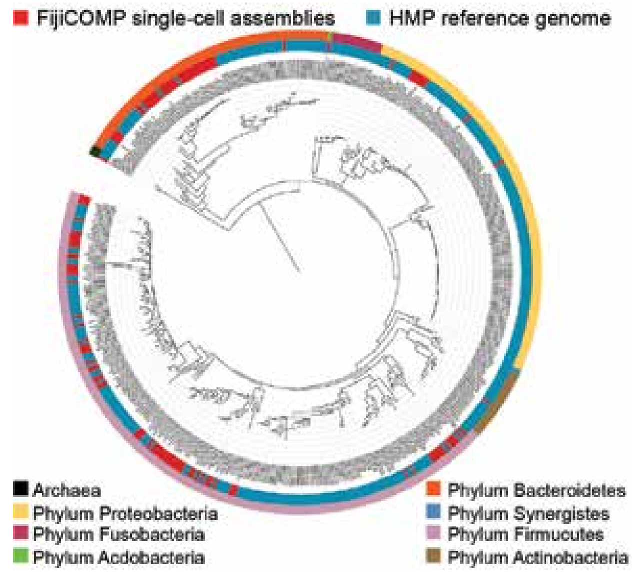
For a gene to be transferred into someone's microbiome, Brito said, the transporting microbe doesn't even have to survive. Its genes can still be passed on and integrated into another bacteria's genome.

HORIZONTAL GENE TRANSFER

Bacteria engage in a process of gene sharing called horizontal gene transfer. Bacteria can pick up genes from their environments or from other bacteria to adapt to their environments. Before Professor Brito's study, it was not clear whether this pool of mobile genes that bacteria could sample from was uniform around the world or whether there were local flavors of genes that bacteria living in those environments could sample from. On one hand, horizontal gene transfer can be an extremely efficient way of transferring genes and in the cases of a few infamous genes, namely ndm1, a carbapenem resistance gene and most recently a colistin-resistance gene, mcr-1, these genes have managed to spread around the globe. Yet, other examples suggest that these pools of mobile genes may be localized. In the mouths of individuals who have had amalgam fillings, containing trace amounts of mercury, the organisms have acquired mercury resistance genes. Similarly, in the guts of Japanese individuals, microbes can be found who have acquired genes from the organisms living on the seaweed they are consuming that helps them degrade seaweed polysaccharides.

"It's thought that that's primarily the way antibiotic resistance spreads," she said. "Pathogens acquire resistance from the microbiome. This is actually a fundamental question that I want to continue looking at in my lab."

Brito said that while the group's years of research and study answered many questions, it has raised new ones. "It has given us a lot of preliminary data to chew on and figure out the next steps," she said.



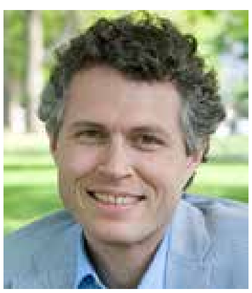
Read more:

[1] "Mobile genes in the human microbiome are structured from global to individual scales," Brito I.L., Yilmaz S., Huang K., Xu L., Jupiter S.D., Jenkins A.P., Naisilisili W., Tamminen M., Smillie C.S., Wortman J.R., Birren B.W., Xavier R.J., Blainey P.C., Singh A.K., Gevers D., Alm E.J. *Nature*. 2016 Jul 21;535(7612):435-9.

[2] "Virtual microfluidics for digital quantification and single-cell sequencing," Xu L., Brito I.L., Alm E.J., Blainey P.C., *Nat Methods*. 2016 Sep;13(9):759-62. doi: 10.1038/nmeth.3955. Epub 2016 Aug 1.

About the Research Image (right): Reference genomes from the Human Microbiome Project with close to 200 single-cell bacterial genomes from the FijiCOMP cohort from a diverse set of lineages, making this study one of the largest bacterial single-cell studies to date. They employed a novel sequencing approach they developed in which cells are encapsulated in hydrogel and amplified in situ [2]. These genomes could then be compared to identify a putative set of mobile genes. Adapted from [1].

WELCOME MERT SABUNCU


Mert Sabuncu

Mert Sabuncu will join the Meinig School as an assistant professor in July 2017 with joint appointments in BME and ECE. Sabuncu received a Ph.D. in electrical engineering from Princeton University, where his dissertation work focused on the image processing problem of establishing spatial correspondence across multiple clinical scans. He then moved to Massachusetts Institute of Technology (MIT) to do a post-doc at the Computer Science and Artificial Intelligence Lab, where he continued to work on algorithms for biomedical image analysis.

