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

BME

Newsletter
Fall 2019

MAKING CONNECTIONS: MICROBIOME RESEARCH AT CORNELL

BME MESSAGE

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

Welcome to our 2019 newsletter and the fifteenth year of Biomedical Engineering at Cornell, our "crystal anniversary!" We reflect on our path to this point with a timeline including notable milestones and growth on pages 10-11.

Fifteen years ago, Biomedical Engineering began at Cornell as a graduate-only department offering Ph.D. and Master of Engineering degrees. Today those two programs remain vital and essential parts of the Meinig School. This year our graduate program took the bold step of eliminating the GRE requirement, perhaps the first BME program to do so (p. 15). The response from our student community has been positive. Among other things, we expect that this change will attract a broader applicant pool to our programs.

We are proud of the recent addition of our undergraduate major. This past May we graduated our second class of biomedical engineering undergraduates. The class of 2019 was nearly twice as large as our first class in 2018. As you will see, we are not only attracting outstanding students, but have high concentration of scholar athletes among our majors (p. 8). In tandem with the undergraduate major we have started an undergraduate chapter of the Biomedical Engineering Society (BMES), new student project teams, and the like. We are grateful to Beckie and Neil Robertson for creating an endowment in honor of Michael Shuler, our founding chair, to support these undergraduate student activities (p. 15).

Our students and faculty continue to excel, as evident from the awards and other recognitions received this year (p. 16). With the election of Jonathan Butcher, Chris Hernandez and Chris Schaffer, all full professors in BME are now Fellows of the American Institute of Medical and Biological Engineering (AIMBE). The accomplishments of our graduate students continue to be recognized by the National Science Foundation (NSF) with graduate research fellowships (GRFP). Our first B.S. graduates also have received NSF graduate fellowships to continue their studies. After 15 years we are proud to have trained a healthy number of engineering faculty and industry leaders around the country.

Our faculty has grown substantially from the initial three faculty lines with six individuals in 2004. This year we are happy to welcome Esak (Isaac) Lee (p. 7), who joins us from the laboratory of Dr. Christopher Chen in Boston. Esak develops organ-on-chip models to study the lymph system and associated diseases. He has been appointed a Nancy and Peter Meinig Family Investigator in the Life Sciences. We look forward to seeing his research lab develop and flourish.

As a community, biomedical engineers excel at interdisciplinary collaborations. Research in the microbiome is one such area and is featured in this edition of our newsletter (p. 4). We expect our faculty working on questions associated with immunity, infection and inflammation to continue to expand. The establishment of the Cornell Center for Immunology will help foster that growth.

Finally, we continue to move forward on solutions for our teaching space in Comstock Hall. The BME laboratories and design studio will likely occupy the entire basement. We have seen the first renderings of our laboratories and look forward to the construction process starting a year from now. There will be many details to finalize between now and then.

As you will see in the following pages, the past year has been a good one. I hope you enjoy reading through our highlights. We look forward to catching up with everyone at the annual meeting of the Biomedical Engineering Society (BMES) in Philadelphia this fall and similar professional and alumni gatherings throughout the year. Connecting with BME alumni and friends remains one of the best perks of being director. Please stay in touch!

Sincerely,

Marjolein C.H. van der Meulen
James M. and Marsha McCormick
Director of Biomedical Engineering
Swanson Professor of Biomedical Engineering

CORNELL BME 15 YEARS 2004-2019

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.

CORNELL BME NEWSLETTER

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ABOUT THE COVER

Cover design by Rob Kurcoba

Cover image: Cross-section of mouse colons stained with immunofluorescence (using antibodies). Cell nuclei (blue) and proteins called E-cadherins that bind cells to each other (green), part of experiments to show whether different compositions of microbiota result in different susceptibilities to a Citrobacter infection, which mimics E. Coli. (Source: Brito Lab)

Photography by: Suzanne Aceti Koehl, Cornell University Photography, Robyn Wishna and Heather Ainsworth

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ALL EYES ON THE MICROBIOME

by Chris Dawson

WE CONTAIN MULTITUDES

For every cell that is you, at least one other cell you carry around is not you. These other cells are predominantly bacteria, but also viruses, fungi, and other archaea along for the ride. A study published in *Nature* in 2016 estimates somewhere between 30 trillion and 50 trillion of these microbes exist on and in each adult human.

We know that some microbes help digest the food we eat, regulate our immune system, defend against other bacteria, and produce vitamins necessary for good health. But exactly what else they do and how they do it has become one of the hottest areas of research in all of biology and related fields.

This collection of microbes you and every other person carries around is called the human microbiome, and researchers at the Nancy E. and Peter C. Meinig School of Biomedical Engineering (BME) at Cornell are among those on the leading edge of this rapidly-developing field. Meinig School faculty Ilana Brito, Iwijn De Vlaminck, Ankur Singh, Warren Zipfel, and Christopher Hernandez all conduct and support research into various aspects of the microbiome.

APPLYING WHAT WE LEARN

"There is now a microbiome supergroup on campus," says Brito, assistant professor and Mong Family Sesquicentennial Faculty Fellow in Biomedical Engineering and a global leader in microbiome research. Though the work being done across the group has a broad range of research aims, the underlying goal is shared. These researchers strive to understand the microbiome so they can put it to work. Biomedical engineers do exactly this—they apply engineering principles and design concepts to biology and medicine, with the goal of improving human health.

Ankur Singh, associate professor in the Meinig School and the Sibley School of Mechanical and Aerospace Engineering (MAE), is a perfect example of someone bringing engineering to biology.

Professor Ilana Brito (center) in the microbiome lab with Ph.D. students Josh Jones (left) and Hao Zhou (right). (Image: Robyn Wishna)

Work originating in Singh's lab and recently published in *Science Advances* describes how newly-developed nanogels can improve the effectiveness of vaccines in mice with metabolic disorders. "This paper highlights how the microbiome can impact our engineered vaccines and how we can overcome these problems by developing advanced materials," says Singh.

"[WORKING WITH] THE MEDICAL SCHOOL AND THE VET SCHOOL ALLOWS MICROBIOME RESEARCHERS TO TAKE SEVERAL POINTS OF VIEW... LITTLE TO NO BARRIERS TO COLLABORATION EXIST HERE."

—Ilana Brito, Assistant Professor, Mong Family Sesquicentennial Faculty Fellow in Biomedical Engineering

The list of study authors reveals the extent to which microbiome research draws on expertise from across the University. The 12 authors represent the Meinig School, the Sibley School, the Department of Materials Science and Engineering (MSE), the Department of Microbiology in Cornell's College of Agriculture and Life Sciences (CALS), Biological Sciences (also in CALS), the Department of Microbiology and Immunology in Cornell's College of Veterinary Medicine, and the Englander Institute for Precision Medicine at Weill Cornell Medicine. This breadth of knowledge defines research at the Meinig School, says Brito, and deepens knowledge discovery.

"[Working with] the medical school and the vet school allows microbiome researchers to take several points of view," says Brito. "Cornell Engineering's graduate field system (which allows faculty to teach and advise students from outside their home department) is also

incredibly helpful. Little to no barriers to collaboration exist here. The University makes it easy." Brito hypothesizes that one aspect of Cornell may contribute to the ease of collaborations here: "Little towns don't support big egos," she says. "We are all in it because we love the science. We really value the contributions everyone can make."

