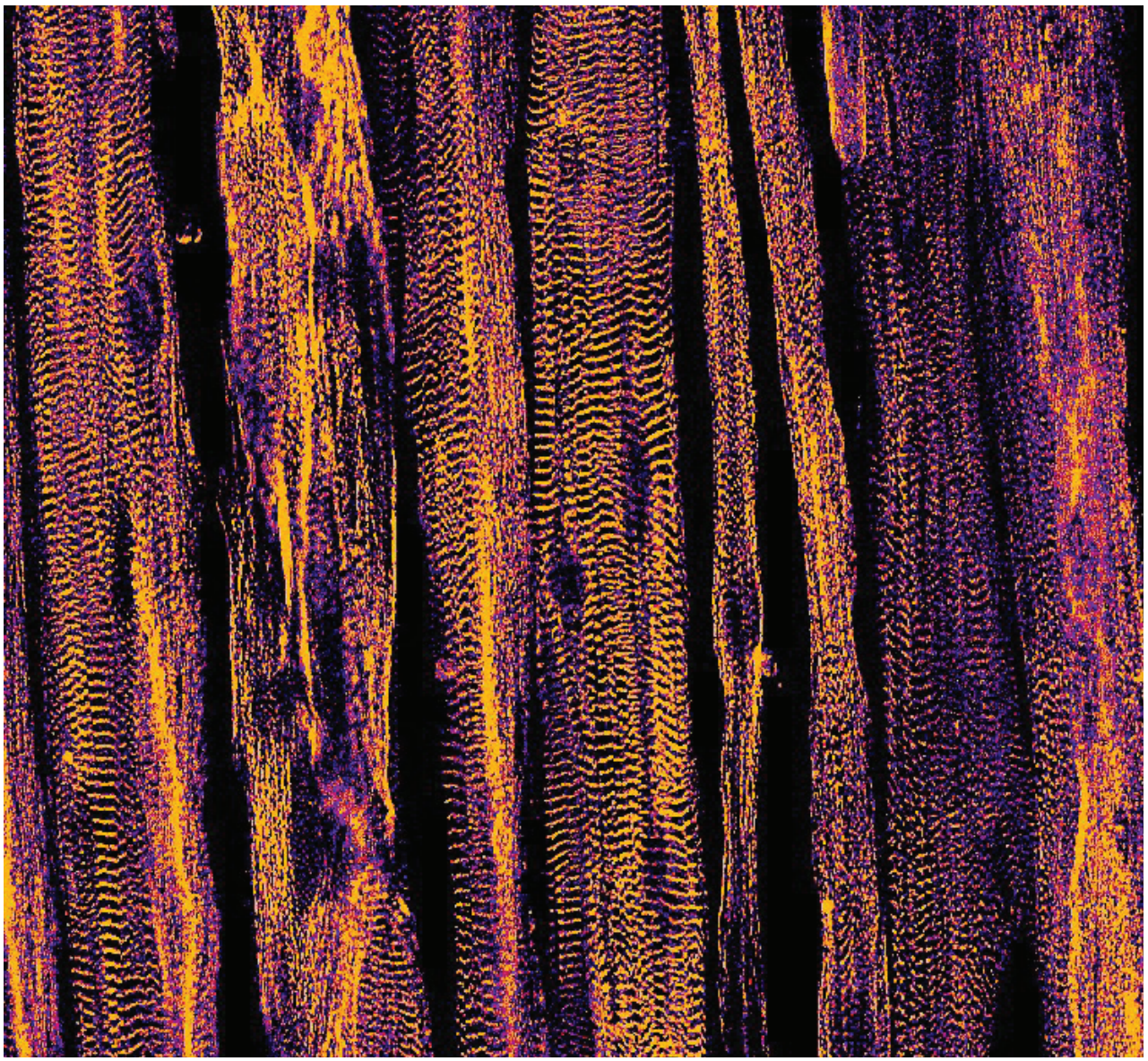
BIOMEDICAL ENGINEERING

Annual Magazine | Volume 6 | 2023



Institute of Biomedical Engineering
UNIVERSITY OF TORONTO

Cover by:

Heta Lad | PhD candidate | Penney Gilbert Lab

Earning our stripes; Using biofabrication and tissue engineering techniques, we reconstruct miniaturized versions of human skeletal muscle tissue in a dish. Highlighted in this image are immunostained skeletal muscle fibers showcasing their beautiful and prominent striations/ stripes in a 3D human microtissue grown in the lab.

The cover was one of the top three winners by popular vote from the BME community.

Data Sources:

Graduate Office, BME
Finance Office, BME
SciVal, Elsevier

Note from the Director: Dr. Milos Popovic

Welcome to the sixth edition of the Institute of Biomedical Engineering annual magazine. Each year, our goal is to encapsulate the essence of our Institute by spotlighting research endeavors, alumni achievements, and student life experiences.

The driving force behind our success lies within the people of this Institute. Our esteemed faculty members lead groundbreaking research initiatives and forge influential collaborations with key academic and industry partners. Their accomplishments await you in the following pages.

BME trainees continue to flourish in their pursuits long after their time here at the Institute. In this edition, we showcase alumni spanning various industries,. While their roles may vary, they have all harnessed the skill set cultivated during their studies at the Institute to propel their careers. It's a delight to reconnect with them.

At BME, we hold inclusivity and support for every member of our community in high regard. One of the ways we foster this environment is by highlighting the experiences and viewpoints of our diverse student body. Through sharing their narratives and spotlighting their unique skills and contributions, we aim to cultivate a deeper appreciation for all members of our diverse community.

I trust you will find enjoyment in this volume, and we eagerly anticipate another year filled with exciting achievements and accomplishments!

Milos Popovic
Professor and Director

Dr. Warren Chan's legacy as the Director of BME (2018-2023)

As the Institute welcomes Dr. Milos Popovic as its director in 2023, it is pertinent to acknowledge the substantial contributions of the previous director, Dr. Warren Chan, at the Institute of Biomedical Engineering. During his leadership, Dr. Chan made significant contributions to the infrastructure, teaching, people, and culture at the Institute of Biomedical Engineering.

Dr. Chan, a distinguished figure at the University of Toronto for over two decades, achieved eminence in diagnostics, nanomedicine and drug delivery, with a body of work encompassing transformative and high-impact discoveries published in esteemed peer-reviewed journals. He is also heavily involved with the Canadian scientific landscape, where he led the increase in the number of CIHR BME panels. He is a CIHR executive team for the BME grant panel and chaired the Canadian Cancer Society Innovation and Technology grant panel.

Upon assuming the directorship in 2018, Dr. Chan articulated a grand vision to position the Institute as a leading biomedical engineering institution in Canada and globally, emphasizing the expansion of its research capacity and improving the overall student and teaching experience. Below we briefly describe some of his activities as director.

To realize this vision, Dr. Chan increased the institute's budget by 41% in his term, with a 20% budget surplus annually to enhance the institute through new hiring, infrastructure, and faculty and student support. The Institute strategically recruited eight junior faculty members with varied specializations, expanding the Institute's expertise and ensuring alignment with evolving trends. This initiative precipitated a renaming of the Institute in 2020, from the "Institute of Biomaterials and Biomedical Engineering" to the more inclusive "Institute of Biomedical Engineering."

Recognizing the imperative of updated infrastructure to support a growing research community, Dr. Chan initiated many construction projects. The Institute expanded its research facilities and office spaces. It resulted in over 7,000 square feet of modern laboratory space, 3,000 square feet of faculty and staff office spaces, and 2,000 square feet of student office space. He laid the groundwork for further expansions. Also, the Institute saw an overall operating research funding increase from $579K to $955K per faculty from 2018 to 2022. The Institute had increased financial and administrative support to the faculty for graduate students and contributed to matching grant programs.

In response to a 45% increase in graduate students in his term, Dr. Chan oversaw a comprehensive overhaul of the BME curriculum, expanding the number of courses offered from 13 to 32 annually and broadening the scope of topics covered.

From a teaching perspective, new structures within the curriculum were developed to enhance the student experience, leading to the Institute's improved teaching evaluations and comments from below to significantly above the averages compared to other physical sciences departments. The undergraduate bioengineering and biomedical engineering minors were merged to centralize bioengineering education at the university.

He championed graduate students. The student stipend increased by over 20%, with a 50% increase in teaching assistants. There was a greater focus on committee meetings and participating in education activities, leading to a better overall graduate student experience.

Furthermore, Dr. Chan instituted the Annual BME dinner at the Royal Ontario Museum in 2019, a highly successful event designed to honour the achievements of students and faculty members. Following a brief hiatus due to the pandemic, the event resumed in 2022.

Finally, he created a unique operating and administrative infrastructure in the Institute that is now being assimilated by other departments to ensure the smooth running of daily operations.

Dr. Warren Chan's long-lasting legacy is one of strategic vision and unwavering commitment to advancing biomedical engineering. His significant contributions have reshaped the Institute and influenced the broader biomedical research landscape.

"We all are profoundly grateful to Warren for his leadership during one of the most challenging times for the Institute and the University. We are also grateful for his vision, for optimizing the operations of the Institute, and for hiring an outstanding cohort of junior faculty. Warren left an important mark on the Institute, which will be visible for many years to come. Thank you, Warren!" said Milos R. Popovic, Director of the Institute of Biomedical Engineering.

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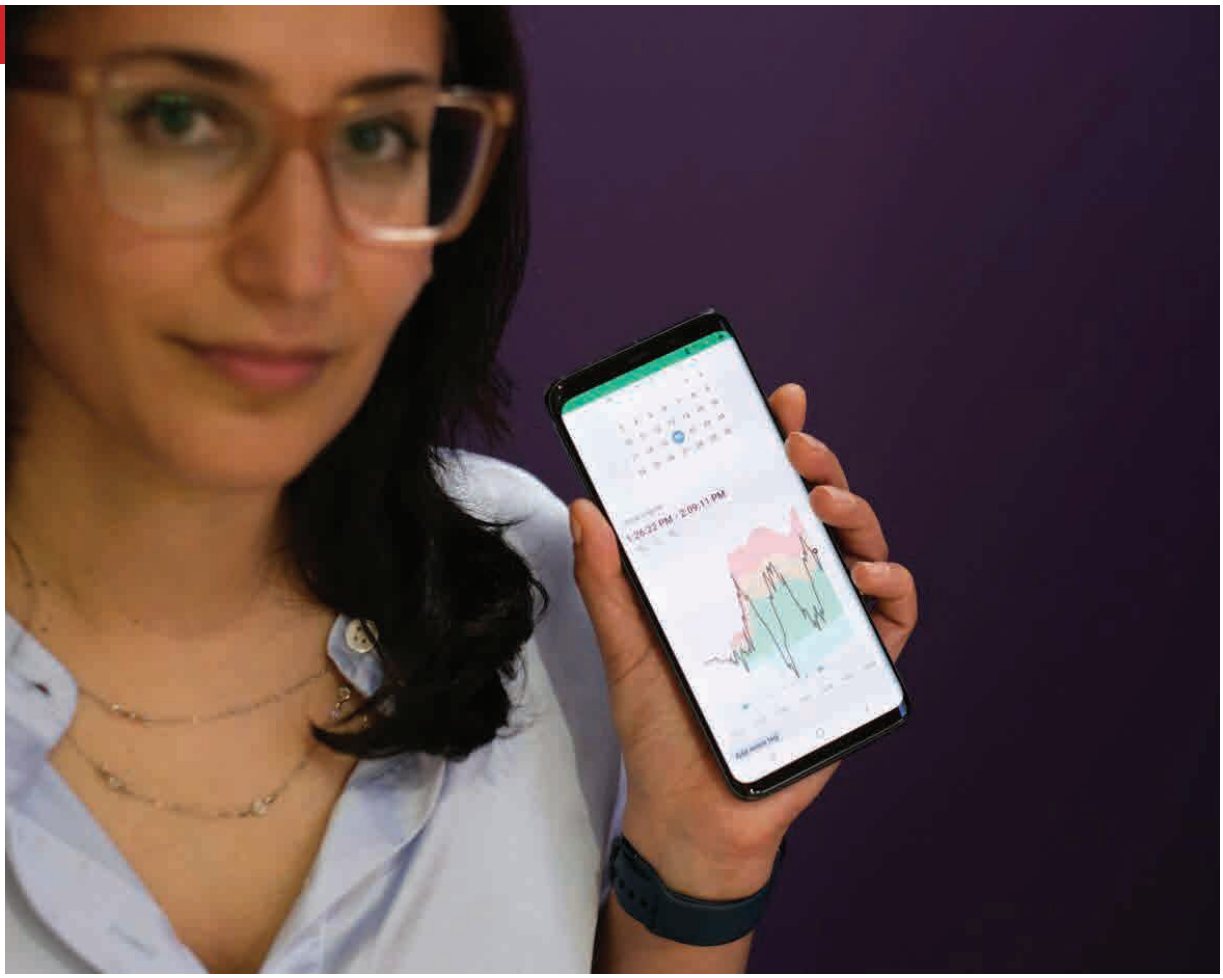


Supporting neurodiversity through personalized health

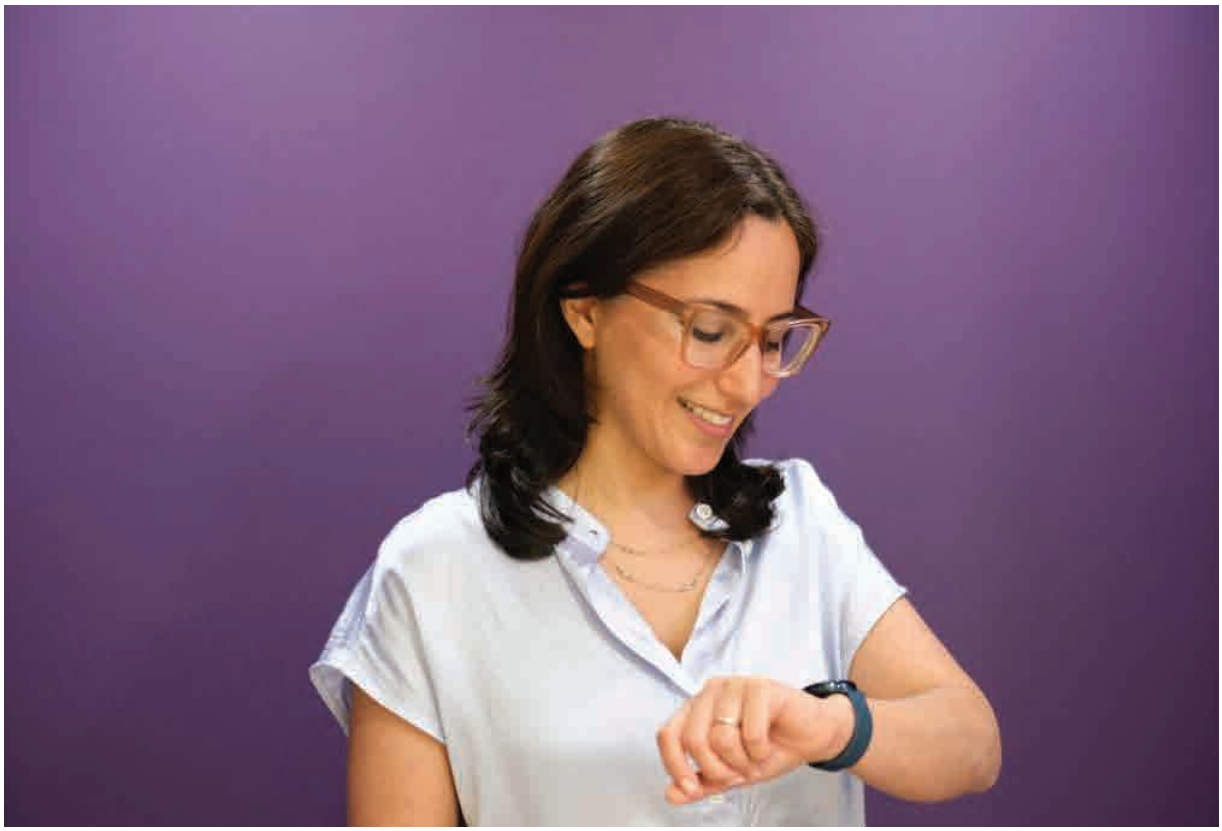
Dr. Azadeh Kushki and her team of researchers at the Autism Research Centre within the Holland Bloorview Kids Rehabilitation Hospital are dedicated to advancing personalized healthcare for children with neurodevelopmental conditions, including autism and ADHD. They employ data science techniques to gain insights into the diverse trajectories of brain development, and leverage technology-driven methods to provide tailored support for each child. Their approach integrates various data streams, ranging from neuroimaging results to clinical records, in order to pinpoint the unique biological and behavioral characteristics associated with neurodevelopmental variances and disabilities. This enables them to discern how these distinctive features correlate with outcomes such as responsiveness to interventions. By taking into account individual distinctions, personalized healthcare holds great potential for significantly enhancing the well-being of neurodivergent children.

Developing a better understanding of neurodiversity

One of the major projects in the Kushki lab is to

← Dr. Azadeh Kushki and her team are working on various personalized technologies to support neurodiversity. From left to right: Dr. Azadeh Kushki; Eric Wan, PhD candidate; Marlee Vandewouw, PhD candidate; Azadeh Sereshki, PhD candidate; Sara Alatrash, MASc candidate.

challenge the nature of our existing diagnosis labels for neurodevelopmental conditions like autism, ADHD, and obsessive-compulsive disorder. These labels are currently very broad and there is significantly variability within each label in terms of biology, response to intervention, and experiences of distress and disability. To be able to individualize supports for children with these conditions, we need more precise groupings that align with



biology. Dr. Kushki's team is using data science to do this. One way to extract this information is by looking at neuroimaging data.

"My project focuses on using different types of brain scans to study neurodevelopmental conditions," says Marlee Vandewouw, a senior doctoral student in the Kushki lab. "We are currently trying to come up with better groupings of kids based on their neurobiology instead of our existing labels."

"My study findings suggest that our broad diagnostic labels do not always align with unique patterns of brain function," says Marlee. "Brain-based groupings, instead of our existing diagnosis labels, can help us understand and support the unique strengths and needs of neurodivergent children through personalized approaches."

