ROSALIND & MORRIS GOODMAN

CANCER INSTITUTE / ANNUAL IMPACT REPORT 2020-2021

McGill | Rosalind & Morris Goodman Cancer Institute

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MESSAGE FROM **THE DIRECTOR**

I am proud to present our Annual Report for 2020-21, a year that has been marked by unique challenges and great change.

The difficulties imposed by COVID-19 have been truly unprecedented, pressuring our sources of funding and necessitating changes to our research and training operations. But despite the adversity, we have continued to thrive, showing extraordinary resilience and determination as we have risen to meet the challenges of conducting world-leading cancer research during the pandemic. We have adapted our day-to-day routines and adjusted our ways of working to make the most of these conditions. Most of all, we have sustained our scientific output - continuing to publish outstanding cancer research and collaborate with colleagues around the world to advance ground-breaking new ideas. Several of our investigators have also contributed their knowledge and expertise to the fight against COVID-19. These efforts have been nothing short of remarkable and are a testament to the talent and drive of our principal investigators, trainees and staff.

These are truly exciting times, as we have not only weathered the storm but taken major steps in our growth and development. On June 3rd, 2021, at our Santé online event, we officially announced the establishment of the Rosalind and Morris Goodman Cancer Institute (GCI). This change in our academic status at McGill heralds a renewal of our research and training programs, with a cutting-edge interdisciplinary focus. The GCI will draw on the diverse strengths of our community, uniting biomedical scientists with world-leading experts in engineering, chemistry, and computational methods including artificial intelligence, as well as clinician-scientists who are poised to bring our breakthroughs directly to patients. Building on the foundations laid by the Goodman Cancer Research Centre (GCRC), the new Institute will extend its reach through leadership in networks and consortia that span provincial and national borders.

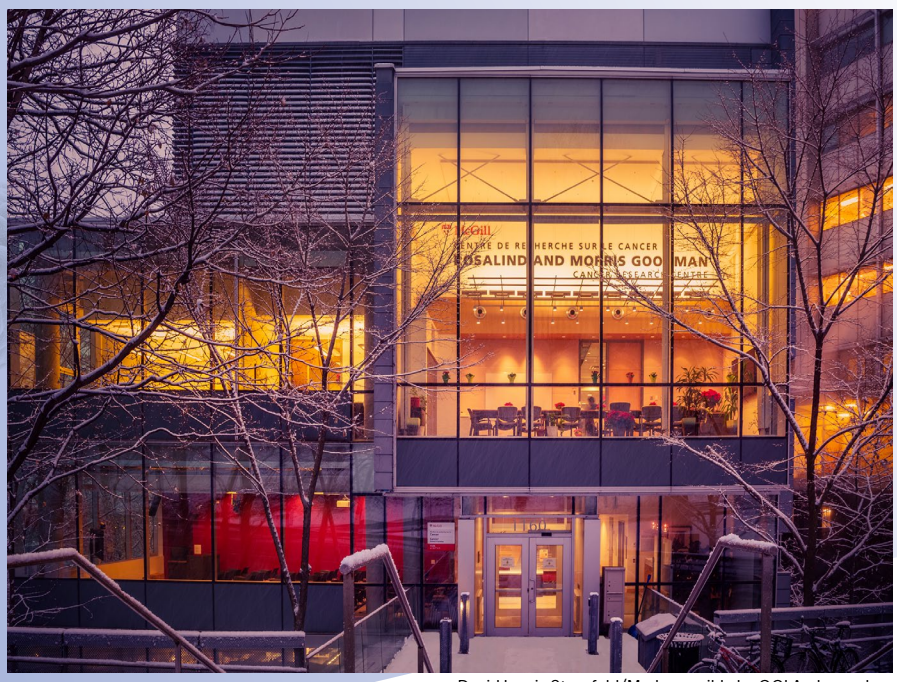
In the aftermath of the pandemic, we are facing the well-documented and tragic consequences of delayed screening, surgeries, and other treatments for cancer patients. There has never been a more urgent need for innovative cancer research. With the continued support of our donors and partners, the GCI is ready to meet these challenges.

I would like to extend my sincere thanks to all the individuals and organizations that continue to support our Institute. We look forward to building the future of the GCI together as we work toward a world without the suffering caused by cancer.

Morag Park, C.Q., Ph.D., FRSC, FCAHS
Director, Rosalind and Morris Goodman Cancer Institute
Diane and Sal Guerrera Chair in Cancer Genetics
Distinguished James McGill Professor, Depts. of Oncology,
Biochemistry and Medicine, McGill University

ANNOUNCEMENT OF THE INSTITUTE

Since its founding in 1978 as the McGill Cancer Centre, the Rosalind and Morris Goodman Cancer Research Centre (GCRC) has served as a hub for cancer research within the McGill community. It has now taken the next step in its evolution, having received McGill Senate approval to become an Academic Institute in February 2020 and, in May 2021, officially becoming the **Rosalind and Morris Goodman Cancer Institute (GCI)**.



David Lewis Sternfeld/Made possible by GCI Ambassadors

A call to action for change

The new Institute will bring an interdisciplinary approach to cancer research that will harness the power of fundamental, translational and clinical research. By uniting researchers and clinicians, teachers and learners from the biomedical, physical, social and computational sciences, including experts in artificial intelligence, the Institute will develop a culture of creativity and collaboration. Allowing ideas, data and expertise to cross traditional boundaries between disciplines will encourage the "out-of-the-box" thinking that often leads to major breakthroughs. Within this interdisciplinary context, the Institute will develop a culture of innovation, fostering entrepreneurship and collaboration between the academic, clinical and private sectors. This will enable data and ideas to flow freely from the laboratory to the clinic and back, providing clear pathways for knowledge translation that will lead more quickly to tangible benefits for cancer patients.

The GCI's collaborative, interdisciplinary mandate will extend beyond research to education and training, with unique graduate training programs currently under development that will span the entire spectrum of cancer research and address the most important cancer problems. The GCI is already collaborating with partners throughout the Faculties of Medicine and Health Sciences, Science, and Engineering to build this cutting-edge training program. With interdisciplinary Master's and PhD programs under development, this initiative will attract trainees from many backgrounds, including those not traditionally associated with cancer research. This will allow the GCI, and the university more broadly, to draw on diverse pools of local, national and international talent and train the next generation of leaders in a thriving environment where they will develop strong expertise in diverse fields.

"McGill's long-time commitment to cancer research has allowed us to attract some of the brightest and best researchers from across the globe to Montreal," says Suzanne Fortier, Principal and Vice-Chancellor of McGill University. "The exceptional people and world-class facilities at this new Institute will allow our researchers to work in innovative ways to enable ground-breaking discoveries and therapies while helping us better understand, prevent and treat cancer, which continues to be one of humanity's greatest challenges."