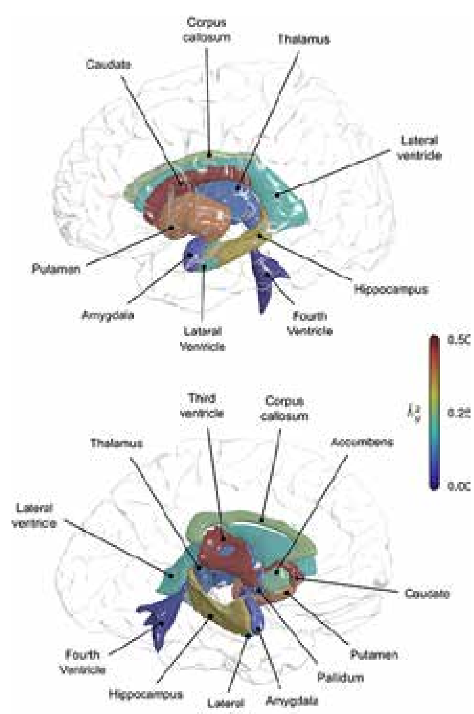
Sabuncu's main research interests lie in medical image analysis with an emphasis on neurology and neuroscience, computational imaging genetics, signal/image processing, pattern recognition, and artificial intelligence. One area of particular interest is the characterization of pre-clinical Alzheimer's disease—the phase of the disease where no symptoms have yet appeared and an intervention is likely to be successful. Most recently, as part of a BrightFocus grant, his work focused specifically on developing a computer system to analyze brain MRIs and saliva-derived DNA data to reliably determine risk of Alzheimer's before memory complaints begin.

In the coming year Sabuncu will transition from a faculty position at the A. A. Martinos Center for Biomedical Imaging (Massachusetts General Hospital and Harvard Medical School). As a new assistant professor at Cornell, his lab will develop cutting-edge machine learning and probabilistic inference algorithms to analyze and exploit biomedical image data, together with other clinical data types such as genomics and electronic health records.

Read more:

"Morphometricity as a measure of the neuroanatomical signature of a trait," Sabuncu M., Ge T., Holmes A.J., Smoller J.W., Buckner R., and Fischl B., Proceedings of the National Academy of Sciences, USA. Epub 2016 Sep 9.

About the Research Image (below)
The heritability of the shapes of neuroanatomical structures estimated using computational techniques developed by Mert Sabuncu and colleagues.



FACULTY RESEARCH

CANCER CELLS' ABILITY TO SELF-REPAIR MAY SPAWN NEW TREATMENTS

ByTom Fleischman

Because they have narrow bodies and no collarbones, mice are able to squeeze through holes as small as a quarter-inch in diameter.

Cancer cells similarly are able to migrate through extremely tight quarters but with a major difference: The journey often comes at a price—the deformation and, in some cases, rupture of the outer lining of a cell's nucleus.

A research group headed by Jan Lammerding, associate professor of biomedical engineering, has been studying this phenomenon in hope of using it to develop both treatment and diagnostic solutions for the millions of people who deal with cancer every day.

Lammerding's group reports on this research in a paper published in the journal *Science*. His group's paper was being published simultaneously with research by a French group, which found similar results in immune cells.

While deformation and rupture can sometimes lead to apoptosis (cell death), the cell also has the ability to repair itself.

"I think most cell biologists would probably say that these cells will not do very well after deformation and rupture," said group member Philipp Isermann, a visiting scholar in biomedical engineering. "And it was quite surprising that about 90 percent of these ruptured cells survived."

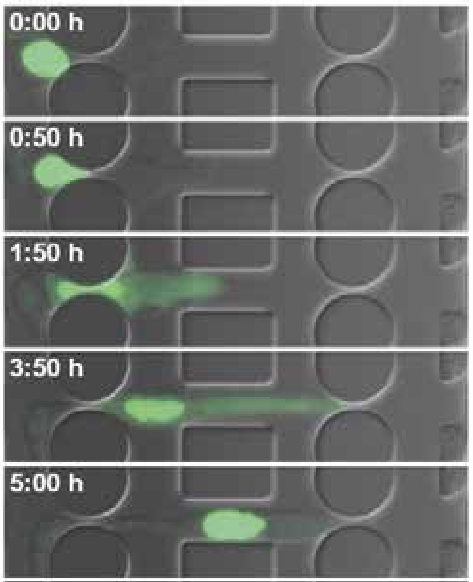
Added post-doctoral researcher Celine Denais: "You would think that, as with a balloon, at some point it will pop. We've been amazed with how these cells can handle this deformation."

There is also the possibility that a ruptured cell could mutate into a more aggressive form of cancer.

"You have so many migrating cells," Lammerding said, "that even if a small fraction of them picks up a mutation, that is bad because it means the cancer is evolving.

"The good part is, this rupturing also makes the cancer cell vulnerable," he said. "Most cells in the body stay in place, and it's presumably mostly cancer cells that are moving around. So if we can block the mechanisms that allow them to repair themselves, then we potentially could target metastatic cancer cells."

Lammerding began his work in this area while teaching at Harvard Medical School. Part of the reason he came to Cornell in 2011, he said, was to take advantage of the fabrication capabilities at the Cornell NanoScale Science and Technology Facility, where the model environments used in the study were built.



A live cell fluorescence microscopy image sequence showing a cancer cell undergoing nuclear envelope rupture during migration through a constriction, visualized by green fluorescent protein spilling from the nucleus into the cytoplasm.