Another way to learn about individual differences is by understanding the predictors of outcomes.

"My research looks at what clinical and demographic factors predict children's ability to independently do the skills they need to function in life. I also look at how these skills compare to what is expected based on a child's cognitive strengths and needs, and how they change over time." says Eric Wan, another PhD student in the lab.

"This work will ultimately inform personalization of interventions and supports to enhance outcomes for neurodivergent children. "

Personalized health for supporting neurodivergent children

Given the large variability in autism and ADHD, personalized health has the potential to improve our understanding of neurodevelopmental conditions and inform the development of more effective and targeted interventions and supports.

One way to do this is to look at what predicts responses to treatments and interventions.

"My thesis project is focusing on how brain function may predict response to pharmacological interventions in autism," says Azadeh Sereshki, a PhD student in Dr. Kushki's lab.

Another project examines the predictors of irritability in autism. "Irritability can negatively impact outcomes for many children and increase the experiences of distress and disabling. My work examine the factors that predict irritability to inform targeted and personalized interventions." Says Sara Alatrash, a Master's student in Dr. Kushki's lab. "This work can help us learn which treatments work best for whom, improve our ability to find the best medication fit faster, and reduce exposure to ineffective drugs with serious side effects."

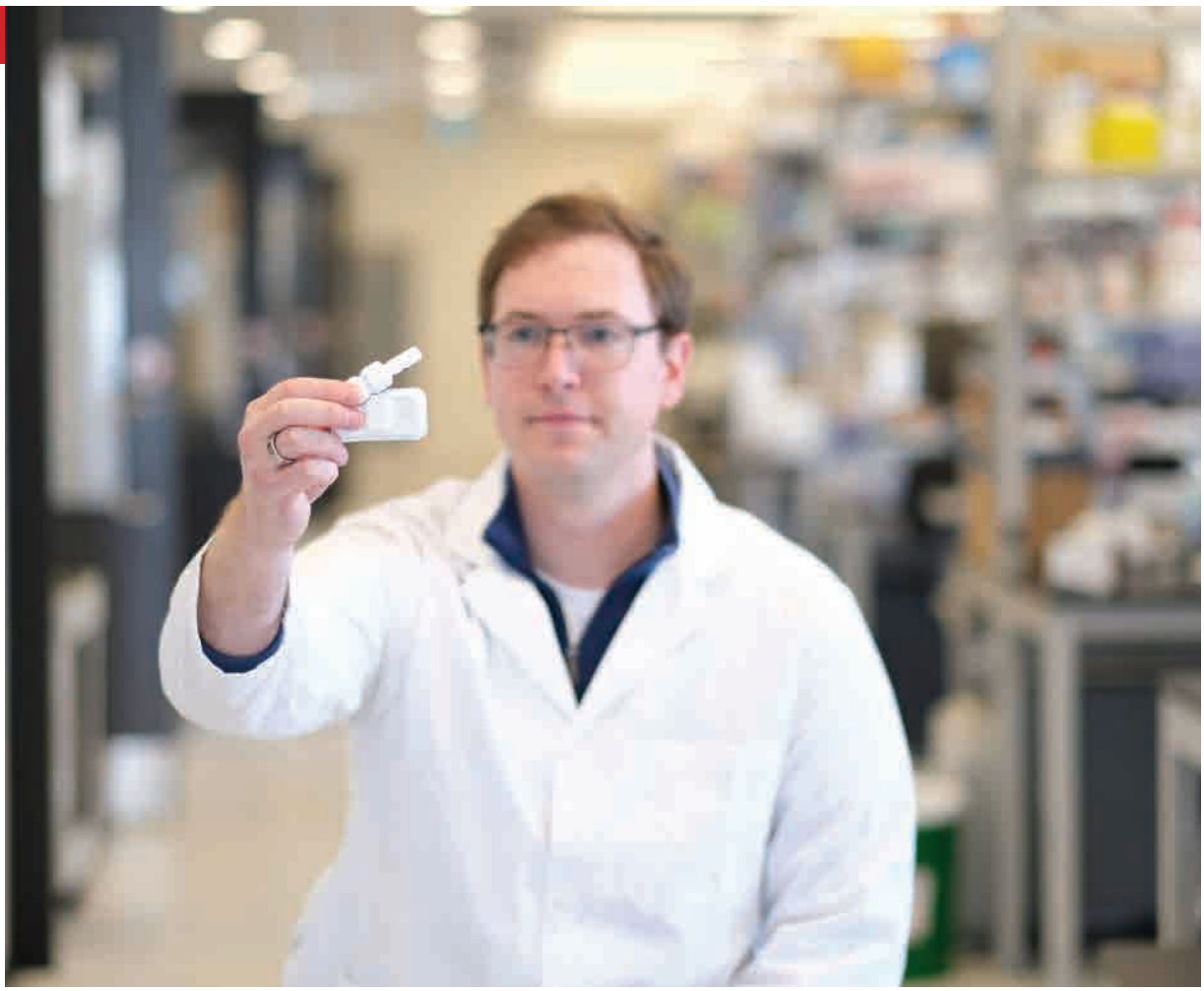
Another approach to personalized health in Kushki's research is using data from a variety of sources to better understand the children's evolving needs in real world environments. This is where technologies like wearable devices really shine, because they can collect continuous and fine-grained data not only about children, but also about their environments.

One of the successful projects from the Kushki lab is holly™, an application that runs on a smartwatch to help children manage their emotions. holly™ measures heart rate and activity level and computes the level of intensity of the emotions a child is experiencing. holly™ then alerts the children or their caregivers when emotional intensity levels are rising, and intervention is needed. holly™ has been validated in lab and real environments and shown to improve awareness of emotional levels in children and adults.

"Our goal is to improve awareness and understanding of internal states, especially for children who may not be able to communicate these feelings in the moment," says Dr. Kushki. "The goal is to enable effective and timely emotional regulation and support positive participation and mental health outcomes."

"Wearable devices like smart watches allow us to collect information about the emotions children are experiences as well as environmental factors that may trigger these emotions. This information can help us identify environmental modifications to help reduce stress and disability."

"Every child is different with unique strengths and needs. With personalized health approaches, we can support children in ways that are tailored to their specific needs," says Dr. Kushki, "This is where we hope to be in 5-10 years, so that every child can receive the support that best matches their biology and environment, whenever they need it, wherever they need it." ■

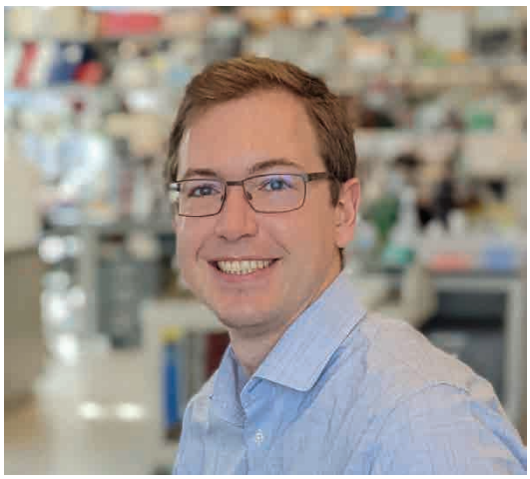


Wearable medical device redefines cardiovascular monitoring

A team of researchers led by Professor Daniel Franklin from the University of Toronto Faculty of Applied Science and Engineering, Dr. Andreas Tzavelis, and Professor John Rogers at Northwestern University has unveiled a cutting-edge wearable medical device designed to revolutionize cardiovascular monitoring. This innovative device integrates multiple sensory modalities to provide a comprehensive assessment of hemodynamic status, surpassing conventional blood pressure monitoring. The findings were published in Nature Biomedical Engineering.

The device's core innovation lies in its ability to measure not only blood pressure, but also correlates for cardiac output and vascular resistance, key indicators of the body's regulatory processes for maintaining blood pressure. This addresses a critical gap in current monitoring methods, where underlying cardiovascular issues may go unnoticed despite normal blood pressure readings.

"Your body goes through great lengths to regulate and maintain blood pressure. If the ability of your heart to pump blood declines, say due to progression of



↑ Dr. Daniel Franklin (left) and Dr. Andreas Tzavelis (right) are the two leading authors of this research.

disease, your body may compensate by constricting blood vessels to maintain blood pressure." Said Professor Tzavelis.

The wearable system also enables remote monitoring, allowing patients to record data in their natural environments. This continuous stream of data provides a holistic view of an individual's cardiovascular health, allowing for early detection and intervention from health care providers.

"This device offers a more comprehensive approach to quantifying an individual's risk for heart failure and disease. Instead of periodic clinic visits, patients can now record data daily, providing invaluable insights into how their hemodynamic vital signs evolve over time," said Professor Franklin.

The system consists of two devices—a chest patch and a peripheral device—that work in tandem. The chest patch, measuring approximately 44 centimeters by 70 centimeters, is attached using medical-grade adhesive.

The technology behind these devices advances on that found within some commercial smart watches for non-invasive blood pressure measurements. Pulse arrival time, a well-established metric for estimating blood pressure, is used in conjunction with miniature spectrometers in the peripheral device. This enables the measurement of pulse wave dynamics as they propagate through the large arteries and the skin simultaneously, offering a deeper understanding of blood pressure and its regulation.

The devices are constructed using flexible printed circuit boards, encapsulated in medical-grade silicone. Their flexible design allows for various form factors, making them adaptable to different wearables, including wristbands, rings, and compact patches.

Moreover, these devices are hermetically sealed, ensuring water resistance and enabling them to be sterilized for medical use. They are wirelessly charged, eliminating the need for cumbersome connectors, or charging ports.

Professor Franklin acknowledges the collaborative effort that made this breakthrough possible. "It's been a large team effort, with each member contributing their expertise in various aspects of the project."

The project received support from the Ted Rogers Centre for Heart Research and was funded in part by TRANSFORM HF, a program aimed at advancing heart failure research.

With this wearable medical device, Professor Franklin and his team are poised to redefine cardiovascular monitoring, providing a new level of insight and precision in managing heart health. ■

Science Meets Parliament: building relationships between scientists and Parliamentarians in Canada

In an era where scientific advancements are shaping our world at an unprecedented pace, it is crucial that scientists and policymakers work hand in hand to ensure evidence-based decision-making. Recognizing this need, the Canadian Science Policy Center launched the Science Meets Parliament (SMP) program in 2018. This initiative aims to bridge the gap between scientific research and policy development by fostering direct engagement between scientists and parliamentarians. The SMP 2023 event

← Science Meets Parliament aim to foster direct engagement and communication between scientists and parliamentarians to bridge the gap between scientific research and policy development. From left to right: Dr. Björn Herrmann, Tony Van Bynen, Dr. Penney Gilbert.

showcased the power of building relationships and the importance of scientists being trained in the art of raising pertinent issues in a constructive manner.

Dr. Penney Gilbert, an associate professor at the Institute of Biomedical Engineering at the University of Toronto, was one of the delegates selected to participate in the 2023 SMP program. She was a representative of the Stem Cell Network, which was a generous sponsor of the event. As a stem cell scientist working on predictive human cell-based assays and advocating for the reduction of animal usage in scientific research, Dr. Gilbert became interested in engaging with parliamentarians about using policy to drive science.

"Through my research, I aim to create assays that enable the scientific community to reduce or eliminate the use of animals in experiments. By demonstrating the equivalent results achieved with human cell-based assays, we can contribute to the validation and acceptance of these alternative methods." Said Dr. Gilbert, "This not only aligns with the government's goal of phasing out animal testing for toxicity by 2035 but also offers translational advantages by utilizing human cell systems in studying biology."

The Liberal Party of Canada shares this perspective, as evidenced by their 2021 platform mandates and the recently passed Bill S-5, which includes a focus on animal welfare and the gradual elimination of animal use for toxicity testing. This alignment of goals and values provides an opportunity for researchers to engage with parliamentarians and discuss the potential of human cell-based assays as alternatives to animal testing.

"I believe an important part of the program is to build dialogue between parliamentarians and scientists," said Dr. Gilbert.

The SMP program seeks to cultivate relationships and effective communication between scientists and parliamentarians, creating an environment where scientific expertise is readily available to inform policy decisions.

Traditionally, parliamentarians have relied on government-employed scientists for scientific advice. However, by actively reaching out to policymakers, scientists can ensure their research findings are directly communicated and understood.

The program targets motivated individuals, specifically, mid-career Tier 2 Canada Research Chairs and Banting Postdoctoral Fellows, providing them with the necessary skills to understand science policy, and policy for science, at the parliamentary level. Participants undergo online training sessions covering various topics such as science policy, equity, diversity, and inclusion in science, the Library of Parliament, and science communication. The program culminates in a two-day event in Ottawa, where participants receive further training on connecting with parliamentarians and engage in casual conversations with them.

Parliamentarians such as Elizabeth May (Co-lead of the Green Party) and Tony van Bynen (Liberal Party representative), were two government representatives who were able to meet with scientists this year.

The Science Meets Parliament program in Canada represents a significant step towards strengthening science-policy collaboration. By facilitating direct engagement between scientists and parliamentarians, the program empowers scientists to actively contribute to evidence-based decision-making.

"Through building relationships and advocating for scientific issues, scientists can shape the future of Canadian society." said Dr. Gilbert. "As we embrace a future driven by scientific advancements, the collaborative efforts between scientists and policymakers are vital to address the complex challenges we face and create a better world for all." ■

Shaping the future of medical device innovation: an alumnus Q&A with the director of product development at MolecuLight

Nikola Andric graduated from the BME Master of Engineering program in 2017. Now, he is the Director of Product Development at MolecuLight, where he spearheads the advancement of fluorescence wound imaging devices for bacterial load visualization and wound measurement. By combining his passion for wound care treatment with technical knowhow, he is hoping to develop medical devices that can elevate the performance of clinicians in wound care settings.

Can you describe your current role and the day-to-day responsibilities that come with it?

I am the Director of Product Development at MolecuLight. MolecuLight manufactures fluorescence wound imaging medical devices that allow clinicians to visualize high bacterial loads in wounds and digitally measure wounds with a high degree of accuracy.

I wear many different hats in my role. Firstly, I am responsible for planning and executing our engineering projects to launch new products and features. This involves working closely with our engineering, quality, manufacturing, and clinical teams to ensure we build the right solutions with high quality. This also means creating efficient development processes for our multi-disciplinary team and ensuring these processes satisfy quality assurance. Additionally, I work closely with our customers and clinical team to define user needs and product specifications to then translate those into engineering requirements. My day-to-day responsibilities typically include morning scrum meetings with our engineering team to provide progress transparency and evaluate prototypes, working with the customers to define new product features, and implementing integrations with customers. A big part of my job in the last year has been implementing electronic medical records (EMR) integration solutions for our products with a variety of hospital institutions.

What's your day-to-day like?

My day begins in the mornings where I have my scrum calls with the engineering team. We get together and make sure that we understand what everyone's working on, our progress, and how we can eliminate any obstacles. I have regular calls with our clinical team to understand customer feedback and new developments from the field. With any free-time I can find, I work on product designs for upcoming products and features on our roadmap. This involves defining technical specifications for my team. Throughout the day, I follow up with the engineering and quality assurance teams, making sure we're on track with certain deliverables.

Can you talk about a specific project or achievement that you are particularly proud of in your current role?

In my current role, I'm particularly proud of the work I've done to integrate our medical device software and wound data with EMR systems. With medical devices, it's important to understand that clinicians are busy and don't have a lot of time to learn new workflows and perform new functions. Any solutions introduced into a clinical setting must be intuitive and as efficient as possible! This is something we are really focused on here at MolecuLight. I've recently led several projects to integrate our MolecuLightDX™ device into existing EMR systems. This allows clinicians to quickly capture their wound images and have the wound data automatically uploaded and documented in their medical records. I remember during my MEng program, we had a guest lecturer speak about the complexity of hospital IT systems and how we can strive to better integrate data into these systems. That lecture always stuck with me and now I'm fortunate to have had hands-on experience working with these EMR systems to streamline clinician workflows.

How does your flagship product, MolecuLightDX™, work in a clinical setting?

Currently, clinicians in wound care rely on capturing white light images of wounds and taking manual measurements using tools like smartphones, iPads, or cameras. Our goal with the MolecuLightDX™ is to introduce a more advanced and powerful imaging modality specific to wound care. Similar to X-rays or MRIs, our device offers a unique imaging approach to address an important challenge – detecting bacterial loads within wounds at the point-of-care and to do so in real-time, something that conventional methods are unable to do.

The MolecuLightDX™ is designed to be a portable, user-friendly point-of-care device that fits easily into a clinician's pocket. It empowers clinicians to capture crucial wound data quickly and efficiently during their visits to inform their clinical decision-making. For instance, during my recent work trip, I accompanied clinicians to various remote locations, including nursing homes and patients' homes. The device allows them to not only perform wound care procedures but also gather essential data about wound size, healing progress, and bacterial burden on the spot. This eliminates the need for time-consuming bacterial swabs and lab testing while simultaneously assisting clinicians with targeted cleaning and debridement.

Our device is carefully crafted for mobility and ease of use. Its design facilitates one-handed operation and can be used by both left- and right-handed users. It addresses the practical needs of clinicians who work in diverse environments, from healthcare facilities to patients' homes. In essence, the MolecuLightDX™ enhances the entire wound care process by providing real-time, accurate, and accessible imaging and measurement capabilities, contributing to more effective patient care.

Our global user base, including thousands of physicians and nurse practitioners, handles complex wound cases with multiple procedures. We're focused on streamlining their tasks without burdening them further. Unlike some competitors, our approach is entirely non-contact, accurately measuring wounds without attaching markers. Additionally, we address connectivity challenges. Our technology integrates with medical record systems, ensuring functionality even without strong Wi-Fi, which is crucial for effective care delivery, especially in patients' homes.

Security is another critical dimension. Our device prioritizes robust security for patient data storage, distinguishing us from phones susceptible to vulnerabilities. We strike a balance between security, user-friendliness, and durability. Our devices are engineered for real-world clinical demands, showcasing our commitment to trusted and reliable medical technology.

What skills and knowledge have been most valuable to you in your current job, and how did you acquire them?