"This new Institute is a call to action for change in how we approach cancer research. It will open doors for breakthroughs we never imagined," says Morag Park, Director of the GCI. "We are thankful to the Goodman family who helped make the creation of this Institute possible and we are grateful for the longstanding strength of McGill scientists and clinicians. We look forward to continuing their mission to turn hard-to-treat cancers into treatable diseases."

Despite recent improvements in prevention, screening, diagnosis and treatment, there remain significant challenges to reducing the burden of cancer and improving outcomes for patients. To address unmet clinical needs, such as treatments for metastatic and drug-resistant disease, a holistic approach incorporating diverse technologies, expertise and ways of thinking is needed. The GCI is therefore well positioned at the juncture of novelty and opportunity.

"The GCI represents a wonderful stride in our investigators' research into fundamental, clinical and multidisciplinary cancer research. The GCI will now be in a better position to train the cancer research leaders of tomorrow."

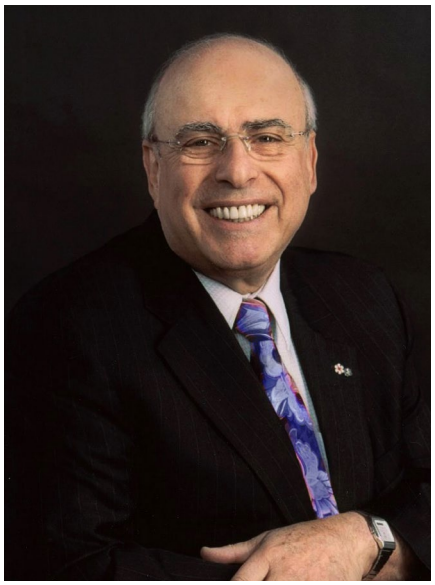
NICOLE BEAUCHEMIN
Professor and Senior Research Advisor, GCI

"Cancer is in fact not one, but a variety of complex human diseases. By bringing together the scientific fields at the heart of cancer research, the GCI will meet the challenge of this complexity. Our integrated approach holds promise for trainees and researchers alike and fits naturally with the long-standing collaborative mindset that has always prevailed in our community."

THOMAS DUCHAINE
Associate Director, GCI

The GCI is built on the generosity of the Goodman family and its many donors, the innovations of its world-class researchers, and the hard work of its staff, graduate students and post-graduates. I am excited to help build on this foundation and to support our journey through these challenging times."

TRINA JOHNSON
Deputy Director, GCI



"The remarkable leadership of the centre over the years has played a big part in our success. I'm proud to have been a part of it."

PHIL GOLD
First Director of the McGill Cancer Centre

"It is an immense privilege and it gives our family great pride to be associated with the Rosalind and Morris Goodman Cancer Institute and with its great work recognized around the world."

MORRIS GOODMAN
Co-Founder and Chairman of the Board, Pharmascience Inc.;
Co-Founder, The Morris & Rosalind Goodman Family Foundation

RESILIENCE IN THE **FACE OF ADVERSITY**

Owen Egan

The COVID-19 pandemic has been the defining feature of the past year and continues to affect all areas of cancer research. Significantly, McGill University paused most on-site research activities from March-June 2020, followed by a phased re-opening. The effect of the pandemic on revenues for many established funders of cancer research, including charities and private foundations, has also been dramatic.

But the GCI has refused to let COVID-19 stop life-saving cancer research. Through the resilience and determination of our community, we have kept our cutting-edge projects and innovation platforms running. Our excellence has continued to be recognized by funding agencies while we have also diversified our sources of funding, such as by doubling our support from the private sector, allowing us to maintain funding for our operations at 99% of FY20 levels.

Many of our scientists have also led or collaborated on important projects designed to improve the treatment of COVID-19, breaking down traditional barriers between fields and demonstrating the power of interdisciplinary research to address the most important questions. By learning from each other, we can not only advance COVID-19 and infectious disease research, but also prepare to face the challenges of the post-pandemic era, including an increased burden and enhanced complications from cancers.

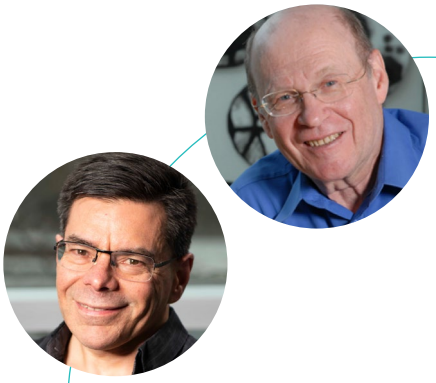
Bringing our Expertise to the Fight Against COVID-19

- The involvement of the immune response is a key commonality between cancer and COVID-19. This presents opportunities, through collaborating and sharing expertise and resources, to apply knowledge gained by cancer researchers in the setting of COVID-19. Jonathan Spicer and members of the Lung Cancer Research Network are among the world leaders in the study of neutrophil extracellular traps (NETs), which are extracellular structures made up of DNA and protein derived from an immune cell type known as neutrophils. While they are an important part of the body's innate immune response to pathogens such as bacteria, NETs also contribute to the pathology of many diseases. These include both cancer and the Acute Respiratory Distress Syndrome (ARDS) that is often fatal in advanced cases of COVID-19. Dr. Spicer is leading clinical trials testing whether drugs that dismantle NETs or prevent their formation can improve outcomes for patients suffering from severe COVID-19. The findings of these studies could also hold clues as to whether cancer patients may also benefit from therapeutic approaches targeting NETs.

"Recent work in COVID-19 patients has shown that NETs predict poor outcomes and severity of disease. NET inhibitors are therefore now being tested for the first time in humans. Besides holding promise for COVID-19 patients, the results of these clinical trials will have major implications for the field of cancer."

DANIELA QUAIL

- Nahum Sonenberg and Jerry Pelletier were awarded a special operating grant from the Canadian Institutes of Health Research (CIHR) as part of the COVID-19 Rapid Research Funding Opportunity to develop therapeutic strategies against SARS-CoV2. Their project focused on engineering and using defective forms of SARS-CoV2 that cannot replicate once they infect human cells. While they do not cause disease themselves, these agents, referred to as INTERCEPTORS, interfere with SARS-CoV2 by competing with it for cellular resources and triggering the body's antiviral immune responses. This approach holds great promise as a potential treatment for coronavirus-induced disease.



THE GCI **AT A GLANCE**

27
FULL-TIME
Investigators

27
ASSOCIATE AND AFFILIATE MEMBERS

13
DEPARTMENTS
at the Faculty of Medicine and Health Sciences and the Faculty of Science

185
RESEARCH TRAINEES
including undergraduates, graduates, and post-doctoral fellows

34
STAFF
in administration and operations

128
PEER-REVIEWED SCIENTIFIC PUBLICATIONS,
46% of which were in high-impact journals

$1.1
MILLION
in scholarships and fellowships awarded to our trainees

$22.8
MILLION
in in grant, salary and contract funding awarded to GCI investigators

$3.4
MILLION
raised for the GCI through philanthropy in the 2021 fiscal year

7
INNOVATION PLATFORMS
bringing the most advanced technology to our research

89
Highly qualified
RESEARCH PERSONNEL

36
COUNTRIES
across the globe in our collaborative research network

WORLD COLLABORATIONS

Ongoing research collaborations in 36 countries

As well as having local and national partners, the Rosalind and Morris Goodman Cancer Insitute also has a worldwide network — no longer do patients only benefit from the research performed in their own city. Instead, scientists are pooling their resources and knowledge base, sharing them with international colleagues, all while learning from one another.

