CornellEngineering
Meinig School of Biomedical Engineering

2021
Commencement

May 30, 2021

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!

DOCTOR OF PHILOSOPHY

Aaron Chiou
Thesis title: "Spatially resolved approaches to study tumor-bone matrix crosstalk relevant to breast cancer skeletal metastasis."
Advisor: Claudia Fischbach

Terence Gee
Thesis title: "Co-regulatory Mechanisms of Cellular Recruitment in Fibrocalcific Aortic Valve Disease."
Advisor: Jonathan Butcher

Korie A. Grayson
Thesis title: "Cellular Delivery of TRAIL to Treat Metastatic Castration-Resistant Prostate Cancer."
Advisor: Michael King

Rebecca Irwin
Thesis title: "Imaging the Microscale Mechanical Response of Articular Cartilage in Early Stage Osteoarthritis Treatments."
Advisor: Lawrence Bonassar

Ramin Jafari
Thesis title: "Advanced MRI Techniques for Assessment of Liver Disease."
Advisor: Yi Wang

Lu Ling
Thesis title: "In Vitro Models and Imaging Tools to Assess Roles of Obesity Associated Stromal Microenvironment on Breast Cancer Progression."
Advisor: Claudia Fischbach

Alexander Loiben
Thesis title: "Modeling and leveraging signaling networks in muscle stem cell fate regulation."
Advisor: Ben Cosgrove

Juan Paredes
Thesis title: "The Role of the Extracellular Matrix in Scarless Tendon Healing and its Implications in the Development of Novel Tendon Therapeutics."
Advisor: Nelly Andarawis-Puri

Shivem Shah
Thesis title: "Designer Immune Organoids to Study B cell Differentiation & Disease."
Advisor: Ankur Singh

Sarah Snyder
Thesis title: "Quinidine-Containing Polymers for Reversal of P-Glycoprotein Mediated Drug Efflux in Multidrug Resistant Cancers."
Advisor: David Putnam

Tiffany St. Bernard
Thesis title: "Injectable Devices for Minimally Invasive Ultrasonic Neuromodulation."
Advisor: Amit Lal

Chelsea Stowell
Thesis title: "Design and validation of resorbable vascular grafts in large animals."
Advisor: Yadong Wang

Ruisheng Wang
Thesis title: "Developing Point-of-Care Diagnostics for Global Health Applications."
Advisor: David Erickson

Yen-Lin (Ian) Wu
Thesis title: "Fabrication of Vascular Grafts and Effects of Design Parameters on Arterial Remodeling and Development of Tissue Engineered Heart Valve for Percutaneous Transcatheter Delivery."
Advisor: Yadong Wang

Fei Xia
Thesis title: "Deep Tissue Imaging with Short-Wave Infrared Light and Adaptive Optics."
Advisor: Chris Xu

Matthew Zanotelli
Thesis title: "Bioenergetic Regulation of Metastatic Cell Migration and Tumor Angiogenesis By Matrix Mechanics."
Advisor: Cynthia Reinhart-King

Yuying (Sylvia) Zhang
Thesis title: "Imaging In Vivo Dynamics of Inflammation and Neurodegeration."
Advisor: Nozomi Nishimura

Sophia Ziemian
Thesis title: "The Roles of Subchondral Bone Mass, Stiffness, and Remodeling in Load-Induced Osteoarthritis Development."
Advisor: Marjolein van der Meulen

DOCTOR OF PHILOSOPHY

FACULTY STATEMENTS

Aaron Chiou *by Claudia Fischbach*

Metastatic breast cancer spreads to the skeleton in 80% of all patients, but why bones are preferred sites for metastasis remains unknown. To elucidate the relationship between breast cancer and bone metastasis, Aaron hypothesized that breast cancer cells secrete factors that prepare the skeleton for successful seeding of tumor cells and thus, metastasis formation. To address this hypothesis, he used an interdisciplinary set of techniques that included vitro and in vivo models of bone metastasis, omics approaches, and advanced 3D imaging of fluorescently labeled cells. As of now, Aaron's work resulted in 10 published manuscripts and several awards including a F31 fellowship and a Young Investigator Award at the International Conference on the Chemistry and Biology of Mineralized Tissues. Aaron defined a completely new research direction in the Fischbach lab all while managing several interdisciplinary and global collaborations. He has an unusual ability to think 'outside the box' and develop innovative, new research hypotheses. In addition to his scientific aptitude, Aaron demonstrated exceptional leadership and teaching skills. Aaron moved to California in summer of 2020 and is now a postdoctoral fellow at Stanford. We miss him, but enjoy following his successes as a scientist, teacher, and mentor.

Terrence Gee *by Jonathan Butcher*

Terence arrived to the Butcher lab after earning his B.S. at UC Riverside. Terence's research focused on elaborating how the endothelial and interstitial cells of the aortic valve collaborate to maintain tissue homeostasis and calcific degeneration. Terence developed and implemented a novel 3D culture platform that replicated clinically relevant complex calcified tissue lesions on the bench. He used this to discover the importance of inflammation triggering for activating disease reprogramming in valve cells. Terence also spearheaded the establishment of novel molecular genetics techniques in the lab, including inducible lineage drivers and and CRISPR based technologies to test the collaborative roles of transcriptional regulators Notch and NFkB in aortic valve homeostasis and disease. In addition to these primary experiments, Terence mentored multiple undergraduates and collaborated in multiple other research projects with his wealth of molecular engineering expertise. Terence was awarded an NSF Graduate Research Fellowship, has three papers published to date with two more in review. After graduation Terence is headed back to southern

California to begin his next journey with several offers to choose from. Congratulations Terence!