One goal of Brito's work is to understand exactly how genes transfer between organisms in the microbiome. Transfer of genetic material is thought to be the mechanism behind the development of antibiotic resistance in pathogens, but the process is not well understood. The Brito lab uses experimental and computational approaches to pioneer new technologies and to investigate natural microbial communities (such as gut microbiomes of humans, animals and even environmental microbiomes) to learn about this gene flow. The hope is this work will enhance our understanding of microbial ecology and inform current efforts to combat antibiotic resistance. A long-term application could include engineering microbial therapeutics for gene delivery to the microbiome to enhance human health, to stem inflammation, for example.

Another Meinig School faculty member, Christopher Hernandez (who is also on the faculty of the Sibley School), was drawn into microbiome research through his expertise in bone and bone properties. Researchers have known bone density is correlated with age-related fractures. "But we have also known that something else is contributing," says Hernandez. "People have been trying to figure it out for years. We published a paper two years ago showing that changes in gut microbiota can influence the mechanical properties of bone tissue."

Recently Hernandez published a study in *Clinical Orthopaedics and Related Research* linking a healthy gut microbiome to successful joint replacement surgery outcomes. Hernandez partnered with researchers from New York's Hospital for Special Surgery and Cornell Weill Medicine to show that gut microbiome health in mice influences the risk of infection after knee or hip replacement. The study could point to ways in which

A titanium knee replacement for a mouse was used to study the effects of the gut microbiome on implant infection (Image: Christopher Hernandez)

human patients could be treated with microbiome-based therapies or probiotics before undergoing a joint replacement operation to reduce the incidence of post-operative infection.

"[INTERDISCIPLINARY] CONNECTIONS ARE ESSENTIAL TO THIS WORK. THEY ARE WHAT MAKE THIS WORK POSSIBLE."
—Christopher Hernandez, Associate Professor

A major challenge for researchers examining bone tissue as it relates to the microbiome is moving the work from showing correlations to demonstrating causation. "The big questions now in this area all have to do with 'what is the mechanism?'" says Hernandez. "And we [at Cornell] are particularly well-positioned to answer. We understand the underlying biology and the mechanics of what is going on—the actual mechanical forces and interactions." Hernandez echoes Brito's thoughts on how valuable Cornell Engineering's connections to the vet school and the Hospital for Special Surgery are for digging into these questions. "These connections are essential to this work. They are what make this work possible."

EXPANDING THE RESEARCH COMMUNITY

With researchers world-wide exploring everything from the basic science of the microbiome to the more complex questions of its role in rheumatoid arthritis, colorectal cancer, obesity, diabetes, bone strength, and even mental health, there is growing awareness of the need for researchers in all of these fields to share information.

Brito has seen the fruitful result of scientific knowledge-sharing firsthand through a week-long meeting she organized and hosted at Cornell in 2018 as part of a Gates Foundation grant she was awarded to study antibiotic-resistance genes in human microbiomes around the world. The award stipulated she must collaborate with scientists from almost every continent. Rather than travel from country to country, building relationships one at a time, Brito realized "I could bring everyone here to Cornell and build something greater than its parts." And so she did.

The "Our Microbes, Our Global Health" workshops and symposium brought people from more than a dozen countries to Cornell to discuss their work at the intersection of human microbiome research and global health issues.

The conference was a great success, and Brito reported recently that a number of global collaborative projects grew out of connections made that week at Cornell. Focused time in the same place allowed researchers to exchange information and ideas in a deeper and more enduring way than through phone or electronic meetings.

AN AUSPICIOUS START

These are the early days of microbiome research, but Cornell University, in general, and the Meinig School specifically, have staked out a place as leaders in the field. With so many tools and approaches available, it is hard to think of a university better situated to push forward the basic scientific discoveries about the microbiome and to then use that knowledge to engineer solutions to vexing human health problems.

CORNELL-TANZANIA COLLABORATION ON MEDICAL EQUIPMENT

In a new international exchange program between Cornell University and Arusha Technical College (ATC), six Meinig School undergraduates and professors Chris Schaffer and Nozomi Nishimura visited Tanzania this past summer to establish collaborative senior design capstone projects with ATC students.

To come up with ideas, Cornell and ATC students visited local hospitals. Health care in Tanzania is far behind U.S. standards and a particular challenge is that much of the medical equipment is broken. The Cornell and ATC students worked together to repair equipment and identify needs for novel devices. The Cornell students were inspired by the chance to be integrated into health care. "Being provided this amazing opportunity and working in Tanzanian hospitals, I was able to witness such impact," said Allison Nestor '20.

Students from Cornell and Arusha Technical College on safari at Tarangire National Park.

"IT WAS THE FIRST TIME I GOT TO SEE HOW DIRECTLY BIOMEDICAL ENGINEERING IMPACTS PEOPLE'S LIVES—NOT JUST THE TRAJECTORY OF THE FUTURE MEDICAL FIELD."
—Roanne Yehia '20

The program was initiated by BME Ph.D. student Menansili Mejooli, who is also on the faculty at ATC. In addition to an educational mission, this program's goal is to build a bilateral partnership between ATC and Cornell that could lead to novel Tanzanian industries and forward-looking investments in education and human resources. This fall, the ATC students came to Ithaca to attend professor James Antaki's senior design course with the Cornell students, and to kickoff year-long capstone projects.

" It was a unique opportunity for students to learn how devices fail in the field. We hope to make this program available every year and will be seeking ways to fund this longterm," said professor Schaffer.

The program is currently funded by an Engaged Cornell Curriculum Development grant as well as a L'Oréal Changing the Face of STEM Mentorship grant.

BME undergrads Emma Stowe '20 (middle) and Roanne Yehia '20 (lower right) working on a fetal doppler monitor with Arusha Technical College students and instructors, Fadhili Malisa, Shaban Khalfan and Asmin Issa in Tanzania.

ESAK (ISAAC) LEE

Esak (Isaac) Lee

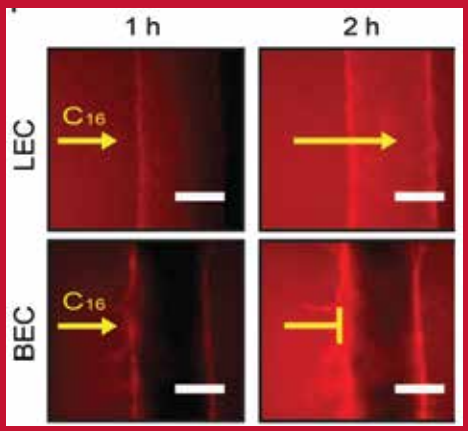
Esak (Isaac) Lee joined the Meinig School as an assistant professor in July 2019. He was appointed a Nancy and Peter Meinig Family Investigator in the Life Sciences.

Dr. Lee comes to Cornell from the Wyss Institute for Biologically Inspired Engineering at Harvard University and Department of Biomedical Engineering at Boston University, where he worked with Christopher S. Chen as a postdoctoral fellow in bioengineering, tissue engineering, and organs-on-chip technology. Dr. Lee's postdoctoral research focused on three-dimensional (3D) tissue engineered organ-on-chip models to study lymphatic biology and cancer biology. Using lymphatics-on-chip to recapitulate native lymphatic vessel structure and function, Dr. Lee revealed a new therapeutic target to treat lymphedema. Lymphedema affects 150 million individuals worldwide, but has no clinically available drug for treatment. Another cancer-on-chip effort by Dr. Lee led to the discovery of novel tumor-vascular interactions in pancreatic cancer and lung cancer, suggesting new strategies to halt tumor metastasis.