Australia	Kingdom of Saudi Arabia
Austria	Mexico
Belgium	Morocco
Brazil	Netherlands
Canada	New Zealand
Chile	Norway
China	Poland
Denmark	Qatar
Egypt	Singapore
Finland	South Korea
France	Spain
Germany	Sweden
Greece	Switzerland
India	Tanzania
Ireland	Turkey
Israel	UK
Italy	USA
Japan	Venezuela

UNDERSTANDING THE **PROBLEMS THAT MATTER**

The NETs effect of obesity on breast cancer

Obesity is a growing public health crisis, with 2/3 of the world's population predicted to be overweight or obese by 2030. Already responsible for up to 20% of all cancer deaths, obesity competes with smoking as the leading modifiable risk factor for cancer mortality. Although alarming in and of themselves, these facts also conceal a complex reality. About 25% of obese people have normal metabolism and may avoid the risks normally associated with obesity, while one in five people of normal weight are "metabolically obese" with similar health risks to obese individuals, including an increased risk of developing and dying from cancer.

In breast cancer, metabolic obesity elevates the risk of metastasis (spread to distant organs), the major cause of cancer-related death. Underlying this phenomenon are obesity-associated changes in the composition of the tumour microenvironment, which contains immune and other normal cells within and surrounding the tumour. However, which of these changes are most important, and how they can be stopped, remains unclear.

Dr. Daniela Quail and colleagues discovered how obesity alters immune cells known as neutrophils. In laboratory models and in obese patients, the altered neutrophils stimulate blood vessel leakage in the lungs. They also form DNA- and protein-rich structures called neutrophil extracellular traps (NETs) that interact with cancer cells. Together, these obesity-associated changes make it easier for breast cancer cells to enter the lungs from the bloodstream and grow into metastatic tumours.

Dr. Quail's discoveries suggest new ways to prevent the metastasis-promoting effects of obesity. They were published in the prestigious scientific journal Nature Cancer and highlighted by Nature Reviews Cancer, Cancer Discovery and The Oncology Times.

Owen Egan

PETER SIEGEL developed many of the most important models of cancer metastasis, now used worldwide, and discovered how metastatic cancer cells adapt their metabolism to grow in specific secondary organs. His recent work has revealed key molecular mechanisms and therapeutic targets involved in the spread of breast tumours and other cancers to the liver and brain. Among many other accomplishments, he leads Canada's principal research team dedicated to studying cancer metabolism, based at the GCI and funded by the Terry Fox Research Institute (TFRI).

"Daniela's research is a critical step forward in devising ways to impair the tumour-promoting and pro-metastatic effects of obesity."

PETER SIEGEL

DANIELA QUAIL was recruited by the GCI in 2017 following a post-doctoral fellowship at Memorial Sloan Kettering Cancer Center in New York. A rising star in her field, she has already made major discoveries on how interactions between cancer and immune cells influence tumour progression, and how this is affected by inflammation that becomes fuelled by metabolic obesity.

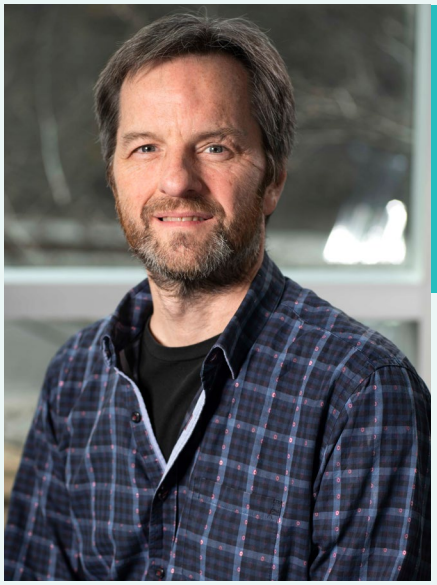
"Our work will change how we look at risk factors for cancer mortality, especially obesity."

DANIELA QUAIL

A stem cell balancing act

Stem cells possess important properties such as immortality and the ability to generate other cell types. Each time a stem cell divides, the newly formed daughter cells can retain stem cell properties or become the more specialized cells that form functional tissues. The balance between these fates must be finely tuned to maintain tissues in a healthy state. An accumulation of cells with stem-like properties can be associated with features of cancer including uncontrolled growth, metastasis and drug resistance.

Maxime Bouchard discovered a gene network that controls stem cell fate decisions during the normal development of the prostate gland. He showed that genetic changes associated with prostate cancer perturb this network, causing the prostate stem cell population to expand, while therapies targeting this expansion can prevent prostate cancer progression in pre-clinical models. His work, published in the journal ELife, paves the way for new prostate cancer therapies designed to correct imbalances in cellular populations.



MAXIME BOUCHARD investigates how fundamental mechanisms controlling tissue and organ development can also drive cancer. He explores these fascinating parallels using the urogenital system as a model, an approach that has also led him to discover the genetic and molecular basis of several inherited diseases.

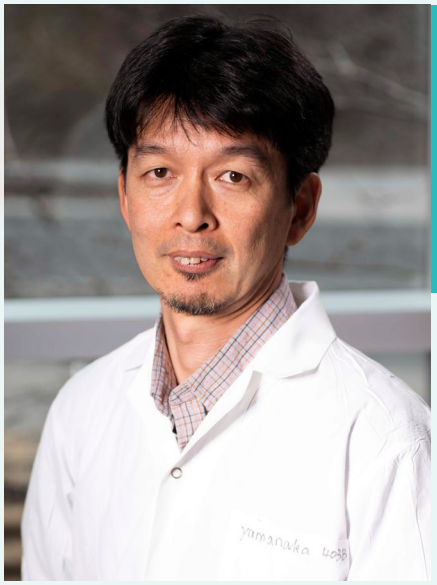
"Understanding a new biological mechanism is like being the kid who finally finds the hidden candy."

MAXIME BOUCHARD

Revealing the origins of a lethal cancer

Cancer is caused by genetic changes in normal cells. The biology of these "cells of origin" is an important determinant of how the tumour progresses. High grade serous ovarian carcinoma (HGSOC), one of the most aggressive forms of ovarian cancer, originates in the fallopian tube. However, the different populations of cells that make up the fallopian tube are poorly understood.