"They work very well and have become very popular," he said. "Every time I go to a meeting and present this work, people come up to me and say, 'Can we get some of these models?'"

The group looked at two factors in the cell's migration process: the rupturing of the nuclear envelope, which they tracked using green and red fluorescent proteins normally localized to the cell nuclei, but that spill into the cell body when the nucleus ruptures; and damage to the cell's DNA.

Jan Lammmerding

"We're still trying to find out if there are differences between cells, and a lot of what we see is very similar between normal cells and cancer cells," he said, adding that by trying to identify potentially unique deformation-and-repair properties of cancer cells, treatments that are minimally deleterious to healthy cells may be developed.

"Now that we kind of know what we're looking for, now that we know the molecular pathways involved in the repair," he said, "could we then specifically target invasive cancer cells and not have the sledgehammer that hits everything?"

Other contributors to the paper, "Nuclear envelope rupture and repair during cancer cell migration," included: Rachel Gilbert, former undergraduate and master's student in biological engineering; Alexandra McGregor, Cornell graduate student in biomedical engineering; and former postdoctoral fellow Patricia Davidson, now at the Institut Curie in Paris. The group was also assisted with in vitro and in vivo experimentation by Katarina Wolf and Peter Friedl of Radboud University Medical Center in the Netherlands.

This work was supported by grants from the National Institutes of Health, the Department of Defense Breast Cancer Research Program, the National Cancer Institute and the National Science Foundation.

Read more:

"Nuclear envelope rupture and repair during cancer cell migration." Denais C.M., Gilbert R.M., Isermann P., McGregor A.L., te Lindert M., Weigelin B., Davidson P.M., Friedl P., Wolf K., Lammerding J. *Science*: 352, Issue 6283, pp. 353-358 (2016).

SUMMER IMMERSION TERM CONNECTS STUDENTS WITH CLINICAL MEDICINE

The 2016 Ph.D. Summer Immersion Group at Weill Cornell Medicine's campus in New York City.

While much can be learned from focused time in the academic classroom and research lab, for biomedical researchers nothing is quite like the knowledge that can be gained from exposure to the real-world challenges of the clinic. Such is the purpose of the Meinig School's summer immersion term for first-year Ph.D. students. Now in its 11th year and supported by an NIH T35 training grant just renewed this summer for another five years, the program gives students the ultimate insider's look at the successes and challenges of human medicine and an opportunity to integrate that information into their thesis research and careers.

"The clinical summer immersion is designed to connect BME to healthcare and society and to steer and enhance students' research interests towards medicine," says Yi Wang, director of the program and faculty distinguished professor in radiology. "It impacts their Ph.D. thesis research by adding a medical conscience and influencing their long term career towards improving healthcare."

Located at the Weill Cornell Medicine campus and associated institutions in New York City, the program brings Ph.D. students from the Ithaca campus for seven weeks of dedicated and intensive exposure to clinical practice. They are paired with expert clinical faculty mentors, whom they shadow in various settings from the operating room and outpatient clinic to participating in clinical research. The experience is further enhanced by coursework on organ anatomy, diseases, and diagnosis directly related to a specific clinical practice, as well as lectures in bioethics and regulatory affairs bioethics. Through this close interaction and focused study, students become familiar with clinical issues and clinical thought processes, and chronicle their experience weekly on an immersion term blog, the most recent of which can be found at: http://bmeimmersion2016.blogspot.com/. The summer immersion term culminates back on campus in Ithaca with a poster session, in which the student participants present an aspect of what they learned to their peers and professors.

Students are not the only ones who benefit from the program. "As clinicians we face many unsolved medical problems in our practice and do not have the technical expertise or time to develop needed technology," says Dr. Martin Prince, professor of radiology and a multiple principal investigator on the NIH T35 grant. "When students discover technical needs during their visit, their basic science training may start to cross-pollinate with clinical science, leading to synergistic productivity in their biomedical research pursuits."

"It's a great way to connect a student's laboratory work with healthcare," agrees professor Peter Doerschuk, interim director of graduate studies. "They develop a perspective on what kinds of technology solutions can be clinically workable. They begin to learn the language of clinical medicine and how to interact with clinicians in a meaningful way. They come to appreciate the impact of medical technology. It gives their discoveries the best chance to benefit clinical medicine."

In his 2016 immersion term blog, Matthew Zanotelli confirmed: "The immersion experience brought me important insight into how medical devices, biomaterials, or tissue engineered constructs are actually used in the operating room and/or clinic. This knowledge will surely impact how I approach my own research back in Ithaca."

From seeing patients' struggles to understanding the physicians' challenges and opportunities, students in the Ph.D. summer immersion term are exposed to knowledge that cannot be obtained in classrooms or the basic research laboratory. They come to appreciate the urgency and importance of developing medical technology solutions as well as the utility of medical technology in medicine. In this manner, the clinical summer immersion both provides perspective and enhances enthusiasm for improving healthcare through medical research.

