

A scanning electron micrograph (SEM) showing numerous spherical cells with a highly textured, porous surface. The cells are scattered across the frame, with some in sharp focus and others blurred in the background. The overall color palette is a range of blues and teals, from light cyan to deep navy.

iBEST

AT A GLANCE

Ryerson
University

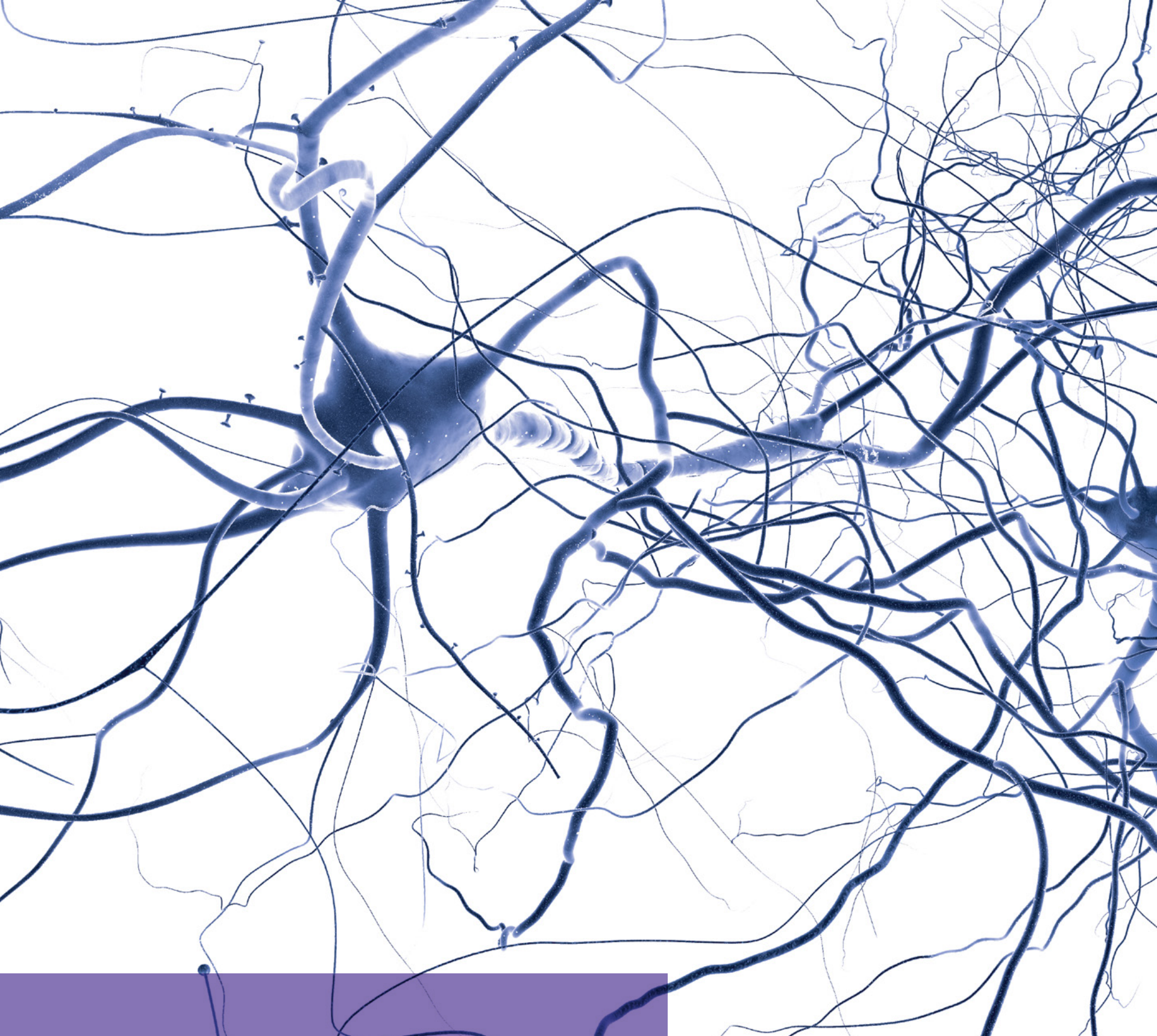
St. Michael's

Inspired Care. Inspiring Science.