Korie A. Grayson *by Mike King*

Korie Grayson is from Norfolk, VA, and moved with the King Lab from Cornell to Vanderbilt University in 2017, while staying enrolled as a Cornell student. She received the prestigious National Science Foundation graduate fellowship, and is also an Alfred P. Sloan fellow. Her project focused on developing new therapies for late stage prostate cancer, and she is committed to improving the lives of prostate cancer patients as this disease has affected so many families, including her own. Korie has published one collaborative paper from her PhD. so far, and has three first-authored manuscripts that are currently in review.
As a senior member of the King Lab, Korie is a passionate devotee of good lab practice. Korie's career path has been celebrated in podcasts and national publications such as Forbes Magazine, and she is an inspiration to the next generation of young researchers. After graduation, Korie will take a position as a postdoctoral scholar at the University of Michigan.

Rebecca Irwin *by Lawrence Bonassar*

Rebecca Irwin joined the Bonassar Lab after completing her bachelor's degree in Biomedical Engineering from Binghamton University. Her thesis research focused on developing micro-rheology techniques to understand the mechanics of articular cartilage in health, disease, and repair. Her work has been published in multiple peer-reviewed journals including *PLoS One*, *Osteoarthritis and Cartilage*, and the *Orthopaedic Journal of Sports Medicine*. Her awards include a GAANN fellowship from the Department of Education and a research grant from the Arthroscopy Associate of North America. After graduation, Rebecca will continue her academic training as a postdoctoral associate at Duke University. Congratulations, Rebecca!

Ramin Jafari *by Yi Wang*

Ramin Jafari joined Wang Lab after completing his master's degree in Electrical and Computer Engineering from University of Alaska Fairbanks. Ramin developed non-invasive quantitative methods to assess liver disease states as well as effectiveness of therapies using magnetic resonance imaging (MRI) during his Ph.D. studies (January 2016-August 2020) in my lab. His work involved sequence development, data acquisition, image reconstruction, modeling, and statistical analysis. Ramin had multiple conference submissions and publications, including four first-author peer-reviewed journal articles. He received several rewards for his work, including Magna Cum Laude Merit Award for his

conference submission at the ISMRM 27th Annual Meeting, and his latest journal publication (Magnetic Resonance in Medicine, April 2021 issue, 85#4) was selected as the cover image. Ramin is currently a Research Fellow at Memorial Sloan Kettering Cancer Center developing image reconstruction techniques.

Lu Ling *by Claudia Fischbach*

Obesity increases breast cancer risk and worsens patient prognosis, but the underlying mechanisms are poorly understood. Lu tackled this challenge by integrating biomaterials & tissue engineering, advanced imaging approaches, and biochemical analyses methods to study how obesity influences otherwise benign cells. She identified that stromal cells isolated from obese adipose tissue more effectively promote tumor cell invasion relative to their lean counterparts and that direct cell-contact mediated changes in extracellular matrix remodeling and mechanosignaling play a role in this process. Lu became an expert in integrating a complex body of knowledge from multiple fields to generate highly relevant and transformative insights, which are published in several articles. Furthermore, she never shied away from challenging or new tasks and has pioneered many techniques that are now routinely used in the lab. In addition to her research, Lu is genuinely interested in reaching out to the broader public with a focus on mentoring undergraduate students and community engagement. She has been a terrific mentor to many lab members, a key collaborator on many publications, and also stands out as a pastry chef. We will miss her, but look forward to following the successes she will undoubtedly have as a postdoc.

Alex Loiben *by Ben Cosgrove*

Alex Loiben joined the Cosgrove lab after completing a bachelor's degree in Bioengineering at the University of Illinois at Urbana-Champaign. Alex's thesis research focused on the how multiple signaling pathways control muscle stem and progenitor cell fates in response to cytokine signals, through a mixture of data-driven modeling and cell culture experimental models. His studies have helped resolve new methods for directing muscle cells towards the distinct fates of proliferative self-renewal or commitment into mature differentiated cells, and have been leveraged into a new long-term muscle stem cell expansion method to improve cell-based therapies for muscle disease. Alex has been awarded US DOE GAANN and DeVries Fellowships. He has published at *Cellular and Molecular Bioengineering* and bioRxiv. He has presented his work at the Biomedical Engineering Society Annual Meeting and the Society for Muscle Biology: Frontiers in Myogenesis Conference. Alex has been a fabulous mentor to others in the lab and been a thoughtful advocate

for other graduate students in the GPSA. He will start a postdoctoral fellowship with Daniel Yang at the University of Washington School of Medicine later this summer. Congrats to Alex!