BRINGING CROWD POWER TO ALZHEIMER'S RESEARCH

Two years ago, Dr. Pietro Michelucci was a hammer looking for a nail. Michelucci, an artificial intelligence expert with a longstanding interest in distributed human-machine systems, had been a science advisor to DARPA, the research arm of the U.S. Department of Defense. After 10 years of supporting national security, he was ready to refocus his efforts onto humanitarian activities with global impact; he wanted to apply his expertise to building powerful problem-solving systems that combined the complementary abilities of humans and computers to achieve new capabilities that neither humans nor computers could achieve in isolation. And that's exactly what he did.

At the same time, the Schaffer-Nishimura Lab had been studying brain blood flow in mouse models of Alzheimer's disease. Using multiphoton microscopy, they found that a small fraction of capillaries were plugged and had no blood flow. Such stalled capillaries are also found in the brains of myeloproliferative disease mouse models. However, the image analysis for finding the stalled capillaries is extremely challenging. Professor Chris Schaffer explained that for each week's worth of data collection, it could take a trained laboratory technician an entire year to analyze the data. Schaffer explained that, although their findings were promising, because of this analytic bottleneck it could take decades to run the series of studies needed to arrive at a treatment target.

"I was very excited to meet Chris," says Michelucci. "Alzheimer's disease is the only top 10 killer without an effective treatment, so it definitely met our criterion of being a high impact problem. The next question was: can we use human computation to help solve it?"

It turned out that Schaffer had already tried machine-based solutions, and the best one was only 85% accurate. But once Michelucci saw the specific visual tasks involved, he realized that those tasks mapped almost perfectly onto two existing and highly-successful citizen science platforms: stardust@home and EyeWire, which both use online games to crowdsource data analysis. Both platforms have had tens of thousands of volunteer participants and their crowd-based results have been published in top-tier journals.

Pietro Michelucci, a cognitive scientist, joins BME this fall as a visiting professor to bring "the power of crowds" to Alzheimer's disease research.

Michelucci contacted the progenitors of both platforms, who recognized the good fit and graciously offered to help adapt their existing platforms to Schaffer's data. With a high impact societal problem, a well-defined solution, and a dream team of collaborators in place, Michelucci was able to attract the funding from the BrightFocus Foundation.

Since the project kicked off at the beginning of 2016, the growing 15-member team has been heavily engaged in developing the citizen science platform for Schaffer's research. Indeed, one of the two platforms is poised to launch in October 2016. Called "Stall Catchers," this new software will allow members of the general public, ages eight and older, to play an online game that will analyze Schaffer's Alzheimer's data. With an active community of online participants, Michelucci estimates that the analysis time for each experiment will be reduced from one year to one week. "In practice, this means we could potentially get to an effective treatment

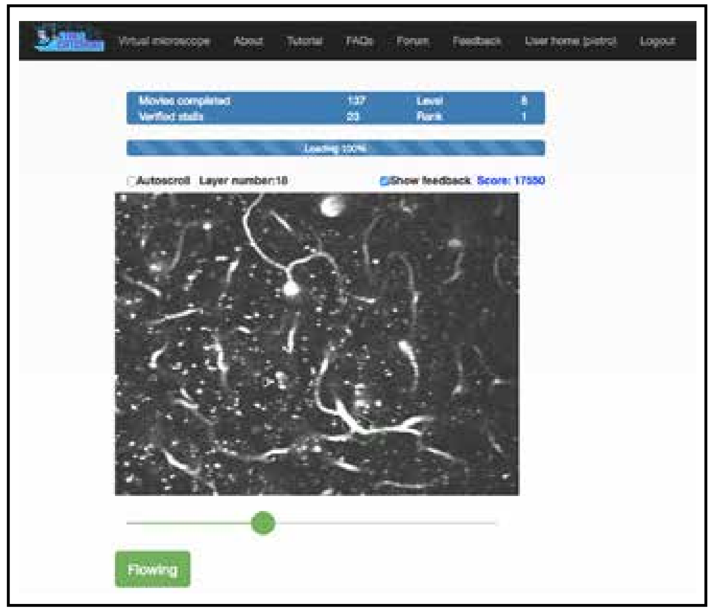
In March, Schaffer-Nishimura Lab members got together to use a prototype of StallCatchers, a web-based software that allows the general public to play an online game that analyzes data from experiments on Alzheimer's disease.

target for blood flow deficits in Alzheimer's disease in a few years instead of decades," says Michelucci. "That's the power of human computation."

Michelucci, who published a seminal text and established the first scholarly journal on human computation, is also the founder of the Human Computation Institute (HCI), a distributed organization that now includes 28 external professors representing 15 related disciplines.

"Operationally, HCI conducts scientific research, but our agenda is driven by societal need," says Michelucci. "So once organizational constructs were in place, I was looking for a big problem to solve—a way to help millions of people, and that's when the stars began to align."