Prior to the Wyss Institute, Dr. Lee received his B.S. (chemical engineering) and M.S. (pharmacy) from Seoul National University, and Ph.D. in bioengineering from Johns Hopkins University. He studied the roles of lymphatic and blood vessels in breast tumor growth and metastasis using cell biology/biochemistry methods and mouse models under the mentorship of Aleksander S. Popel.

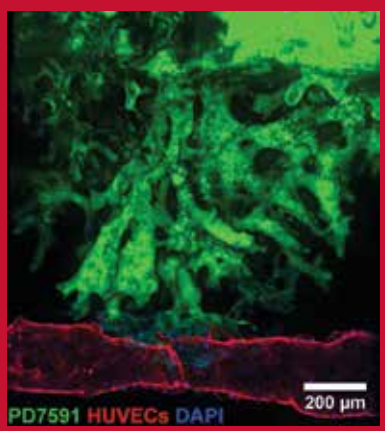
At Cornell, the Lee laboratory will create and nurture a diverse community dedicated to discovery, scholarship, and leadership to improve human health and wellness by taking principles from engineering, biology, and medicine. To achieve the mission, Dr. Lee's independent research program will focus on the morphogenesis, homeostasis and disease pathogenesis of lymphatic vessels and blood vessels and their microenvironments and provide new strategies for regenerative medicine and treatment of cancer, immune diseases, and edema. The laboratory is working to develop novel 3D organ-on-chip systems, cellular and molecular tools, and in vivo models to better understand the mechanisms by which cells regulate and respond to biological and mechanical cues.

Learn more about Dr. Lee's research: leelab.bme.cornell.edu



A) Lymphatics-on-chip recapitulates lymphatic drainage. C16 fatty acid (red) drainage by lymphatic endothelial cell (LEC)-generated lymphatic vessels and blood endothelial cell (BEC)-generated blood vessels. Scale bars 100 μm.

B) Lymphatics-on-chip reveals a potential drug to normalize lymphatic drainage in lymphedema, which is validated in a mouse model. Scale bars 5 mm.



C) 3D biomimetic pancreatic cancer-on-chip shows tumor migration and interaction with blood vessels. This model reveals blood vessel ablation, a new mechanism for tumor vascular invasion. Green: metastatic pancreatic cancer cells (PD7591), Red: blood endothelial cells (HUVECs).

SPOTLIGHT ON BME STUDENT ATHLETES

Step into a BME 3410 class on any given day and you might see students hopping on one leg and covered in reflective markers adhered to major joint locations from head to toe. You won't be witnessing a bold new dance, but rather a test for measuring movement explosiveness and repetitive hopping while software tracks a 3D map of the markers. From here, students dive into coding and calculations.

Systems Mechanobiology, required for students in the biomechanics and mechanobiology (BMMB) concentration, uses labs like this one to study how mechanical forces orchestrate the formation, function, and disease pathogenesis in the human body, from molecular to organ systems. The course was created and led by Meinig School professor and founding director of undergraduate studies Jonathan Butcher.

"Engineering really comes alive in the hopping lab," says Butcher, "when students with previous leg injuries compare their kinematics and biomechanics to their other leg and those of non-injured bodies." This was especially relevant last spring when nearly a third of the class was athletes, most members of a varsity sport.

"[BMMB] is a highly quantitative, rigorous concentration in the BME major," said Butcher, "so I was intrigued to see so many athletes, already committed to a busy training schedule, enrolled." It turns out this was no coincidence.

A survey revealed that athletics drew these students to the BMMB concentration. Danielle Jorgenson '20 plays for Cornell's varsity women's basketball team and confirmed a useful synergy between the two interests. "I use my knowledge from [BME and BMMB] to improve my injury prevention and best methods for training/stretching, and to yield the best results on the court."

Jorgenson found the hopping lab particularly inspiring when she "could see how it could be used to analyze athletes to maximize their explosion when going up for a lay-up or jumping for a rebound. Data processing and analysis are important avenues for preventing common injuries such as ACL tears."

Danielle Jorgenson '20 in the hopping lab (top), on the court (center), and in the classroom (bottom).

In fact, Jorgenson's interest in BMMB originated from injury—her own. "I tore my ACL during freshman season and had a lot of rehabilitation. I became fascinated with the recovery process. The concentration specifically is important for understanding the benefits of weight-lifting and high-intensity interval training to increase bone mass and reduce lactic acid build up during workouts."

Emma Stowe '20 of Cornell's triathlon team was similarly drawn to BMMB. "Knowing the physical limits of my body in terms of injury and endurance from my experiences running, biking, and swimming, helps me better internalize many of the concepts covered."

Samantha Henry '20 of Cornell's varsity gymnastics team is interested in "how movement changes with different injuries and impacts over time."

So how do these student athletes juggle everything? Varsity field hockey member Kirsten Pienaar '20 said the athletics season's rigid structure helps her balance workload. "It sounds counter-intuitive, but when you have to give up three hours for training every day, you use what remains much more effectively."

As for whether these students will merge these two interests in the future, Butcher outlines a variety of different career paths for BMMB students in the class. Jorgenson sees a path in concussion research toward developing better helmets. "It would allow me to stay extremely close to sports and improve the sports experience for future generations of athletes."

Whatever their futures hold, it's clear these student athletes are finding a way to succeed and grow by developing lasting connections between their physical and intellectual pursuits.

CONNECTING CANCER RESEARCHERS WITH CANCER PATIENTS

by Bob Riter

Group photo of the spring 2019 Cornell Cancer Partnership course.

A unique partnership between Cornell University and the Cancer Resource Center of the Finger Lakes connects students and cancer researchers with individuals in the Ithaca area personally affected by cancer.

Now in its sixth year, the program began with a focus on doctoral students in the basic sciences and bioengineering engaged in cancer research. The intent was to provide budding researchers with a better understanding of the human side of cancer and to provide opportunities for them to practice communicating their research with non-scientists.

The partnership was initiated by Bob Riter, then executive director of the Cancer Resource Center of the Finger Lakes, and Bob Weiss, professor of molecular genetics and associate dean for research and graduate education in the College of Veterinary Medicine. Peter DelNero, Ph.D. '17, and Alexandra McGregor, Ph.D. '18, then doctoral students in the Meinig School of Biomedical Engineering, were instrumental in bridging the researcher and patient communities. DelNero and McGregor's article about their experience, "From Patients to Partners" was published in *Science.*

At first, the collaboration was informal with students regularly presenting cancer research in lay language to an audience of patients, family members, and the general public. In addition, a few students became regular participants in the support groups of the Cancer Resource Center. They often researched scientific questions for patients and had the opportunity to observe the cancer experience in real time.

"THROUGH OUR PARTNERSHIP [WITH PATIENTS], WE DISCOVERED THAT RESEARCH IS NOT THE ONLY WAY THAT SCIENTISTS CAN MAKE A POSITIVE DIFFERENCE IN THE FIGHT AGAINST CANCER."

—Peter DelNero, Ph.D. '17, and Alexandra McGregor, Ph.D. '18

("From Patients to Partners" *Science.* 20 Oct 2017: Vol. 358, Issue 361, pp. 414)

Funding from Engaged Cornell helped establish a four-course curriculum leading to a Cornell Graduate Certificate of Engagement in Public Communication of Science and Technology. This institutionalized the partnership and made it an ongoing part of the Cornell curriculum.