In terms of valuable skills: critical thinking, problem solving, and communication. I attribute my problem solving and critical thinking skills to my time at U of T engineering. Understanding how to approach a complex problem is critical in my role. As a student, I had lots of practice working on technical group projects. Communication is extremely important when working in a multi-disciplinary team. Customers speak a different language than engineers and it's important to effectively communicate product concepts to different audiences. I got a lot of practice doing this when I was in student government and theatre groups at U of T.

The MEng program gave me a general understanding of how medical devices are developed and the processes involved from the quality assurance and regulatory perspective to ensure high quality products with low risk to patient and users. I apply this knowledge daily since I am in charge of managing our development projects. Understanding the regulatory pathways for the Food and Drug Administration (FDA) was also critical from a business perspective. Any new plan to launch a medical device starts with understanding how the product will be approved by regulatory bodies.

In my undergrad, I gained a background in microbiology through my research summers and thesis in bioengineering. My professional experience year was also focused on imaging technologies. Combining my experience with bacteria and imaging – MolecuLight seemed liked the perfect fit!

What do you enjoy most about your current job, and what are some of the biggest challenges you face?

I am extremely passionate about our product and the clinical impact MolecuLight is making in wound care. We are the only FDA cleared medical device that allows fluorescence wound imaging to visualize high bacterial loads – and our device is well on the way to become a global standard in wound care. I've seen first-hand and through numerous case studies how our wound imaging procedure can greatly impact patient outcomes. This could mean less antibiotic usage, fewer amputations, and faster wound healing times. We are building a whole new imaging modality to completely revolutionize wound care, and I think that's very exciting!

The biggest challenge I face in my role is making sure we build the right product and right workflow! There are endless problems to solve in wound care and countless different solutions. However, to build a truly successful and impactful product, it's important to listen to users and truly uncover their needs and critical issues they are facing. You can't solve everything at once so you must be strategic with how you implement solutions.

What are some important trends or changes happening in your industry, and how do you see them affecting your job or the field in the future?

Artificial Intelligence (AI) is on track to change lots of industries, healthcare included. There are many medical data software companies who are looking to capitalize on AI to better predict patient outcomes and suggest clinical interventions. The idea here is to be proactive rather than reactive. Like other imaging modalities (X-Rays, MRI's, Ultrasounds), our fluorescence wound imaging relies on image interpretation. Clinicians are trained to interpret medical images to determine a treatment plan. One can imagine that AI algorithms could be developed and taught to interpret medical images for clinicians. This could lead to both cost and time savings.

How do you stay up-to-date with the latest developments and trends in your field, and what resources do you recommend for others interested in doing the same?

One thing I do is follow a wide range of medical device companies on LinkedIn. All companies do press releases and post new updates on their LinkedIn profiles. It's a great way to stay up to date. Also, MolecuLight has a medical communications team that regularly releases publications and works with key opinion leaders to document interesting new findings in wound care. I make sure to stay-up to date with our publications and any other wound care publications. I also am not afraid to ask questions. Whether it's within a different department in your company or when you're at a customer site, if you are curious and don't know a lot about something, always speak up!■

Advancing drug discovery through cutting-edge microscopy

Amine Driouchi embarked on his science journey at King's College London in biochemistry, and this eventually led to his PhD work in Dr. Chris Yip's lab at the University of Toronto. Now he is working as a senior scientist for Eikon Therapeutics, a California-based biotechnology company that develops drug discovery technologies using super-resolution microscopy. Here, Amine shares his academic journey and what he is doing now at Eikon.

Can you briefly describe your academic journey before joining Eikon?

Before joining Eikon Therapeutics, my academic journey was driven by a passion for understanding biology at its fundamental level. During my undergraduate studies in biochemistry at King's College London, I realized the need to move beyond descriptive approaches and delve into single molecule biophysics to explore molecular complexities.

I pursued labs in biophysics during graduate school and joined Chris Yip's lab at the University of Toronto (U of T). Chris's mentorship encouraged curiosity and fearlessness, allowing me to take on challenging and risky projects.

After U of T, I spent two years in Chicago, furthering my personal growth in a research environment. Throughout my journey, I experienced various international moves, which shaped my ability to manage stress and adapt to new environments.

The desire to apply single molecule tracking and super-resolution techniques to drug discovery motivated me to build my own platform before discovering Eikon. Connecting with Eikon's team, I realized it was the perfect fit for my mission. After joining Eikon, I became part of an incredible journey with a small team, pushing our mission forward. The experience felt like years of work with brilliant minds tackling fascinating scientific questions.

My driving force has always been the underlying scientific questions and the desire to make methods that truly help us understand biology. Success in drug discovery is essential, but even if we do not achieve it, our efforts to advance scientific knowledge are valuable and fulfilling.

As a senior scientist, what is your day to day like?

As a senior scientist at Eikon, my day-to-day work has evolved significantly since I joined the company a few years ago. Back then, my role was quite diverse, and I worked at the interface of biology and engineering, utilizing my expertise in advanced microscopy, particularly super-resolution microscopy, which I had gained during my PhD and postdoctoral fellowship.

During the early days, close collaboration with various departments and team members was essential as we collected vast amounts of data from numerous well plates containing thousands of cells and millions of trajectories. Our primary focus was on developing the platform, ensuring we had the necessary hardware and software to effectively process and interpret the data. Additionally, we worked closely with the automation team to identify and resolve any issues in the system, making our assays more robust and dependable for day-to-day operations.

As Eikon experienced rapid growth and expanded to almost four hundred employees, roles and responsibilities evolved. Now, individuals like me are encouraged to specialize further. Currently, I am deeply involved in early research and development, collaborating with colleagues who share a similar background. Together, and along with my team, our task is to explore new possibilities and determine the platform's strategic direction for the next two to three years.

The journey at Eikon has been incredibly dynamic, witnessing the company's remarkable growth and adapting my role accordingly. From overseeing a broad range of tasks in the initial stages to now increasingly focusing on specialized research and development efforts, I continue to find great excitement and fulfillment in contributing to Eikon's innovative projects.

What does Eikon specialize in?

At Eikon Therapeutics, our specialization lies in examining protein motion in living cells using our innovative technology platform. We focus on gaining valuable insights into drug target engagement, protein disruptions, and subpopulations within cells. Our approach involves single particle tracking, which allows us to move beyond traditional methods and capture the full spectrum of protein diffusion speeds under different perturbations. This comprehensive understanding of target behavior and interactions with cofactors over time sets us apart.

We are also expanding our capabilities beyond single particle tracking. We have a range of advanced microscopy techniques at our disposal, and we continuously strive to improve and explore new measurements with our high-end cameras and optical components. We have also invested in building orthogonal capabilities, including biochemistry, chemistry, and assay biology groups, enabling us to manage protein purification,

run luciferase, immunofluorescence assays, and even conduct medicinal chemistry internally.

Having medicinal chemistry capabilities has been a notable change for us. It allows us to rapidly iterate on molecule modifications based on data from various assays, leading to faster progress and innovation.

What is the advantage of using microscopy to examine biological processes inside the cell, in real time?

Using microscopy to examine biological processes inside the cell in real time offers us a significant advantage in our work. It allows us to tackle the complexity of these processes by delving into the intricacies and variations within individual cells, rather than averaging out data as in traditional biochemical methods like western blots.

This detailed information gives us valuable insights into how several factors regulate cells, their spatial

distribution, and the heterogeneity brought about by intracellular components. With this level of understanding, we aspire to specifically target subsets of proteins or cells that are relevant to a particular therapeutic indication. This targeted approach can give us a competitive edge in our drug discovery efforts.

In our field, there is a tendency to average granular datasets for simplicity, but we recognize the importance of questioning the origins of trends. By delving deeper into the details, we can improve drug selectivity and specificity, leading to potentially cleaner drugs. As our research advances, we have progressed to more complex and costly systems, including animal and clinical trials, and having a better understanding of the mechanisms and biology in these systems aids our medicinal chemistry efforts.

Can you give me an example of a use case, where using these advanced microscopy techniques can help solve a biological problem?

Using single particle tracking, we can infer whether a protein exists as a free monomer, a heterodimer, or part of a larger complex based on diffusion coefficient measurements. This provides us with a deeper understanding of how proteins associate with their cofactors. At Eikon, we thrive on operating outside the norm and exploring uncharted territories. By focusing on promising areas that others might overlook, we gain a competitive edge in drug discovery and target identification.

Our platform's emphasis on protein-protein interactions and understanding their behavior over time is a notable change. This level of insight is rarely achieved in living cells through conventional approaches, and it holds immense potential for refining our understanding of cellular function and protein dynamics.

In fact, we are currently engaged in exciting collaborations that leverage our platform's scale and capabilities to push the boundaries of research. Together, we are making significant strides in studying protein dynamics as they transition from monomers to higher-order oligomers under specific conditions.

What is a major challenge for you and the company right now?

In my view, the evolution of super-resolution technology in the next few years will depend on how we tackle the challenges currently faced in the field of microscopy, especially in super resolution microscopy and single particle tracking. One major challenge is the proliferation of methods and papers with questionable quality and contributions, which can lead to distractions and dilute research efforts.

However, I have noticed that researchers tend to rise to the occasion when faced with challenging problems, and they actively start experimenting and innovating. To move forward, it is crucial for us to refocus our efforts on addressing the most critical biological questions using super resolution microscopy. This involves customizing imaging techniques to suit the specific biology of interest, effectively bringing the microscope to the biology rather than forcing the biology to fit the microscope.

At Eikon, I encounter a similar challenge in a growing company, where some folks may perceive the technology as fixed and inflexible. However, I advocate for maintaining a sense of flexibility and customization, as this allows us to address a wide array of biological questions, considering the diverse range of targets and cellular processes.

In the context of super resolution microscopy, the role of hardware and software is paramount. For instance, properly studying protein motion in cells is a non-trivial task, especially when dealing with a high labeling density, where reconnection of individual detections become particularly challenging. To ensure the reliability and significance of our assay results, we need trustworthy outputs and downstream analyses that provide a genuine assay window.

In conclusion, the key to the evolution of super-resolution technology in the coming years lies in embracing change and refocusing our efforts on addressing biologically relevant questions while adapting imaging approaches to suit the specific biological context, whether in a research lab or a pharmaceutical company. By doing so, we can make significant strides in advancing super-resolution microscopy and its applications in understanding complex biological processes at a finer scale. ■

Navigating medical education and building a patient-centred healthcare system

Alison Hacker recently graduated from the MEng program at the University of Toronto. Now pursuing a degree in medicine at Queen's University, Alison talks about what motivates her in medicine, and how incorporating social considerations when treating patients could produce better outcomes.

How far are you into medical school?

I have completed my first year and I am about to enter my second year at Queen's University for medicine. Currently, I am in my pre-clerkship year, which focuses on foundational learning. This involves a combination of course-based and case-based learning, as well as small group sessions. During this time, we acquire a mix of basic science and medical knowledge, establishing a solid foundation.

In addition to theoretical learning, we are gradually introduced to clinical skills and practice. This includes learning how to perform physical examinations, interpreting vital signs and symptoms, and formulating differential diagnoses. We develop a physician's approach to problem-solving, learning to consider various factors when assessing patients and determining appropriate tests or treatments.

Once we begin the clerkship phase, which starts in the third year, we will engage in core rotations. This means we will work in hospitals and other clinical settings, alongside preceptors who are physicians or residents guiding and instructing us. This is when we will have direct patient interaction, conducting interviews, running tests, and performing physical examinations in a real practice setting.

Have you decided on a specialty yet?

Currently, I see myself working with people of various age groups and backgrounds. There are specialties that focus on specific patient populations, while others are more general. I am inclined towards the broader spectrum. I can envision myself working with children, young adults, and older adults.

What are some new trends you see changing in medical education?

It is crucial to have a deep understanding of the science, physiology, and appropriate care plans for patients. There is an increasing emphasis on the social determinants of health. Recognizing and appreciating these determinants is essential in ensuring that patients feel comfortable with their healthcare providers.

Building trust and establishing longitudinal relationships with patients is key to achieving this. Patients should feel confident in approaching their physicians and discussing how social or cultural factors may be affecting their health. It is important to broaden the care plan beyond medical needs and offer support and resources within the community.

For instance, during the COVID-19 pandemic, vaccine hesitancy became a significant issue. There are various reasons behind this hesitancy, such as a lack of education regarding vaccine science. Additionally, cultural perspectives play a crucial role. For example, some indigenous populations in Canada were hesitant to take vaccines due to historical abuses by medical providers, which eroded trust. Tailoring care to these specific populations becomes essential in encouraging vaccination and rebuilding trust over time.

In a broader sense, medical education now recognizes the significance of community health and the need to establish trust within communities. This involves understanding and addressing the specific healthcare needs of different populations. For example, in dermatology, there is a growing understanding of how conditions may present differently in individuals with darker skin tones. This awareness ensures that conditions are not missed and that people of colour receive appropriate care.

What does a medical system that perfectly incorporates social consideration look like?

As an individual working in healthcare, there are important steps you can take to contribute to positive change. Advocating for inclusion is crucial, not only in terms of increasing diversity within medical schools but also ensuring that healthcare providers reflect the communities they serve. When patients seek healthcare, it is beneficial for them to encounter providers who look like them and understand their unique challenges in accessing healthcare. This can help foster trust and improve patient experiences.

Face-to-face interactions and building relationships with patients are vital. Patients need to feel seen, cared for, and understood beyond their medical needs. Meeting their emotional and psychological needs contributes to a holistic approach to healthcare.

While individual efforts are essential, it is also important to recognize the need for systemic changes.

Addressing healthcare disparities, promoting diversity in the healthcare workforce, and implementing policies that support equitable access to care are long-term solutions that require collective action.

By combining individual advocacy, patient-centered care, and efforts towards systemic change, healthcare professionals can contribute to a more inclusive and patient-centered healthcare system.

How do you stay engaged in so many different topics when treating patients? Isn't it difficult to be an 'expert' in everything?

Effective healthcare involves not just physicians but also a range of professionals such as nurses, occupational therapists, physiotherapists, social workers, and others. Each member of the team plays a unique

role and contributes to comprehensive patient care.

Recognizing the value of a team-based approach allows healthcare providers to address the diverse needs of patients more effectively. For example, while physicians focus on the medical aspects, they should also consider the social determinants of health and connect patients with the appropriate professionals who can help with specific challenges. If a patient expresses social problems that impact their well-being, a social worker can assist in addressing those issues, which can positively influence treatment adherence and overall patient outcomes.

Understanding when to involve specialists in different areas is also important. Mental health is an integral part of overall well-being, and recognizing when a patient needs support from psychiatry or psychotherapy is crucial. By referring patients to the appropriate specialists, healthcare providers can ensure that the patient's emotional and psychological needs are adequately addressed alongside their physical health.

Healthcare is indeed a holistic endeavor, and no single healthcare provider can solve all of a patient's problems or fully comprehend every detail of their history. However, being able to identify when certain factors, such as social circumstances or specific healthcare needs, impact a patient's health allows providers to call upon the expertise of other team members. Collaborating and leveraging the skills of different professionals within the healthcare team leads to more comprehensive and patient-centered care.

What are some of the things you like and dislike about medicine?

Medicine provides a unique opportunity to combine your passion for science and academia with the ability to make a tangible impact on people's lives and their health. It's fulfilling to apply your knowledge and skills in a way that directly benefits patients and contributes to their well-being. The meaningfulness of the field is a significant aspect that attracts many individuals to pursue a career in medicine.

At the same time, it is important to acknowledge the challenges and limitations within the medical profession. The competitive nature of medical school admissions and the resources required to succeed in the application process can create barriers, disproportionately favoring those with privilege. This can result in talented individuals who are passionate and capable of providing excellent care being excluded from the profession.

It is important to foster a more inclusive and equitable medical profession, where aspiring healthcare providers from all backgrounds have a fair chance to contribute their skills and knowledge.

Could you provide any recommendations or guidance for engineers who are interested in pursuing a career in the field of medicine?

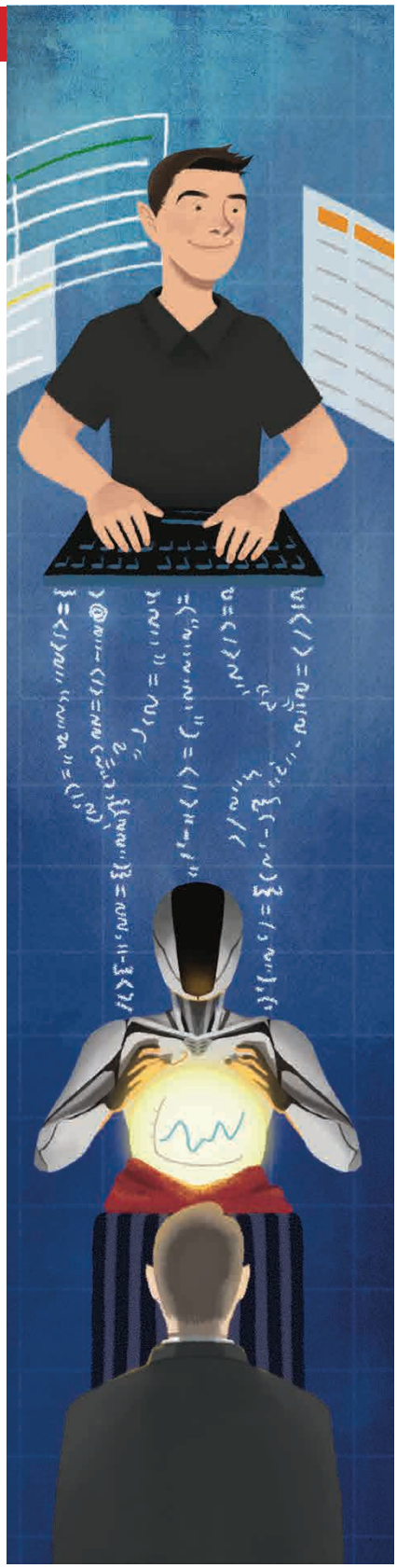
Seek diverse perspectives: Encourage them to speak with a variety of healthcare professionals from different specialties and backgrounds. This can include physicians, nurses, therapists, administrators, and other allied health professionals. Hearing about their experiences, challenges, and rewards can provide a comprehensive understanding of the field.

