Alma Mater

Far above Cayuga’s waters,
With its waves of blue,
Stands our noble alma mater,
Glorious to view.

Lift the chorus, speed it onward,
Loud her praises tell;
Hail to thee, our alma mater!
Hail, all hail, Cornell!

Far above the busy humming
Of the bustling town,
Reared against the arch of heaven,
Looks she proudly down.

Lift the chorus, speed it onward,
Loud her praises tell;
Hail to thee, our alma mater!
Hail, all hail, Cornell!
PROGRAM

12:00 Reception

1:00 Welcome
Dr. Marjolein van der Meulen
James M. and Marsha McCormick Director of Biomedical Engineering; Swanson Professor of Biomedical Engineering

1:05 Award Recognition

1:10 Doctor of Philosophy Degree Recipients
Dr. Jan Lammerding
Director of Graduate Studies, Associate Professor

1:30 Master of Engineering Degree Recipients
Dr. Newton de Faria
Master of Engineering Program Director, Professor of Practice

2:15 Bachelor of Science Degree Recipients
Dr. Jonathan Butcher
Associate Director of Biomedical Engineering,
Director of Undergraduate Studies, Associate Professor

2:35 Closing Remarks
Dr. Marjolein van der Meulen
James M. and Marsha McCormick Director of Biomedical Engineering; Swanson Professor of Biomedical Engineering

2:40 Class Photos
DOCTOR OF PHILOSOPHY
AWARDED 2018

Jiahn Choi
Advisor: Nozomi Nishimura
Thesis: “Study of adult stem cell behavior in the crypts of the small intestine using advanced in vivo imaging technology.”

Benjamin Cohen
Advisor: Lawrence Bonassar
Thesis: “Overcoming clinical challenges to tissue engineering the human auricle.”

Christopher DiDomenico
Advisor: Lawrence Bonassar
Thesis: “Evaluating macromolecular transport in articular cartilage: Developing new insights to better predict transport of cartilage-based therapeutics.”

Gregory Fedorchak
Advisor: Jan Lammerding
Thesis: “Getting to the nucleus of it all: Understanding how mutations in nuclear envelope proteins cause muscle disease.”

John Foo
Advisor: William Olbricht

Jason Guss
Advisor: Christopher Hernandez
Thesis: “The role of the gut microbiome in bone and joint disease.”
Frank He
Advisor: Claudia Fischbach
Thesis: “Using physical sciences approaches to investigate the mineralized microenvironments of metastatic breast cancer.”

Derek Holyoak
Advisor: Marjolein van der Meulen
Thesis: “Application of in vivo mechanical loading to understand the pathology, treatment, and prevention of osteoarthritis.”

Jason Jones
Advisor: Nozomi Nishimura
Thesis: “Applications of intravital nonlinear microscopy in cardiovascular research.”

Michael McCoy
Advisor: Claudia Fischbach
Thesis: “Utilizing tissue engineering strategies for modeling the perivascular niche in glioblastoma multiforme.”

Jorge Alexis Mojica-Santiago
Advisor: Lawrence Bonassar

Madhur Srivastava
Advisor: Jack Freed
Thesis: “Improving signal resolution and reducing experiment time in electron spin resonance spectroscopy via data processing methods.”
Zhexun Sun
Advisor: David Putnam

Ashley Torres
Advisor: Christopher Hernandez
Thesis: “Fatigue behavior of cancellous bone, microdamage, and biologically inspired cellular structures.”
DOCTOR OF PHILOSOPHY

FACULTY STATEMENTS

Jiahn Choi

When Jiahn Choi came to Cornell she already had experience in using light to study living systems. At Cornell, she worked on in vivo imaging of the stem cells in the small intestine and discovered a previously unknown behavior of these cells. Intestinal stem cells, which are critical for maintaining a healthy gut, are arranged in a specific pattern in small pockets called crypts. Jiahn’s innovation and insight led to a new method in which she can implant a window into the abdomen of a mouse for time-lapse imaging of cells in the intestine. She used high-power femtosecond laser pulses to disrupt the cell patterning in the crypts and discovered that the stem cells then execute precise motions to restore the patterning. In addition, she found that stem cells perform coordinated dilation and contraction of the crypt to “pump” debris out of crypt. Such behaviors have never been observed before in stem cells. She then discovered that these actions are inhibited in old animals, suggesting this change contributes to the degradation of intestinal function with age. Collaborators from many different labs have visited to learn about Jiahn’s techniques and many more have sent samples and mice to try her unique imaging capabilities. Jiahn received a NYSTEM graduate fellowship for this work. After Cornell, she will continue with research as a post-doc. I have no doubt her creativity and analysis will lead to many more exciting discoveries.