The spring 2019 class, Community-Based Cancer Research Presentations and Discussions (BIOMS 5665), was the largest ever and attracted undergraduate and master's students in addition to the doctoral students and community members. It's likely one of the most diverse classes on campus.

The partnership received a Cornell ToGo (Town-Gown) award in 2013 and continues to evolve in creative ways. Patients visit undergraduate bioengineering courses to suggest how engineers might improve the delivery of cancer care. And community members judge posters presented by doctoral students, awarding the "People's Choice Award" based on the students' ability to explain the science in a clear and accessible manner.

The fall 2019 semester began with an informal panel presentation by cancer patients, survivors and family members, targeted to graduate students beginning research careers. The semester-long class will next be offered in the spring of 2020.

Key
RED: Faculty growth
BLACK: Program milestones

1992
ChemE 481, Biomedical Engineering offered as the first undergraduate course with a focus on BME (taught by professor William Olbricht).

1994
Undergraduate option in bioengineering formed; first class graduated 1995; M.Eng. Dean's Certificate established.

1997
Graduate field of BME approved by N.Y. State to award M.S. and Ph.D. degrees.

1998
Graduate field of BME established; First BME class admitted.

1999
Minor in biomedical engineering established through T&AM.

2001
Biomedical Engineering becomes a program.

1992 - 2003

BME at Cornell Universi

2004
Department of Biomedical Engineering approved with 3 academic programs: Ph.D., M.Eng., undergraduate minor in BME.

Department starts with 6 faculty:
Michael Shuler, founding chair
David Putnam
Lawrence Bonassar
Don Bartel
William Olbricht
Mark Saltzman

May 2007 commencement:
27 M.Eng., 2 M.S., 2 Ph.D.

2007
Claudia Fischbach-Teschl
Jonathan Butcher

2010
Christopher Hernandez

2005
Yi Wang
Warren Zipfel

Summer clinical immersion term program begins.

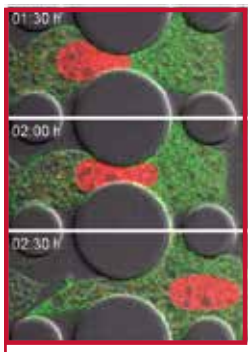
2006
Chris Schaffer
Peter Doerschuk
David Skorton

2008
Cynthia Reinhart-King
Michael King

Weill Hall becomes administrative home for BME.

15 YEARS 2004-2019

ity GROWTH & MILESTONES



2011
Jan Lammerding

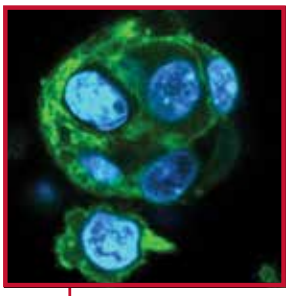
2014
Ben Cosgrove

Marjolein van der Meulen named James M. and Marsha McCormick Director of Biomedical Engineering.

Undergraduate major plan approved by College of Engineering.

2016
Ilana Brito

First class of BME undergraduates begins.



2017
Mert Sabuncu
Ankur Singh
Yadong Wang

15 YEARS CORNELL BME

2019
Esak (Isaac) Lee

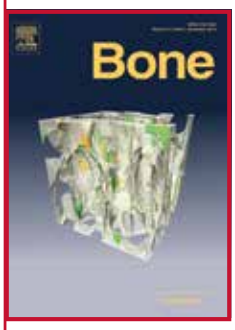
Fifteen years of BME at Cornell University!

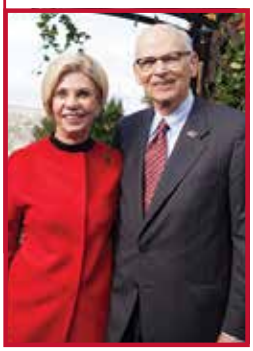
2019

2020+
Nate Cira
Karl Lewis

2013
Nozomi Nishimura
Steven Adie

Undergraduate major plan submitted to the College of Engineering.





2015
Iwijn DeVlaminck
Newton De Faria

$50M gift creates the Nancy E. and Peter C. Meinig School of Biomedical Engineering

Undergraduate BME major receives N.Y. State accreditation

2018
James Antaki

First undergraduate BME class graduates.

SMOOTHER JOINTS TO AVOID ARTHRITIS

Cornell biomedical engineers are improving the outlook for osteoarthritis patients through better lubrication of joints. A new type of treatment for osteoarthritis, currently in canine clinical trials, shows promise for eventual use in humans. The treatment is a synthetic version of lubricin, a naturally occurring joint lubricant that binds to the surface of cartilage in joints and acts as a cushion during high-impact activities, such as running.

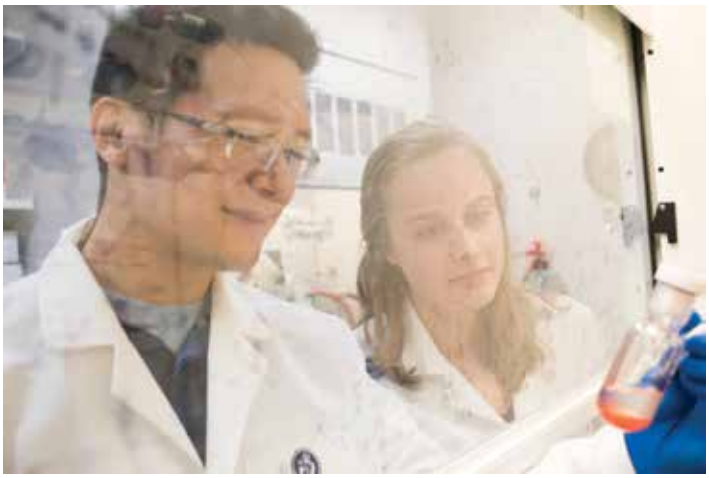
"When the production of that specific lubricant goes down, it creates higher contact between the surfaces of the joint and, over time, it leads to osteoarthritis," said David Putnam, a professor in the College of Engineering with appointments in the Meinig School and the Smith School of Chemical and Biomolecular Engineering.

The synthetic lubricin is patented through Cornell Technology Licensing; an Ithaca company, iFyber, is working with the researchers to develop the synthetic lubricin therapeutic for humans.

In addition to collaborating on the synthetic lubricin, Lawrence Bonassar, the Daljit S. and Elaine Sarkaria Professor in Biomedical Engineering and in Mechanical and Aerospace Engineering, studied the science behind hyaluronic acid (HA) injections that could change how one of the most popular osteoarthritis treatments is regulated.

The medical community has been divided over exactly how HA injections provide pain relief to osteoarthritis patients. HA products, typically injected into the knee, replace naturally occurring HA that has been depleted, lubricating the joints and preventing bones from rubbing together.

These injections, used for arthritis treatment for more than 30 years, constitute a $1 billion market in the U.S. The products are currently classified by the U.S. Food and Drug Administration (FDA) as class III medical devices, meaning pain relief is achieved through mechanical actions—mainly the reduction in friction between the bones—as opposed to chemical actions. But in December 2018, the FDA declared its intention to consider reclassifying HA products as drugs, citing scientific evidence that suggests HA achieves pain relief through chemical actions within the body. If reclassified, new HA products would face a much steeper challenge in reaching the market, affecting treatment options for the 30 million people in the U.S. who have osteoarthritis.