Shadowing and volunteering: Encourage them to participate in job shadowing or volunteer opportunities in healthcare settings. This hands-on experience can give them a taste of what it's like to work in healthcare and help them assess their level of interest and suitability for the field.

Hone your technical skills: The technical skills acquired in engineering, such as coding, data analysis, and problem-solving, can be applied in medical research and healthcare technology. You can explore opportunities in medical informatics, health data analysis, bioinformatics, or medical device development. These skills can help you contribute to advancements in healthcare and improve patient outcomes.

Develop critical thinking and analytical skills: Engineering education emphasizes critical thinking and analytical skills, which are crucial in diagnosing and treating patients. These skills enable you to approach medical cases with a systematic and evidence-based mindset, ensuring accurate assessment and effective treatment plans.

Reflect on personal values and goals: It's important for individuals to reflect on their own values, interests, and long-term goals. Understanding their motivations for pursuing a healthcare career can help them align their choices with their aspirations. ■



Answering business questions with Artificial Intelligence

After **Brandon Rufino** completed his master's in clinical engineering at the Institute of Biomedical Engineering in 2021, he leveraged skillsets in coding, machine learning, and biomedical engineering to design adaptable platforms that helps answer business questions at Sanofi.

What kind of work do you do as a data scientist at Sanofi?

As a data scientist on the Digital Data team at Sanofi, my job is to make sense of large amounts of data and develop analytics to help answer critical business questions.

Data in its raw form is not informative to a business, so here's where analytics and summarization tools come in. These tools can generate insights about a business problem or provide opportunities that eludes the human eye on a quick glance. We have a duty as an industry to more effectively leverage data, digital and technology to change the practice of medicine by discovering and delivering transformative treatments to patients. The goal here is to use artificial intelligence to screen through large sets of data, and then quickly and accurately predict future hypothesis. We call it prescriptive analytics.

The Digital team has ambitions to build the leading digital healthcare platform. This platform consists of integrated data, digital and technology solutions to develop and deliver medicines faster, better engage HCPs and pharmacists, and help patients improve their health. Our use cases support our various businesses, and to name a few: use more data (RWD, genome etc.) and artificial intelligence to accelerate drug discovery and optimize our clinical trials; scale and personalize HCP engagement through multiple digital channels; refine our e-commerce solutions; optimize our marketing spend though data; and digitize our manufacturing facilities. If you look at the data in each of their silos, there are unique operational, security, and monetary considerations associated with each of them. For example, in a randomized clinical trial, we must think about factors like: how can we identify the correct population of people to participate in a clinical trial? How can we encrypt their data so it is secure? Each step requires an intricate communication between the data sources and the business teams consuming the insight. Ultimately, we want to design AI platforms that can pull data from each of their silos and generate insight to a user's business question across the whole pharma chain.

What are some use case examples?

I work within the Research and Development vertical in Digital Data. Here, the team focuses on pre-clinical and clinical applications that accelerate making life-saving miracles for the human population.

Drug discovery: A business unit wants to find out which mRNA vaccine should be tested in the lab for efficacy, prior to testing on cells. We can use active learning in artificial intelligence to tackle that, based on previously existing data. This would save us time and money in the research phase.

Clinical trials: Real World Evidence is making our clinical trials more efficient by reducing the number of patients that have to be enrolled, or enabling them to provide us with their data from a distance using digital biomarkers.

Logistics and transportation: We now have several nearly fully automated, remote-monitored, insight-generating digital factories and are improving our supply chain using predictive AI.

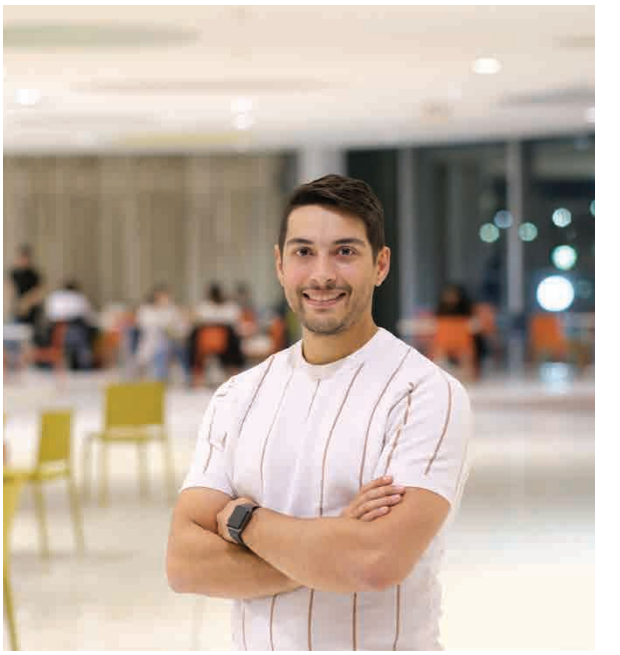
Commercial and marketing: We are deploying direct-to-consumer ecommerce platforms and have deployed a new and improved customer relationship management system that improves our interactions with healthcare professionals.

What are some of the questions you are helping to answer for the clinical team?

One of the common questions we try to answer is, which segment of the population responds better or worse to a particular drug? This is specifically tailored to Randomized Clinical Trials, where we are trying to cross-reference Real World Evidence and use previously existing Randomized Clinical Trials data sources to observe how a drug may perform in different population segments. All of this serves to increase the probability of success to have a drug with high efficacy and safety.

Another common question we try to answer is, how can we take a drug currently in market and find new indications currently not treated with the drug that may benefit from its use. This positioning of our portfolio allows our drugs to provide potentially life-changing treatments to a wider population.

There are a lot of existing data on previous drugs that came out of Sanofi's pipeline. We are examining whether we can use these massive troves of data to help us train AI algorithms that can answer the previously mentioned problems.



Why should Sanofi focus on Data and Artificial Intelligence?

While the healthcare industry is slow to adapt, tech giants are moving into the space quickly and start-ups are increasingly disrupting the well-established beliefs, processes and business models. Whether we're shortening development times for our R&D teams or providing new digital interfaces for patients worldwide, it's clear that embracing digital is key for us to chase the miracles of science to improve people's lives. Sanofi must catch up to its peers in certain areas, and leapfrog them in others, in order to remain relevant. Digital will be a key catalyst in this company-wide modernization.

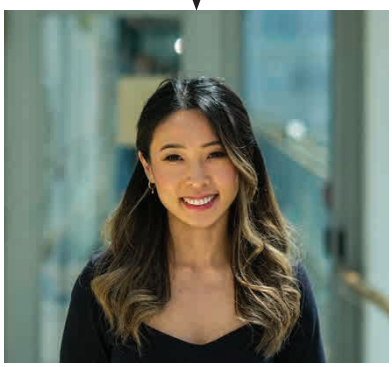
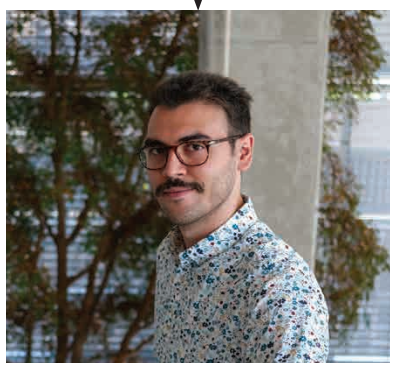
In the first phase of our transformation, we are modernizing our foundation while also creating value for the business. Our modernization is focused on cloud migration, scalable, democratized and AI-driven data solutions, and a more efficient infrastructure. In parallel, we are already creating value for the business across R&D, Manufacturing & Supply, and Commercial through priority initiatives agreed upon by the ExCom.

In the second phase of our transformation, Digital will accelerate the value creation across our GBUs and GFs, create completely new digital businesses, and move us to an AI-driven decision-making organization.

The advantage here would be a more efficient, time saving, and objective systems that can rapidly answer business questions and provide future insights. ■









Two years apart: out of the pandemic and onto greener pastures

The journey of a graduate student is an odyssey, filled with transformative experiences that shape their perspectives for years to come. To capture this experience, we embarked on a time-capsule editorial project, talking to several graduate students in the Institute of Biomedical Engineering as they transition out of the COVID-19 lockdown. Through their stories, we seek to preserve the essence of their hope, aspirations, and unwavering optimism, immortalizing this transformative moment in their lives.

In 2021, one year into the lockdown, we sat down with 6 MASc and PhD students from the Institute, exploring their visions for a world changed in two years' time. During those initial interviews, the COVID-19 pandemic posed significant challenges to these students, disrupting their academic pursuits, limiting research opportunities, and hindering their professional development. Remote learning, virtual conferences, and restricted access to labs and resources became the new norm.

Recently, we had the opportunity to reconnect with these individuals to witness the evolution of their perspectives.

Doris | **2021**

What projects are you working on right now?

Currently, I'm working on my PhD project, where we investigate the role of microRNAs in endothelial cell-cardiomyocyte crosstalk in hypertrophic cardiomyopathy.

What are you looking forward to in your graduate studies?

I'm looking forward to learning advanced experimental techniques and delving deeper into topics in cardiovascular physiology. I also look forward to attending classes in a real lecture hall, connecting with other BME students, and finally traveling to research conferences to immerse myself in the field and network!

What's one thing you would like to improve on?

I'm hoping to improve my technical and communications skills. Most of my research background is in clinical research, and I'm excited to learn more of the basic sciences and biology in cardiovascular research.

What is your perceived career goal after graduating?

I've always been interested in science communication as well as teaching and pedagogy. I've taught science both formally as an undergraduate lab teaching assistant in cellular and molecular biology, and informally as a science instructor with Mad Science Toronto and absolutely loved these experiences. After graduating, I hope to pursue a teaching career in higher education.

Recently, I've reached out to BME alum who are in the teaching stream. I interviewed Dr. Jenna Usprech, an assistant professor in the teaching stream at University of British Columbia. She directed me to various resources and volunteer opportunities to explore throughout graduate school, including the Prospective Professor in Training (PPIT) program and Let's Talk Science. I hope to continue gaining experiences and building my repertoire in teaching and science communication.

What were some challenges for you during COVID-19?

Unfortunately, I started graduate school as a master's student in January 2020, right before the beginning of the first COVID-19 lockdown. Due to restrictions, I was unable to go into the lab or learn techniques from colleagues in my first year, which is essential in basic sciences research. It was difficult to visualize experimental workflows and predict results, especially when I began preparing for my PhD transfer exam. Nevertheless, I think COVID-19 also impacted my future trajectory in a positive way. It helped me set personal goals when working independently and remotely and challenged me to make progress with limited access to resources.

The most challenging part of research and career planning during COVID-19 was the sense of isolation going through graduate school. Before the pandemic, I saw my lab members and colleagues almost every day, and it was easier to reach out, ask questions, discuss ideas, and find mentorship, whereas communicating through an online space 24/7 felt less engaging and personal. Regardless, I'm still thankful to be able to learn and create meaningful connections by reaching out to different BME alum and scheduling zoom call coffee chats with experts I would not have otherwise met!

Doris | **2023**

How has your research project changed in the last 2 years?

At the beginning of my PhD, my work focused on microRNAs involved in the crosstalk between the microvascular endothelium and cardiomyocytes in hypertrophic cardiomyopathy (HCM). As I was creating my model using induced pluripotent stem cell cardiomyocytes derived from patients with HCM and validating with myocardial tissue from donors, we observed fascinating microRNA expression patterns. While a large part of my project continues to look at the role of microRNAs in hypertrophic cardiomyopathy, this finding in the cardiomyocytes encouraged us to look further and explore, which I'm very excited about!

Looking back at your answers now, what advice would you give to your younger self in 2021?

Looking back, I would advise my younger self to approach my PhD one day and one step at a time. Pursuing a doctorate degree is the marathon of all marathons, and while it may be tempting to sprint from day one, it is crucial to take breaks, breathe, and even slow down if it means conserving enough energy to finish the race. This journey will be demanding, but it is also an incredible and worthwhile pursuit.

Have your goals changed? How so?

Since the start of my academic journey, I have remained steadfast in my pursuit of combining my passions for science communication, teaching and pedagogy, and increasing accessibility to science education for underserved communities. Although my goals have remained constant, I've challenged myself to be more open to new experiences, opportunities, and even career paths that align with my interests and values.

What's the next step for you?

After two challenging yet highly rewarding years, my next step is to sustain the momentum I've built up and keep pushing forward. This includes learning from my mentors and peers and seeking out opportunities for academic and professional growth and development. Whether it's conducting research, attending conferences, or taking on leadership roles, I'm eager to expand my horizons and make the most of this next phase of my degree.

Lily | 2021

What projects are you working on right now?

I'm developing stem cell derived models of the blood brain barrier on microfluidic platforms. I'm trying to model this under the context of Alzheimer's disease, and the hope is that, if we can develop a model that mimics how molecules cross the blood brain barrier, we can screen numerous pharmaceutical targets that can be used to treat Alzheimer's.

What are you looking forward to in your graduate studies?

What I really enjoyed about my first graduate experience (MASc) that a lot of my lab mates, had become lifelong friends. It's not often in life that you are going through the same struggle for a few years. I really look forward to meeting a diverse set of people and learn from them.

What's one thing you would like to improve on?

I want to be more comfortable with uncertainty. A lot of graduate students tend to have a type A personality, where we always want to come off as incredibly prepared. But it's also in the past inhibited me from new learning experiences.

What is your perceived career goal after graduating?

I want to work in a clinical field or clinical intersection field. I'm really interested in clinical chemistry as a post-doctoral fellowship. Another career option would be medical science liaison, or something that bridge the industry and the end users.

I'm currently trying to talk to as many people as possible. I think that'll give me perspective on different career paths, and I've definitely learned about positions that I would have never thought about before. A tactic I'm trying right now is cold calling people on LinkedIn and network.

Lily | 2023

How has your research project changed in the last 2 years?

While the scope of my research project remains mostly the same, we've identified some interesting features of our disease models that I'm excited to explore further, including investigating differences in amyloid toxicity and cellular trafficking in cells from patients with Alzheimer's disease.

Looking back at your answers now, what advice would you give to your younger self in 2021?

I would tell myself to value my time more and to not hesitate to pursue an idea. It's great to be cautious, and as scientists, there's always an emphasis to ensure there's logic, reason, and 10+ other citations backing you to do something. However, I think there is an element of creativity that can, at times, get overlooked in scientific training, which could be a barrier to progress. Looking back, I would encourage myself to try new ideas for the sake of exploring what could happen.

Have your goals changed? How so?

My professional goals and interests remain the same, I still want to enter a career that supports science translation and/or intersects with the clinical setting. My personal goals have changed quite a bit, I realize a big part of graduate school is ensuring you maintain balance in your life to keep you resilient and I've started to put a greater importance on relationships and engaging in activities that challenge me in a non-academic setting.

What's the next step for you?

Be disciplined and continue to have passion for the work and push out some papers this year to share with the world!

Stefan | 2021

What projects are you working on right now?

I am researching how to improve the delivery of small materials called nanoparticles to tumours. Nanoparticles can be designed to deliver drugs to cancer cells in tumours. Of the particles that do reach the tumour, many get blocked by a mesh called the extracellular matrix surrounding cancer cells. Thus many nanoparticles cannot reach the cancer cells which lie behind this barrier. I'm investigating how nanoparticles transport deep into the tumour and how the extracellular matrix influences this process.

What are you looking forward to in your graduate studies?

I look forward to connecting with my peers in the BME program since I didn't have much of a chance to this year (partially due to COVID-19). I will be in the PhD program for several years and being with friends makes the ride more enjoyable. I'm also looking forward to honing my technical skills in the lab and more importantly my critical thinking skills. I feel proud when I feel myself improving as a person and a researcher.

What's one thing you would like to improve on?

I want to improve on finding balance in my personal and professional life. Sometimes I will spend a lot of my week dedicated to one or the other rather than having a consistent balance. This is partially due to time management and the nature of experiments.

What is your perceived career goal after graduating?

I am still learning about myself and different opportunities. My career goal doesn't centre around a particular occupation but rather around two of my guiding principles: to become better every day and to improve the lives of others. I believe these two principles will persist during my graduate studies and my life afterwards since I find them rewarding and don't think I will ever satisfy them in my mind. There are many roles and occupations I can pursue to be consistent with my principles.

I consistently work towards fulfilling my two personal guiding principles. I fulfill the first principle by developing new skills, cultivating relationships, and learning from others (both within biomedical engineering and beyond). The second principle I fulfill by dedicating myself to activities that serve others; such as through volunteering and contributing to science that may improve the lives of others.

What were some challenges for you during COVID-19?

I am generally optimistic about the future because there are always opportunities for growth and improvement. As long as I remain flexible, work hard, and have good luck, I believe that many opportunities will exist that interest me. Given the current pandemic and greater awareness of a future pandemic occurring, there may be a greater need for research and development in the fields of biotechnology and biomedical sciences (e.g. therapeutics, vaccines).

I moved to Toronto to begin my PhD in September 2020. When I started, our lab used a booking system to manage when people would be in the lab. Since there was a maximum 50% capacity, it was challenging to learn new skills and connect with people due to space constraints and distancing. Thankfully we were able to adapt to the circumstances with video calls and thoughtful scheduling and communication.

Stefan | **2023**

How has your research project changed in the last 2 years?

Over the last two years the essence of my project has remained the same, but the data I gathered has guided me to work on new directions. Through experimentation, I now realize that my previous understanding of the interactions between nanoparticles and the tumour microenvironment is very different from how I understand it today. Unfortunately I cannot get into specifics at this point.

Looking back at your answers now, what advice would you give to your younger self in 2021?

As I read my answers from two years ago, I would advise my younger self in 2021 to realize that graduate school is not just a place to learn technical skills. Technical skills are a smaller part of the value of graduate school. Instead, graduate school is an excellent environment to learn more about myself, make deep connections with colleagues, and build transferable skills, such as in planning, execution, critical thinking and communication.

Have your goals changed? How so?