“THE SYNERGIES BETWEEN SCIENCE, ENGINEERING AND HEALTH RESEARCH, AS WELL AS THE OPPORTUNITIES FOR COLLABORATION AND KNOWLEDGE TRANSLATION, SPARKED THE FORMATION OF iBEST.”





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MESSAGE FROM OUR CO-DIRECTORS

Seated next to each other at a conference, Dr. Ori Rotstein, director of the Keenan Research Centre for Biomedical Science of St. Michael's Hospital, and Dr. Mohamed Lachemi, then-dean of Ryerson University's Faculty of Engineering, Architecture and Science, started a conversation that led to the creation of one of Canada's most unique biomedical research centres. The synergies between science, engineering and health research, as well as the opportunities for collaboration and knowledge translation, sparked the formation of iBEST. This report looks back at some of iBEST's accomplishments.

iBEST officially opened its doors in January 2016 and has been a hub of productivity, as Ryerson and St. Michael's researchers have garnered a significant number of grants and collaborated on joint projects and publications.

With a greater understanding of clinical needs, our researchers are inspired to consider the benefit of a bench-to-bedside approach, creating opportunities for translational research and promoting rapid prototyping that brings innovation into clinical use faster. Ryerson's graduate programs have now expanded so more student trainees benefit from the knowledge at both institutions.

Nearly 50 researchers are currently working in at least one of iBEST's focus areas. The four themes defined in this report have each received an appointed lead to strategically guide iBEST's development and establish a visiting lecture series for the institute.

Having our labs in close proximity means expertise is just steps away, whether it be clinical and biomedical expertise in the Keenan Research Centre, or engineering and science expertise at the iBEST labs. Our ties to the Biomedical Zone create access to knowledge in commercialization and entrepreneurship, helping speed our research into innovation and adoption.

This report highlights a small selection of discoveries and advancements by iBEST researchers. Proximity breeds collaboration, and with iBEST's diverse membership in one place, our home is truly "Bond" Street.

Dr. Ori Rotstein, Dr. Sri Krishnan and Dr. Michael Kolios

-June, 2017

Co-Directors of the Institute for Biomedical Engineering, Science and Technology, a partnership between St. Michael's Hospital and Ryerson University



RESEARCH THEMES

iBEST provides a collaborative platform for medical research, leading to new and innovative ways of helping patients. With its state-of-the-art labs and infrastructure, the institute is driving discoveries that align with market needs across four main research areas.

BIOMATERIALS, TISSUE INJURY & REPAIR (BTR)

Dr. Haibo Zhang is theme lead of BTR, leading a team of researchers from medical and engineering fields to collaborate on building an advanced scaffold for injured organs. The team is also working to identify key signaling pathways for crosstalk between exogenous and endogenous mesenchymal stromal cells (MSC) in order to accelerate cell regeneration in injured organs. In addition to cell therapy, the team will build and optimize non-invasive ventilator techniques to help lung regeneration after injury.

BIOMEDICAL DELIVERY SYSTEMS (BDS)

Dr. Scott Tsai is theme lead of BDS, heading a group of research teams that are striving to maximize the effectiveness of medication and minimize side effects through the application of microfluidics and nanotechnology. iBEST's innovations in advanced drug delivery systems aim to improve the accuracy of therapeutic medicine and reduce healthcare costs.

BIOMEDICAL IMAGING & THERAPY (BIT)

Dr. General Leung is theme lead of BIT, steering research to develop technologies that enable imaging at the cellular and tissue levels for quick diagnosis, provide real-time feedback during surgery, and offer image guidance for radiation therapy to target and kill cancer cells without having to operate. The BIT teams are also using biomedical signal processing and mathematical modeling of physiological processes to better diagnose diseases, curb their progression, and develop new therapeutic options.

HEALTHCARE ANALYTICS & APPLICATIONS (HAA)

Dr. Alireza Sadeghian is theme lead of HAA, a team of researchers who are utilizing high-performance computing and data analytics tools to improve our understanding and ability to visualize the massive amounts of healthcare data available. This type of research has the potential to advance precision medicine, ultimately providing new insights into the field of healthcare, improving patient outcomes, and avoiding unnecessary costs.