Putnam Lab postdoc Zhexun Sun and Ph.D. student Sarah Snyder checking the lubricin mimetic polymer in the lab (Photo: Robyn Wishna).

A new study by Bonassar and colleagues provides new insight on HA's mode of action. The researchers found the mechanical properties provided by HA's viscosity, specifically its ability to effectively lubricate cartilage, correlate much more directly to clinical efficacy—i.e., pain relief—than previously thought. (Based on articles by Krishna Ramanujan and Syl Kacapyr)

Read more:

"Boundary Mode Lubrication of Articular Cartilage With a Biomimetic Diblock Copolymer." Z. Sun, E. Feeney, Y. Guan, S.G. Cook, D. Gourdon, L.J. Bonassar, and D. Putnam. *PNAS*, 116 (25) 12437-12441.

"Frictional Characterization of Injectable Hyaluronic Acids Is More Predictive of Clinical Outcomes Than Traditional Rheological or Viscoelastic Characterization." E.D. Bonnevie, D. Galesso,C. Secchieri,L.J. Bonassar. *PLOS ONE*, 14 (5):10.1371.

BRAIN BLOOD FLOW FINDING GIVES HOPE FOR ALZHEIMER'S THERAPY

You know that dizzy feeling you get when, after lying down for an extended period, you stand up a little too quickly?

That feeling is caused by a sudden reduction of blood flow to the brain, a reduction of around 30 percent. Now imagine living every minute of every day with that level of decreased blood flow.

People with Alzheimer's disease don't have to imagine it. The existence of cerebral blood flow reduction in Alzheimer's patients has been known for decades, but the exact correlation to impaired cognitive function is less understood.

"People probably adapt to the decreased blood flow, so that they don't feel dizzy all of the time, but there's clear evidence that it impacts cognitive function," said Chris Schaffer, associate professor at the Meinig School.

A new study from the joint lab of Schaffer and Nozomi Nishimura, associate professor in the Meinig School, offers an explanation for this dramatic blood flow decrease: white blood cells stuck to the inside of capillaries, the smallest blood vessels in the brain. And while only a small percentage of capillaries experience this blockage, each stalled vessel leads to decreased blood flow in multiple downstream vessels, resulting in a

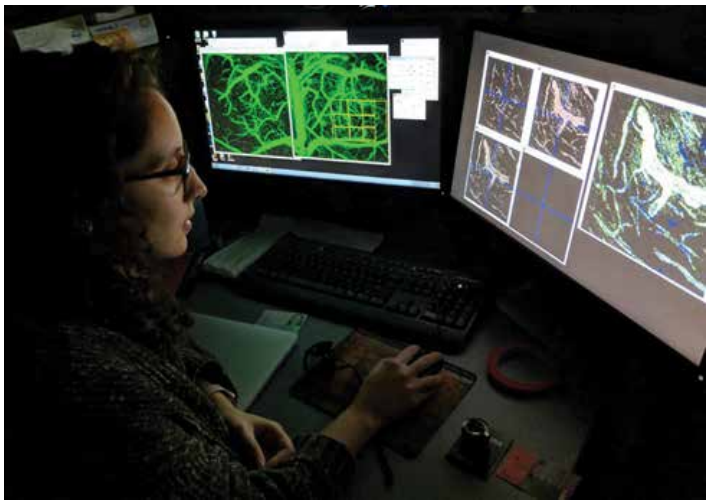
dramatic reduction in overall brain blood flow.

To test the effect of the stalls on performance of memory tasks in Alzheimer's mice, they were given an antibody that interfered with the adhesion of white blood cells to capillary walls, which caused the stalled capillaries to start flowing again. Brain blood flow increased rapidly and memory function was improved within a few hours, even in aged mice with more advanced stages of Alzheimer's disease.

"Now that we know the cellular mechanism," Schaffer said, "it's a much narrower path to identify the drug or the therapeutic approach to treat it."

Read more:

"Neutrophil Adhesion in Brain Capillaries Reduces Cortical Blood Flow and Impairs Memory Function in Alzheimer's Disease Mouse Models." J.C. Cruz Hernández, O. Bracko, C.J. Kersbergen, V. Muse, M. Haft-Javaherian, M. Berg, L. Park, L.K. Vinarcsik, I. Ivasyk, D.A. Rivera, Y. Kang, M. Cortes-Canteli, M. Peyrounette, V. Doyeux, A. Smith, J. Zhou, G. Otte, J.D. Beverly, E. Davenport, Y. Davit, C.P. Lin, S. Strickland, C. Iadecola, S. Lorthois, N. Nishimura, C.B. Schaffer. *Nature Neuroscience*. 22(3):413-420, 16, pages 59–62 (2019).



Graduate student Nancy Uribe-Ruiz imaging brain blood vessels in mice with two-photon microscopy.

ELEGANT TRICK IMPROVES SINGLE-CELL RNA SEQUENCING

Droplet microfluidics has revolutionized single-cell RNA sequencing, offering a low-cost, high-throughput method for single-cell genomics. However, this method has been limited in its ability to capture complete RNA transcription information.

Researchers at Cornell—led by Iwijn De Vlaminck, assistant professor in the Meinig School—have come up with an elegant, low-cost method that solves that problem. Not only does it push single-cell genomics forward, it may allow for new avenues for studies of infection and immune biology.

Drop-seq, is a method to simultaneously and efficiently characterize the identities of thousands of cells, using nanoliter-scale droplets and attaching a unique identifier to each cell's RNA.

"Those technologies are very popular because they've lowered the cost of these types of analyses and sort of democratized them, made them very cheap and easy to do for many labs," De Vlaminck said.

Drop-seq, a current method for simultaneously characterizing the identities of thousands of cells, uses nanoliter-scale droplets and attaches a unique identifier to each cell's RNA. The drawback is that it can only identify a certain type of messenger RNA (mRNA) molecule, which limits the potential scope of analyses. Messenger RNA carries the genetic information copied from DNA in the process of translation.

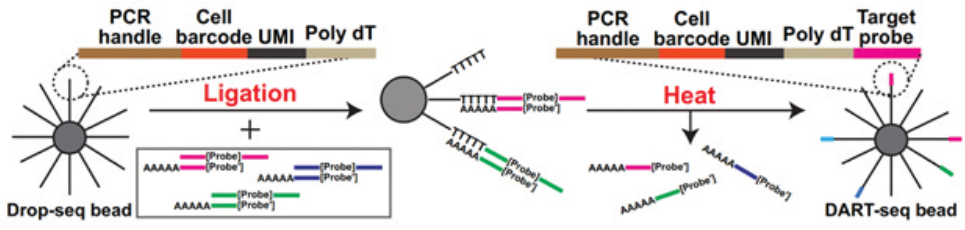
De Vlaminck and collaborators have come up with a new method, DART-seq (droplet-assisted RNA targeting by single-cell sequencing), a simple, inexpensive twist to the existing Drop-seq protocol.

In Drop-seq, individual cells are encapsulated with labeled microparticles that initiate reverse transcription of cellular mRNA. The De Vlaminck group devised an effective method to enzymatically customize the beads prior to performing conventional Drop-seq analysis, which allows for the recovery and analysis of a greater variety of molecules than are available through Drop-seq sequencing.