My principles that guide my goals and behaviour have not changed. I am interested in pursuing a career in academia at the moment. However I also enjoy learning about careers outside of academia. I've learned that the mindset and abilities you develop throughout your PhD open you up to several opportunities that I was unaware of two years ago.

What's the next step for you?

I am entering my fourth year in September 2023 and am excited to continue working on my research.

Anchana | **2021**

What projects are you working on right now?

I am currently working on the foot clearance project in Dr. Tilak Dutta's lab. We are evaluating strategies for enhancing community mobility for individuals with disabilities. As part of my research, we will be assessing environmental features and testing interventions to improve pedestrian mobility.

What are you looking forward to in your graduate studies?

I am looking forward to learning as much as possible about biomedical innovations, specifically in rehabilitation. I would like to network with others in this field, and get further exposure to biomedical engineering in real-life examples. I hope that my work will be able to impact the lives of clients who will benefit from this research. I want to contribute to scientific progress through my lab's research.

What's one thing you would like to improve on?

I want to improve on my design thinking skills and develop solutions to assist those who will benefit from the design, accessibility, and usability of medical devices.

What is your perceived career goal after graduating?

I'm not too sure about this yet, as I'm still exploring my options in both academia and industry. I hope to conduct meaningful research in this program and continue to select courses that pique my interest. Because I don't come from an engineering background, this field is still very new to me and I hope to gain experience through the many opportunities that come my way on a daily basis through the department and my lab.

I am attending networking events offered by the department and participating in additional sessions that discuss career navigation in this program.

What were some challenges for you during COVID-19?

So far, it hasn't affected my career progression as much because I am just getting started in the program. Due to COVID-19 restrictions, some events and sessions that would've been more interactive in person are online, so I do find myself wishing that the restrictions would get lifted. However, the department and my supervisor make these events and meetings enjoyable. On the other end, in some ways it is easier to have meetings online with those who are located in other areas and get more done during the day.

In terms of research, my onboarding was a bit delayed due to difficulties getting appointments because of the pandemic. This wasn't too bad because my research is online right now, so there was no rush to get those items completed.

Anchana | **2023**

How has your research project changed in the last 2 years?

When I started my Masters we were going in and out of lockdown due to the pandemic, so it's been a huge shift since then. I'm able to go to the lab and do my data collection as expected, without restrictions. My supervisor Dr. Tilak Dutta helped modify the project so that we are collecting more meaningful data. We are evaluating strategies for enhancing community mobility for pedestrians by measuring their minimum foot clearance (MFC) values as they navigate public walkways. The biggest change was the development of the MFC Finder Application by Dr. Hamed Ghomashchi on the Engineering Health Team. This application allows me to easily retrieve a pedestrian's MFC value and assess their risk for tripping on a public walkway as they walk in front of the data collection module. We are now collecting data from seven different pedestrian groups; healthy younger adults, healthy older adults, individuals with visually detected gait asymmetry, walker users, cane users, white cane users, and healthy adults looking down at a mobile device. The ultimate goal of this work is to inform better design and maintenance guidelines for outdoor walkways to reduce the risk of tripping for vulnerable pedestrians. Now that there are no restrictions in Toronto, we are getting a lot of pedestrians for our data collection, which is great for results!

Looking back at your answers now, what advice would you give to your younger self in 2021?

I would tell myself to enjoy the process more and not to worry so much if I don't know what the future holds for me. Being open to new experiences definitely helps in grad school, you never know what's out there!

Have your goals changed? How so?

My goals change quite often, I find that there are so many opportunities that come my way and I want to try everything. I realized how much I enjoy working with a team, where I can learn from different people so I would want to continue working with a group instead of doing everything by myself as I had initially thought. I'm more comfortable with coding now, so I'd want to continue challenging myself with new languages in the future.

What's the next step for you?

After I defend my thesis, I am hoping to go into industry for a few years. I am expecting to use a lot of the skills I gained in my graduate studies as I step away from academia. My ultimate goal is to return for my PhD as I am still very passionate about research.

I am going to defend my thesis in early September. I am hoping to go into industry for a few years following that. I am expecting to use a lot of the skills I gained in my graduate studies as I step away from academia. My ultimate goal is to return for my PhD as I am still very passionate about research and had such a wonderful experience with my lab!

Meghan | **2021**

What projects are you working on right now?

Right now, I am working on investigating how nanostructure design parameters influence a structure's uptake into cells. The impact of this work is that by deciphering how the different structure designs lead to improved or reduced uptake by different cells we can potentially selectively increase uptake into a desired cell type while minimizing uptake by off target cells via design strategies. This has important applications in targeted therapeutic delivery, for example.

What are you looking forward to in your graduate studies?

I am looking forward to learning new things, developing new skills, and making new friends!

What's one thing you would like to improve on?

I would like to improve on how I read and retain information from literature. I sometimes find it difficult to recall specifics regarding what I have read so I hope I can find a way to improve on this and gain more insight from my readings.

What is your perceived career goal after graduating?

At this time, I think I would enjoy a career in consulting or venture capital. So rather than being the one working in the lab to move science forward I would be contributing to scientific progress by securing funding for research groups or facilitating commercialization of their solutions.

I am currently working as a contract scientific consultant with a company that has developed a COVID-19 product they want to bring to market. I am incredibly grateful for this opportunity because I am gaining potentially career relevant experience while pursuing my studies.

What were some challenges for you during COVID-19?

I think the COVID-19 pandemic gave me a greater appreciation for science. When I'm in the lab I sometimes question how what I am doing will have any tangible impact or application in the real world, but the pandemic demonstrated how science, and more specifically scientists coming together to work towards a common goal, can provide solutions that make a difference in the world. I don't feel as though COVID-19 affected my career progression however, it was interesting to observe how different professions and different companies were impacted by the pandemic and how they handled such impact. I think the impact COVID-19 has had on my future trajectory is that it has solidified my desire to want to continue being involved in science even after completing my studies.

I think what was most challenging for research during COVID-19 was trying to work around the capacity limits and scheduling. Not being able to come into lab exactly when you want and being able to stay as long as you want does impact the rate at which you can progress in your experiments. Additionally, I missed having all my peers working alongside me to provide guidance when faced with a challenge or just moral support when experiments aren't working. Regarding career planning, that was not something I was actively working on/thinking about during COVID-19. Rather, I was more focused on research and therefore cannot speak to any challenges.

Meghan | **2023**

How has your research project changed in the last 2 years?

My research project has changed to focus on how the surface chemistry of DNA origami nanostructures can be optimized or engineered for improved delivery to the lymph node. Targeting the lymph node is important for vaccine applications, therefore improving the delivery of the nanostructures to the lymph node may result in a more robust immune response when used in vaccine applications.

Looking back at your answers now, what advice would you give to your younger self in 2021?

I would tell my younger self to dedicate more effort to planning and articulating a project. At the beginning of my PhD I was very excited to learn new techniques, put them into practice and start generating data. However, I wish I had been more consistent and dedicated a little bit more time to working on my project plan to ensure all experiments are in line with the big picture.

Have your goals changed? How so?

I don't think my goals have changed significantly, I still plan on entering the industry post graduation but I am taking this time to learn more about the different types of opportunities for PhD graduates.

What's the next step for you?

The next step for me is to prepare a first author manuscript and hopefully attend some conferences to hear what other researchers in the field are working on, in addition to sharing my own work.

Shana | **2021**

What projects are you working on right now?

Currently, a lot of my time is spent drafting my research proposal and figuring out what I would like my overarching project aims to be. I'm also working towards developing a DNA origami imaging technique that can be used simultaneously with flow cytometry.

What are you looking forward to in your graduate studies?

I'm looking forward to becoming more knowledgeable on how our immune system works and learning how we can leverage it to fight disease. I'm excited to be able to follow through with a project from start to finish, to learn new techniques in the lab, publish my first article, and to meet new people.

What's one thing you would like to improve on?

I want to improve on my presentation skills and my ability to give scientific talks.

What is your perceived career goal after graduating?

After graduating, my career goal is to work in a biomedical/biotechnology industry job or cancer research center, doing meaningful work that I enjoy.

Throughout my PhD I plan on attending conferences and networking events to learn more about what's out there and to help me develop a clearer idea of what field I want to be in when I do graduate.

What were some challenges for you during COVID-19?

At the start of COVID-19, I was just finishing my internship and it really got me to think about what I wanted to do next. Staying home and having more time to myself is what had me decide I wanted to pursue graduate studies. I felt like it wasn't a great time to be in the job market and that I wasn't done learning. I think because I've started my graduate studies Sept 2021, that COVID-19 won't impact my future trajectory that much, but we shall see.

It's been challenging trying to meet new people in BME as our courses have remained online however, my research hasn't been impacted.

Shana | **2023**

How has your research project changed in the last 2 years?

The overarching goal of my research project is the same as it was two years ago but the specific aims that I want to complete have evolved as I've learned more about the subject. As you read more about your PhD thesis area, you begin to understand the foundational knowledge of the field and therefore, you can see how your project can add to it. Because of this, what I aim to complete in my degree has changed over the years.

Looking back at your answers now, what advice would you give to your younger self in 2021?

The advice I would give my younger self would be to spend as much time as you need on understanding the subject area and planning your specific aims at the beginning. These things really help guide you on where to start with your research and point you in the right direction. The second thing would be to continue to pursue what you're passionate about because that's what keeps you motivated and that's why it's amazing to me how two years went by so quickly.

Have your goals changed? How so?

No, my goals haven't changed. I still am eager to pursue a career in industry working on cancer research.

What's the next step for you?

My next milestone is publishing my first first-author research article. I'm in the final stages of publishing the DNA origami imaging/flow cytometry technique that I spoke to two years ago. It's really exciting to see a project come together and to be able to publish it to the science community. ■

Incoming Class of **2023**

In September, BME welcomed 100+ students into our graduate programs. We asked some of these students why they chose our programs, and what they are looking forward to in this year.

Cecil Chikezie, PhD Program

I look forward to learning from my supervisor, Professor Patricia Trbovich, and the HumanEra lab members at North York General Hospital. Through our interaction, I will gain more expertise in the fields of Human Factors Engineering, Patient Safety, and Quality Improvement.

My interest in Biomedical engineering was bolstered during the COVID-19 pandemic. Kenya, my home country, was subject to high costs of oxygen ventilators, stiff global competition to obtain test kits, and deficient expertise to manufacture either product locally. Therefore, I decided to pursue biomedical engineering to positively impact the Kenyan and global healthcare systems.

Ferdinand Avikpe, PhD Program

Biomedical engineering became an area of interest through a combination of my love for science and my desire to be part of developing medical technology solutions that would improve access to healthcare. When the pandemic came during my 2nd year of university, I was introduced to nanotechnology and tissue engineering by chance and developed a strong interest in this branch of technology. Specifically, I found the use of nanotechnology in the production of mRNA vaccines for COVID-19 really interesting. I was intrigued by the technological capacity to see and subsequently control individual molecules and atoms. I was convinced that nanotechnology would present interesting opportunities to develop novel and revolutionary medical solutions for our struggling society. Since my undergrad University did not have a biomedical engineering program, I picked up a second major in Mathematics in addition to my biochemistry major with the aim of applying to biomedical engineering for graduate school.

Brynn Voigt, MASc Program

I'm eagerly anticipating delving deeper into the realm of medical technology and engaging with the exceptional research community at U of T.

My motivation to pursue biomedical engineering stems from a strong desire to make a meaningful difference in the healthcare sector. I aspire to leverage the knowledge gained during my studies to play a role in the development of cutting-edge medical devices.

Koorosh Roohi, PhD Program

Pursuing a graduate degree in biomedical engineering was inspired by a deep-seated desire to create something truly impactful and useful for others. I've always been drawn to the idea of using my skills and knowledge to make a positive difference in the world. Biomedical engineering offers a unique opportunity to do just that, as it sits at the intersection of cutting-edge technology and healthcare.

Aman Rahimatpure, MEng Program

I'm excited about delving deeper into advanced subjects, engaging in meaningful research, expanding my knowledge, and contributing to the academic community through my studies and discoveries. I am also eager to make connections with professors, my peers, and experts in the field!

This unique opportunity combines my passion for technology with my desire to contribute to human health and well-being. I aim to participate in the creation of innovative medical solutions and the enhancement of patient care.

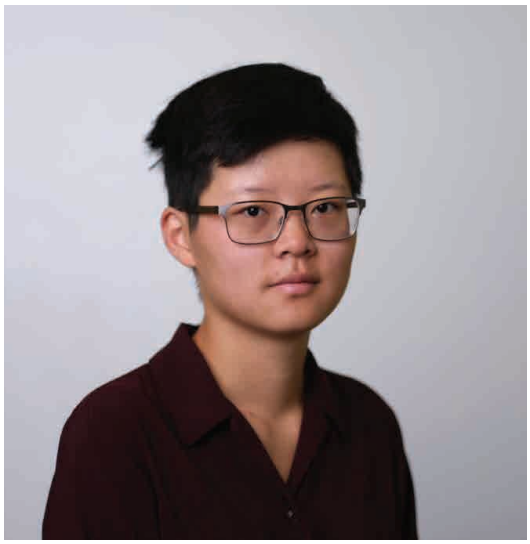
Bernadette Ng, MASc Program

Fueled by my undergraduate research on lungs-on-a-chip, I am driven to acquire the skills necessary to embark on a career focused on diagnostic devices for remote areas. This experience has ignited my passion for delving deeper into the field of biomedical engineering.

Jemila Abdulai, MEng Program

I chose Biomedical Engineering at UofT because I want to better my skills and myself as an individual. I look forward to meeting new people, learning new things, and growing as a biomedical engineer. I am confident that earning this master's degree at the University of Toronto will provide me with the tools and competencies required to produce high-quality and collaborative skills that will be useful in my future career endeavors.

My goal is to gain expertise in areas where I could help save lives. I want to contribute to the well-being of my community by being innovative in my approach to health care. Hence, my decision to study Biomedical Engineering. Since I enjoy learning about biomedical engineering design and processes, I need to gain advanced knowledge and cutting-edge practical skills in the field. This is necessary to implement modern and innovative diagnostic and therapeutic healthcare in my country.



Katrina Meng, MASc Program

I'm most excited to expand my knowledge in the fields of biomedical engineering that interest me most; prosthetics and orthotics. I am also excited to learn from and work with the motivated and inspirational students at BME and PROPEL lab.

I love engineering as a creative outlet. Biomedical engineering in particular allows you to work with patients in a more personal way, and can have a direct positive impact on people and their health.

Fateme Pourghasem, PhD Program

I'm excited about the prospect of exploring a multitude of opportunities during my time at UofT, renowned as one of the world's top universities. With a fervent commitment to revolutionizing the healthcare sector through advancements in AI, I'm confident that my endeavors could yield significant achievements. The exceptional resources provided by the university will undoubtedly play a pivotal role in realizing these ambitions.

The motivation behind my pursuit of biomedical engineering lies in my research focus on AI-assisted rehabilitation at UofT. The presence of exceptional labs, featuring a diverse array of interdisciplinary experts, coupled with the chance to engage with actual patients and the flexibility to enroll in courses across various departments, reinforces my belief in the Biomedical Engineering department's capacity to provide comprehensive learning during my PhD journey.

Pourya Moghadam, PhD Program

I chose biomedical engineering because of its highly professional resources, professors, and facilities. I look forward to making international progress in the field of my research.

Thierry Dugas, MASc Program

I am looking forward to collaborating with clinicians in a multidisciplinary environment, meeting like-minded individuals, and exploring new areas of research. I also hope to get involved in a wide range of opportunities to gain the knowledge and skills to contribute to advancing and improving access to medical technologies for everyone.

I was inspired to study biomedical engineering after seeing the tangible impact of engineering design in improving the quality of life of patients. I find motivating the possibility of applying problem-solving and technical skills to research with real-world implications.

Ben Kozlowski, MASc Program

I am excited to engage in a multitude of research opportunities within my field of study, developing an inquisitive and critical mindset to serve me within academia and other avenues of my life. In relation, I am eager to take on teaching prospects within my Department and the University as a whole to begin translating my knowledge base with prospective students. With this, working with like-minded individuals in a community that values direction and serves to bolster collaborative ideals and ensure holistic growth.

Pursuing a degree in Biomedical Engineering ticks all the boxes of my academic interests and proclivities, harbouring the infusion of biomedical and core scientific knowledge with analytical foundations. It is the best of both worlds and opens the doors to a multitude of modes of thinking, as to apply directly what you learn to a health care frame. The collaboration between faculty and academics in BME is second to none, and I intend to maximize my opportunities here throughout my tenure.

Martin Hermans, MEng Program

I am excited to build upon my undergraduate knowledge and innovate within my chosen field to ultimately contribute meaningfully to the global community.

I chose to study biomedical engineering because I wish to explore my interests and passions in the intersectionality of engineering and medicine, and the program offers both theoretical coursework and practical components.

Benjamin Banh, MEng Program

Coming from a life science background, I'm excited to learn more about how the biological sciences connect and intersect with technology and engineering. I hope to further develop my skills in problem-solving while using my own unique skillset coming from a life and biological sciences background to create solutions to current and future healthcare problems. I plan to explore both biological and technical pathways to further developing and optimizing healthcare.

As someone who hopes to pursue medicine and work in the health-care system, I am constantly thinking of new and innovative ways to offer patients the best care possible. With technology being a prominent and influential tool in the world of medicine, I have become aware of its role and importance in the development of treatments and diagnosis of different conditions. The MEng Biomedical Engineering program offers a chance for students to gain real-world experience in the healthcare sector and a chance to immerse themselves in the field intersecting medicine and technology.

Camille Guerin, MEng Program

Studying biomedical engineering was motivated by my aspiration to blend my enthusiasm for science and technology with a profound commitment to making a positive difference in human health and well-being.

Wisdom Mawuenyefia Amenyo, MEng Program

I'm excited to join a dynamic community of passionate peers and professionals in science and engineering, united by a common goal of creating positive change. I'm drawn to purpose-driven work and eager to contribute to advancements in modern health. I aspire to be a catalyst for growth and sustainability, utilizing my skills to address evolving healthcare challenges. My interest in Biomedical Engineering stems from a desire to fill gaps in technology and expertise. I aim to lead transformative efforts in healthcare, particularly in underserved regions. My goal is to establish a robust and innovative health network in areas like Sub-Saharan Africa, South-East Asia, and parts of South America, addressing key issues in access, emergency response, training, and planning.