SEEING THROUGH THE SKIN, AND SKULL

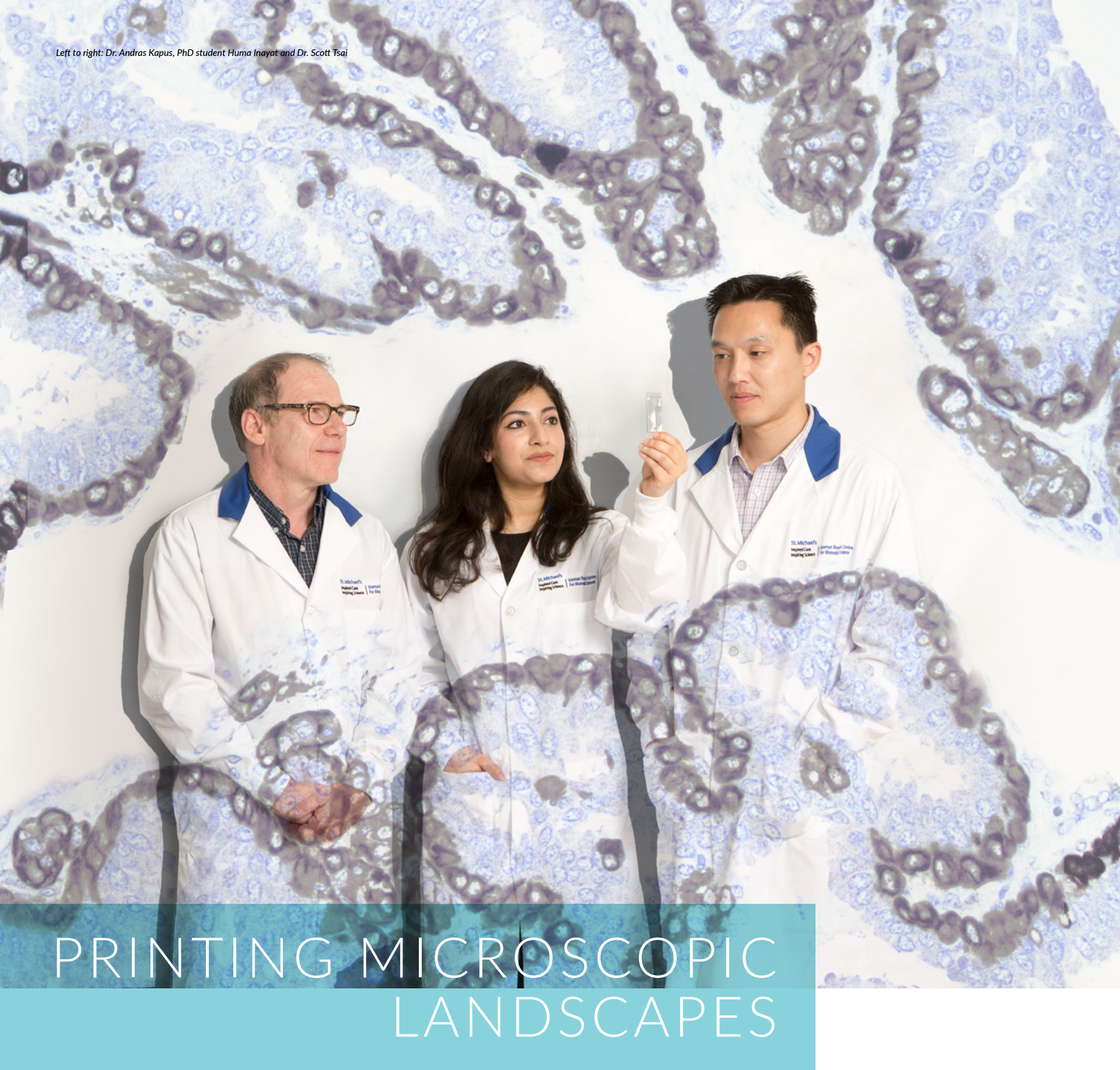
Each year, 40,000 Canadians suffer cardiac arrest outside the hospital and more than 90 per cent of these people will not survive. What many don't realize is that one of the most lethal effects of cardiac arrest is brain injury from lack of oxygen.

Though there are devices that can measure oxygen levels in the brain, there are none with the capacity to tell clinicians whether the brain is using the oxygen that it receives. Dr. Steve Lin, an emergency physician with St. Michael's Hospital and a researcher with the hospital's Keenan Research Centre for Biomedical Science, teamed up with Dr. Vladislav Toronov, a physicist from Ryerson University, to prototype a new biomedical device to solve this problem.