In addition, this technology can identify virus-infected cells, and quantify viral and host gene expression, thus enabling examination of the host response to infection at the single-cell level.

Read more:

"Simultaneous Multiplexed Amplicon Sequencing and Transcriptome Profiling in Single Cells." M. Saikia, P. Burnham, S.H. Keshavjee, M. F. Z. Wang, M. Heyang, P. Moral-Lopez, M.M. Hinchman, C.G. Danko, J. S. L. Parker, & I. De Vlaminck. *Nature Methods*, 16, pages59–62 (2019).



DART-seq, a new tool for single cell transcriptomics.

STAFF GRADUATE AARON WINDSOR

Aaron Windsor being hooded by Jan Lammerding at the May 2019 BME Commencement (Photo: Heather Ainsworth Photography).

The Meinig School was thrilled this past spring to add its first staff graduate to the commencement program; Aaron Windsor, an employee at Cornell NanoScale Science & Technology Facility (CNF), and a member of the Meinig School's Lammerding Lab, received his M.S. in biomedical engineering in May.

While Windsor's walk across the stage to receive his diploma took minutes, his journey to that moment began nearly 15 years earlier when he started as a tech at the Cornell Nutrient Lab in July 2004. After moving to a Research Support Specialist (RSS) position at Laboratory of Elementary Particles Physics (LEPP) in 2006, Windsor found a home at the Cornell NanoScale Science & Technology Facility (CNF) in 2009. Through his work at CNF, Windsor discovered his role involved more than facility maintenance and he came to appreciate the interdisciplinary and rapidly-evolving nature of the nanotechnology field.

After a year at CNF, Windsor decided he could best serve this diverse research community by going back to college. He began by auditing nanofabrication courses through Cornell's part-time study (formerly extramural study) program, but when he found he was not absorbing any of the material that way, he decided to start taking the courses for credit. This decision, said Windsor, not only helped him learn what came easy at his later age, but also gave him the credentials required for his next step; entering a graduate program.

"After assisting others with their research and external remote projects, I wanted to work on something that was my own."

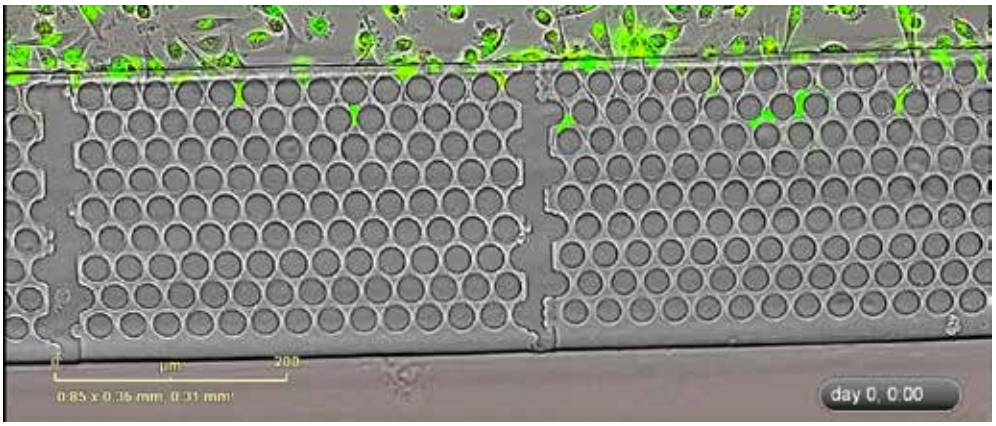
Windsor approached the Biomedical Engineering (BME) field about entering graduate school through Cornell's Employee Degree Program. "I remember professor Chris Schaffer asking me if I wanted to do a lengthy research project or make some 'cool stuff' and I knew [BME] was the right place for me," said Windsor. It turned out Meinig School Professor Jan Lammerding was looking for a student with CNF experience, and the rest is history.

"I couldn't have asked for a better group of people to work with for over the past three years," said Windsor.

The feeling was mutual. "It was wonderful having Aaron in our lab," said Lammerding of Windsor's role and impact. "His outstanding experience with nanofabrication lead to the implementation of several new ideas and fabrication of microfluidic devices that are now being used in the lab on a daily basis."

While the experience was worthwhile, Windsor acknowledges there were also challenges. "I graduated with my B.S. in biology in 1995 before the internet existed, so there was a huge technical gap I had to overcome. As a non-traditional student, I was on my own most of the time, which sometimes made class work and projects difficult. Plus, I was single when I started taking classes nine years ago and now I'm married with two children. I had to do most of my work after my family went to bed, so I haven't really slept much in the past six years."

But it was worth the work, says Windsor. "I am extremely thankful for Cornell not only to be an employee, but also, now, an alumnus. I now feel I am truly a part of the university."



Windsor's research at the Meinig School focused on designing microfluidic devices that mimic the confined environment inside living tissues, enabling the study of cancer metastasis in vitro. Shown here are fluorescently-labeled cancer cells migrating through such a microfluidic device (Image: Lammerding Lab).

MEINIG SCHOOL ELIMINATES GRE REQUIREMENT

Faculty vote overwhelmingly to remove requirement

This summer the Meinig School announced it will no longer consider the Graduate Record Examination (GRE) scores in making decisions about admission to the doctor of philosophy (Ph.D.) and master of engineering (M.Eng.) programs in the biomedical engineering graduate field. The decision was supported by an overwhelming majority of the graduate field faculty, and the change will be effective for the fall 2019 application cycle for all graduate and professional degree programs.

The graduate field faculty was persuaded by several compelling arguments about the inequities inherent in this standardized test, including numerous recent studies reporting that the GRE shows little correlation with graduate student success and that the test can be biased against women, underrepresented minorities, students from underserved communities, and international students.

"Removing the GRE scores from consideration is expected to reduce barriers to graduate education and contribute to a fairer and more holistic review process while also providing significant cost savings for applicants," said Meinig School associate professor and director of graduate studies Jan Lammerding.

The BME graduate field will continue to review and make refinements to its holistic review practices for applications to its graduate programs to ensure a fair and unbiased admissions process. For more information, visit: bit.ly/cornellbmenogre

THANK YOU

Beckie Robertson (front row, second from right) with Mike Shuler (far right) and Cornell alums from the same cohort (from left: George Georgiou, Jeff Chalmess, Mike Domach, Ann Lee and Bill Bentley) at the Shuler Symposium celebration, June 27, 2018. (Photo: Thomas Hoebbel)

The Meinig School is grateful to Beckie Robertson ('82 Chem E) and Dr. Neil L. Robertson ('82 Chem E) for establishing the Michael L. Shuler Director's Fund for Biomedical Engineering. This fund honors the legacy of Mike Shuler, the Samuel B. Eckert Professor Emeritus of Engineering and founding chair of the Department of Biomedical Engineering at Cornell. Beckie's experiences as an undergraduate researcher in Mike's lab inspired the Robertsons to establish a fund which provides flexible support of experiential learning opportunities for BME majors, such as research, student project teams, conference travel, and group interactions with clinicians at Weill Cornell Medicine.

Beckie Robertson has nearly 25 years of experience as a venture capitalist and is the co-founder and managing director of Versant Ventures, a health care investment firm emphasizing the development of novel therapeutics. An active volunteer for Cornell, Beckie serves on the Cornell Board of Trustees, the BME Advisory Council, the Engineering College Council, and the Board of the McGovern Center Life Sciences Incubator. She is a particularly committed supporter of the Cornell Silicon Valley (CSV) Advisors, where she works with other CSV members to heighten Cornell's exposure in the Bay Area.