Juan Paredes *by Nelly Andarawis-Puri*

Juan Paredes joined the Andarawis-Puri Lab after completing his bachelor's degree in Biomedical Engineering from the University at Buffalo. During his Ph.D., his research focused on utilizing principles from regenerative medicine to encourage improved healing of tendons following acute injuries. To accomplish this goal, he utilized a naturally occurring model of regeneration and identified a unique matrix environment that could be used as a template to drive scarless tendon healing in normal healing models. Building from this finding, Dr. Paredes translated his work towards therapeutic advances and developed an innovative therapeutic-hydrogel system to improve the structural and functional healing response of normal healing tendons. His work has been published in the journal of orthopedic research, connective tissue research and the FASEB journal. In addition to his academic career, Juan has worked closely with the DPE department as a graduate student coordinator for the CUEmpower program. Upon graduation, Juan will be continuing his career as a consultant at Exponent Inc. Congratulations, Juan!

Shivem B. Shah *by Ankur Singh*

Shivem Shah joined my lab in 2015 after completing his B.S. in Biomedical Engineering from Boston University. He joined Singh lab as a Presidential Life Science's fellow and his Ph.D. research has focused on multiscale engineering of immune cells and lymphoid organs. The technology he has developed has found important applications in infection and cancer field. During his Ph.D., Shiv has won several awards and honors including the NIH T32 Immunoengineering training fellowship, Dept. of Education GAANN fellowship, STAR award from the Society for Biomaterials, among others. He has published his work in *Nature Reviews Materials*, *Biomaterials*, *ACS Biomaterials Science and Engineering*, *Cell Reports*, *Current Opinion in Hematology*, and *Acta Biomaterialia*. Outside of the laboratory, Shiv has continued to excel academically and spends his time growing as a mentor and teacher with the Society of Asian Scientists and Engineers (SASE). Shiv has volunteered with local upstate New York cancer resource center, and he was chosen to serve on Board of Directors. He continues to also attend support groups and learns from patients and survivors. Upon graduation, Shiv will be starting his MD at Columbia Medicine and he aspired to be a physician-scientist in coming years. Many congratulations, Shiv!

Sarah Snyder *by David Putnam*

Sarah Snyder joined the Putnam Lab from the University of Akron where, as an undergraduate student, she majored in Biomedical Engineering, studied under Rebecca Kuntz Willits and published a first-author paper in the *Annals of Biomedical Engineering*. Sarah's graduate thesis research focused on targeting drugs to specific tissues using FDA-approved drugs new ways. Her project encompassed careful organic and polymer chemistry to make new drug targeting systems. It included detailed studies of how these new compounds interact with cells grown in culture and how these systems circulate in the body to get medicines where they are intended to go. The first manuscript from her thesis work was published in the *Journal of Controlled Release*, the highest-ranked journal in her field of research. Beyond research, Sarah's impact on both our group and the Meinig School of Biomedical Engineering is extensive. The lab and offices are filled with reminders of Sarah's intellectual humor, which bring daily smiles to the occupants of Weill Hall. Her positive outlook gracefully balanced the rigors of scientific research with the hardships that life brings. In recognition of her achievements, she was awarded a highly competitive and well-deserved Provost Fellowship for Advanced Doctoral Students. Sarah will continue her research growth in Professor Pat Stayton's group at the University of Washington where she will focus on the design and synthesis of polymer conjugates for the treatment of diseases in the developing world. It is difficult to watch Sarah leave our small research community, but we are all grateful to have worked with her, and we look forward to seeing her talent make far-reaching impacts throughout her career.

Tiffany St. Bernard *by Amit Lal*

Tiffany St. Bernard joined the SonicMEMS Lab, directed by Prof. Amit Lal, after completing her bachelor's degree in Biology from the University of Connecticut. Her thesis research focused on using ultrasound to excite neurons and nerves and create devices and ultrasonic neuromodulation methods. Tiffany's journey began using 100 kHz ultrasound from silicon-microfabricated ultrasonic probes to excite crayfish nerves. Tiffany then used MHz and GHz frequency ultrasonic transducers to excite sciatic nerves in rats. These results highlighted the need to consider thermal aspects of ultrasonic absorption at GHz frequencies. Tiffany developed a procedure to deliver silicon chips and spheres near the vagus nerve of rats under visual guidance using an ultrasonic imager. This work led to new techniques that be used for ultrasonic neuromodulation of vagus nerves. Tiffany is a true entrepreneur, and throughout her doctoral career, she was engaged in startups and helping other startups. She is currently the CEO and co-founder of Hair Days, developing novel solutions for multi-ethnic women. Congratulations Tiffany!

Chelsea Stowell *by Yadong Wang*

Chelsea joined the Wang Lab after graduating summa cum laude from Vanderbilt University. She has led our effort on testing vascular grafts in large animal models. She has published in *Biomaterials*, a leading journal in our field. She has been recognized by several awards including the NSF-GRFP and an Honorable Mention for the Goldwater Scholarship. She has worked hard both on her Ph.D. project and on keeping our lab functioning smoothly before and after our move from the University of Pittsburgh. She will continue her academic career in David Kaplan's Lab at Tufts. Congratulations, Chelsea!