Dr. Toronov previously developed the next-generation of a technology called hyperspectral near-infrared spectroscopy (hNIRS), which measures brain oxygen levels and whether neurons in the brain are functioning. hNIRS beams pass through the skin, soft tissue, and skull into the brain and then "sensors worn around the patient's head capture the light that's bounced back," said Dr. Toronov.

The pair worked with the Heart and Vascular Program of St. Michael's to evaluate a prototype of the hNIRS device, piloting the study with ten patients undergoing valve replacements. "When you put a valve in a heart, there is a moment when you have to stop the heart to get the valve in the right position," explained Dr. Lin. "That moment simulates cardiac arrest."

Dr. Toronov said their next step is to refine the device into something that clinicians could readily use, and further evaluate whether their device can help to improve CPR treatment for patients during cardiac arrest.



PRINTING MICROSCOPIC LANDSCAPES

Combining mechanical engineering expertise and medical science, Ryerson's Dr. Scott Tsai and St. Michael's Dr. Andras Kapus are developing methods to prevent organ scarring, which can cause lifelong repercussions for patients.

The pair are co-supervising Ryerson biomedical engineering PhD student Huma Inayat in a project that involves printing miniature "landscapes" to study how cells covering the surface of organs respond to stress depending on their location. One such stress is transforming growth factor (TGF) beta, a chemical that can induce organ scarring.

Dr. Tsai carries out the printing of these microscopic landscapes in order to control patterns formed by the cells. "What we are doing is patterning the cells and creating gaps between the cells that will mimic wounds," said Dr. Tsai. "We can change the size of the wound and see cell transformation."

Dr. Kapus, a researcher with St. Michael's Keenan Research Centre for Biomedical Science, focuses on organ scarring that occurs in diseases such as diabetes. He's studying the biology of the cells grown in Dr. Tsai's landscapes and observing their growth.

Cells located at the boundary of a cell layer (e.g., at the edge of a wound) react differently to the same challenge compared to cells surrounded by other cells on all sides, such as those in the middle of an organ. For example, 'edge cells' exposed to TGF beta become scar-forming cells, whereas 'middle cells' do not show much change.

"If we understand how to reprogram edge-like behavior to middle-type behavior, we could develop therapies to lessen organ scarring," said Dr. Kapus. "This is important with regard to many diseases, including diabetes, hypertension, and kidney failure."



The picture of health



Precision therapies



Shining the light on A Dark Room

iBEST COLLABORATIONS

THE PICTURE OF HEALTH

Managing diabetes is crucial for patients with this chronic illness. To provide advanced support for patients, St. Michael's researchers Dr. Karen Cross, a surgeon-scientist, and Dr. General Leung have created a way to detect complications earlier. Using infrared light, the Multispectral Mobile Tissue Assessment (MIMOSA) device is designed to help people with diabetes detect poor circulation in their feet, which is a precursor to diabetic ulcers, providing data that empowers patients to take control of managing their own condition.

PRECISION THERAPIES

Ryerson's Dr. Raffi Karshafian and St. Michael's Dr. Warren Lee are combining microbubbles and ultrasound as a new method to implement targeted drug delivery in the human lung. The team is studying the effectiveness of injecting microbubbles to treat acute respiratory distress syndrome. The injured fluid-filled regions of the lung allow ultrasound waves to selectively penetrate the damaged tissue, which burst the microbubbles, enhancing deposition of medications and genes in the targeted areas.

SHINING THE LIGHT ON A DARK ROOM

In ice hockey culture, the realities of concussions are often downplayed and victims can be stigmatized. Featuring evidence-based science from St Michael's Hospital psychiatrist Shree Bhalerao, psychiatry resident Ryan Todd and neurosurgeon Michael Cusimano teamed up with Ryerson Radio and Television Arts School of Media professor Joe Recupero to produce a knowledge mobilization documentary film that addresses the stigma around concussions in athletes. *A Dark Room* highlights the serious mental health repercussions that can result from concussions and other traumatic brain injuries.



RESEARCH CORE FACILITIES

“Research Core Facilities are at the centre of so many of iBEST’s discoveries. Our team provides iBEST members with access to the latest tools to address and answer research questions, and teaches novel techniques that make us all stronger researchers.”