Benjamin Cohen

Benjamin Cohen came to Cornell from Boston University. His thesis research focused on using cartilage cells and stem cells to engineer shaped human cartilage for the treatment of congenital birth defects such as microtia. His work has been presented at several conferences, including meetings of the Tissue Engineering and Regenerative Medicine International Society (TERMIS) and the American Society of Reconstructive Medicine. His work has been published in Tissue Engineering, Annals of Plastic Surgery, and Biofabrication, with an additional manuscript under consideration at PLoS ONE. In 2016, he was awarded a fellowship from the New York State Stem Cell Foundation. After graduation, Ben will pursue a career in the biotechnology industry.
Christopher DiDomenico

Christopher DiDomenico came to Cornell from Bucknell University. His thesis research focused on understanding the transport of therapeutic antibodies into cartilage for the treatment of arthritis. He presented his work at several conferences, including the meetings of the Orthopaedic Research Society and the Biomedical Engineering Society. He has published multiple manuscripts, including two papers in the *Journal of Biomechanical Engineering* and a paper in *Nature Reviews Rheumatology*, with additional manuscripts under consideration in *Osteoarthritis and Cartilage* and the *Journal of Biomechanics*. After graduation, Chris will pursue a career in consulting with ARCCA, Inc.

Gregory Fedorchak

Greg Fedorchak joined the Lammerding Lab after completing his Bachelor of Science at the University of Rochester. Greg’s Ph.D. research in the Lammerding Lab has been focused on investigating how mutations in proteins of the cell nucleus cause muscular dystrophy and heart disease, and to determine whether the cell nucleus can directly sense and respond to mechanical forces, for example, when muscle cells are stretched or exercised. As part of his research, Greg has developed and applied several novel experimental techniques, including the ‘microharpoon’ assay, to investigate whether disease-causing mutations render cells more susceptible to mechanical stress and thereby result in muscle-specific defects. Greg has been a wonderful lab member who combines outstanding talent, intelligence, and dedication with an always uplifting spirit, humbleness, and endless support for his lab mates and the broader community. Besides being an excellent researcher who has produced high impact work and was awarded a National Science Foundation (NSF) Graduate Research Fellowship, Greg left a lasting impression as a baker, BBQ master, best buddy, host and couch provider, and teacher. His social engagement and love to help others is evidenced in his numerous outreach efforts, including as a NSF GK-12 fellow to work with a local high school teacher, being a Big Brother, and helping as a camp-counsellor for children with muscular dystrophy. After fulfilling his final graduation ‘requirement’, leading his team to the Intramural Flag Football Championship, Greg became the first BME Ph.D. student to graduate from the Lammerding lab. We will miss Greg’s wonderful work and spirit in the lab, the many late-evening conversations, and his delicious focaccia bread, which has been the star of many Lammerding Lab bake sales. Greg will be a great catch for any company that lands him!
John Foo

by William Olbricht

John Foo joined the Olbricht lab after graduating from the University of Michigan. His doctoral research centered on improving the delivery of therapeutic drugs to the brain to treat debilitating and deadly brain diseases such as glioblastoma. Because the blood-brain barrier prevents most drugs in the bloodstream from entering the brain, one promising solution is to infuse the drug directly into the diseased parts of the brain, a method called convection-enhanced delivery. John evaluated the effects of focused ultrasound on convection-enhanced delivery to better understand how ultrasound can augment this drug delivery modality. He received the Med-into-Grad fellowship from the Howard Hughes Medical Institute for this work. John is also passionate about teaching and instructor development. He received the BME Ph.D. TA of the year award and was a fellow at both the Engineering Learning Initiatives and the Center for Teaching Innovation. He also received the John S. Knight Writing Institute Buttrick-Crippen fellowship to develop and teach the first engineering-themed First-Year Writing Seminar at Cornell. John is currently the Assistant Director for Faculty Programs and Services in Science and Engineering at Columbia University’s Center for Teaching and Learning.