Ruisheng (Rick) Wang *by David Erickson*

Ruisheng (Rick) Wang joined the Erickson lab in 2015 after obtaining his bachelor's degree in mechanical engineering from Clarkson University. Over his time at Cornell, Rick made important developments in technology related to infectious diseases diagnostics including a differential diagnostic for Dengue/Chikungunya infection, and two new platform for phenotypically determining the antibiotic susceptibility of various bacterial organisms. Beyond his research activities, Rick was also very active in the entrepreneurial and broader engineering consulting ecosystems at Cornell. He served as a fund manager for Big Red Venture Fund, the president of Technology Entrepreneurship @ Cornell, and the VP of Alumni Relations for the Cornell Graduate Consulting Group. Following graduation Rick plans to join the Boston Consulting Group.

Yen Lin (Ian) Wu *by Yadong Wang*

Yen-Lin Wu joined the Wang Lab after completing his bachelor's degree in Chemical Engineering at National Taiwan University. His research focuses on fabrication of vascular grafts. He developed a new 'ink' for 3D printing and designed a new way to pattern the grafts. He published several articles in flagship journals in his fields including *Tissue Engineering and Biomaterials*. Upon graduation, Yen-Lin will join 3M in their Global Innovation Center. Congratulations, Yen-Lin!

Fei Xia *by Chris Xu*

Fei Xia joined the Xu lab after completing her bachelor's degree in Optoelectronics from Huazhong University of Science and Technology. Her thesis research focused on tool development for pushing the limit of deep mouse brain imaging at high spatial resolution. Fei's strategy to achieving deep imaging involved multiple techniques such as linear and nonlinear microscopy with short-wave infrared light, adaptive optics, and wavefront sensing. Her work has resulted in numerous journals articles, including four as the first or co-first authors being published or submitted and a fifth one to be submitted soon. She has received several

awards and honors during her Ph.D., including being selected as a Mong Neurotech Fellow by Mong Family Foundation and a third-place award from the Data Open Worldwide Championship. Upon graduation, Fei will be continuing her career as a postdoc in Paris, France, working on computational imaging. Congratulations, Fei!

Matthew Zanotelli *by Cynthia Reinhart-King*

Matt received his undergraduate degree at the University of Wisconsin-Madison in Biomedical Engineering and Biochemistry. His Ph.D. thesis at Cornell examines how cells navigate through tissue with a focus on how they utilize energy to move. His work is notable for being some of the first in the field to connect cellular energetics, cell migration, and the architecture of tissue. Matt's findings have important ramifications for cancer, wound healing, and numerous other diseases, and they have already served as a critical foundation on which the field is growing. His thesis research has resulted in 12 published papers and four papers in preparation, in addition to the four papers he had published as an undergraduate student. These include articles in *Nature Communications*, *Cell Metabolism*, *PNAS*, and *Molecular Biology of the Cell*. Both the quality and quantity of research and publications he has produced is truly impressive. He has also won several awards include an NSF Graduate Research Fellowship and an award from the Biomedical Engineering Society. Following his Ph.D., Matt will be staying in Ithaca to work with Richard Cerione in the Department of Molecular Medicine at Cornell as a postdoctoral associate, and he ultimately plans to pursue a career in academia.

Yuying (Sylvia) Zhang *by Nozomi Nishimura*

Silvia Zhang investigated the mechanisms of neurodegenerative diseases. Using multiphoton microscopy, she was the first to see many surprising behaviors of brain cells. First, she studied the relationship between vascular dysfunction and Alzheimer's disease. She discovered that amyloid-beta plaques, toxic protein deposits long thought to static, change dynamically with inflammation, even disappearing after blood vessels clots. She then used a laser to make small injuries to neurons to study how inflammatory cells interact. She developed new methods of visualizing neurons and their connections in the living brain. Her pioneering images show that the inflammatory cells and neurons interact in complex ways that could explain how inflammation can affect neuronal wiring. These experiments were made possible by tenacity and a talent for difficult experiments we once thought were impossible. She was awarded the Hsien Wu and Daisy Yen Wu Scholarship at Cornell. In addition to research, she is already highly accomplished in the business

world, winning the 2018 Duke/UNC Case Competition. Her next step will be McKinsey and Company, where we are sure she will continue to show the world amazing things.

Sophia Ziemian *by Marjolein van der Meulen*

Sophia Ziemian came to Cornell after making outstanding research and athletic contributions during her B.S. and M.S. in Biomedical Engineering at Duke University. When she arrived in Ithaca, she was interested in continuing in osteoarthritis research, particularly to understand the role of the underlying bone in the development of joint damage. The results from Sophia's thesis experiments are paradigm shifting, demonstrating that bone properties contribute to cartilage damage but in a fashion that is opposite to conventional lore. The first study she worked on at Cornell was recognized with the Orthopaedic Research Society/Ruth Jackson Orthopaedic Society Young Female Investigator Travel Grant and won second place in the 2018 ASME-Bioengineering Division Ph.D. student paper competition at the World Congress of Biomechanics in Dublin, Ireland. Within the van der Meulen group Sophia has been a leader and major presence, contributing to the group climate, mentoring new graduate students in the lab, and advising a cohort of undergraduates. She has transferred these leadership skills to coaching for the Cornell Track team. We have enjoyed her continued influence as a postdoctoral fellow and look forward to seeing her future success.