Haotian Xue, PhD Program

I am excited to deepen my professional skills and explore the wonders of Biomedical Engineering with peers who share my passion.

I was drawn to Biomedical Engineering at UofT due to my deep passion for healthcare, complemented by the outstanding resources and faculty, which collectively offer an amazing platform for innovation in the field.

Sorsha Asady, MASc Program

I am deeply drawn to the intricate process of analyzing collected data and deciphering its clinical significance. This desire stems from my aspiration to merge my fervor for medicine and pediatric healthcare with a strong foundation in technical engineering skills. This dynamic combination fuels my pursuit of a career that seamlessly blends these two disciplines to make a meaningful impact in the healthcare industry.

Savina Cammalleri, PhD Program

I am looking forward to meeting like-minded, passionate, and creative people looking to push the boundaries of science and technology.

As an undergraduate alumnus, I could not imagine a better place to pursue a PhD. The university is a place of diverse thinkers with lots of collaborative efforts. The MPUTC program I am pursuing will allow me to travel to the Max Planck Institute in Germany to push further our understanding of the molecular manifestation of Alzheimer's disease.

Nicholas Dietrich, MD/MEng Program

I'm eagerly anticipating the opportunity to delve into the latest breakthroughs in medicine and collaborate with a community of brilliant peers. My inspiration to study biomedical engineering lies in its unique intersection with medicine, offering the chance to pioneer innovative technologies that enhance healthcare practices. This convergence of disciplines propels my passion for making a tangible difference in the field.

Avantika Vaidya, MEng Program

In addition to all the amazing academic opportunities that the institute has to offer, I'm looking forward to collaborating and learning from a diverse network of passionate peers and professionals within BME and at UofT. I think the BME program's design offers unparalleled opportunities for both professional and personal growth, and I'm excited to use this graduate program to foster positive change in my communities and in industry.

I have always had a very deep inclination towards all subjects within STEM, but I have always admired the unique potential that biomedical engineering has to address complex human healthcare issues from an innovative design perspective. I was inspired to join the BME industry after observing how directly medical technology influences the success of the healthcare industry and the kinds of large-scale impact innovation can have within the field. I hope to garner skills and knowledge from this program to help advance the field further.

Peter Greechan, PhD Program

I'm focused on fostering a vibrant community within the Institute of Biomedical Engineering and deepening my understanding of neuromodulation. This drive is deeply influenced by my mother's impactful work in healthcare and my own fervor for the sciences. Together, these experiences fuel my dedication to contributing meaningfully to the field.

Peter Chimienti, MEng Program

I'm eager to broaden my expertise in the realm of medical devices and biomedical engineering. My enduring passion for engineering has always been a driving force, and the prospect of crafting devices and therapies that can alleviate illness and enhance quality of life is an extraordinary opportunity that I simply couldn't resist delving into. This convergence of my interests and aspirations propels me forward in this field.

Zahra Niazi, MEng Program

I am genuinely looking forward to studying the courses I have selected for my program. Moreover, I'm excited about utilizing the unique resources provided by the school to enhance my skills and personal growth.

The dynamic and interdisciplinary nature of the program which combines both medicine and engineering is what appealed to me. Coming from a background in biomedical sciences, I wanted to align my existing skills and knowledge with the practical applications I'm excited to learn about through this master's program.

Elizabeth Acheampong, MEng Program

I look forward to exploring new opportunities, contributing to the biomedical engineering community, making wonderful friends, and being the best version of myself.

In my senior high education, I had the opportunity to join a cohort of students who engineered robotic systems from cheap mechanical and electronic components. This exploration together with my interest in healthcare birthed in me a singular interest in biomedical engineering. In 2018, I began my biomedical engineering undergraduate studies at Kwame Nkrumah University of Science and Technology. I wasn't sure of my long-term goals until in the same year, my wonderful mother was diagnosed with the uncommon but fatal cancer multiple myeloma. Since then, I've become increasingly driven to contribute to the effort to address the issue of delayed sickness detection and to push the advancement of modern medicine through biomedical engineering.

Anna Maria Pius, MEng Program

I am looking forward to connecting with like-minded individuals and building my professional network while exploring various domains in Biomedical Engineering.

Fateme Eskandary, PhD Program

I'm thrilled about the opportunity to receive world-class research training and be part of a community that shares a deep passion for learning and creating. It's incredibly enriching to have a network of like-minded individuals who are eager to explore various fields.

In my quest to help others, I've realized that simplicity is key. Health is a universal need, and that's where I've chosen to focus my efforts. The prospect of creating solutions that could potentially improve the lives of thousands worldwide is what truly excites me. It allows me to blend different disciplines, push the boundaries of knowledge, and make a positive impact on a global scale.

Minnie Menezes, MASc Program

I am looking forward to finally working in a hospital and actually doing BME research every day of school!

My love for healthcare and medicine has been around since I was a child. I've always been passionate about helping others and doing so first-hand brings me much joy.

Jade Huang, MASc Program

I look forward to strengthening my technical and professional skills as an independent researcher while making meaningful connections with like-minded people and generating lasting memories. As a MASc student, I want my research to positively impact patients' lives and improve their overall quality of life.

I was motivated by the potential treatments in regenerative medicine for human application while completing my undergraduate thesis at the University of Toronto. I wanted to conduct graduate-level research in a rigorous yet supportive atmosphere, and choosing BME was an easy decision to continue my academic journey.

Emnpreet Bahra, MEng Program

Graduate school gives me the chance to further my knowledge in an emerging field through interdisciplinary collaboration and industry connections. I am excited to take courses at the intersection of engineering and medicine, and I look forward to working with like-minded people along the way!

My passion for design thinking and medicine has been a driving force in my decision to pursue a career in biomedical engineering and has given me unique experiences in healthcare. Combined, they have the ability to drive positive change in our society, and biomedical engineering allows me to be a part of that!

Samantha Unger, PhD Program

I'm excited to meet other students and researchers, while continuing to expand my skillset and contributing to the support of human health.

I love how multidisciplinary biomedical engineering is, bringing together approaches and ideas from different fields. I appreciate how this leads to unique collaboration and innovation that has the ability to create a meaningful impact.

Zarifa Nazarali, MEng Program

I look forward to joining the diverse, talented community at UofT and contributing to advancements in the field of BME!

BME is the perfect amalgamation of life science, technology, and design. I was immediately captivated by the multidisciplinary approach to solving complex problems, with the ultimate goal of transforming global health. The dynamic nature of the field along with the potential for exponential growth and innovation is exciting!

Adriel Ngo, MEng Program

I'm looking forward to enhancing my technical skills and learning more about medical device development. I'm excited to experience new opportunities.

I was inspired to study biomedical engineering when I discovered a passion for working on engineering design for innovative technologies that can directly impact public health and improve the quality of life of people in need.

Emmanuella Akowuah, MEng Program

I love applying engineering principles to medicine. I want to learn more about biomedical engineering especially in the field of rehabilitation and gain more opportunities to utilize the knowledge gained.

I selected the program because of its curriculum and the opportunity to gain more professional skills in my field. Also, its connection with rehabilitation institutes and company. ■

Student Research Conference **2023**

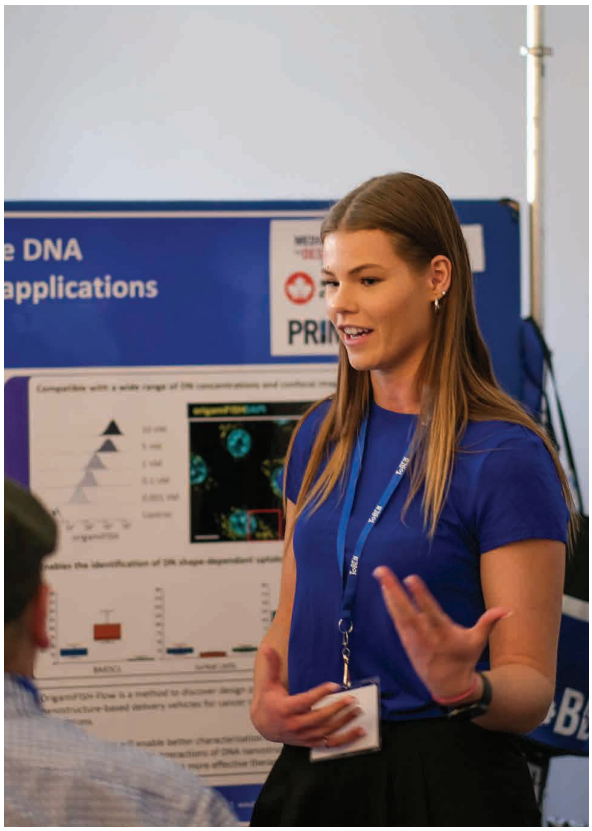
The 2023 Toronto Biomedical Engineering Conference, held at Hart House, took attendees on an exhilarating journey into the realm of artificial intelligence in biomedical engineering. This year's conference attracted an impressive gathering of over 300 students, reflecting the growing fascination with the intersection of AI and healthcare.

Renowned speakers Dr. Sonya MacParland, Dr. Shuichi Takayama, and Dr. Yasser Iturria-Medina captivated audiences with their insightful keynote speeches, shedding light on the latest advancements and future prospects in biomedical engineering. The scientific rigor and innovative problem-solving skills displayed by the poster and oral presenters left judges impressed across various streams, including clinical, molecular, and tissue engineering.

In addition to the captivating scientific presentations, this year's workshops focused on ethics in artificial intelligence

and machine learning, as well as developing career paths. Participants were given insights and advice from various experts in the AI space as well as UofT BME alumni. Invited panelists included Dr. Yalda Mohsenzadeh, Dr. Muhammad Mamdani, Dr. Milos Popovic, Dr. Babak Taati, Dr. Elham Dolatabadi, Dr. Bastien Moineau, and Bryan Piper.

The conference concluded with a memorable dinner at the renowned Royal Ontario Museum, where the much-anticipated announcement of award winners took place.■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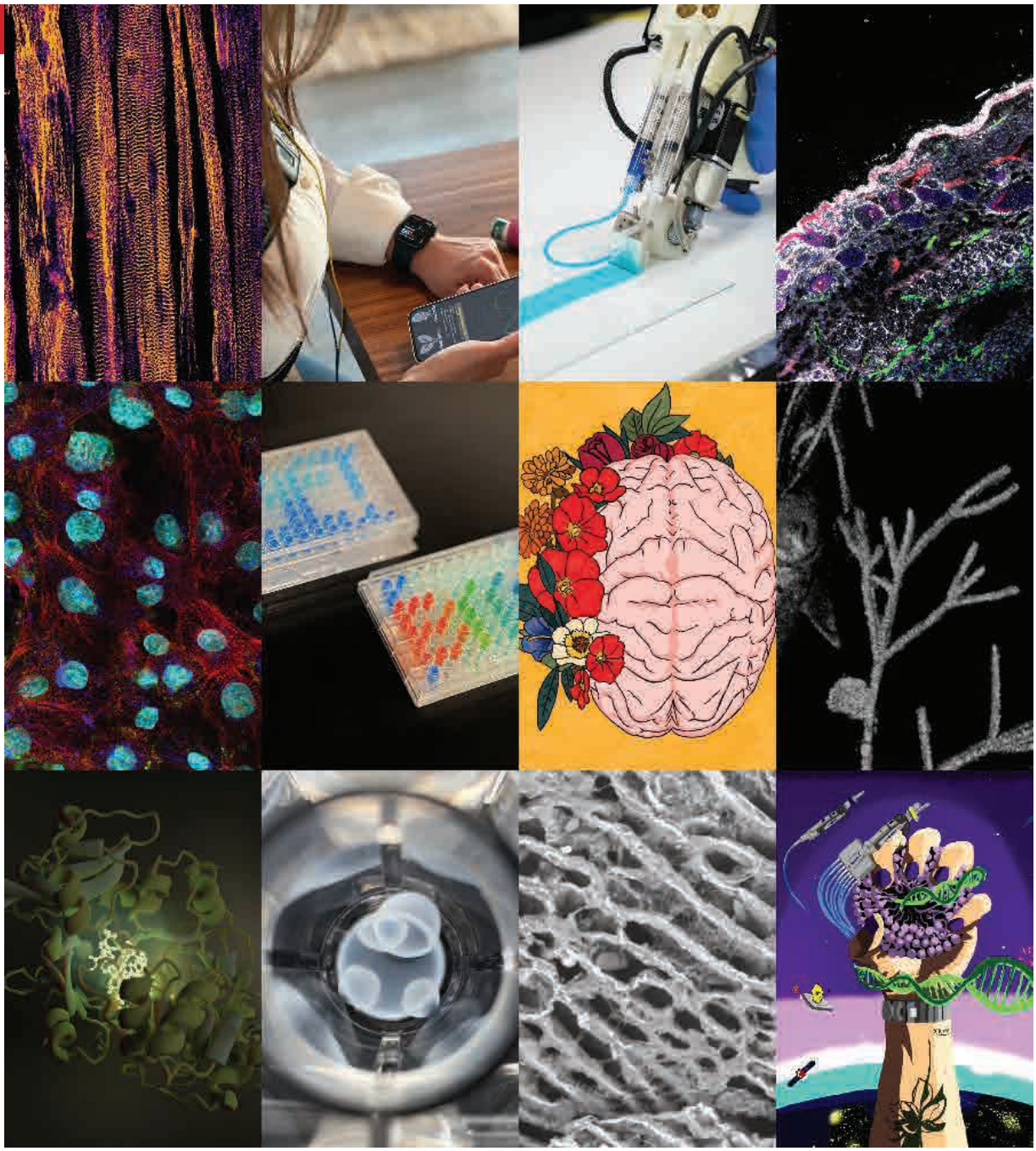
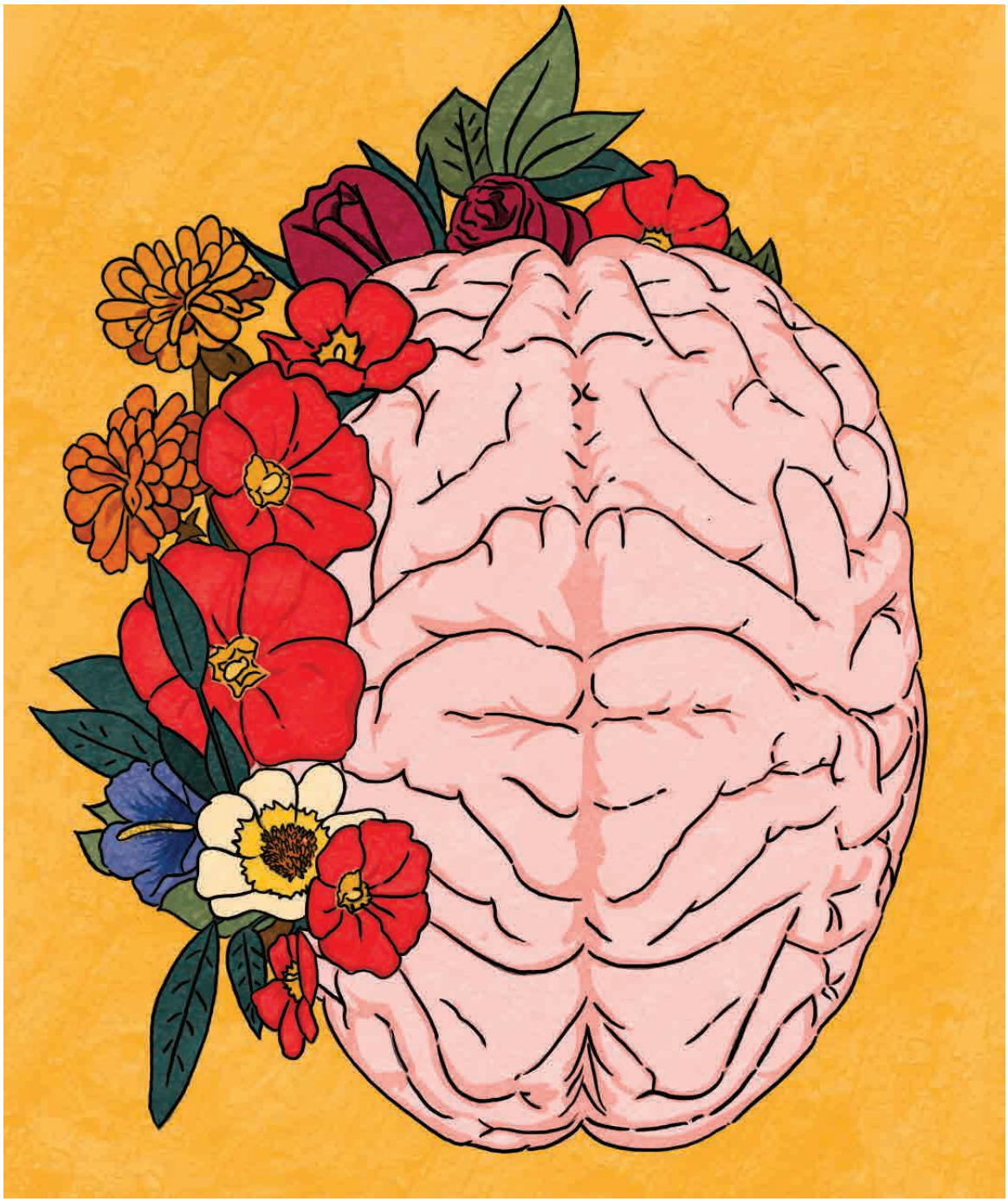