Yojiro Yamanaka led one of the world's first studies of the cellular composition of the fallopian tube using cutting-edge genetic engineering and single-cell analysis. His work uncovered five cell populations in mouse models of fallopian tube development and revealed the relationships between them. In a separate study, He created powerful pre-clinical models of HGSOC by using genome engineering to introduce the mutations observed in HGSOC patients into the cells of the mouse fallopian tube. These findings, published in the journals Cell Reports and Cancer Research, provide unprecedented insight into how distinct populations of cells in the female reproductive tract interact during development and how they can become the cells of origin of ovarian tumours.



YOJIRO YAMANAKA creates ground-breaking models that reveal how tissues are organized during normal development and how disruption of this process contributes to cancers, including aggressive ovarian tumours.

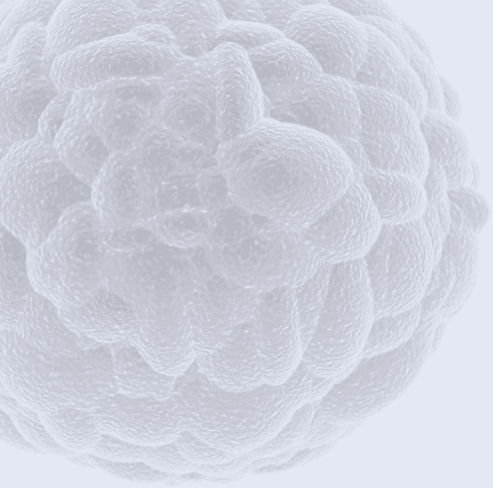
"Out of 100 trillion cells in our body, cancer originates from just a single cell. Our work is essential to prevent this rare occurrence."

YOJIRO YAMANAKA

MICHEL TREMBLAY discovered molecular pathways that control the behaviour of cancer cells, stem cells and the immune system, leading to promising new treatments for cancer, diabetes and other diseases. A former Director of the McGill Cancer Centre and the GCRC, he also leads the McGill Regenerative Medicine (MRM) Network, which seeks to treat cancer and other diseases by combining engineering with knowledge of stem cells and developmental biology.

"Yojiro and Maxime lead thriving research programs that have unveiled how cancer initiation and relapse are linked to stem cells and developmental genetic programs. They are formidable examples of how scientific discoveries drive clinical advances."

MICHEL TREMBLAY



Lung cancer – cell by cell

Already the most common malignancy, lung cancer's worldwide incidence is increasing, with 3 million diagnoses per year anticipated by 2030. With advanced, metastatic disease remaining incurable, lung cancer accounts for 25% of all cancer-related deaths.

In 2018, the GCI launched the Lung Cancer Research Network, led by Logan Walsh and Jonathan Spicer, to meet these challenges. By linking innovative clinical trials with cutting-edge technology, the network aims to double survivorship among lung cancer patients by 2028. A key priority is immunotherapy, a promising class of anti-cancer drugs that trigger the patient's own immune system to destroy tumour cells. However, while some lung cancers respond to immunotherapy, others resist. To understand why, members of the network are using the GCI's powerful single-cell imaging technology, known as imaging mass cytometry (IMC), to visualize the lung cancer immune microenvironment, cell by cell. Through state-of-the-art data analysis, including artificial intelligence, these images reveal the spatial organization of tumour and immune cells in lung cancer. By applying this pipeline to samples from clinical trials led by Dr. Spicer, tumours that respond to immunotherapy can be compared to those that resist. This approach allows the discovery of biomarkers — specific tumour characteristics that can identify patients who will benefit the most from these therapies. It also promises to reveal new targets and approaches to improve immunotherapy responses in patients with resistant lung tumours.

GCI Director **MORAG PARK** is known for paradigm-shifting discoveries, visionary ideas and bold leadership that have shaped cancer research in Canada and around the world. She discovered the cancer-causing gene *MET* and pioneered the idea that the normal cellular and structural components of tissue (the "microenvironment") determine the biology and outcome of breast cancer. She is a driving force behind the establishment of several research consortia dedicated to advancing precision medicine for cancer, including the Lung Cancer Research Network.

"Logan and Jon bring exceptional leadership and immense talent as Co-directors of the Lung Cancer Research Network. They are using the most advanced technologies available to improve precision medicine and immunotherapy for lung cancer patients, leading to better outcomes."

MORAG PARK

One of the most talented young clinician-scientists in the world, **JONATHAN SPICER**'s trailblazing surgical techniques and leadership of innovative clinical trials are poised to dramatically improve clinical outcomes for lung cancer patients. He was recruited to McGill from MD Anderson Cancer Center in Houston, Texas.

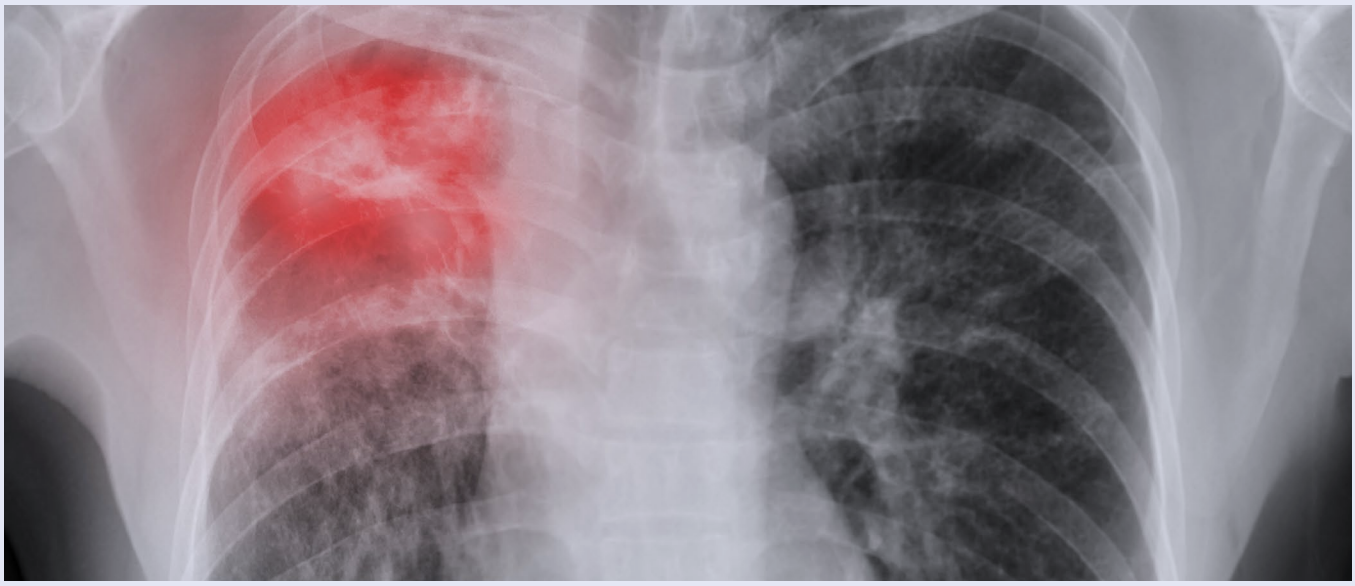
"We have a tremendously fun team that keeps driving progress and allowing us to do better for our future patients."