Michelucci recently moved to Ithaca to work more closely with the Schaffer-Nishimura Lab as the project develops. He hopes to develop EyesOnALZ (formerly known as WeCureALZ) into a sustainable enterprise that could support researchers around the globe, enabling blood flow studies related to a variety of diseases, including diabetes, macular degeneration, and cancer tumors. To learn more about EyesOnALZ, and to pre-register to participate in an online activity that will directly contribute to Alzheimer's research, visit eyesonalz.com.



A screen shot from the StallCatchers interface shows flowing and stalled capillaries in multiphoton microscopy images of a mouse brain. Go to www.stallcatchers.com to play.

MEET THE 2016 NSF FELLOWS

The Meinig School of Biomedical Engineering proudly congratulates the five students who each won a 2016 National Science Foundation Graduate Research Fellowship.

Three Fellows will study cancer. Johana Uribe, in the Reinhart-King Lab, will study the forces used by cancer cells to migrate from the primary tumor, investigating the role of matrix architecture and cell shape and size changes in metastatic cell migration. Lauren Hapach, also in the Reinhart-King Lab, will investigate intratumor heterogeneity by characterizing invasive and noninvasive cancer cell phenotypes in relation to their metastatic potential. And Monet Roberts, of the Pazseck Lab, will study the biophysical mechanisms involving the role of glycoproteins in breast cancer progression and metastasis.

Ruisheng (Rick) Wang, from the Erickson Lab, will work on developing the FeverPhone, a point-of-care platform for rapid detection of infectious diseases in low-resource settings. His effort will involve the design and development of novel multiplexed immunoassays, which will facilitate differential diagnosis of acute febrile illnesses such as dengue, malaria, and Zika.

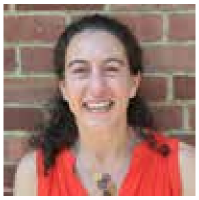
Pablo Palomino, from the Donnelly Lab, will investigate the role of type 2 diabetes mellitus (T2DM) in altering bone quality by comparing cortical bone properties from T2DM and non-diabetic patients. Specifically, he will quantify non-enzymatic glycation of the collagen matrix, assess spectroscopic measures of bone composition, and examine the behavior of cortical microbeams in bending. This study will help to understand why T2DM patients fracture more often than non-diabetics with otherwise similar risk factors.

NSF Fellowship winners (from L to R): Lauren Hapach, Pablo Palomino, Ruisheng Wang, Johana Uribe, and Monet Roberts.

Congratulations also go to students receiving honorable mentions this year: Matthew Zanotelli (Reinhart-King Lab), Stephen Sloan (Bonassar Lab), Sarah Snyder (Putnam Lab), Shivem Shah (Singh Lab), Amanda Rooney (van der Meulen Lab), Yehudah Pardo (Ma/Luo Lab), Adam Munoz (Reinhart-King Lab), Zeinab Mohamed (King Lab), Nicole Diamantides (Bonassar Lab), Victor Aguilar (Cosgrove Lab), and Marysol Luna (Hernandez Lab).

HONORS & AWARDS

CORE FACULTY



Assistant Professor Ilana Brito

Appointed a Mong Family Sesquitennial Faculty Fellow in Biomedical Engineering.

Professor of Practice Newton de Faria

Appointed Professor of Practice, a newly created title for faculty with significant, high-level experience in industry, who enrich student experiences by bringing to Cornell a deep understanding and appreciation of the standard practice in industry.

Assistant Professor Iwijn De Vlaminck

Appointed the Robert N. Noyce Assistant Professor in Life Science and Technology.

Associate Professor Chris Hernandez

Elected to Membership Committee of the Orthopaedic Research Society (ORS).

Professor Mike King

Inducted Fellow of the Biomedical Engineering Society (BMES) at the annual conference in Tampa in October.

Associate Professor Claudia Fischbach-Teschl

Elected Fellow of the College of Fellows of the American Institute for Medical and Biological Engineering (AIMBE).

Associate Professor Cynthia Reinhart-King

Elected Program Chair of the 2016 BMES Annual Meeting. She was also elected a fellow of the College of Fellows of the American Institute for Medical and Biological Engineering (AIMBE).

Associate Professor Chris Schaffer

Elected Associate Dean of Faculty. He was also awarded a 5-year, $2M R01 grant from the NIH to study Alzheimer's Disease.

Professor Michael Shuler

Awarded a 2015 Lush Science Prize award recognizing projects and individuals who work towards replacing animals in toxicity testing.

Professor Marjolein van der Meulen

Elected to Board of Directors of the Biomedical Engineering Society (BMES), as well as to the Orthopedic Research Society (ORS) Program Committee.

Professor Yi Wang

Awarded a Distinguished Investigator award from the Academy of Radiology Research.

FIELD FACULTY

Lynden Archer (CBE), the James A. Friend Family Distinguished Professor of Engineering, was featured by the National Science Foundation (NSF) for its online After the Lecture series.

Adele Boskey (Hospital for Special Surgery, Weill Cornell Medicine), professor, received the 2015 Lawrence G. Raisz Award from the American Society for Bone and Mineral Research.