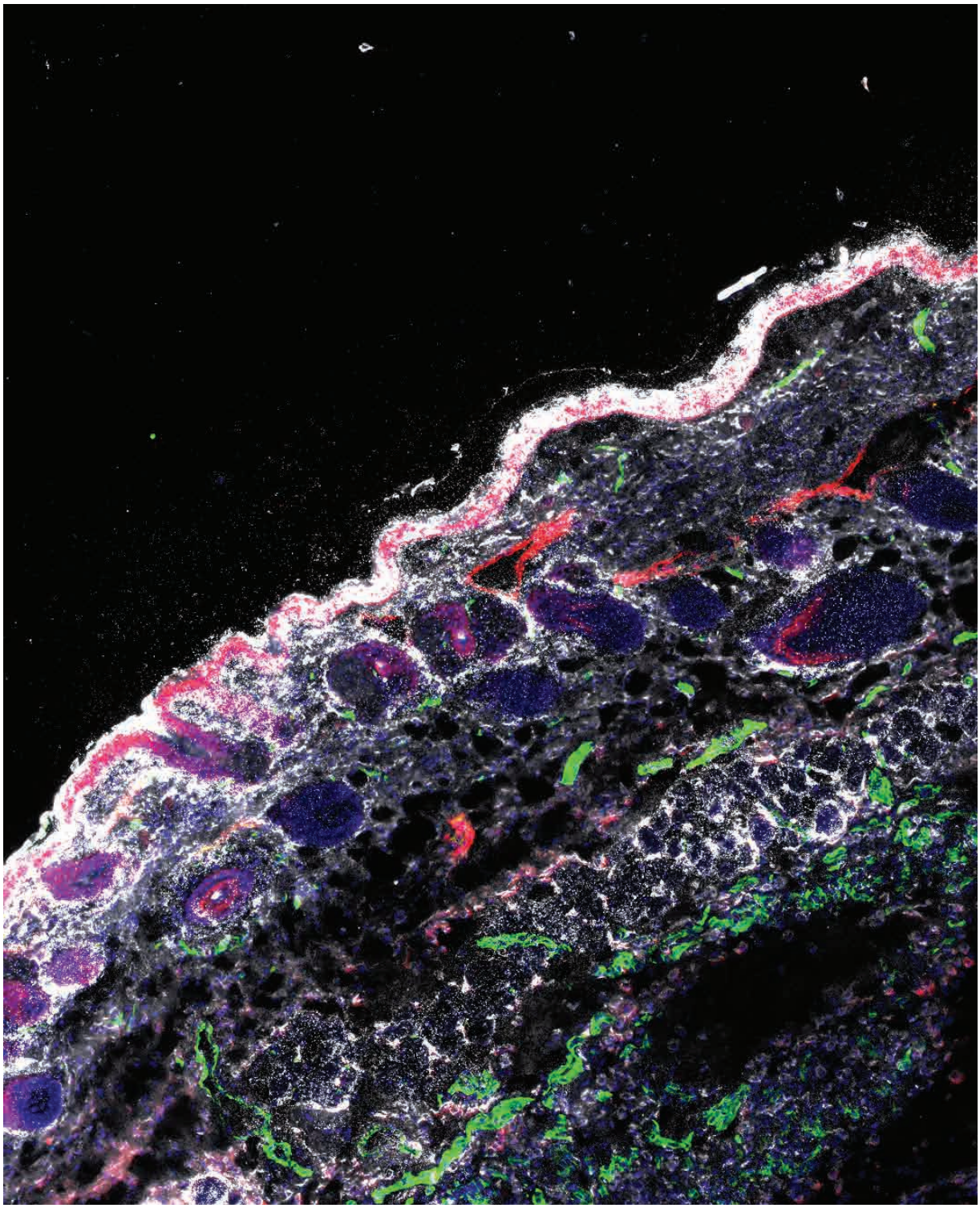
Research Gallery of **2023**

Each year, we invite our community to unleash their creativity by submitting vibrant images, captivating photos, and inspiring illustrations that vividly showcase their incredible work.



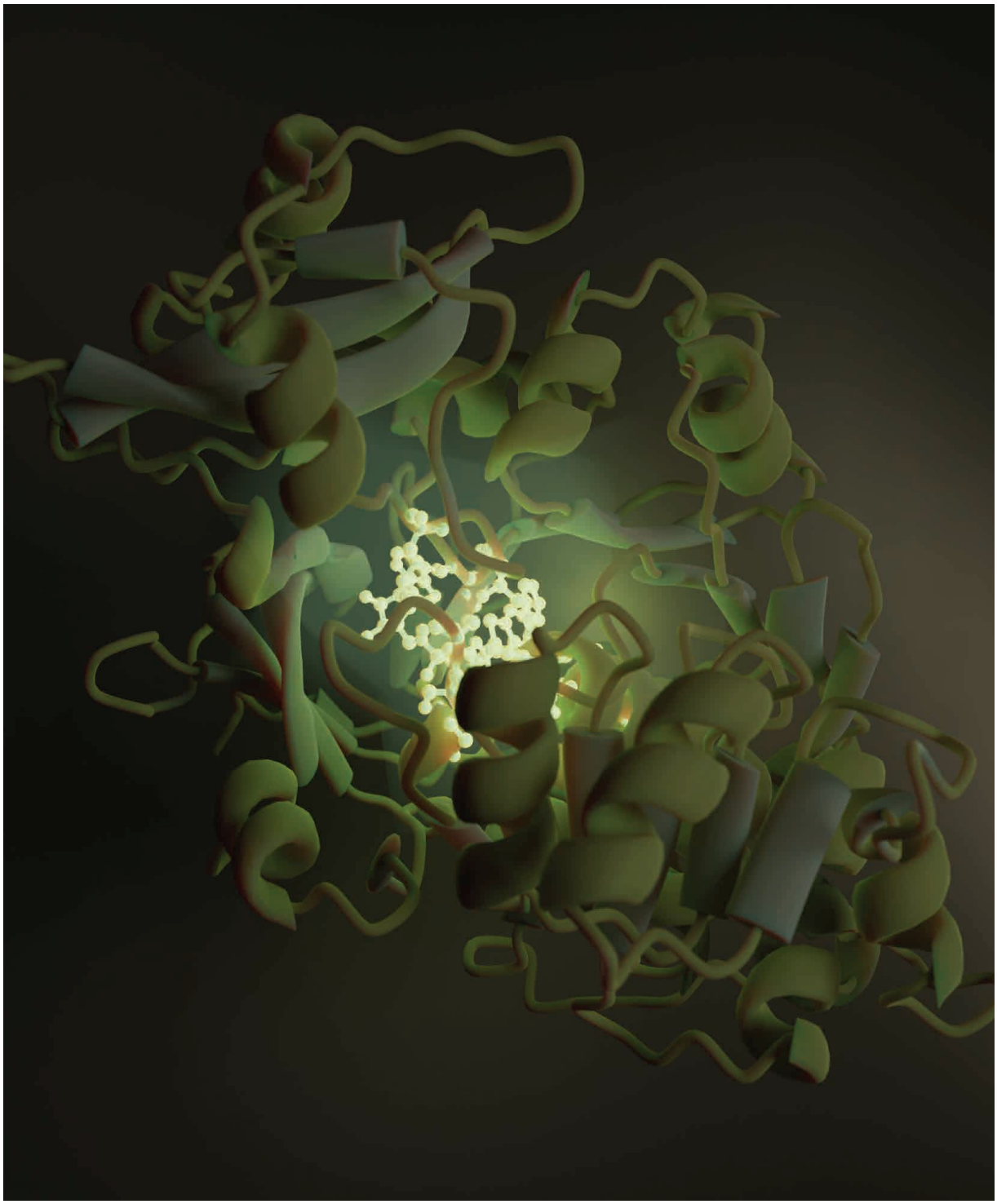
↑ **Karly Franz** | PhD Candidate | Tom Chau Lab

The brain and mental processing are central to my research, which focuses on understanding how autism affects the brain. The brain is one of the final frontiers of research; it facilitates our perception and connection with the world, yet possesses an organic complexity that we continue to unravel through investigation. This illustration also speaks to the mental health of BME students, staff, and faculty, something that has gained significant importance and become a prominent topic of discussion since the COVID-19 pandemic. Taking the time and steps to maintain a healthy mind enables the creation of a foundation from which our research and inspiration can bloom.



↑ **Dr. Luan N.M. Nguyen** | Postdoctoral Fellow | Warren Chan Lab

Histology of nanoparticles (white) in the skin tissues surrounding a tumour. Blue, nuclei; Green, blood vessels; Red, lymphatics.

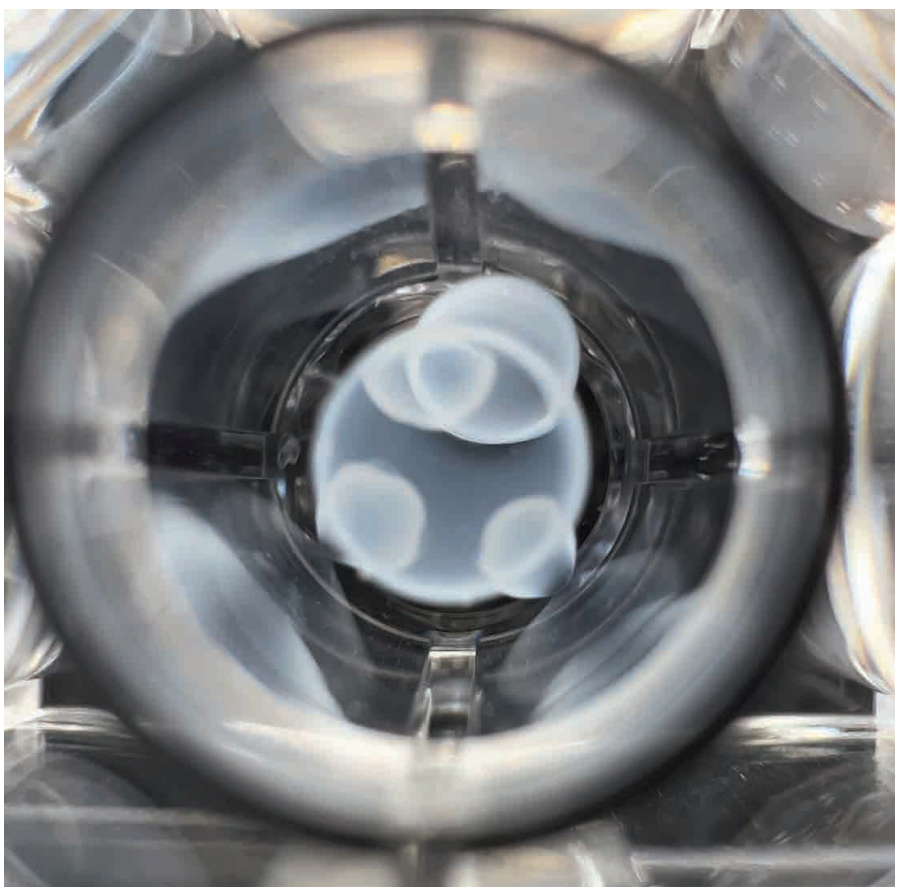


↑ **Grayson Tilstra** | PhD Candidate | Omar Khan Lab

Firefly Luciferase rendered using Blender. When bound to its chemical substrate, luciferin, Firefly Luciferase produces a bright yellow-green luminescence. Multiple forms of Luciferase exist in nature. In our lab we use it to detect protein expression within cells.

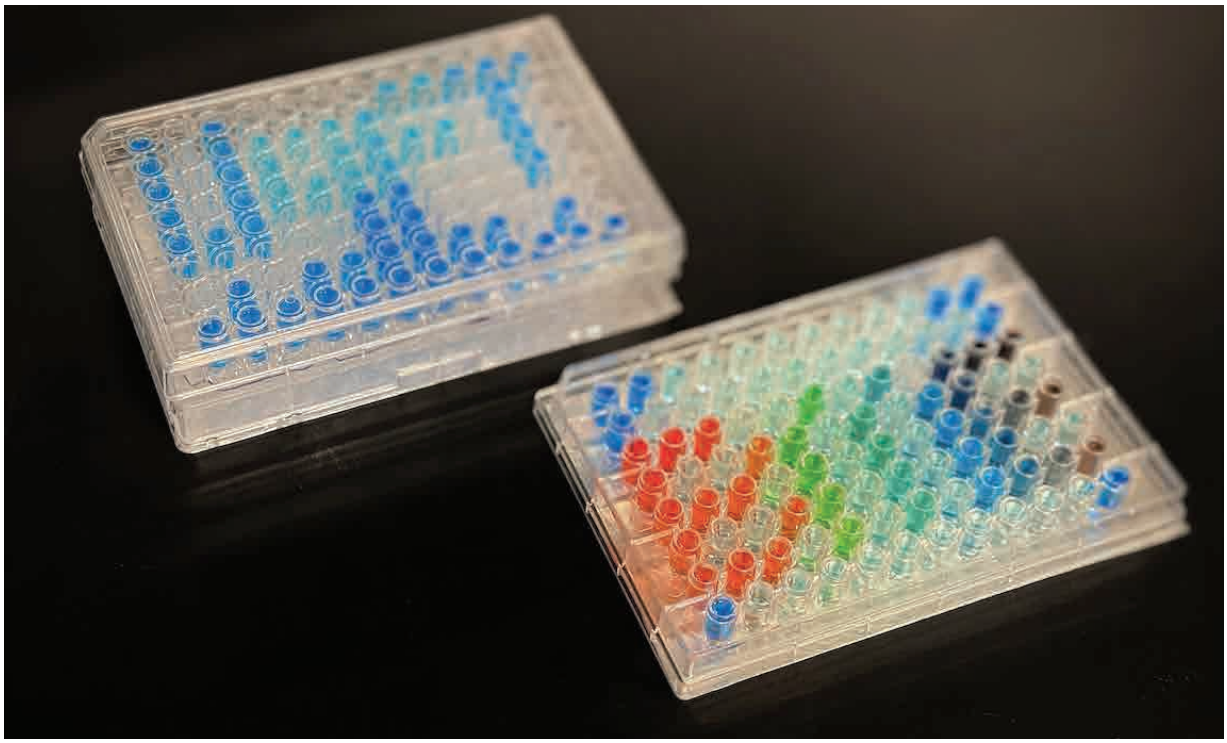
↑ Nirmal Pol
| PhD Candidate
| Lueder Kahrs Lab

Harnessing the real-time micron resolution capabilities of Optical Coherence Tomography imaging to autonomously navigate a robotic surgical scissor tool within a vascular phantom to target abnormalities with microscopic precision.



→ Mohammad Nazeri
| PhD Candidate
| Frank Gu Lab

Tiny Plate, Big Discovery: Where Polymers and Drugs Meet for a Nice Gel on the 96-Well Plate

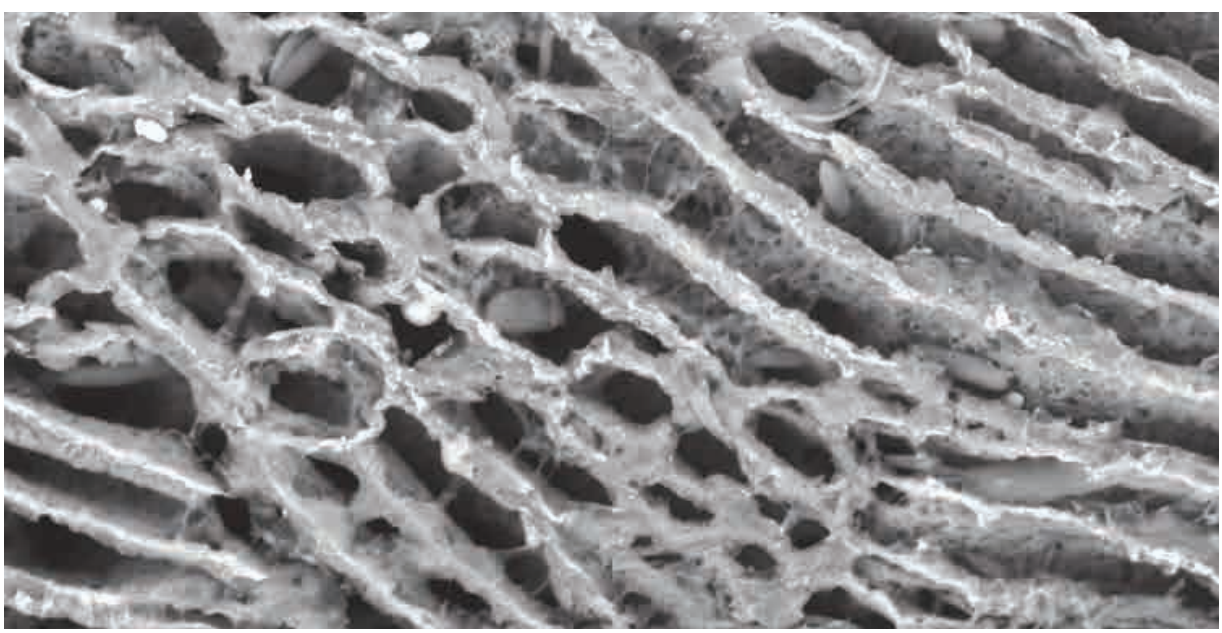


↑ Haotian Xue | PhD Candidate | Aereas Aung Lab

The UofT BME community is a mosaic of equality and inclusion, where every creative mind with a passion for biomedical engineering contributes to the symphony of cutting-edge research. Together, we're not just spelled as "UofT BME"—we're building the foundations of a healthier and brighter future.

↓ Sargol Okhovatian
| PhD Candidate | Milica Radisic Lab

Zoomed in SEM of highly porous and aligned biomaterial that enables cardiac tissue orientation.