Jason Guss

by Christopher Hernandez

Jason joined Cornell after receiving degrees in Mechanical Engineering and Biology at SUNY Binghamton. Jason’s research focused on the effects of the microbiome on bone and joint disease. Jason has done groundbreaking work showing that the microbes that live in the gut have the potential to influence how strong bones are and how osteoarthritis develops. In his first study Jason showed that modifications to the constituents of the microbiome can alter the material properties of bone, making bone weaker than one would think based on bone size and density. His findings have the potential to explain why many people with otherwise normal bone density experience spontaneous fractures during normal activity. In his second project Jason showed that modifications to the constituents of the gut microbiome have the potential to help prevent osteoarthritis. Jason’s work is changing the way we think about musculoskeletal disease in a fundamental way. Jason received a number of awards during his time in graduate school including Honorable Mention from the National Science Foundation, a Young Investigator Travel Award from the American Society for Bone and Mineral Research, and Best Student Presentation from the Orthopaedic Research Society Preclinical Models section. Additionally, Jason was recently awarded first place in the three minute thesis competition, demonstrating his ability to communicate his research to a broader audience. In collaboration with students outside of the laboratory Jason helped found OrthoFit Inc., a start up company located in Ithaca that uses biomechanical monitoring to prevent workplace injuries. After finishing his Ph.D. he plans on working full time as CEO of OrthoFit.
Frank He

by Claudia Fischbach

Frank He joined the Fischbach Lab to study the role of bone mineral in breast cancer skeletal metastasis. He utilized a highly collaborative approach in which he combined cancer biology with tissue engineering, biomaterials, and clinical strategies. To advance his work, Frank not only worked with faculty from different Cornell departments and even campuses, but also spent more than one year in Germany to analyze bone mineral chemical and structural properties at the Max Planck Institute for Colloids and Interfaces. Clearly, such a highly collaborative project requires a special individual with intellectual curiosity, creativity, and strong management and leadership skills. Frank has been that person. In addition, he impresses because of his maturity and exemplary communication skills. Perhaps not surprisingly, he has received a number of prestigious fellowships including a NSF predoctoral fellowship, and a Howard Hughes Medical Institute (HHMI) Med-into-Grad fellowship. Frank is an exceptionally bright, hard-working, highly motivated, and creative student and it has been a tremendous pleasure to see him develop both academically and personally during his time at Cornell. I still haven’t seen his dancing skills, but apparently, they improved during his time in Germany as well! Clearly, Frank is a very well-rounded individual who will do well with whatever he sets his eye on—we are all curious to see where his future path takes him.

Derek Holyoak

by Marjolein van der Meulen

Derek has worked on load-induced osteoarthritis, covering a broad spectrum of questions starting with demonstrating the role of cartilage properties in disease development. Understanding how the disease progresses with repetitive loading enabled Derek to consider the other end of the spectrum, treatment including delivering drugs to load-bearing joints and novel methods of inhibiting cartilage loss. Derek joined my research group five years ago after completing his undergraduate degree at the University of Connecticut. At Cornell he hit the ground running, taking ownership of an NIH-funded study that required an enormous amount of effort, particularly for a new graduate student. Then he moved on to considering how to deliver drugs to the knee joint, a challenging chemical and mechanical environment. His experiments considering novel methods to deliver drugs to the knee joint are currently being completed. Finally, Derek is also looking at a method to inhibit cartilage damage, using an innovative approach that will add greatly to the field. As a Ph.D. student, Derek has been a major contributor to the environment in my laboratory and the Meinig School with his positive outlook and work ethic. He has also been an incredibly effective teaching assistant and mentor to undergraduate students in the laboratory. He really brings out the best in everyone.
Jason Jones

by Nozomi Nishimura

Jason Jones took on and succeeded in an extremely high-risk, technically challenging project—microscopy of the beating heart within a living organism. He developed methods for two- and three-photon microscopy that enabled the first-ever measurement of cardiac action potentials in individual myocytes in an intact animal with natural blood flow and breathing. Our understanding of heart failure and cardiovascular disease has been hindered by the inability to study heart function on the cellular scale in the context of the whole animal. So far, studies of cell behavior have been limited to extracted tissues or cell-culture methods that lack systems such as blood flow and the immune system. Jason’s optical instrumentation and computation tools lay the foundation for an entirely new era in our ability to study cardiovascular disease. His discoveries also include a new way to visualize atherosclerotic plaques inside vessel walls using third harmonic generation. In addition to his research accomplishments, he also shared his inventiveness with the high school students in Onandaga, NY by bringing 3D printing to the classroom through the NSF CLIMB program. Jason’s courage, resilience and drive are the epitome of what enables exploration and discovery. I cannot imagine what he will find in the future, but look forward to being amazed.