- Stephen Barker, Director, Research Facilities

By maximizing usage and sharing resources and facilities, iBEST expands the research capacity of both institutions. St. Michael's Research Core Facilities (RCF) help coordinate lab operations, offering the institute significant savings that translate into additional cutting-edge equipment, greater purchasing power and improved training made available to our scientists and students.

RCF specialize in flow cytometry, histology, genomics, bioimaging and microfabrication. With their oversight of resources and infrastructure, RCF help enable much of the research within iBEST, including professional training. More than 70 iBEST trainees have participated in their clinics so far.

The microfabrication services offered by the RCF include the clean room. While not yet outfitted, the final space will combine resources from both institutions for building miniature labs on microchips—such as the work featured in this report on printing miniature “landscapes” to study cells covering the surfaces of organs.*

** as of printing, June 2017*



iBEST STUDENT EXPERIENCE

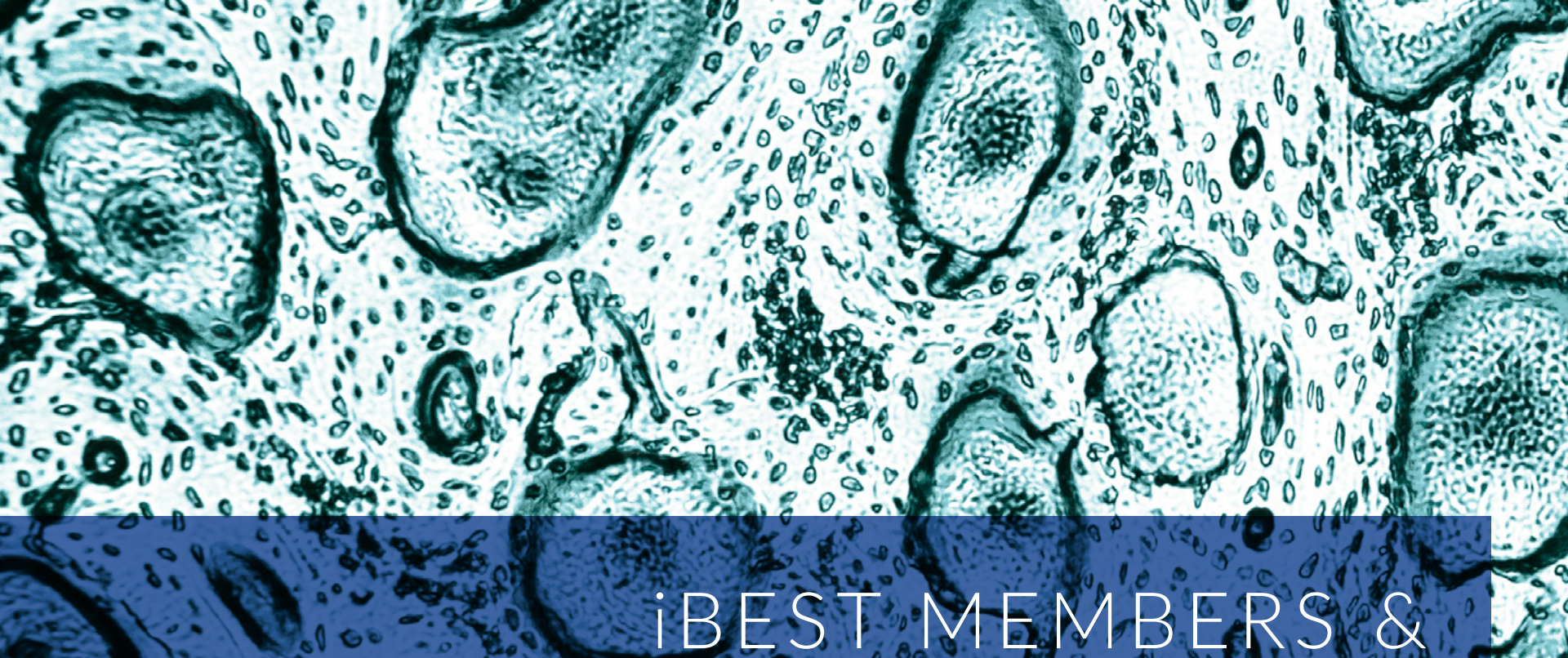
“We don’t just learn scientific theory - we live research in action. Students at iBEST learn about research leadership, have access to a hub of mentors, and receive the training we need to be successful throughout our careers.”