Susan Daniel (CBE), associate professor, has been awarded a seed grant from the MSKCC-Cornell Center for Cancer Nanotechnology Excellence to begin new cancer research. The award is for $150,000 over two years. She is also one of two women to receive an inaugural Schwartz Award.

Minglin Ma (BEE), assistant professor, won a Hartwell Individual Biomedical Research Award, worth $300,000 over three years to fund early-stage, innovative and cutting-edge biomedical research to benefit children in the United States. Ma's research will focus on his diabetes work.

Matthew Paszek (CBE), assistant professor, received a National Institutes of Health (NIH) Director's New Innovator Award for his project, "Mechanobiology of the cellular glycocalyx."

Ankur Singh (ECE), assistant professor, received a National Science Foundation Faculty Early Career Development award. He also received the 2015 Biomaterials Outstanding Paper award at the 10th World Biomaterials Congress.

STUDENTS & POSTDOCS

Olufumilayo Adebayo, a Ph.D. student in the van der Meulen Lab, won second place in the NSBE (National Society of Black Engineers) Technical Research Exhibition poster competition.

Sung Ji Ahn, a Ph.D. student in the Schaffer-Nishimura Lab, won the 2016 Biomedical Optics Student Poster Presentation Award.

Brandon Borde and **Stephen Sloan**, graduate students in the Bonassar Lab, co-authored a paper that won the Best Oral Presentation award at the World Forum for Spine Research.

Alexander Boys, a Ph.D. student in the Bonassar Lab, received the NSF EAPSI Fellowship to travel to China to perform research at the National Center for Nanoscience and Technology (NCNST) in Beijing.

Erin Cresswell and **Jason Guss**, both Ph.D. students in the Hernandez Lab, each received a 2016 Young Investigator Travel Award from the American Society for Bone and Mineral Research.

Peter DelNero, a Ph.D. student in the Fischbach-Teschl Lab, received a Cornell Engaged Graduate Student Grant and a Buttrick-Crippen Fellowship to enhance public awareness and communication related to cancer.

Joshua Elacqua, an undergraduate student in the Lammerding Lab, received a BMES Student Travel Award to attend the 2016 BMES Annual Meeting in Minneapolis.

Natalie Kelly, a Ph.D. student in the van der Meulen Lab, received a Young Investigator travel grant from the American Society of Bone and Mineral Research to attend its 2015 Annual Meeting.

Julie Kohn, a Ph.D. student in the Reinhart-King Lab, won a Whitaker Fellowship to study for a year at the University of Cape Town in South Africa.

Aniqua Rahman and **Matthew Zanotelli** from the Reinhart-King Lab both won student travel awards from BMES.

Nora Springer, a Ph.D. student in the Fischbach-Teschl Lab, was awarded second place in the American Veterinary Medical Association Young Investigator Award.

Derek Sung, an undergraduate student in the Butcher Lab, was awarded the Elena Aikawa Best Abstract & Keynote: Basic Science to Elucidate Mechanisms of Valve Disease at the annual Heart Valve Society meeting.

Ashley Torres, a Ph.D. student in the Hernandez Lab, was inducted into the Bouchet Graduate Honor Society, 2016, and received Best Poster and Best Graduate Poster at the Society of Hispanic Professional Engineers National Meeting, fall 2015.

Five students, **David Bassen** (Butcher Lab), **Ashley Earle** (Lammerding Lab), **Frank He** (Fischbach-Teschl Lab), **Derek Holyoak** (van der Meulen Lab), and **Emmanuel Lollis** (Reinhart-King Lab), were awarded 2016 Graduate Assistantships in Areas of National Need (GAANN) fellowships, which focus on developing a fellow's teaching, communication, and leadership skills, as well as providing them with a solid foundation for conducting research. The program provides training in best-practice pedagogical techniques and an introduction to education research. The students are mentored in a practical teaching experience by faculty and trained by Cornell's Center for Teaching Excellence.

GAANN Assitantship Fellows (L to R): David Bassen, Derek Holyoak, Frank He, Emmanuel Lollis, and Ashley Earle.

ALUMNI

Karen Duffy, a 2014 M.Eng. graduate of the Shuler Lab, was named a Gates Cambridge Scholar. She will work to engineer new biopolymers with advantageous properties for therapeutic applications.

Chelsea Gregg, a 2016 Ph.D. graduate of the Butcher Lab, was selected to participate in AIMBE's 2016-17 FDA Scholars Program, a highly competitive program consisting of one-year immersion experiences in the Center for Devices and Radiological Health (CDRH) within the U.S. Food and Drug Administration (FDA).

Darvin Griffin, a 2015 Ph.D. graduate of the Bonassar Lab, was named a 2016 DiscoverE New Faces of Engineering Honoree. The award honors engineers under 30-years-old who are making a mark on their industry.

Katie Hudson, a 2016 Ph.D. graduate in the Bonassar Lab, received a RoosterBio Travel Award to attend the 2016 ORS society meeting.