Michael McCoy

by Claudia Fischbach

Michael McCoy is a Ph.D. student in the Fischbach Lab whose project integrated biomedical engineering and cancer biology towards gaining a better understanding of glioblastoma multiforme, a particularly aggressive and therapy resistant type of brain cancer. Michael’s intellectual curiosity, technical skills, and leadership made his own studies a success and also enriched many other projects in the lab! In addition, he has gone above and beyond in reaching out to the broader community. He not only led numerous activities to help get children engaged in science in general, but also served as a mentor in the Cornell’s McNair Scholars program, a program geared towards preparing undergraduate students from traditionally underrepresented background for doctoral studies. Furthermore, he has been an amazing mentor to the undergraduate students working with him and very proactively advanced their scientific and professional development. Not surprisingly, his efforts were rewarded with many fellowships including a prestigious graduate research fellowship from the National Science Foundation. Not many students expose themselves to a similarly busy schedule and are able to thrive. Michael did, and has become an amazing leader and go-to person in the lab throughout this whole journey—all while staying very humble. He is forward thinking, a wonderful team player, and somebody who cares. Undoubtedly, we will miss him—he has a bright future ahead of him and we all feel privileged to have been able to work with him!
Jorge Alexis Mojica-Santiago

Jorge Mojica-Santiago came to Cornell from University of Puerto Rico, Mayaguez. His thesis research focused on developing tissue engineered intervertebral disc for use in the canine cervical spine. He has presented his work at several conferences, including meetings of the Orthopaedic Research Society and the Biomedical Engineering Society, and has been published in *PLoS ONE*, with an additional manuscript in revision at the *Journal of Orthopaedic Research – Spine*. His outstanding work has been recognized with multiple awards including a National Science Foundation Graduate Research Fellowship and a poster presentation award at the Spine Research Symposium. He is planning on pursuing postdoctoral studies in the field of biomaterials.

Madhur Srivastava

Madhur came from a signal processing background, having done undergraduate work at the Jaypee University of Engineering and Technology in Guna, India, and obtaining an M.Eng. in Electrical and Computer Engineering at Cornell. He switched to BME because he wanted a more biological graduate field, and to do so with an interdisciplinary bent. To that end he has conducted research with the NIH-funded ACERT Center in the Dept. of Chemistry & Chemical Biology under the direction of Prof. Jack Freed, on reducing noise in experimental signals for biomedical applications without sacrificing accuracy of resolution. Madhur’s stated goal is to make healthcare more available by dramatically reducing the costs and time necessary to run diagnostics such as NMR and MRI while improving their resolution; he developed, and is continuing to further develop, a set of noise-reduction methods that made it possible to reduce data-acquisition times by one to two orders of magnitude— with the aim of someday being able to do, e.g., an MRI scan under ER conditions. So far three papers with him as lead author have appeared in major journals such as IEEE Access; three more will come out of his dissertation, and many more are expected from work with ACERT collaborators. NIH site reviewers already called his work “potentially transformative;” and to date 15 research groups world-wide have sent him over 150 datasets for denoising. In addition, Madhur undertook intensive training in many entrepreneurship workshops at Cornell, to better position himself for possible commercialization opportunities.

Finally, Madhur recognizes the importance of having a balanced set of interests beyond the lab, both personally and professionally: he has served as a dorm advisor, played on the Cornell Cricket Club team, and developed/presented multiple science outreach programs for K-12 audiences as well as for K-12 teachers, both in Tompkins county as well as around New York State.
Zhexun Sun by David Putnam

Zhexun Sun joined the Putnam Lab following completion of his Masters of Science degree in Chemistry from Rutgers University. He originally joined the BME program at Cornell as a Masters of Engineering student with the intention of enhancing his understanding of how chemistry can be applied in the design of compounds applied to human health. There are very few individuals who successfully convert from the Masters of Engineering program in to the Ph.D. program, but Zhexun’s outstanding work during his Masters work clearly supported his academic continuation toward his doctorate. It was the right decision. Zhexun exemplifies the balance between the fundamental and mechanistic understanding of biomaterials and how they can be used to improve health. Specifically, Zhexun created a new class of polymers that coat the surfaces of the cartilage in joints. These polymers make the surface of joint cartilage extraordinarily slippery, making them potentially useful as a treatment for osteoarthritis. On a personal note, it was a great pleasure to work with Zhexun. Every advisor dreams of a student who sees the big picture, yet focuses on the details. He epitomizes the definition of a Team Player, always stepping up to make sure students are trained well and moving forward. He will be greatly missed and I am sure he will be a great success wherever his next career step takes him.