Dr. Neil Robertson is the senior director of non-volatile memory devices at Western Digital. An expert in the design of magnetic read sensors and magnetoresistive random-access memory, Neil previously worked as a research manager for the IBM Almaden Research Center. He was a member of Cornell's Class of '82 20th Reunion Campaign Major Gifts Committee.

Together the Robertsons have hosted alumni dinners and events in their home and are dedicated volunteer leaders on behalf of Cornell.

HONORS & AWARDS

CORE FACULTY

Lawrence Bonassar
Named 2019 Class of Fellows of the Biomedical Engineering Society (BMES).

Jonathan Butcher
Elected American Institute for Medical and Biological Engineering (AIMBE) College of Fellows; awarded 2018 Sonny Yau '72 Award for excellence in teaching and mentoring from Cornell Engineering.

Ben Cosgrove
Awarded 2018 Research Grant for Junior Faculty from the Glenn Foundation for Medical Research and the American Federation for Aging Research (AFAR); awarded 2019 John Swanson '61 ME in honor of his mother Dortothy G. Swanson Award for excellence in teaching and mentoring from Cornell Engineering.

Iwijn De Vlaminck
Awarded $200,000 grant from the Kenneth Rainin Foundation for research on cell-free DNA as a non-invasive test of bacterial translocation, ileal inflammation, and extra-intestinal Crohn's disease; honored as an inspirational Cornell faculty member by a Merrill Presidential Scholar.

Chris Hernandez
Elected American Institute for Medical and Biological Engineering (AIMBE) College of Fellows; Fellow of the American Society for Bone and Mineral Research (ASBMR).

Jan Lammerding
Awarded Faculty Teaching, Advising, and Mentorship Award from the Cornell Graduate and Professional Student Assembly (GPSA); awarded 2019 Sonny Yau '72 Award for excellence in teaching and mentoring from Cornell Engineering.

Esak (Isaac) Lee
Appointed the Nancy and Peter Meinig Family Investigator in the Life Sciences.

Nozomi Nishimura
Honored as an inspirational Cornell faculty member by a Merrill Presidential Scholar.

David Putnam
Awarded Excellence in Teaching award from Cornell Engineering.

Chris Schaffer
Elected American Institute for Medical and Biological Engineering (AIMBE) College of Fellows; Research Excellence Award from Cornell Engineering.

Michael Shuler
Awarded 2019 Biotechnology Progress Award for Excellence in Biological Engineering Publication to be awarded at the AIChE meeting Nov 10-14.

Ankur Singh
Awarded Research Excellence Award from Cornell Engineering; elected inaugural Chair of the new Immuno Delivery Focus Group at the Controlled Release Society.

Shalu Suri
Awarded James and Mary Tien Excellence in Teaching Award from Cornell Engineering.

Marjolein van der Meulen
Renewed as the James M. and Marsha McCormick Director of Biomedical Engineering for an additional five-year term starting July 1, 2019, and ending June 30, 2024.

STUDENTS & POSTDOCS

GRADUATE STUDENTS

Bayan Alturkestani (M.Eng.) awarded 1st place at the SABIC competition for entrepreneurship in Washington D.C.

David Bassen (Butcher Lab) awarded an INTERN fellowship from the NSF.

Carolyn Chlebek (van der Meulen Lab) selected as one of two winners of the 2019 Kappa Delta/ORS Travel Awards; received the Cornell Caroline Coffey Fund Travel Award to participate in the 2019 American Society for Bone and Mineral Research Annual Meeting.

Nicole Diamantides (Bonassar Lab) won a poster award at the meeting of the International Society of Biofabrication in Wurzburg, Germany.

Elizabeth Feeney (Bonassar Lab) placed 3rd in the Ph.D. Student Paper Competition at the Summer Biomechanics, Bioengineering, and Biotransport Conference (SB3C).

Marie Beatrix Kruth (M.Eng.) won second place at the MIT Hacking Medicine competition held in New York City in November 2018.

Menansili Mejooli (Schaffer-Nishimra Lab) awarded 2019 Africa Fund Fellowship.

Jill Middendorf (Bonassar lab) awarded a young scientist travel grant to attend the ORS 2019 annual meeting.

Taylor Oeschger (Singh Lab) won first place in the Collegiate Poster Competition at the Society of Women Engineers (SWE) Local in Baltimore; awarded the Nellie Yeh-Poh Lin Whetten Memorial Award from CNF.

Leah Pagnozzi (Butcher Lab) awarded a Provost Diversity Fellowship.

Monet Roberts (Paszek Lab) inducted into the Cornell chapter of the Edward A. Bouchet Graduate Honor Society.

Guy Scuderi (Butcher Lab) awarded a Vertebrate Genomics Training fellowship.

Stephen Sloan (Bonassar Lab) won a podium presentation award at the meeting of the Philadelphia Spine Research Society and the Spine Section of the Orthopaedic Research Society; awarded a travel grant to attend the 2019 Association for Clinical and Translational Science Conference in Washington, D.C.

Reagan Stephenson (Singh Lab) awarded a poster award from the Society for Biomaterials.

Taylor Walker (M.Eng.) selected a *Forbes* 30 Under 30 Scholar.

Tibra Wheeler (Singh/van der Meulen Labs) selected a *Forbes* 30 Under 30 Scholar; awarded a SIG poster award from the Society for Biomaterials.

Yuying (Sylvia) Zhang (Nishimura Lab) selected as recipient of the Hsien Wu and Daisy Yen Wu Scholarship from the Cornell University Graduate School.

Chelsea Stephens (Butcher Lab), **Monet Roberts** (Paszek Lab), **Carolyn Chlebek** (van der Meulen Lab), **Rose Buchmann** (Erickson Lab), and **Tibra Wheeler** (Singh/van der Meulen Labs) each received awards at the Diversity Programs in Engineering 2019 banquet.

UNDERGRADUATE STUDENTS

Heather Lukas awarded a scholarship from Tau Beta Pi for the 2018-2019 academic year.

Crystal Lee, Shweta Modi, Alice Yan, Joy Li, and Holly Zheng awarded first place in the 2019 Engineering Showcase held at Johnson & Johnson World Headquarters on Feb. 28, 2019.

Haley Antoine and **Samantha Pitts** each received awards at the Diversity Programs in Engineering 2019 banquet.

POSTDOCS

Oliver Bracko (Schaffer-Nishiumra Lab) awarded 3MT Competition Post-Doctoral Fellow award from the Vascular Cognitive Disorders PIA.

Tyler Kirby (Lammerding Lab) awarded a development grant from the Muscular Dystrophy Association for his research on Emery-Dreifuss Muscular Dystrophy (EDMD).

Ana Maria Porras (Brito Lab) selected Ambassador for the If/Then program from the AAAS; awarded a Cornell Presidential Postdoctoral Fellowship.