Ryan Jefferis, a 2015 M.Eng. graduate, and team won the Cleveland Medical Hackathon by designing a blood pressure cuff that integrates its measurements into the cloud for direct review by a clinical professional.

Julius N. Korley, a 2010 Ph.D. graduate of the Putnam Lab, Sloan Scholar, and President and CEO of Affinity Therapeutics, was named to Crain's Forty Under 40 in 2015.

Michael Mitchell, a 2015 Ph.D. graduate of the King Lab, was selected as a member of the 2016 Tissue Engineering Young Investigator Council; and received a Burroughs Wellcome Fund Career Award at the Scientific Interface for his research on developing a new class of materials and devices that detect and treat bone marrow disorders.

Han Tang, a 2016 M.Eng. graduate of the Adie Lab, won the Hamamatsu Best Paper Award and $500 for her talk and proceedings manuscript "GPU-based computational adaptive optics for volumetric optical coherence microscopy" at the SPIE Photonics West BIOS 2016 conference.

ALUMNI

Waleed Abdel-Naby, Ph.D. 2015

While studying under Dr. Mark Rosenblatt at Cornell, Waleed Abdel-Naby's graduate research focused on the development of novel technologies utilizing silk-derived biomaterials for regenerative medicine and biomedical applications. Specifically, his dissertation described bio-engineered, silk-based biopolymers for use in reconstruction of the ocular surface. Excelling in both the academic and laboratory settings garnered him multiple awards; he received the 2013 Clinical and Translational Science Center Novel Technology Team Award from Weill Cornell Medical College for his dissertation, as well as a prestigious NSF Graduate Research Fellowship Program Award. He is also the inventor on two Cornell-owned patents for his promising silk technology.

Realizing the potential translatability of his technology, Abdel-Naby has made significant contributions to the development of novel technologies utilizing silk-derived biomaterials since graduating from Cornell. He co-founded Novyx Technologies, LLC, to focus on the commercialization of novel, silk-based therapeutics for epithelial tissue regeneration and wound repair. Currently he is collaborating with Dr. Jason Spector and Dr. Enrique Rodriguez-Boulan at Weill Cornell Medicine to develop novel, silk-based dressings for the treatment of chronic diabetic wounds. As CEO of Novyx, he is also raising seed funding to support the commercialization of this promising technology.

Jaclyn Carlson, M.Eng. 2012

Jaclyn Carlson received an M.Eng. in 2012, after working with mentor Dr. Jonathan Black to design a conformable bone graft substitute. This experience sparked her interest in orthopedics and following graduation she worked for a healthcare consulting firm based out of New York City. As a consultant she worked to optimize hospital and pharmaceutical company operations, and during one engagement was sent to Romania for three months to work with a local hospital. However, through this position she realized she desired a more hands on role in healthcare and medicine.

While volunteering at a stray dog shelter in Romania, she decided that veterinary medicine was a perfect way to incorporate her engineering degree, love for animals, and willingness for a hands-on medical role. She transitioned from her consulting job to a research position in a neurotrauma lab at the University of California, San Francisco. Her research focused on adolescent concussion, and this experience furthered her ideas about incorporating biomedical engineering into a career as a veterinarian. Her desire to blend biomedical research and veterinary medicine grew and led her to her current role as a student in the VMD/Ph.D. combined degree program at the University of Pennsylvania. Carlson will pursue this degree with a focus in orthopedics.

Daniel Dotse, M.Eng. 2011

Daniel Dotse studied biomedical engineering at Cornell University with a keen interest in nanotechnology. Dotse's Cornell education was made possible by the Lester B. Knight Scholarship for bright low-income students with a strong interest in engineering and business. The impact of the scholarship went beyond financial freedom to pursue his passions, and Dotse was compelled and motivated to explore ways he could positively impact others in the way that the scholarship opportunity opened up doors for him. This led him to establish a 30,000-book library in his home country, Ghana. And now with his non-profit Teach For Ghana, Dotse hopes to provide access to an excellent education to all children in Ghana.

Prior to establishing Teach For Ghana, Dotse worked at Regeneron Pharmaceuticals, Inc. At Regeneron, his role entailed purifying protein molecules for the manufacture of active pharmaceutical products for treating various diseases. He credits this experience for exposing him to the power of social change on a large scale. For him, it was incredibly rewarding to produce innovative drugs that were accessible to a large number of individuals.

Katy Fang, M.Eng. 2014

Katy worked in Jonathan Butcher's lab working on genetic factors of aortic calcification. After graduating with an M.Eng. degree in 2014, she moved to Warsaw, Ind., to be an engineer with Zimmer Biomet working with design controls of orthopedic implants. She then moved to Chicago where she's lived for the past year and works as an engineer in the medical device division of Fresenius Kabi, a German company that makes blood filtration and transfusion machines. At Fresenius Kabi, her work is half dedicated to being a technical contributor and half to being a project manager, a skill developed at Cornell while working multiple simultaneous projects as part of the M.Eng. program.