- Winnie Qian, a Master’s student with the Keenan Research Centre for Biomedical Science and the president of SRSA

With the launch of iBEST, the St. Michael’s Research Student Association (SRSA) expanded to include student trainees based at Ryerson. Along with opportunities to observe and take part in research at an institutional level, our students have access to collaborative networks, interdisciplinary research leaders, state-of-the-art technology, clinical experts, and twice as many academic mentors, offering them a breadth of experience and knowledge unparalleled in the field, paired with practical applied skills training using advanced medical technology.

As a hub for science, engineering, biomedical research and entrepreneurship, iBEST brings disciplines and expertise together to more readily develop solutions for real patients. The institute presents a tremendous opportunity for student trainees who want to be part of translational research that truly goes from bench to bedside.

Students at iBEST also have a voice and opportunities that aren’t available elsewhere, such as seats at the table for symposium planning, as well as within the Keenan Research Centre for Biomedical Science’s Leadership Committee and on the Scientific Operating Committee.



iBEST MEMBERS & LEADERSHIP

iBEST includes researchers from diverse backgrounds at both Ryerson University and St. Michael's Hospital. These are the current members, including resident and non-resident members.*

Andrew Baker (St. Michael's Hospital)
Jennifer Beck (St. Michael's Hospital)
Habiba Bougherara (Ryerson University)
Laurent Brochard (St. Michael's Hospital)
Kim Connelly (St. Michael's Hospital)
Karen Cross (St. Michael's Hospital)
Gerard Curley (St. Michael's Hospital)
Timothy Daniels (St. Michael's Hospital)
Claudia dos Santos (St. Michael's Hospital)
Alexandre Douplik (Ryerson University)
Greg Fairn (St. Michael's Hospital)
Richard Gilbert (St. Michael's Hospital)
Howard Ginsberg (St. Michael's Hospital)
Teodor Grantcharov (St. Michael's Hospital)
Greg Hare (St. Michael's Hospital)
Dae Kun Hwang (Ryerson University)
Andras Kapus (St. Michael's Hospital)

Rafi Karshafian (Ryerson University)
April Khademi (Ryerson University)
Michael Kolios (Ryerson University)
Sri Krishnan (Ryerson University)
John Laffey (St. Michael's Hospital)
Warren Lee (St. Michael's Hospital)
Howard Leong-Poi (St. Michael's Hospital)
General Leung (St. Michael's Hospital)
Tom Marotta (St. Michael's Hospital)
Philip Marsden (St. Michael's Hospital)
John Marshall (St. Michael's Hospital)
Gaspard Montandon (St. Michael's Hospital)
Heyu Ni (St. Michael's Hospital)
Joe Recupero (Ryerson University)
Ori Rotstein (St. Michael's Hospital)
Alireza Sadeghian (Ryerson University)
Tom Schweizer (St. Michael's Hospital)

Christer Sinderby (St. Michael's Hospital)
Katalin Szaszi (St. Michael's Hospital)
Jahan Tavakkoli (Ryerson University)
Vladimir Toronov (Ryerson University)
Mark Towler (Ryerson University)
Scott Tsai (Ryerson University)
Karthi Umapathy (Ryerson University)
Krishnan Venkatakrishnan (Ryerson University)
Subodh Verma (St. Michael's Hospital)
Stephen Waldman (Ryerson University)
Xiao-Yan Wen (St. Michael's Hospital)
Yeni Yuçel (St. Michael's Hospital)
Darren Yuen (St. Michael's Hospital)
Haibo Zhang (St. Michael's Hospital)

** as of June 2017*

In 2013, Ryerson University and St. Michael's Hospital agreed on a 20-year partnership to launch iBEST with leadership from both institutions.

iBEST EXECUTIVE COMMITTEE

Dr. Chris Evans, Provost (Interim) and Vice-President, Academic, Ryerson University
Dr. Steven N. Liss, Vice-President, Research and Innovation, Ryerson University
Dr. Arthur Slutsky, Vice-President of Research, St. Michael's Hospital

iBEST SCIENTIFIC OPERATIONS COMMITTEE (SOC)

Stephen Barker, Facilities
Brigitte Dreger-Smylie, Biomedical Zone Representative
Sahil Gupta, St. Michael's Research Student Association Representative
Dr. Andras Kapus, Research Training Centre
Sylvia Kavanagh, Communications
Geoff Koehler, Communications
Dr. Michael Kolios, Scientific Director