Ashley Torres by Christopher Hernandez

Ashley joined the laboratory after undergraduate research at the University of California, Davis. Ashley’s graduate studies were supported by a National Science Foundation Fellowship and a Coleman Fellowship. Ashley’s research focused on understanding how mechanical damage accumulates in bone over time—a process believed to explain a majority of osteoporosis-related fractures in the spine. Before Ashley had begun her work, our understanding of how mechanical loads cause cracks to grow in bone was limited to laboratory experiments examining only a dozen small cracks. During her studies, Ashley tracked the propagation of over 1200 cracks in bone and published her work in the Proceedings of the National Academy of Sciences of the USA. More recently Ashley has translated her findings from bone to materials science and has developed bone-inspired foams that you might one day see in structures as varied as airplane wings and sneakers. Ashley has received a number of prestigious awards and honors including, best presentations at the Society of Hispanic Professional Engineers, the Kappa Delta/ORS travel award, a Finalist for the European Biomechanics Society student competition, induction into the Bouchet Honor Society, and most recently the Ephraim Garcia Graduate Excellence in Mentoring Award. Additionally, you may have seen Ashley lead the procession at commencement this morning. Ashley has inspired me with her talent, dedication and ability to overcome challenges. She sets
a high bar for students in my laboratory both in terms of her science and as a role model and mentor. Ashley is currently enrolled in the Master of Business Administration at Cornell Tech and has a promising career as an entrepreneur.
MASTER OF ENGINEERING

AWARDED 2018

Sherman Isiah Abrams
Victor Mayora Aguilar**
Richard William Armbruster
Beatrice Awasthi
Vaishali Balachandran
Nathan Alexander Bernitz Barr
Jash Bhayani
Kristin Brune
Joseph Carnicelli
Amy Chan-Young Lee*
Chao-Yuan Chang
Xiyu Chen
Yun-Fang Cho
Jenna Chong
Rechea Cheyeanne Christie
Dylan James Cornell
Marissa Kate D’Amelio
Allisen Goncalves
Justin Arthur Hansen
Sissy Henriquez
Prajakta Kalangutkar
Aliza Khan
Ka Kyung Kim
Kun Ho Kim
Hiralben Manojbhai Kothari
Carolyn Marie Krasniak
Nuo Li
Regina Ying Zi Lin
Wenjie Liu
Yangchen Liu
Shahid Adil Manzar
Zahid Ageel Manzar
Erin Marie McConnaghy
Bhavya Uday Mehta
Alexandra Marie Meilhac
Natasha Mohanty
Yufeng Nai
Blake Oliaro
Rebecca Michelle Organ
Ismael Oumzil
Venkata Kalyan Paruchuri
Michael Pierdes*
Louis Pollenz
Pallavi Pradeep
Shashank Prakash
Guanwen Qu
Michael James Rose
Clara Sant’anna Melo De Oliveira
Omkar Jayant Saraf
Lirong Shao
Yvonne Jia-Wen Shieh
Simrit Kaur Sidhu
Charul Singh
Nerwyn Pal Singh
Alexander Stone
Xinya Su
Eliot Christopher Teal
Samuel James Tome
Marin Yang Fu Varney
Prashanth Nikhil Veeragandham
Saloni Verma
Saumya Rajeshkumar Vora
Cory Alexander Waldman
Chang Wang
AWARDED 2018, CONTINUED

Zixian Wang  
Youwen Xia  
Wei Yen  
Hanbei Zhang

Jingyi Zhang  
Shixin Zhao  
Haiyue Zou

*Conferred December 2017  
**MS degree conferred December 2017
MASTER OF ENGINEERING
2017-18 PROJECTS

TEAM PROJECTS

Sleep monitoring and environmental control
Chun Chen, Yuchen Li, Shuyao Liu, Chang Wang

Developed a system applied in Intensive Care Units (ICU), which can detect the external factors (environmental factors: temperature, sound, humidity and light) and internal factor (patients’ movements) and notify the healthcare workers when these factors are supposed to be adjusted or examinations are required and alter the environment in ICU rooms to some extent, to promote the sleep quality of patients.