MASTER OF ENGINEERING

Nicole Alimena
Menasseh Bekele
James Bennett
Aaron Berman
Asmita Bhatta
Jacob Boles
Sonny Carlton
William Chan
Xiaohui Chen
Yucong Chen
Yanda Cheng
Michaela Chum
Angelys Cuello
Kathryn Dickieson
Benjamin Dickstein
Ye Fang
Erin Gunduz
Jared Gurba
Maddie Hornstein
Mengjiang Huang
Sarah Ingerick
Shreyans Mayank Jain
Maho Koga
Abby Kotwick
Jeremiah Leit
Yuxi Li
Chialin Liao
Jason Lin
Nevin Ling
Sixie Liu
Diksha Matta
Jesse McDonald
John Montani
Maddison Nadolny
Chirac Ndetan
Ari Padda
Virja Pandya
Alex Paul
Junshi Peng
Ha Trang Pham
Kirsten Pienaar
Steffy Rodrigues
Bahareh Saadatmand
Shwetha Sairam
Brian Schultheis
Rishi Singhal
Denielle Smith
Arjun Sree Manoj
Jinling Sun
Karli Thornton
Ashley Townsel
Archana Varman
Tyler Webb
Jacob Weinman
Kelly Wu
Dianwen Xu
Chengqi Xu

MASTER OF ENGINEERING 2020-21 PROJECTS

TEAM PROJECTS

Robotic Mobility Device for Toddlers

James Bennett, Maddison Nadolny, Angelys Cuello, Denielle Smith, Caroline Waksmuski

The primary method through which toddlers (children 1-3 years old) learn is environmental interaction. This is achieved mainly via independent mobility (i.e., crawling and/or walking). In typically developing toddlers, independent mobility is accompanied by development in emotional, perceptual, cognitive, and social behavior. However, toddlers with independent mobility limiting disabilities have demonstrated apathetic behavior, depressed motivation, and a lack of curiosity and confidence. Providing independent mobility devices may prevent these effects from developing, unfortunately, powered wheelchairs are typically not prescribed to toddlers. Therefore, our team is creating a powered independent mobility device for toddlers with mobility delays/ impairments that enables environmental interaction.

External Ventricular and Lumbar Over-Drainage Detection

Menasseh Bekele, Sarah Ingerick, Steffy Rodrigues, Jacob Weinman

External ventricular drains and lumbar drains (EVDs and LDs) are used to relieve fatal increases in intracranial pressure caused by excess cerebrospinal fluid (CSF). While these drains can be lifesaving, over-drainage of CSF can result in severe neurologic injury or death. Despite the medical necessity and the danger associated with over-draining, these remain one of the few pieces of hospital equipment for which there is no alarm system able to alert clinicians of impending over-drainage. Therefore, our team is creating a non-invasive device that will detect the amount of drained CSF, regardless of color, and alert medical staff when it has exceeded a user-specified threshold.

Detection and Response System for Opioid Overdose

Sonny Carlton, Archana Varman, and Noah Marinaro

In the past 12 months, 65,000 Americans have died from opioid overdoses with deaths increasing five fold since 2000. Opioid related deaths are due to over prescription of legal opioids and new, more potent synthetic opioids such as fentanyl flooding the market. Our team has developed a device to treat this epidemic and drastically reduce the number of deaths it causes. Although a treatment exists, it must be administered within a 6 to 8-minute window after onset. As a result, we have designed our device to constantly measure physiological symptoms with a chest belt which triggers our autoinjector to administer the treatment once the user's biomarkers indicate an overdose.

Liquid Ventilator for Covid-19 patients

Rishi Singhal, Sanasi Gore

In the COVID-19 pandemic, patients arriving in hospitals sometimes present low oxygen levels however show no trouble breathing, known as silent hypoxia, due to debris found in the alveoli. Effective cleaning of the alveoli is still inefficient through the use of gas ventilation making the ability to clear the alveoli of debris and facilitate gas exchange through a liquid mechanism extremely valuable. This project aims to use PFC (perfluorocarbon) to provide liquid ventilation to patients to reduce the surface tension on alveoli and specifically the pressure when administering oxygen.

Electrical Stimulation Bioreactor

Jeremiah Leit, Nevin Ling

Each year millions of people in the US and across the globe die from heart disease. Therefore it is essential to have the ability to test drugs that can impact the heat in a realistic manner. This requires the usage of mature Cardiomyocytes. This reactor concept is designed in order to promote cardiomyocyte development through the use of mechanical and electrical stimulus. This will result in the development of testable tissues for in vitro drug experimentation.

Uniaxial cell stretcher to measure the biophysical properties of cells and the cell nucleus

Jacob Boles, Ye Fang, Alex Paul, Emine Ozen

Genetic mutations can perturb cellular structure and result in a variety of diseases, ranging from muscular dystrophies to premature aging and cancer. To understand how these mutations affect the mechanical integrity of the cell and its nucleus, it is necessary for a device to induce mechanical strain onto the cells and observe them under in vitro conditions. Currently, the industry standards offer different functionalities, however they do not fully meet our current stakeholder's needs. This project designed and fabricated a uniaxial stretching device that can apply 20% strain while allowing for high-resolution and live-cell imaging on a confocal microscope.