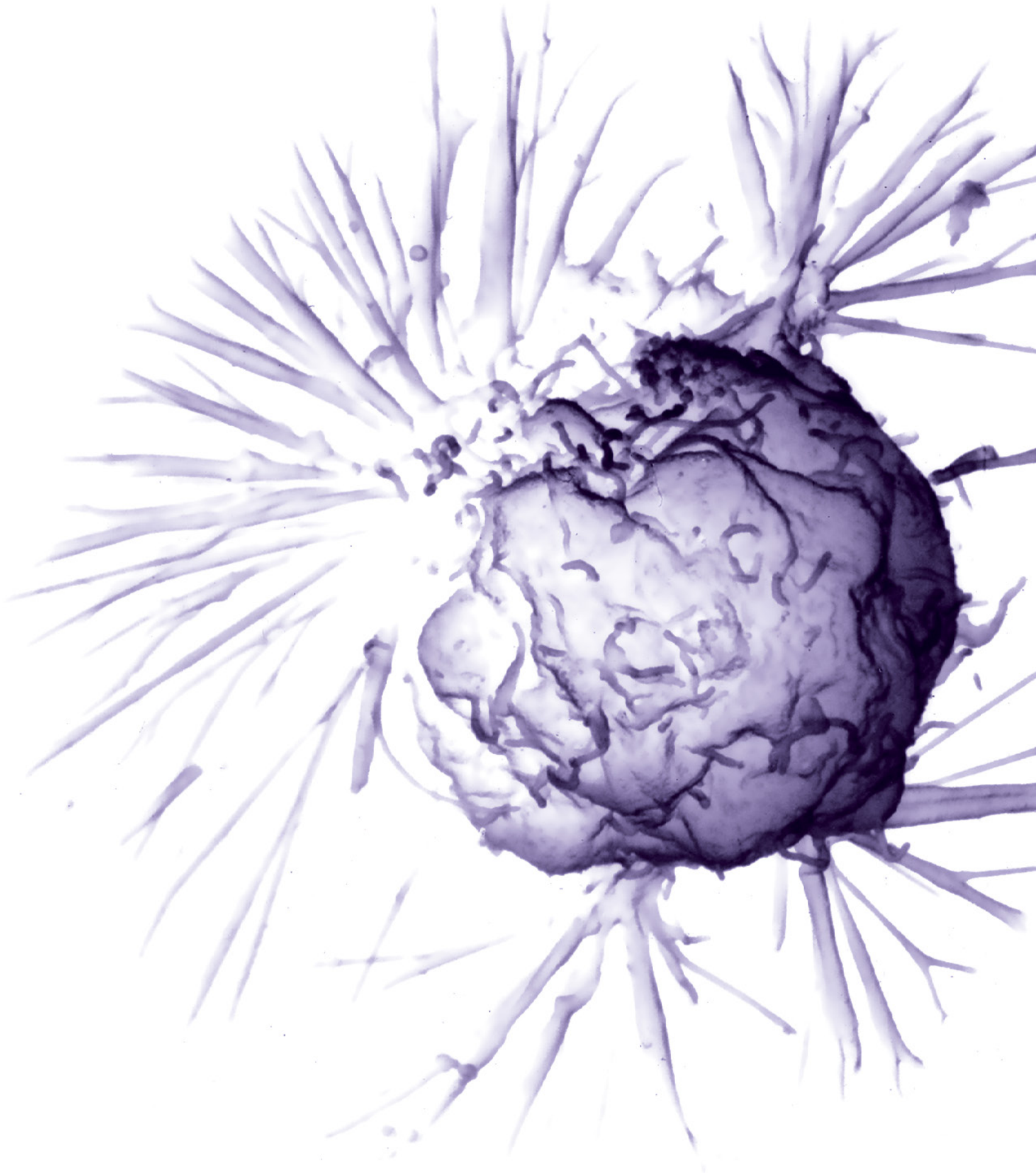
Dr. Sri Krishnan, Scientific Director
Dr. General Leung, Theme Lead
Jennifer MacInnis, Research Office Liaison
Dr. Linda Maxwell, Biomedical Zone Representative
Dr. Ori Rotstein, Scientific Director
Dr. Alireza Sadeghian, Theme Lead
Samar Saneinejad, Research Office Liaison
Imran Sheikh, iBEST Coordinator