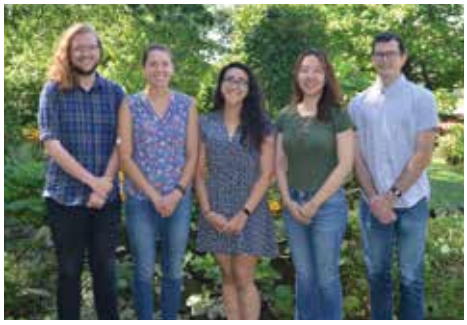
ALUMNI

Young Hye Song (Ph.D. 2016, Fischbach-Teschl Lab) will join the University of Arakansas Department of Biomedical Engineering as an assistant professor in August 2019.

STAFF

Belinda Floyd received the Unsung Hero Award from Cornell's Graduate Office of Inclusion and Student Engagement and the Graduate and Professional Student Diversity Council.

MEET THE 2019 NSF FELLOWS



2019 NSF Fellows L to R: Garrett Beeghly, Christine Harper, Daniella Fodera, Yuyan Wang, and Ben Albert. (Photo: Suzanne Aceti Koehl)

The Meinig School proudly congratulates Ph.D. students Garrett Beeghly (Fischbach-Teschl Lab), Christine Harper (Hernandez Lab), Daniella Fodera (Andarawis-Puri Lab), Yuyan Wang (Paszek Lab), and Ben Albert (Butcher Lab) who each won a 2019 National Science Foundation (NSF) Graduate Research Fellowship (GRFP). The NSF GRFP offers three years of stipend support during a five-year fellowship tenure to applicants selected through a national competition. Congratulations also go to students receiving honorable mentions this year: Taylor Oeschger (Erickson Lab) and David McKellar (Cosgrove, De Vlaminck Labs).

FACULTY PROMOTIONS

Steve Adie promoted to the rank of associate professor.

Claudia Fischbach-Teschl promoted to the rank of professor.

Nozomi Nishimura promoted to the rank of associate professor.

Ankur Singh promoted to the rank of associate professor.

ALUMNI PROFILES

EMILY BROOKS PH.D. 2012

Emily Brooks received her Ph.D. in the Fischbach-Teschl Lab in 2012. Her research focused on the role of host tissue stem cells in breast tumorigenesis, specifically evaluating the ability of these cells to alter the tumor microenvironment through chemical and mechanical cues in a manner that contributes to tumor growth.

After graduating, Brooks took a postdoctoral position at Boston Biomedical, Inc. (BBI), a pharmaceutical company focused on the development of oncology therapeutics. She rapidly gained extensive industry experience in optimization of in vivo models for drug development, pharmacodynamic assessments, and identification of biomarkers. Her position has transitioned since joining the company. Originally, her work focused on lab analysis to better understand the drug compounds in development, with a focus on research. As she gained more industry experience, she also gained a better understanding of the clinical development process through management of contracted research organizations, eventually leading her to her current position as the director of the Biomarker Assay Development and Companion Diagnostics group at BBI. In this position, she oversees the development of assays to identify biomarkers for all compounds in the pipeline and ensures assays required to select for treatment meet regulatory standards required of companion diagnostics. The in-depth evaluation of the tumor microenvironment continues to play a central role in her current position as she works to understand the mechanisms of action that allow new compounds to be effective in the oncology field.

GAURANG DIMRI M.ENG. 2016

Gaurang Dimri completed his B.S. in biomedical engineering from the University at Buffalo in 2015 followed by his M.Eng. in biomedical engineering from Cornell University in 2016. While at Cornell, Gaurang was a graduate assistant for the OADI Research Scholars Program as well as a co-founder of a student start-up focused on the development of a medical device for bacterial detection.

After graduating, Dimri started his first position at Medtronic as a systems engineer working on a surgical robot for minimally invasive surgeries. The skills and experiences fostered at Cornell were critical for his first role as they helped in reducing the learning curve for such a complex and integrated medical device. His main role focused on developing the system testing methodologies for the verification and validation efforts. During this time, Dimri was also a co-sponsor/advisor for a BME M.Eng. project alongside a surgeon at Guthrie Hospital.

After working at Medtronic for two years, Dimri started a position as a design quality assurance engineer at Zoll Medical focused on resuscitation and acute critical care solutions. Here, he focuses on the validation efforts of all products in the Zoll portfolio to ensure the highest quality for clinicians, EMS, and fire professionals. Dimri hopes to continue his growth within systems/testing for medical devices and continue to develop his technical and professional skills as a young engineer.

ABHISHEK RAMKUMAR, PH.D. 2010

Abhishek Ramkumar received his B.Tech. (2004) in electrical engineering from the Indian Institute of Technology-Bombay (IIT Bombay) in Mumbai, India, and his M.S. (2008) and Ph.D. (2010) in biomedical engineering from Cornell University under the mentorship of professor Amit Lal in the School of Electrical and Computer Engineering.

His research focused on developing silicon-based ultrasonic surgical tools for cardiac electrophysiological activity mapping and tissue characterization during microdissection surgery, and involved multidisciplinary collaborations with Cornell's veterinary school and the urology surgery department at Weill Cornell Medicine.

Following graduate school, Ramkumar joined Blue Highway LLC, a Welch Allyn company, and was in charge of vetting physics and biophysics R&D concepts from technical feasibility to market size and patent landscape, for disseminating angel round funding to university research groups and early-to-mid stage startup firms engaged in commercialization of breakthrough medical diagnostic technologies. After his stint at Blue Highway, Abhishek transitioned to Palo Alto Research Center (PARC), a Xerox company, where he led the design and development activities related to multiple, industry-sponsored medical device projects and successfully deployed prototypes for use in feasibility studies at industry sites.

Recently, Ramkumar co-founded Abram Scientific, Inc., a medical diagnostic device company with a vision to develop a low cost diagnostic platform for hemostasis monitoring in cardiovascular disease management. The company has developed a first-of-its-kind, disruptive blood coagulation diagnostic platform that is capable of translating multiple lab-based tests to a cost-effective, hand-held format. Serving as the president of the company, Ramkumar currently leads the business development, product development, and intellectual property management efforts to further the company's mission.

CHRISTINE TAN, PH.D. 2011

Christine Tan is a chartered engineer and a fellow of the Institute of Engineering and Technology UK (IET). Tan completed degrees in biomedical engineering, graduating with a B.Eng. (First Class Honors) from Imperial College London, and a Ph.D. from Cornell University under the mentorship of professor Harold Craighead. Her Ph.D. research led to breakthroughs in nanofabricated single molecule/single cell chips for new biomedical applications such as cancer studies. The solid foundation in interdisciplinary thinking from a world-class education had well positioned Tan to take on key leadership roles in industry.

Previously, Tan was principal engineer at Globalfoundries, the world's second-largest semiconductor microchip foundry, leading cross-functional teams to tackle multi-dimensional manufacturing challenges. Tan developed "best-in-class" design for manufacturability (DFM) solutions for increasing product line yield, serving customers such as Broadcom, Qualcomm, IBM, NXP. These efforts resulted in two published IEEE articles and subsequently won the Globalfoundries' Global Quality Award Top Prize. Tan also served as program manager at Dornier Medizintechnik GmbH driving product quality, head of international business development (Photonics) at Shanghai International Micro-Tech Affiliation Center, and is currently chief technical advisor at ICA Technology and vice president of business development (strategy) at FIoT-Open Lab.

Tan is a rare hybrid combining deep technical expertise and business acumen, having fostered many international collaborations to industrialize emerging high-tech business. Some recent industrial accomplishments include Shanghai's first Silicon Photonics International Platform and an IoT Joint Innovation Lab with INFINEON Technologies Germany.

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