JONATHAN SPICER

With a rare combination of expertise in cutting-edge computational biology and experimental genetics, **LOGAN WALSH** has developed a unique research program that is revealing the genetic basis of lung cancer and identifying new therapeutic targets. He was recruited by the GCI from Memorial Sloan Kettering Cancer Center in New York in 2017.

"Using our technology to work directly with clinical resources and data is the key to finally beating lung cancer."

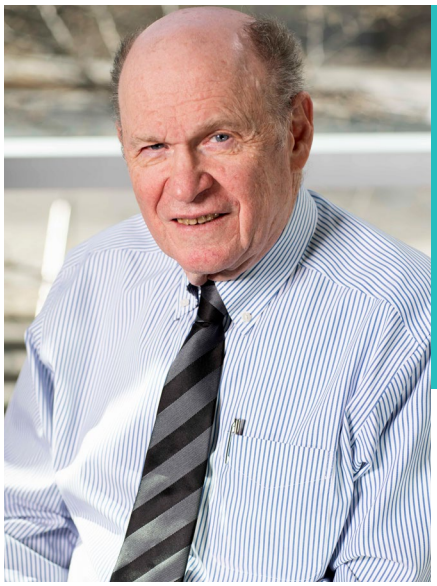
LOGAN WALSH



The sound of silencing

MicroRNAs (miRNAs) are small molecules that suppress, or "silence," specific sets of target genes. This phenomenon, referred to as RNA interference (RNAi), coordinates genetic programs that control normal cellular function and are also implicated in many cancers.

Since the inception of the field, Thomas Duchaine has led the way to a better understanding of RNAi mechanisms and pathways. With powerful genetic techniques and keen insight, his work has revealed how miRNAs are produced and processed into their final form and how they silence their targets. His ground-breaking studies, in model systems ranging from nematode worms to human tumour cells, have taught us how miRNAs control normal physiology and how alterations in their production and function can lead to cancer. Some of his most recent work, published in the journal Nucleic Acids Research, revealed a previously unknown network of interacting proteins allowing miRNAs to block protein production. These findings have expanded our knowledge of the fundamental mechanisms regulating genes in both normal and cancer cells.



By discovering how cells regulate the initial steps of protein production, **NAHUM SONENBERG** revealed a molecular mechanism fundamental to life – from metabolism to learning and memory, immunity and the circadian clock – as well as a crucial factor in cancer. An immense influence on cancer research, he has been awarded many of the world's most prestigious scientific prizes, including the Gairdner International Foundation Award (2008), the Lewis S. Rosenstiel Award (2011) and the Wolf Prize (2014), regarded as the third most prestigious prize in the field of medicine. His vision has led to promising new therapies that have entered the clinic or are currently in clinical trials.

"Thomas' research on microRNAs is imperative for the development of new drugs to treat cancer."

NAHUM SONENBERG

GCI Associate Director **THOMAS DUCHAINE** was instrumental in establishing the field of RNA interference (RNAi), a spectrum of cellular pathways where genes are switched off by small RNA molecules. His discoveries are shedding new light on how RNAi works and revealing its crucial roles in normal biology and in diseases including cancer.

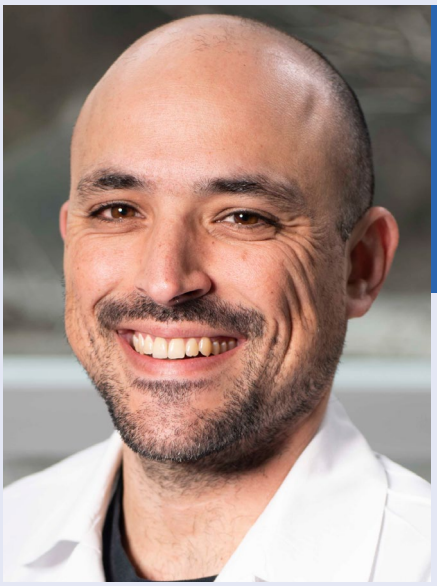
"The discovery of RNAi and microRNA pathways opened entirely new possibilities in personalized medicine for cancer, including powerful new tumour biomarkers, therapeutic targets and strategies."

THOMAS DUCHAINE

Turning up the heat to beat cancer

Adipocytes are a critical cell type in the regulation of energy balance and body weight. They exist in three forms that store energy as fat (white adipocytes) or consume energy to generate heat (brown and beige adipocytes). The latter process, referred to as thermogenesis, counteracts obesity by protecting against lipid over-accumulation. With the rising prevalence and many health risks of obesity, including cancer, there is intense interest in the potential of increasing the amount or activity of brown adipose tissue to restore metabolic health. To make this a reality, we need a deeper, more complete understanding of adipocyte biology at the molecular level.

Lawrence Kazak discovered some of the most important mechanisms controlling adipocyte function and determined their physiological roles. He established that creatine, a small molecule that preserves cellular energy levels under conditions of high demand, is essential for thermogenesis. In 2021, he and his collaborators published two studies in Nature, one of the most influential scientific journals in the world, that identified the specific enzymes responsible for creatine's effect on brown adipose tissue. Their findings are an important step on the path towards new cancer therapies that harness the energy-burning capacity of brown fat.



Recruited to the GCI from Harvard in 2018, **LAWRENCE KAZAK** is an authority on energy metabolism and the biology of adipocytes (fat cells). His discoveries are leading the way to exciting new strategies for treating cancer and metabolic disease.

"My lab is trying to understand the molecular underpinnings of making healthier fat."

LAWRENCE KAZAK

VINCENT GIGUÈRE is one of the world's leading experts on metabolism and hormone function in cancer, metabolic disorders and obesity. He is renowned for his discovery of the estrogen-related receptors (ERRs), which are master regulators of genetic programs controlling metabolism.

"Lawrence is a brilliant young scientist who is exploring new avenues to change the behaviour of fat cells and slow down the initiation and progression of cancer."

VINCENT GIGUÈRE

Adding dimension to cancer metabolism

Cancer is a genetic disease, but understanding cancer requires more than knowledge of genes and their functions. The physical and mechanical properties of tumours are dramatically different from normal tissue and play a central role in tumour initiation and growth, escape from the immune system, metastasis and drug resistance.

Through strong collaborations and world-leading technology, the GCI is making a major impact at the intersection of cancer biology and engineering, allowing us to better understand the physical reality of cancer and opening the door to new therapies. Among our major discoveries from the past year are the findings of Luke McCaffrey and Chris Moraes, published in the journal Communications Biology. They showed that cancer cells adapt their metabolic activity and nutrient use under 3D growth conditions mimicking tissue, compared to growth as a flat monolayer. They also found that physical cues, such as the stiffness of the 3D environment, cause cancer cells to rewire their metabolism in ways that may be exploited therapeutically. Their work epitomizes the power of integrating biologists and engineers in an interdisciplinary team approach to advance cancer research.