Craniectomy Prosthesis

Shwetha Sairam, Karli Thornton, Tyler Webb, Stacey Kim

Over 100,000 Americans undergo decompressive craniectomies every year, as a result of stroke, infection, or traumatic brain injury. Prevalence of this surgery is exponentially greater worldwide. During the procedure, the bone flap of the skull is removed so that intracranial pressure is reduced but this leaves the surgical site unprotected. Since increasing the time to replace the bone flap minimizes complications, the need exists to deliver skull prosthetics for post craniectomy patients to protect the surgical site. No current solutions address custom surgical site protection. An affordable cranial prosthetic concept is developed to provide optimal protection, comfort, and aesthetic appeal.

Quantifying Physiological and Behavioral Responses to Pain

Michaela Chum, Jared Gurba, John Montani, Virja Pandya

Pain is a highly subjective experience that impacts all people. It is prevalent post-surgery and often associated with medical complications like illness, injury and disability, making it a useful measure for diagnosing and monitoring patients' ailments. Unfortunately, current pain assessment techniques – Numerical Rating Scale and Visual Analog Scale – have proven faulty and insufficient. These systems rely on self-reporting which is unreliable when patients exhibit drug seeking behavior or are unable to properly communicate their pain. The purpose of this project was to identify physiological and behavioral measures that correlate to pain to improve the pain assessment process.

Augmented Reality for Cancer Mapping

Ashley Townsel, Sixie Liu, Ari Padda, Bahareh Saadatmand

Increasing recurrence rates after tumor resection surgeries lends to the need for real-time imaging techniques that accurately map cancerous tissue. We modeled a cancerous tumor with BxPC-3 pancreatic cancer cells and used antibody-conjugated microbubbles to serve as a cell-specific contrast agent for US imaging. US images were then post-processed to create 3D reconstructed figures and antibody binding was quantified to model tumor specificity. Future direction includes the use of HoloLens2 to detect the location and distribution properties of tumors in real-time. This enhanced visualization will assist physicians in mapping tumors and in determining optimal treatment options.

Detection of Adverse Events

Maddie Hornstein, Abby Kotwick, Arjun Sree Manoj

The design team focused on developing an approach for the detection and quantification of specific adverse events related to various types of injections. Various approaches to the problem were researched, existing and emerging technologies were compiled and investigated to determine the most promising option. The team narrowed down the detection mechanisms and proposed potential device designs.

Reconstituting Ophthalmic Drugs

Nicole Alimena, Jesse McDonald, Mengjiang Huang

The main purpose of this project is to investigate the effects of different shaking patterns on the successful reconstitution of ophthalmic drugs for veterinary purposes in order to design research protocols. Shaking patterns of 'gently,' 'vigorously,' and 'shake well' were recorded with a MyRIO microcontroller with an accelerometer and analyzed with DIAdem and MATLAB. We have found that 20% of people have the same shake well pattern, and the rest vary greater than one standard deviation.

MASTER OF ENGINEERING 2020-21 PROJECTS

INDIVIDUAL RESEARCH PROJECTS

Uptake Kinetics of Poly(acrylic acid) Microgels

Ben Dickstein, advised by Dr. David Putnam

Design and synthesize poly(acrylic acid) microgels to assess the selectivity of different formulations to absorb and retain targets from an aqueous environment.

Axial Compression Tibial Loading System

Yanda Cheng & Chirac Ndetan, advised by Dr. Karl Lewis

In order to process the Tibial loading on the bond based on a complex mechanical structure in a dynamic environment of bone. As the control demand and experiment setup become highly complex, one of the solutions is to provide a precise control loading system that includes an actuator provided by Zaber.INC and force sensor provided by SENEIT. INC. The software control shall provide the basic flexibility for the user to adjust the loading parameter to match the different types of research experiments' requirements. The hardware design shall able to hold the mouse knee and feet with designed position properly.

Modeling the Mechanical Behavior of Intervertebral Disc Implants Using Finite Element Analysis

Maho Koga, advised by Dr. Lawrence Bonassar

Intervertebral disc degeneration is a complex phenomenon that leads to impairment. Tissue engineering constructs for restoring native tissue require a cage for mechanical stability, however current in vivo results demonstrate cages break in vivo. This highlights a need for a more robust understanding of the mechanics and failure mode. Finite element (FE) analysis allows for biomechanical insight while significantly cutting down on costs and time. We report the development of a FE model that simulates stress localization along the corners of cages under compression between vertebrae. This model provides a method for rapidly testing new cage designs for clinical applications.

Arabidopsis Growth in Martian Regolith

Kathryn Dickieson, advised by Dr. Christopher Mason & Dr. Jocelyn Rose

Securing a sustainable food source will be critical for astronauts and others exploring space in the upcoming years. It is imperative to find a solution that allows space pioneers to grow food and medicinal compounds without adding excessive weight to a space flight. We developed the silica aerogel plant growth medium, the lightest growth media available on the market currently while providing protection against extreme environments. The plants grown in this medium combined with simulated Martian soil grow larger than those grown in regular media. This plant medium optimizes plant growth while minimizing weight when transporting humans in space and granting the ability to thrive beyond earth.