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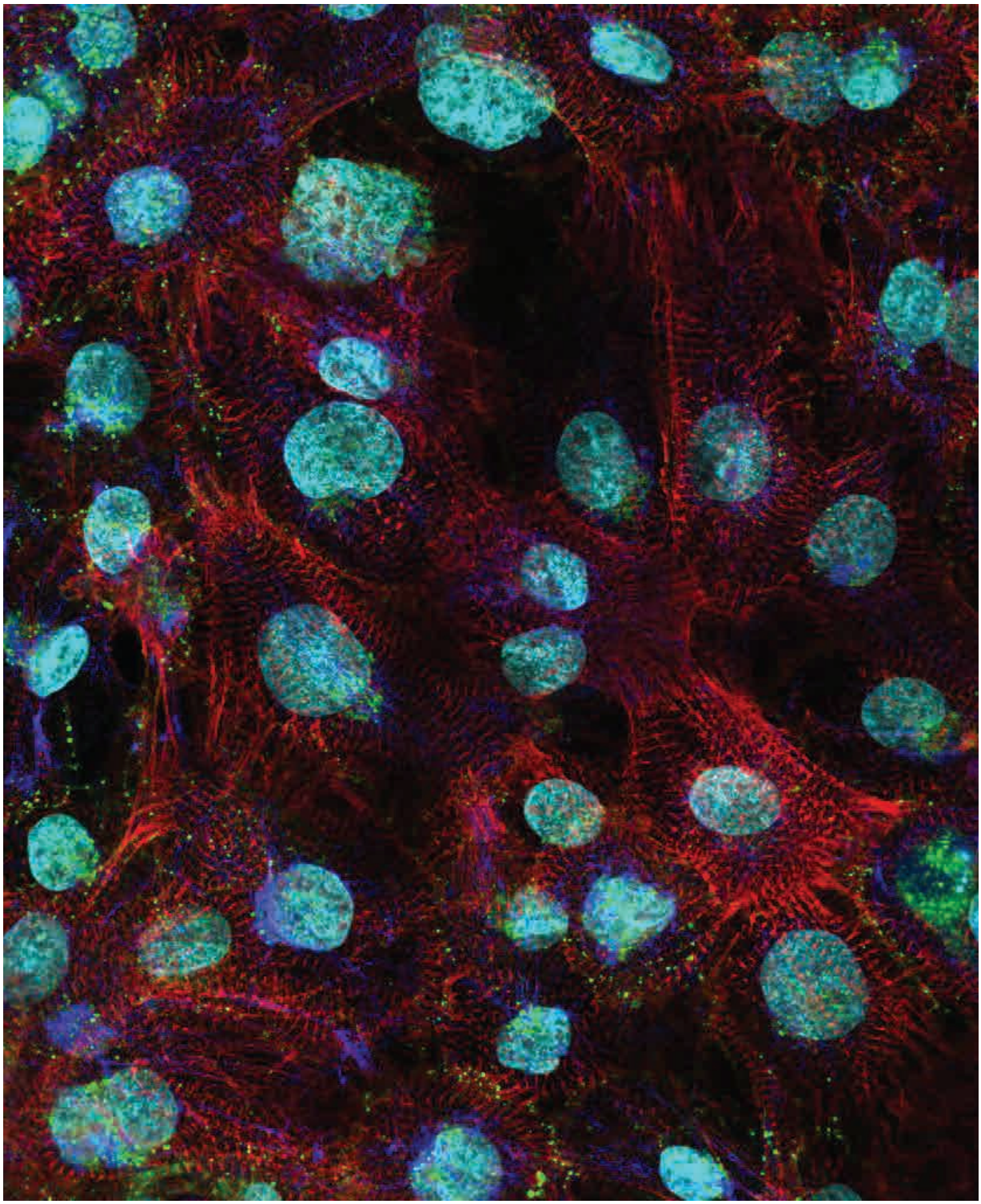
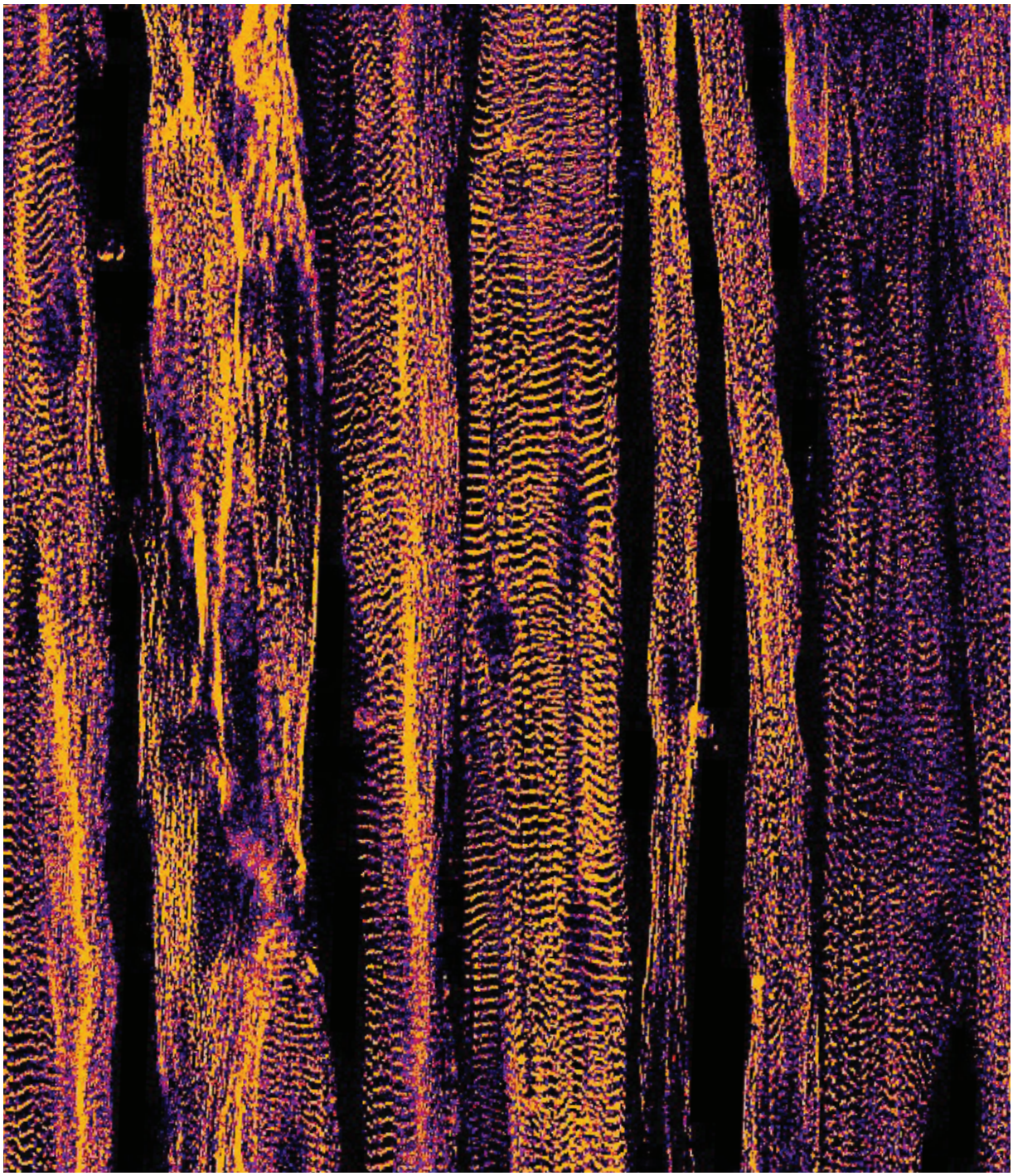


← **Ryan C.L. Lee** | PhD Candidate | Leo Chou Lab

Why do we shoot at each other, when we can shoot for the stars?

↑ **Yu Ding** | MASc Candidate | Craig Simmons Lab

Cardiomyocytes in maturation - stained 4 ways and overlaid.



↑ **Heta Lad** | PhD Candidate | Penney Gilbert Lab

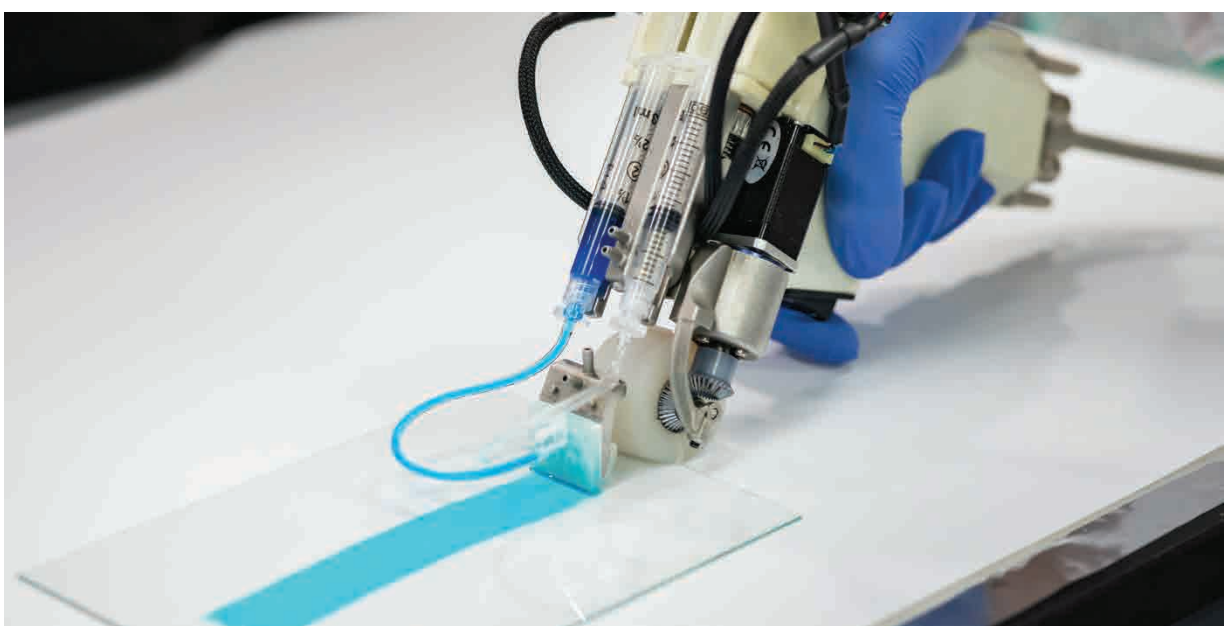
Earning our stripes; Using biofabrication and tissue engineering techniques, we reconstruct miniaturized versions of human skeletal muscle tissue in a dish. Highlighted in this image are immunostained skeletal muscle fibers showcasing their beautiful and prominent striations/stripes in a 3D human microtissue grown in the lab.

↑ Shaghayegh Chavoshian
| PhD candidate | Azadeh Yadollahi Lab

Monitoring cardiac and respiratory signals through a wearable device and mobile application can predict asthma worsening. This application can provide warnings to prompt individuals to take additional precautions, empowering them to improve asthma management and minimizing the risk of hospitalizations.

↓ Sushant Singh
| PhD Candidate | Axel Guenther Lab

The images depict the handheld bioprinting technology developed in our laboratory for the treatment of full-thickness skin defects, including burns. The bioink used in the process is identifiable by its blue color.

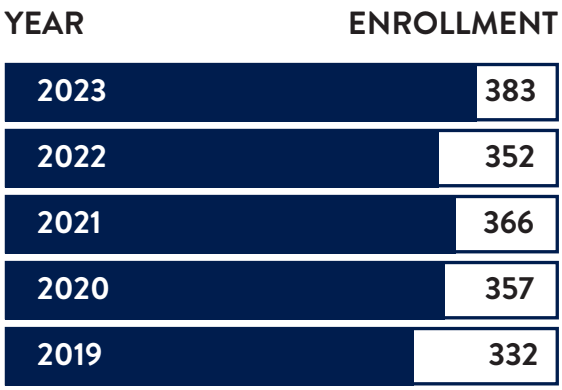


2023 in Numbers

We have summarized the 2022-2023 academic year in student distribution, funding information, and research capacity in the following pages.

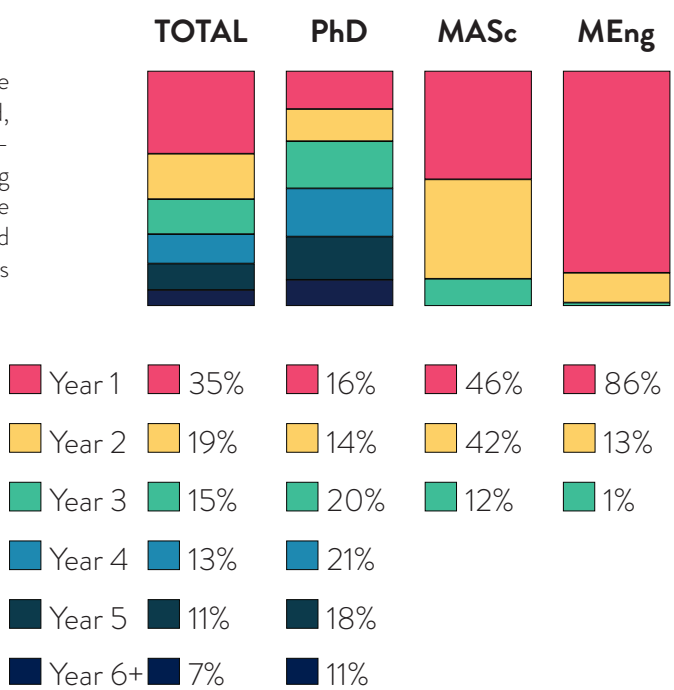
Enrollment Trend

BME graduate student body has been experiencing steady growth in the past 5 years. At the beginning of 2023 academic year, the graduate population had an increase (8.8%) compared to the previous year. The enrollment represent the number of students registered in our programs as of September of every year. Data was collected in October 2023.



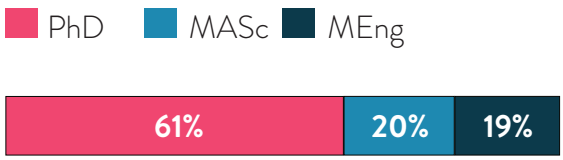
Enrollment Year Distribution

First year students are the most prevalent in the student body. Within the 383 students registered, 135 are first year students. While the student distribution is balanced in PhD and MASc programs, MEng has the highest proportion of first year students. Since this is one year program, the proportion of second year and above is expected to be low. Data was collected in October 2023.



Enrollment Breakdown

Majority of the graduate student population consists of PhD candidates. Data was collected in October 2023.



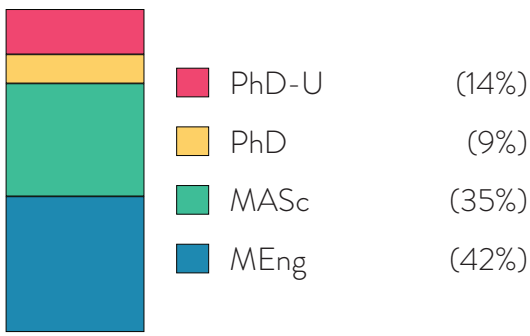
Graduation Summary

The graduation number is similar to the last academic year. The numbers indicate the students who have met all program requirements and are eligible to graduate. The numbers from the 2022-2023 academic year was calculated from combining 2022 September, 2023 January, and 2023 May sessions. Data was collected in October 2023.

YEAR	GRADUATED
2022-23	108
2021-22	115
2020-21	111
2019-20	90
2018-19	97

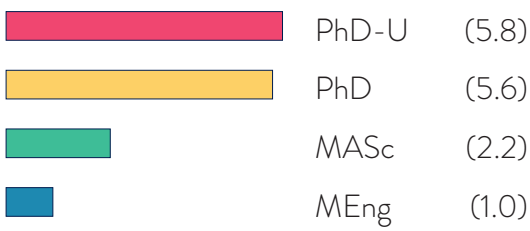
Graduation Breakdown

Graduate proportion is similar to the current student body breakdown, indicating a balanced exit rate amongst students within each program. Bracketed percentages indicate the proportion of students out of 108 total graduates in 2022-2023. PhD-U: students who enrolled directly into PhD from an undergraduate degree. PhD: students who had previously obtained a masters. Data was collected in October 2023.



Graduation Time

Graduation time is dictated by degree type in 2022-2023. PhD-U: students who enrolled directly into PhD from an undergraduate degree. PhD: students who had previously obtained a masters. The number of years was calculated as an average. Data was collected in October 2023.



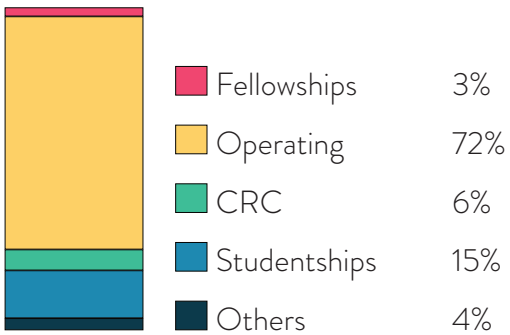
Research Funding Trend

BME has received $8.93 million in research funding amongst 43 core faculty members. On average, funding per faculty member is approximately $0.21 million between September 2022 – August 2023. Data was collected in November 2023.

YEAR	FUNDING
2022-23	$8.93M
2021-22	$7.94M
2020-21	$9.31M
2019-20	$11.13M
2018-19	$10.51M

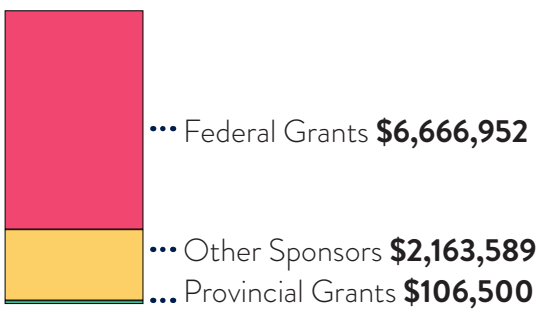
Grant Distribution

There are 108 funding packages for the September 2022 - August 2023 period. Majority of the funding packages were operating grants for research activities. CRC: Canadian Research Chair funding. Others include: physical infrastructure and technology transfer. Data was collected in November 2023.



Funding Breakdown

Majority of the research, equipment, and personnel funding originate from the federal government of Canada. 'Other Sponsors' are categorized as funding from education bodies, foundations, hospitals, international organizations, and societies. The numbers represent percentages of $8.93 million from the September 2022 – August 2023 period. Data was collected in November 2023.



Publication Themes

BME has published 141 peer-reviewed papers during January 2023 - November 2023 from our core faculty members. The data on the right was aggregated *via* SciVal. Larger text size indicate higher frequency in publications gathered in the forementioned period. Data was collected in November 2023.

2023 Community Directory

This year we decided to save some paper! Scan the following QR codes, or click on the QR code if you are viewing the digital version, for a full directory.

CORE FACULTY

AFFILIATED FACULTY

EMERITI

STAFF

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UNIVERSITY OF TORONTO

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