LUKE MCCAFFREY's discoveries have revealed how cells change their internal organization and their interactions with each other to form tissues. His contributions were instrumental in establishing that loss of this organization is a critical step in the formation of many tumours, including breast cancer.

"Chris is transforming the field of cancer research by demonstrating how local mechanical forces influence the behaviour of cells within cancer tissues."

LUKE MCCAFFREY

CHRIS MORAES designs and builds innovative micro-technologies to understand how the physical properties of the tumour microenvironment drive cancer. He is an Associate Professor at McGill's Department of Chemical Engineering and an Associate Member of the GCI.

"Luke develops advanced 3D cancer models, starting from the cellular up to the whole-tissue level, to get a high-resolution look at how the disease progresses."

CHRIS MORAES

Engineering better cancer therapies

Improving precision medicine for cancer requires expertise from many disciplines. The GCI's most recently recruited principal investigator, Guojun Chen, integrates biology, chemistry, materials science and engineering to develop intelligent biomaterials that target drugs, including immunotherapies, more effectively to the sites where they are needed. He is also pioneering strategies that can improve the clinical management of cancer following surgery, as well as efficient methods for genome editing in living tissues. His outstanding work has been published in a range of high impact, widely read journals including Science Advances and Nature Nanotechnology. Already a leader in his fields of research, his arrival shows our ability to recruit the most dynamic young investigators in the world and holds exciting possibilities for the future of interdisciplinary cancer research at the GCI.

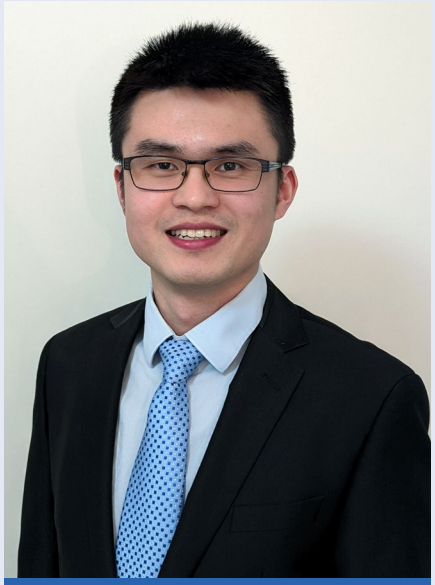
DAVID JUNCKER chairs the Department of Biomedical Engineering at McGill and is an Associate Member of the GCI. He is renowned for leadership and innovation in bio-nanotechnology, an approach that integrates engineering with biology and medicine to develop faster, more accurate and cost-effective ways of diagnosing, modelling and treating diseases, including cancer.

"Guojun's research on smart drugs and immune-engineering can be conceived of as an army of smart, microscopic Trojan horses. They conceal the drugs and explore the entire body until they find the tumour, then latch on and enter the tumour cells, undetected. Once inside, they open up and unload the drug to kill the cancer cell, while simultaneously signaling to the immune system to attack the tumour from the outside. This dual, focused attack will ultimately lead to much more efficient cancer treatment with fewer toxic side effects."

DAVID JUNCKER

"Joining the GCI brings tremendous opportunities to collaborate with some of the best cancer researchers in the world, from diverse fields and backgrounds. This is an environment where projects that cross traditional boundaries between scientific disciplines can take flight, with exciting possibilities not just for scientists, but also for patients."

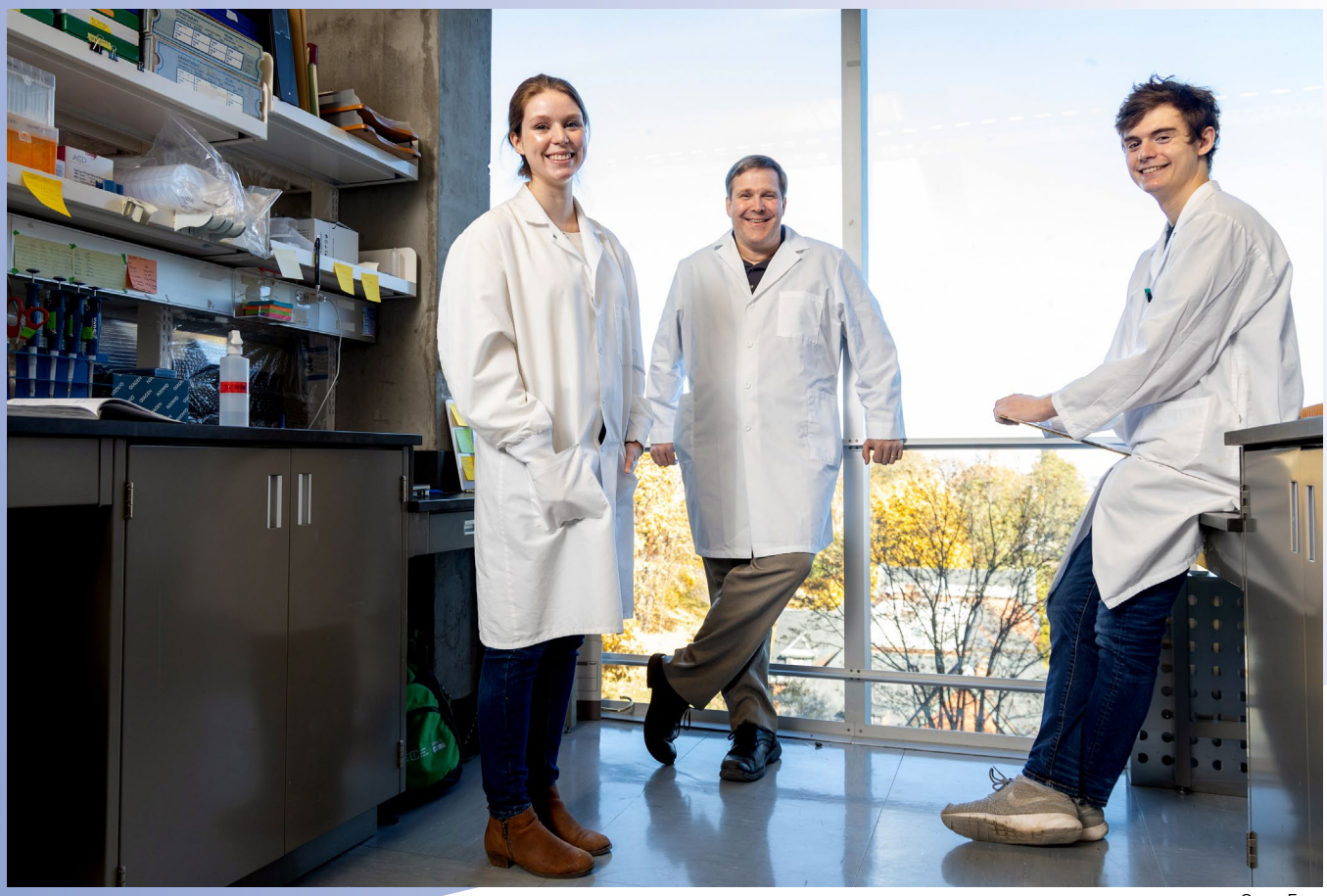
GUOJUN CHEN



GUOJUN CHEN was recruited from UCLA (University of California, Los Angeles) in 2021 as part of the ongoing collaboration between the GCI and the Department of Biomedical Engineering. He has developed revolutionary approaches based on engineering and nanotechnology that promise to dramatically improve drug delivery and maximize the potential of immunotherapy for cancer patients.