Uniaxial Cell Stretcher to Measure the Biophysical Properties of Cells and the Cell Nucleus

Alex Paul, advised by Dr. Jan Lammerding

Genetic mutations can perturb cellular structure and result in a variety of diseases, ranging from muscular dystrophies to premature aging and cancer. To understand how these mutations affect the mechanical integrity of the cell and its nucleus, it is necessary for a device to induce mechanical strain onto the cells and observe them under in vitro conditions. Currently, the industry standards offer different functionalities, however they do not fully meet our current stakeholder's needs. This project designed and fabricated a uniaxial stretching device that can apply 20% strain while allowing for high-resolution and live-cell imaging on a confocal microscope.

AI in the Microelectronics Cleanroom: Label Verification for Large-scale Training Data

Jingyi Zhu, advised by Dr. Peter C. Doerschuk

Many medical and biological challenges can be solved by Micro Electro Mechanical Systems (MEMS). Such devices are typically fabricated in a microelectronics cleanroom by a sequence of three processes: photolithography, etch, and release etch. Our goal is to use Artificial Intelligence (AI) to improve these processes. AI requires training data with accurate labels but the automatically-generated labels in our database, approximately 100,000 Scanning Electron Microscopy (SEM) images, have errors. In this project, an interactive graphical interface for human verification of the labels named "ImageLabelVoter" was designed, built, and successfully tested.

BACHELOR OF SCIENCE

Ethan Blum
Lindsay Browning
Alexandria Calder
Kevin Cavallo
Matthew Caverly
Michelle Chang Wu
Samantha Cohen
Annabelle Cram
Jaimie Diamond
Ana Elhom
Allison Fleisher
Rachel George
Cassandra Gologorsky
Zheshen Gong
Audrey Guo
Shaminta Hamidian
Jessica Hernandez
Michael Hill
Lucas Hyde
Chiemezue Ijomanta
Alexandra Jaster
Taylor Joines
Neha Kapoor
Halee Kim
Nikita Krishnan
Margaret Lejeune
Joyce Liu
Stephanie Lux
Isaac Macrae
Kalyn McGuire
Liam McLane
Shaun Nuzzo
Kristen Ong
Danielle Pike
Samantha Pitts
Alexa Podolsky
Trisha Ray
Maegan Rudolph
Yashi Sanghvi
David Shamritsky
Nicole Soriano
Erica St. Jean
Acacia Tam
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BACHELOR OF SCIENCE 2020-21 PROJECTS

SENIOR DESIGN PROJECTS

Stimuglove via Cipnia

Rachel George, Michelle Chang, Trisha Ray, Acacia Tam, Sophia Windemuth

Chemotherapy-induced peripheral neuropathy (CIPN) is one of the most frequent and dose-limiting side effects from chemotherapy, lasting from weeks to years after treatment for nearly 85% of cancer patients. The Stimuglove works to help reduce the pain and discomfort associated with CIPN, improve motor control, and most importantly, improve patient quality of life through a therapeutic glove that incorporates Scrambler Therapy and fall protection. The Stimuglove is paired with a mobile app that users can use to customize their therapy sessions by selecting regions of pain and to track neuropathy symptom progress.

Visation Waistband

Kevin Cavallo, Jennifer Tieu, Jaimie Diamond, Alexandria Calder

On the global scale, 26 million people are blind, and 216.6 million people suffer from moderate to severe visual impairment. Visually impaired individuals have little to rely on when it comes to navigation; primarily, a white cane is used to detect local obstructions, but lacks the ability to effectively map objects with size and movement indications. A modern navigating waistband that utilizes the principles of sensory-motor technology integration has been developed to track objects in the complete environment of the user. Users will be able to relate vibrational cues to the location and distance of an object, and track their surroundings with superiority.

No Wires Attached (Remote ECG Monitor)

Lindsay Browning, Samantha Pitts, Zheshen Gong, Mary-Jo Ajiduah, Jessica Hernandez

Cardiac patients are often kept in hospitals for long duration stays in order to closely monitor their condition. However, hospital bills create an unsustainable environment, leaving patients in need of an at-home monitoring system. Current devices are bulky, disruptive to everyday life, or not complex enough to detect life-threatening events such as ischemic diseases like heart attacks. No Wires Attached solves this problem by introducing a sleek, comfortable, and wireless device that can be used for short-term and long term applications. With No Wires Attached remote ECG monitor, patients can carry on their normal lives while providing around the clock monitoring with live updates to the doctor. Patients can journal their days and input any symptoms for the doctor to see, as well as receive real time suggestions from our individualized machine learning system. Cardiac patients can live free again, with No Wires Attached.

Posture Patch

Maegan Rudolph, Chiemezue Ijomanta, Nicolas Tan, Ann Zhao

Neck and shoulder pain are among the most common causes of disability and sick leave from work, and studies have shown that improving habitual postural patterns may lead to improvements in neck and shoulder pain. However, it is not always feasible to maintain proper posture while sitting at a desk for people such as students or those with an office job. To encourage good posture while being highly portable and user-friendly, we introduce the Posture Patch. The Posture Patch calibrates for each user to deliver a customized experience and pairs with an app which both allows tracking of posture throughout the day and provides supplemental exercises to further encourage long-term improvements in posture.