Endoscope proximity sensing
Louis Pollenz, Omkar Jayant Saraf

The time it takes for endoscopic surgeon trainees to fully master the techniques is between 3 - 5 ½ years, or 140 - 500 procedures. Our device involves an array of four proximity sensors placed on the tip of the endoscope that are able to detect the location of the endoscope within the colon. The device provides a real-time feedback signal that displays when and where the trainee may have made a mistake, thus decreasing the enormous time and cost implemented in the training process.

Team oxybehmometer
Yangchen Liu, Zahid Manzar

We aim to improve patient quality of care, especially at the emergency and ICU level. Current practice is limited, as there is no quantifiable method to monitor tissue recovery. One thing for sure is that hypoxia always accompanies tissue death! Our probe is designed to measure tissue oxygen concentration in an ICU setting. Our probe is simple, convenient and cheap!

Optimizing the flow output of intra-aortic balloon pumps (IABP) through the use of multiple balloons
Shahid Manzar, Guanwen Qu, Haiyue Zou

IABPs currently on the market have a 0.5 L/min cardiac assist flow rate, 10% of the total required cardiac output. By using multiple balloons, we are able to induce a more unidirectional flow pattern, forcing more blood through the aorta instead of the coronary artery. We have been able to increase flow output by 60% and theorize that it can be further improved
by manipulating balloon timings and obtaining more optimal balloons.

**Surgical solutions in colorectal cancer**  
*Wenjie Liu, Alexander Stone, Saloni Verma, Wei Yen*

This team developed a strategy to identify the borders of healthy tissue during open colorectal surgery, allowing for improved surgical margins and reduced risks of postoperative complications. They accomplished this by designing a device that measures tissue elastic modulus via pipette aspiration.

**Portable handheld device for early detection of preterm birth**  
*Pallavi Pradeep, Lirong Shao, Jiabin You*

Many physiological changes occur within the uterine cervix at the onset of labor from long, stiff, and closed structure to a shorter, softer, and more dilated one. Our team is currently working on a portable handheld device which is capable of detecting these changes in the biomechanical properties of the cervical tissue for an effective and timely diagnosis of premature birth.

**Smart trocar: Revolutionizing the user experience and patient outcomes in minimal invasive surgery**  
*Candice Cho, Rechea Christie, Nerwyn Pal Singh, Youwen Janice Xia*

Although the technology used to complete MIS has evolved, the incidence of injury to vasculature and internal organs and the mortality rate have not dropped below 40% and 15% percent respectively. Our solution is a smart trocar that characterizes different tissue properties and instantaneously notifies the surgeon, a feedback mechanism that is lacking in all current bladed and blunt trocar systems, to aid in the successful access of the abdominal cavity and prevent common first entry injuries.

**Correcting canine mitral valve disease**  
*Lindsay Hale, Erin McConnaghy, Alexandra Meilhac, Michael Rose, Samuel Tome*

Mitral valve disease has a widespread incidence in dogs. 80% are likely to die within two years. Open-heart surgery is expensive and can only be performed by handful of veterinary surgeons. We developed a minimally invasive device to address myxomatous mitral valve disease (MMVD) in small-breed dogs (< 15kg) to reduce disease progression and improve quality of life.
Microfluidic device for nuclear membrane deformation
Richard Armbruster and Vaishali Balachandran

In collaboration with Dr. Jan Lammerding and his laboratory, the team designed and developed a microfluidic device and detection system to elucidate the deformability of the nuclear membrane in target cell populations. Nuclear deformation is measured via nuclear protrusion of cells into small channels under flow conditions. This cellular characteristic is directly correlated with cell type and has the potential to become a significant biomarker for the diagnosis and prognosis of several disease varieties including cancer and muscular dystrophy. The team worked with Cornell Nanoscale Science and Technology Facility to design and fabricate silicon wafer masters for their microfluidic device and constructed a low cost, miniature fluorescent microscope using 3D printing technology.