STRONGER TOGETHER

The GCI serves as a hub for research networks and consortia working across disciplines to bring better precision cancer therapies to the clinic. In collaboration with leading clinicians and clinician-scientists, we are applying our expertise in fundamental science and advanced technology to improve outcomes for cancer patients.



Owen Egan

The Québec Cancer Consortium (QCC)

The Québec Cancer Consortium (QCC) was formed in 2017, under the leadership of GCI Director Morag Park. It unites the GCI with four Montreal hospitals and their respective research centres, as well as partners from the private, public and nonprofit sectors, to advance personalized medicine and immuno-oncology in Quebec. The QCC has received a total of $27.9M from the Ministère de l'Économie et de l'Innovation (MEI) du Québec and partnering organizations. With a goal of doubling patient recruitment to clinical trials of precision medicine in oncology, the QCC opened three investigator-initiated trials in the past year, despite the challenges posed by COVID-19. The consortium also continued to build a strong patient outreach program, with the recruitment of five new Patient Partners (for a total of 11) to advise on and bring the patient perspective to clinical trial design, knowledge dissemination and governance. The QCC also developed state-of-the-art biobank infrastructure for several cancer types, while its investigators made major advances in biomarker discovery to better match patients with precision medicine and immunotherapy strategies.

SU2C Canada Metastatic Breast Cancer Dream Team

Dream Teams are the flagship projects of Stand Up to Cancer (SU2C), establishing nation-wide, multidisciplinary teams to address critical problems in cancer prevention, diagnosis and treatment. Based at the GCI, the SU2C Canada Metastatic Breast Cancer Dream Team is one of only three SU2C Dream Teams based in Canada and the first to be led by McGill investigators. It brings four Canadian hospitals and research centres together under the leadership of Nahum Sonenberg, co-led by Michael Pollak of the Lady Davis Institute (GCI Associate Member). Working with leading oncologists in Montreal (Jewish General Hospital), Edmonton (Cross Cancer Institute) and Vancouver (BC Cancer), the team is conducting the first clinical trial of a new therapy for metastatic breast cancer with $2M in funding from SU2C, the CIHR and the Canadian Cancer Society. The novel drug, known as tomivosertib, is made by eFFECTOR Therapeutics (San Diego), a key collaborator of the program. It is designed to block the over-activation of protein synthesis that occurs in cancer cells, and accumulating evidence from the Dream Team investigators and their colleagues suggests that it may also work by stimulating the immune system to attack the tumour. This innovative clinical trial has now recruited over 20 patients, collecting samples for a unique analysis using multiple "omics" technologies to understand how tomivosertib affects metastatic breast cancers at the cellular and molecular levels.

Owen Egan

Lung Cancer Research Network

Led by Logan Walsh and Jonathan Spicer, the Lung Cancer Research Network was launched in 2018, with philanthropic support from the biannual Goodman Gala, to focus McGill's efforts on the goal of doubling the lung cancer survival rate by 2028. By linking fundamental and translational researchers with clinical collaborators across McGill's thoracic oncology community, the Network aims to improve outcomes by detecting lung cancer earlier and developing more effective treatments. To facilitate this, the Lung Cancer Research Network has worked with the QCC to establish a cutting-edge lung cancer biobank. This unique resource includes samples from patients on innovative immunotherapy clinical trials led by Jonathan Spicer at the MUHC. By linking the GCI's technology and expertise directly with lung cancer patient samples and data, the Lung Cancer Research Network is identifying biomarkers to match patients with effective precision therapies and immunotherapies, while also discovering new drug targets for lung cancer subtypes that currently lack effective therapies.

Marathon of Hope Cancer Centres Network

The Marathon of Hope Cancer Centres Network (MOHCCN) is an initiative led by the Terry Fox Research Institute (TFRI). It was announced in 2019, with an investment of $150M over five years from the Government of Canada. The network will unite Canada's leading cancer centres around a mission to improve outcomes for cancer patients by accelerating the implementation of precision medicine. The goals are ambitious: a set of 15,000 high-quality, sharable cancer patient datasets available to all MOHCCN investigators by 2023. By pooling resources and data and making them accessible across the network, more powerful studies leading to new insights will be made possible. GCI investigators including Morag Park, Ian Watson, Guillaume Bourque and George Zogopoulos have played a leading role in the working groups that are establishing the framework and priorities of the national MOHCCN. The Quebec node of the MOHCCN, building on the QCC and referred to as the MOH-Q, was formally approved in April 2021 following an international review and 10 translational/clinical studies from the GCI and McGill partnering hospitals and research institutes (McGill University Health Centre and Jewish General Hospital) were forwarded for potential MOHCCN funding.

Montreal Cancer Consortium

The MOHCCN in Quebec began with a pilot project, the Montreal Cancer Consortium (MCC), co-led by Ian Watson of the GCI and John Stagg of the Université de Montréal. Launched in June 2018 with $6.5M in funding from TFRI and partners, the goals of the MCC are to determine how tumours respond to or resist therapies, particularly immunotherapy, with a view to optimizing treatment strategies and overcoming resistance. Among the MCC's major achievements are the development of infrastructure and protocols for biobanking and multi-omic analysis of melanoma and acute myeloid leukemia (AML) samples. This framework has enabled cutting-edge projects addressing cancer therapy response and resistance and laid important groundwork for the development of the MOH-Q.

Gail Harvey

Owen Egan

TFNF PPG in Targeting the Metabolic Vulnerabilities of Cancer

The Terry Fox New Frontiers Program Project Grant (TFNF PPG) in Targeting the Metabolic Vulnerabilities of Cancer is led by the GCI's Peter Siegel and co-led by Julie St-Pierre of the University of Ottawa. Funded by the Terry Fox Research Institute (TFRI), with additional support from the Quebec Breast Cancer Foundation (QBCF), it unites McGill researchers with collaborators from three other institutions in Canada and the US in a program that has been continuously funded for over 20 years. The goals of the TFNF PPG are to discover how metabolic adaptations allow tumours to metastasize and resist therapies, and to understand how diet, obesity and adipose tissue biology influence the initiation and progression of cancer. Knowledge in these areas will lead to new strategies to treat aggressive, resistant cancers and improve outcomes for patients through targeting metabolism. The TFNF PPG, together with the Canada Foundation for Innovation (CFI) and the Dr. John A. and Mrs. Clara M. Fraser Memorial Trust, has been a major supporter of the Metabolomics Innovation Resource, now the leading technology platform dedicated to cancer metabolomics in Canada.