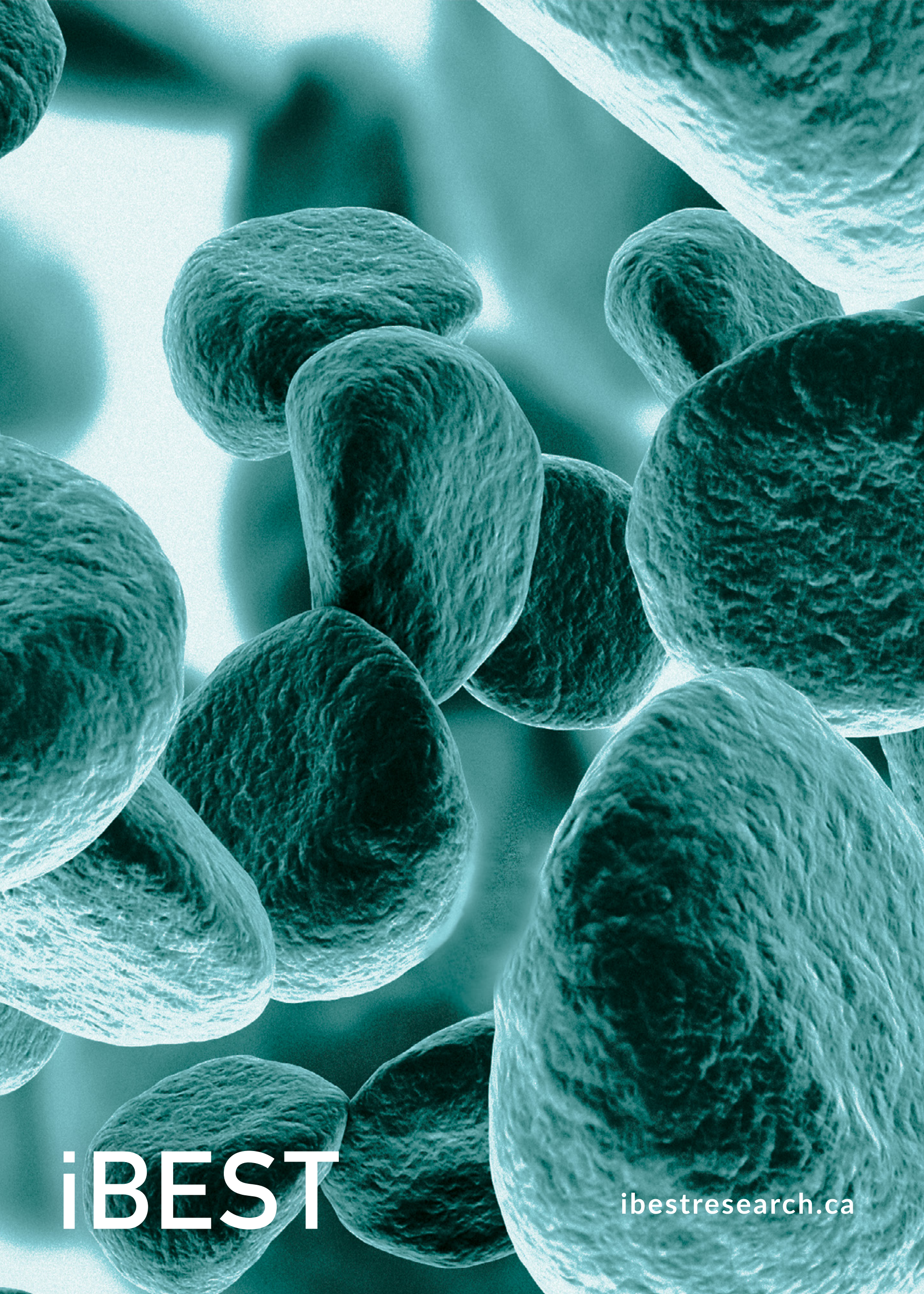
Omar Subedar, St. Michael's Research Student Association Representative
Dr. Scott Tsai, Theme Lead
Dr. Stephen Waldman, Scientific Consultant (PI)
Dr. Yeni Yuçel, Scientific Consultant (PI)
Dr. Haibo Zhang, Theme Lead

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Research Communications, Office of the Vice-President,
Research and Innovation, Ryerson University





iBEST

ibestresearch.ca