PT-2-GO

Shreya Venkatesh, Maggie Lejeune, Shaun Nuzzo, Matthew Caverly

Everyone seems to hate doing physical therapy and physical therapists don't have a way to track if and how patients are doing exercises at home. There is a real need in the medical device market for at-home rehabilitation that motivates users to complete exercises and keep their therapists informed. As of now, there are few medical devices on the market that address these concerns and of the ones that do, many are costly, bulky, or inefficient. Our device will be a unique at-home rehabilitator that applies heat during exercise. Paired with an app, this device will provide short reports of user mobility to physicians and therapists to retain aspects of in-person supervision and guidance during the physiotherapy process. We are confident that this device can provide real-time relief while improving the odds of increasing long-term joint mobility.

The Infusion Buddy

Taylor Joines, Allison Fleisher, Caroline Waksmunski, Audrey Guo

Ambulatory infusion packs allow patients to carry life-saving IV drips with them, but come at the cost of a bulky, intimidating backpack to carry the device. Instead, the Infusion Buddy is a cute, stuffed animal backpack, designed for pediatrics! Inside the toy lies the infusion system, as well as extras like a GPS tracker and vitals equipment, which communicates with a mobile app, allowing guardians and doctors to track infusion statistics. This all-in-one package gives children a safe way to carry their infusions with them, and is perfect for any child who needs an extra friend while they undergo treatment.

BugByte

Alexa Podolsky, Stephie Lux, Liam McLane, Yvette Zhu

Current medical practices have no definitive answer to the commonly-asked question, "what bit me?" BugByte aims to answer this question with regard to bed bug bites. Our device will analyze a sample of blood from the user and pair with an image recognition application to provide users with the information they need not only to treat their reactions but

also to quell their curiosities about whether or not they have been bitten by a bed bug. The application will also provide users with information to learn more about how to protect themselves and prevent these bug bites in the future.

The (Sub)Concussive Project

Nicole Soriano, Kalyn McGuire, Neha Kapoor, Julia Walsh, Shaminta Hamidian

Our objective is two-fold: to prototype a device capable of detecting both concussive and subconcussive impacts in sports, and to develop a machine learning algorithm that can predict the risk of concussion. The future of concussion diagnosis lies in machine learning. In order to accurately predict an athlete's risk based on their cumulative head impact exposure, researchers need high-quality head impact data from a variety of sports and athletes. Our project will facilitate the acquisition of head impact data in non-helmeted sports and enable researchers to better understand the link between head kinematics and brain injury.

SleepSync

David Shamritsky, Danielle Pike, Joyce Liu, Samantha Cohen

SleepSync is a wearable device for the jaw which non-invasively measures and records facial physiological parameters to identify sleep disturbances. The long-term goal of this project is to develop an easily accessible, affordable, and validated device for use in diagnosing and tracking sleep disorders. Mandibular movement events have been clinically shown to indicate respiratory effort (RE) and are associated with Upper Airway Resistance Syndrome (UARS) and obstructive sleep apneas, and can be detected before patients begin to notice the adverse effects of a developing sleep disorder. An algorithm scores the motion of the jaw during sleep periods by combining accelerometer data with facial EMG to identify patterns of RE.

Digestim

Erica St. Jean, Annabelle Cram, Isaac Macrae, Halee Kim

Digestim is a digestive muscle stimulation waistband that aims to reduce IBS symptoms through targeted electrical stimulation and heat therapy. It has been demonstrated that irregular/spastic smooth muscle contractions in the intestines can causeIBS symptoms, so targeting these irregular contractions has the potential to provide relief without drugs, diet changes, or psychotherapy. The goal of this project is to create a compact, portable, practical device to supplement or replace traditional IBS treatments to give those with IBS freedom to expand their lifestyle without letting their symptoms dictate where they go, what they do, or what they eat.

Comfy Crutch

Ethan Blum, Lucas Hyde, Michael Hill, Nikita Krishnan

Most crutch users dislike their experience using crutches. This is often due to two main factors in particular: discomfort with using the crutch itself, and difficulty using the crutches in order to go up and down stairs. The Comfy Crutch however, attempts to mitigate both of these issues. The Comfy Crutch is an attachment for pre-existing crutches that improves user comfort and mobility. This device replaces the base of a pair of crutches with a unique dual-leg, flexing design. By having two points of contact, the Comfy Crutch assists in stair movement through added stability. Likewise, the compression stores energy while walking to help move the user forward. Combining these two features allows the Comfy Crutch to improve standard crutches without making tradeoffs with satisfaction or versatility.

Pocket Pill

Ana Elhom, Kristen Ong, Yashi Sanghvi, Alexandra Jaster

Patient behaviors, including procrastination, forgetfulness, and confusion, account for the large majority of medication non-adherence cases to date, with medical professionals attributing this to the difficulty new patients face in adjusting to a new routine and have cited young age as a major contributing factor to this issue. To maximize patient compliance, we have created Pocket Pill, which is a portable pill-storing device for anytime on-the-go use. The Pocket Pill device is attached to the back of a user's phone, allowing for the individual to store a month's supply of oral contraceptive pills in their original blister pack form. A mobile application accompanies the device to allow users to be alerted visually and/or audibly when a pill needs to be taken in accordance with their specific inputted schedule.