Minimally invasive delivery of an injectable gel for intervertebral disc repair
Nathan Barr, Kristin Brune, Carolyn Krasniak, Bhavya Mehta, Simrit Sidhu, Saumya Vora

Re-herniation occurs after 20% of discectomy procedures, due to a defect in the intervertebral disc from the initial herniation. Secondary surgeries are estimated to cost around $6,907 per patient. We created a device, compatible with minimally invasive surgical hardware, to mix, deliver, and photo-crosslink a gel that seals disc defects following a discectomy procedure. This leads to total repair of the disc and prevents re-herniation, reducing the need for secondary operations as well as the overall financial burden of the disease. Project sponsored by Dr. Lawrence Bonassar (Cornell University Biomedical Engineering Department) & Dr. Roger Hartl (Weill Cornell Medicine).

Dementia screening test
Jash Bhayani, Xiaoqing Cai, Prajakta Kalangutkar, Aliza Khan, Venkata Paruchuri

In conjunction with Welch Allyn, our group worked to create a Virtual Reality based screening test to help diagnose dementia. Early diagnosis of dementia can help physicians to act earlier and slow the onset of conditions such as Alzheimer’s disease. Our device immerses the patient in a realistic setting where they are asked to perform routine tasks such as making a cup of coffee. By using the eye tracking data from the VR headset, we can offer physicians relevant metrics that can help them to diagnose the level of dementia in patients.
The future of keratoplasty
Blake Oliaro, Charul Singh, Marin Varney, Stephanie Yiu, Zixian Wang, Jingyi Zhang

This team worked under the mentorship of Dr. Christopher Sales, who is at the cutting edge of Keratoplasty and an expert in its most recent evolution, Descemet Membrane Endothelial Keratoplasty (DMEK) at Weill Cornell Medicine. The team developed an iDisc, which will help turn the more difficult DMEK procedure easier by providing a dissolvable carrying platform for the tissue. The team aims to accelerate the use of DMEK among surgeons as it provides patients with better visual acuity, lower graft rejection rates and shorter recovery time.

“Smart bandage” for diabetic wounds
Justin Hansen, Sissy Henriquez, Ismael Oumzil, Yvonne Shieh, Eliot Teal

Diabetic foot ulcers (DFUs) and associated diabetic wounds occur in around 15% of the 422 million patients with diabetes. Healing of these chronic wounds is significantly challenging, with the average healing time for simple wounds >2 months. During this period, dressings must be changed on a daily basis, putting significant burden on the patient, nurses and clinicians. Additionally, about 50% of diabetic wounds become infected. We have designed a “Smart Bandage” capable of continuously monitoring the healing of diabetic wounds, therefore reducing clinician involvement and improving outcomes.

Smart brace for gait improvement and rehabilitation
Hiral Kothari, Regina Lin, Cory Waldman, Hanbei Zhang

Our team partnered with Dr Thorne to address foot drop and gait impairments as a result of anoxic brain injury - symptoms that are very common in those suffering other neurological injury. Our team created a smart brace for home rehabilitation of foot drop. The device provides active assistance, moving the foot into dorsi and plantar flexion when the patient is incapable of making/completing the movement and backing off when the patient does not require assistance.

Diagnose, treat, and evaluate functional muscle pain
Dylan Cornell, Allisen Goncalves, Nuo Li, Natasha Mohanty, Yufeng Nai, Ruihong Wang

Under the mentorship of Dr. Norman Marcus and starting from a patent (US #7,826,900 and US #6,432,063), the team designed, built and tested an improved prototype muscle electrostimulation device with additional features including highly customizable electrical waveform output and an onboard Internet connection to a virtual anatomy software package allowing the practitioner to see what muscles are being stimulated in real-time.
**Respiration rate monitoring: The solution for respiratory monitoring in med-surgical ward**

*Xiyu Chen, Clara Sant'anna Melo de Oliveira, Shashank Prakash*

Our device consists of an adhesive patch with a flexible sensor and an electronic module with an accelerometer. They measure the deformation and the acceleration, respectively, of the patient’s abdomen while breathing. All the data acquired by the sensors is transmitted from the electronic module to a nearby measurement device wirelessly using Wi-Fi.