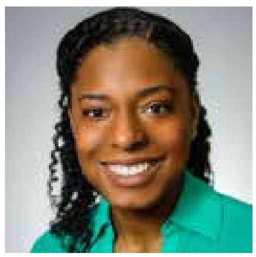
Darvin Griffin, Ph.D. 2015

While earning his M.S. and Ph.D. at Cornell, Darvin Griffin built a portfolio of research in orthopedics and articular repair in collaboration with entities such as Genzyme, Histogenics, and Massachusetts General Hospital. Griffin recently joined the Medtronic—Advanced Energy (MAE) team as a Clinical Project Manager in Medical Affairs. In his role at Advanced Energy, Griffin collaborates with marketing, R&D, and regulatory, focusing on preclinical and human clinical research projects, expanding indications for surgical devices, and growing MAE's portfolio of claims.

Passionate about the value of diversity in the workplace, professional mentorship, and STEM education, Griffin has co-authored multiple peer-reviewed scientific publications and presented research at major healthcare conferences.

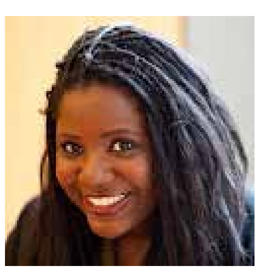
Bina Julian, M.Eng. 2006

Throughout her tenure at Cornell (B.S. '05, M.Eng. '06), Bina Julian pursued her passion for hands-on teaching in both physiological engineering and the molecular principles of biomedical engineering. She received her M.Eng. degree in biomedical engineering studying drug-receptor kinetics under Dr. Linda Nowak. Julian then went on to advance drug discovery and precision medicine research at Pfizer Global R&D and the Broad Institute of Harvard and MIT. Currently, she is a Ph.D. candidate in the lab of Dr. Alan Kopin of Tufts Medical Center where she develops pharmacological tools to probe receptors involved in inflammatory disease. In addition to her research, she has worked with several organizations and startups including Venture Cafe, XX in Health Boston, Biotech Connection Boston and Archimedes Project. She was recently honored with the 2016 Tufts University Presidential Award for Citizenship and Public Service for her leadership of the Tufts Biomedical Business Club and her work creating professional opportunities for scientists. Julian will be defending this December and relocating to the Bay Area.



Stephanie A. Parker, Ph.D. 2015

At Cornell Stephanie conducted research in Dr. Carl Batt's lab focusing on protein engineering for targeted cancer therapeutics. Following graduation, Dr. Parker moved back to home to sunny Southern California. She is currently working as a postdoctoral researcher on a joint project between the Keck Graduate Institute in Claremont, Calif., and Boehringer Ingelheim Pharmaceutical of Fremont, Calif., using computational fluid dynamics (CFD) to model biopharmaceutical unit operations. This project is motivated by the desire to modernize the antibody manufacturing process. Currently the biopharmaceutical industry produces products in batch mode, however they are moving to continuous operations is the future. Specifically, Dr. Parker is designing prototypes for continuous unit operations, utilizing CFD to characterize the designs, and validating designs with experimental data.



Elizabeth Wayne, Ph.D. 2016

Dr. Elizabeth Wayne earned her B.A. in physics from the University of Pennsylvania in 2009 and her Ph.D. in biomedical engineering from Cornell in 2016. Through the guidance of thesis advisor, Professor Chris Schaffer, Wayne used intravital imaging techniques to understand ways in which the innate immune cells can be used to control cancer metastasis.

While at Cornell, Wayne led multiple initiatives, including the Cornell NCI Physical Sciences in Oncology Cancer Brainstorming Club and the 2013 Northeast Conference for Undergraduate Women in Physics. Wayne was very active within the Cornell community; she was a Graduate Resident Fellow at Hans Bethe House on West Campus, a mentor in the Ronald E. McNair Scholars Program, and a Learning Specialist in the Cornell Engineering TA Training Program. She also received campus-wide recognition for her service, receiving awards such as the Alice & Constance Cook Award, Cornell Women's Day Leadership Award, and the Cornell BME Robert I. Mozia Distinguished Service Award.

At present, Wayne is an NIH-NCI Ruth L. Kirschstein NRSA Postdoctoral Fellow in the Carolina Center for Nanotechnology Training Program at the UNC Eshelman School of Pharmacy. Under the supervisor of Professor Alexander Kabanov, she is developing technology to deliver therapeutic genes to solid tumors using macrophages. In particular, her work aims to improve the efficiency of in vivo gene delivery. When she is not doing science, Wayne is currently knitting baby hats for her niece and nephews, frolicking on a nearby beach, trying to figure out how to eradicate spring as a season, and enjoying every sunrise she gets.

Wayne co-hosts PhDivas, an academic and cultural podcast that showcases the accomplishments, challenges, and daily lives of women in academia. So far it has generated over 15,000 plays from listeners all over the world. PhDivas has been featured in the *Cornell Chronicle* and *The LA Times* and content can be found on Soundcloud and iTunes.

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