**Use of TENS to enhance rheumatoid arthritis patients’ experience**

*Sherman Abrams, Marissa D’Amelio, Prashanth Veeragandham*

Pain during injection can lead to a 50% decrease in patient adherence. This concept of pain is due to continuous injection treatments, causing mental and physical burden to the users. Therefore, there exists a medical need to improve patient compliance and decrease patient fear during the self-injection process. We developed the instrumentation, and run experiments to investigate the use of TENS as a pain mitigation method to enhance the patient experience during injection.

**Novel heart bioreactor**

*Joe Carnicelli (Advisor: Dr. Jonathan Butcher)*

The goal of the project was to build a heart valve bioreactor. The reactor aims to simulation the pressure and flows experienced by the aortic or pulmonary heart valve. This bioreactor could be used to grow artificial heart valve scaffolds. Artificial heart valves have potential for use in heart valve replacement to treat heart disease. The reactor could also be used to simulation disease conditions, such as high blood pressure and an abnormal heart rate.
Name: Chao-Yuan Frank Chang  
Advisor: Jan Lammerding  
Project: “Studying the effect of confined migration on cancer cell epigenetic modifications.”

Name: Jenna Chong  
Advisor: David Putnam  
Project: Investigation of outer membrane vesicle colloidal stability to make multivalent vaccines.”

Name: Kun Ho Kim  
Advisor: Benjamin D. Cosgrove  
Project: “Engineering biomaterial microenvironments to facilitate long-term, clinical-scale skeletal muscle stem cell expansion.”

Name: Ka Kyung Kim  
Advisor: Dan Luo

Name: Xinya Su  
Advisor: John Lis  
Project: “Exploration of effects of DSIF on pol II pausing in drosophila using aptamer.”
BACHELOR OF SCIENCE

AWARDED 2018

Wyatt Buchalter
Allison Byrne
Esther Chen
Hannah Childs
Adaugo Ezike (independent major)
Margaret Hale
Jordan Harrod
Halie Hotchkiss
Shannon Hugard
  Tina Jing
  Eric Kaden
  Joseph Kim
  Emma Krebs
Daniel (Alex) Marburgh
  Riona Reeves
  Rohan Roy
  Erica Sadler
  Julia Telischi
  Elizabeth Weiss
  Kelly Wilson
BACHELOR OF SCIENCE
2017-18 PROJECTS

SENIOR DESIGN PROJECTS

MousePad
Jordan Harrod, Riona Reeves, Rohan Roy, Julia Telischi, Kelly Wilson

We created an accurate, user-friendly system capable of monitoring mouse heart rate, respiratory rate, and temperature under anesthesia. The device uses only non-invasive sensors and adjusts system inputs to maintain acceptable conditions for the subject. This product is for use during surgery and imaging and offers data export capability post-procedure.

ThoroughbRed: Novel internal reduction system for equine proximal sesamoid bone fracture repair
Shannon Hugard, Joseph Kim, Emma Krebs, Alex Marburgh, Erica Sadler

Transverse midbody fractures of the sesamoid bone are some of the most common injuries in racehorses. The sesamoid is a free-floating bone essential for guiding the tendons and ligaments in the fetlock joint of a horse. Current repair methods do not provide enough fracture gap reduction for complete recovery. To address this issue, we designed a novel reduction system for equine sesamoid bone fracture repair. This will be marketed primarily to equine surgeons for use in sesamoid bone fractures, although there is the potential for its use in similar injuries in other bones and species.

ComfortFix - Solutions for stereotactic radiosurgery (SRS)
Allison Byrne, Hannah Childs, Halie Hotchkiss, Tina Jing, Eric Kaden

“78,980 people will receive a primary brain tumor diagnosis this year. 23,830 will be malignant.” Tens of thousands of these patients will undergo SRS and there are some important areas of improvements: Mask fabrication process, Inability to adjust mask post fabrication, Patient comfort, and Fixation. We have devised a collection of technology and procedures capable of addressing these needs.
KneesySense: Intraoperative knee force sensor
Wyatt Buchalter, Esther Chen, Margaret Hale, Elizabeth Weiss

Surgical alterations to joint microstructure have long-term impact on load distribution, with clinical implications such as osteoarthritis, but there is currently no reliable mechanism to measure these mechanical changes. Team Kneesy Does It addressed this issue by designing a force sensing and analysis system for use during knee surgery. The KneesySense, compatible with arthroscopic and open joint surgery, detects peak pressures on the articulating surface and is sterilizable, waterproof, and wireless.