INNOVATION & TECHNOLOGY

Our approach to cancer research is driven by technology.

With access to seven Innovation Platforms, GCI scientists and their collaborators use the most advanced techniques available to pursue our research mission, while trainees acquire valuable experience in a cutting-edge environment.

Owen Egan

The ***Single Cell Imaging and Mass Cytometry Analysis Platform*** (SCIMAP) is among the pioneers in Canada of a technology known as mass cytometry. This approach uses heavy metal-labelled antibodies to identify specific cell populations at a single-cell level and precisely map their spatial distribution within a tissue sample.

Since 2011, the ***Metabolomics Innovation Resource (MIR)*** has been the leading cancer-focused metabolomics platform in Canada, providing access to information-rich technologies for metabolomic analysis of cells, tissues and biofluids. MIR enables clients to define small molecules and pathways that shape our overall metabolism, determine their involvement in disease and identify new therapeutic approaches.

The ***McGill Integrated Core for Animal Modelling*** (MICAM) was the first platform in Quebec to offer GEMM (genetically engineered mouse model) technology, which was developed in part by GCI investigators. This platform is now a national leader in rapid model development using genome engineering. MICAM has created nearly 600 GEMMs for 113 Canadian and international clients.

In partnership with the Canadian Centre for Computational Genomics (C3G), the GCI ***Bioinformatics Innovation Platform*** has contributed to over 50 GCI projects involving analysis of large “omics” datasets.

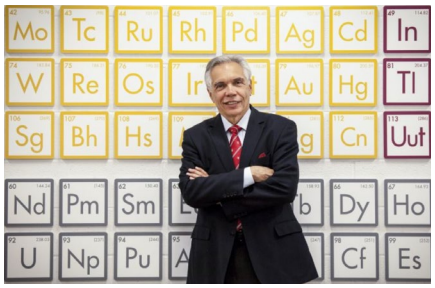
Co-directed by a board-certified pathologist, the ***Histology Innovation Platform*** features state-of-the-art, integrated technologies for microscopic analysis of tissue samples from models and patients, including automated systems for detecting, imaging and quantifying specific proteins in cancer and stromal cells surrounding the tumours.

The ***McGill Platform for Cell Perturbation*** provides libraries of genetic tools that can activate or suppress any gene in the human or mouse genome. These libraries enable the entire genome to be analyzed in a single experiment in a “screening” approach that can reveal new targets for cancer therapy.

The ***Flow Cytometry Innovation Platform*** has seven state-of the-art flow cytometers for quantitative analysis of specific cell types and isolation of pure populations of cells from blood or tissue samples for further analysis.

COMMUNITY & OUTREACH

Our research and training programs are supported by a generous and diverse community. We give back through our fundraising and creative ways of educating the public about cancer research.



- The GCI held **Santé: An Online Red Carpet Event** on June 3rd, 2021. Moderated by Joe Schwartz and with a special guest appearance by Laurent Duvernay-Tardif, the event featured presentations from our researchers, donors and supporters as well as an official announcement of the establishment of the Rosalind and Morris Goodman Cancer Institute.

- The GCI hosted several virtual instalments of its acclaimed **Public Lecture Series**, the first was titled *Metabolism: The Many Fuels of Cancer*. Featuring talks from Daniela Quail and Lawrence Kazak, the lecture reached an audience of over 800 people. A second public lecture on lung cancer, titled *Lungevité*, presented the latest news of the Lung Cancer Research Network, with talks by Logan Walsh and Jonathan Spicer.

- In 2021, the GCI received $520,268 from the **Défi Canderel**, which provides vital support for our student and post-doctoral training. A total of 10 graduate students and four post-doctoral fellows were funded during the past year, allowing them to pursue their research projects at the GCI.

- The **Terry Fox Research Institute** (TFRI) supports many GCI investigators and their collaborators through the Program Project Grant in Oncometabolism, the Marathon of Hope Cancer Centres Network and grants to individual researchers. Each year, the GCI organizes teams to raise funds in support of the Terry Fox Foundation's annual run which are primarily trainee-led and have been highly successful.

$12.7M
FUNDING PROVIDED BY THE BIANNUAL GALA SINCE 2010

$3.4M
RAISED FOR THE GCI IN FY21 THROUGH PHILANTHROPY

44
PUBLIC LECTURES HELD SINCE 2010

EXCELLENCE AT THE INSTITUTE

The excellence of our researchers has been recognized through some of the most prestigious prizes and awards in cancer research.

Our Director, Morag Park, became a "Chevalière de l'Ordre National du Québec," the highest honour bestowed by the Quebec government.

"McGill University is proud that the Government of Quebec has chosen to honour Morag Park for her outstanding contributions to cancer research. Her work has improved our understanding of cancer and has made a mark on Quebec's culture of research excellence,"

MARTHA CRAGO
Vice-Principal, Research and Innovation

Ian Watson received the Team Science Award from the American Association of Cancer Research (AACR), in recognition of his leadership as Co-Chair of The Cancer Genome Atlas (TCGA) cutaneous melanoma project.

George Zogopoulos was recognized for his excellence as a surgeon-scientist, winning the Michael and Renata Hornstein Award from the Department of Surgery, McGill University

In recognition of her legacy as a teacher and mentor, Nicole Beauchemin received a Career Award for Teaching of Basic Cancer Research from McGill's Gerald Bronfman Department of Oncology.

$19.2M

IN OPERATING FUNDS FROM COMPETITIVE GRANTS AND AWARDS

$1.8M

IN INFRASTRUCTURE FUNDING

$930K

IN COMPETITIVE SALARY AWARDS

$790K

IN RESEARCH CONTRACTS

59%

CANADIAN INSTITUTES OF HEALTH RESEARCH

14%

PRIVATE FOUNDATIONS

8%

PRIVATE SECTOR

10%

OTHER GOVERNMENT AGENCIES

6%

CANADIAN CANCER SOCIETY

3%

McGILL

TRAINING THE **NEXT GENERATION**

We recruit the brightest, most inquisitive minds from talent at McGill, throughout Quebec, across Canada and around the world. Our goal is to help them reach their full potential, guiding and inspiring them as they become the next generation of cancer research leaders.

Building a new Cancer Research Training Program

As part of its new mandate as an interdisciplinary research institute, the GCI is working with collaborators and partners from across McGill to create a new training program in Integrated Cancer Sciences. By focusing on training the next generation of cancer research leaders to think and work across traditional disciplinary boundaries, this program will be unique at McGill. The initiative will lead to the development of both MSc and PhD interdisciplinary training programs in the near future.

Owen Egan

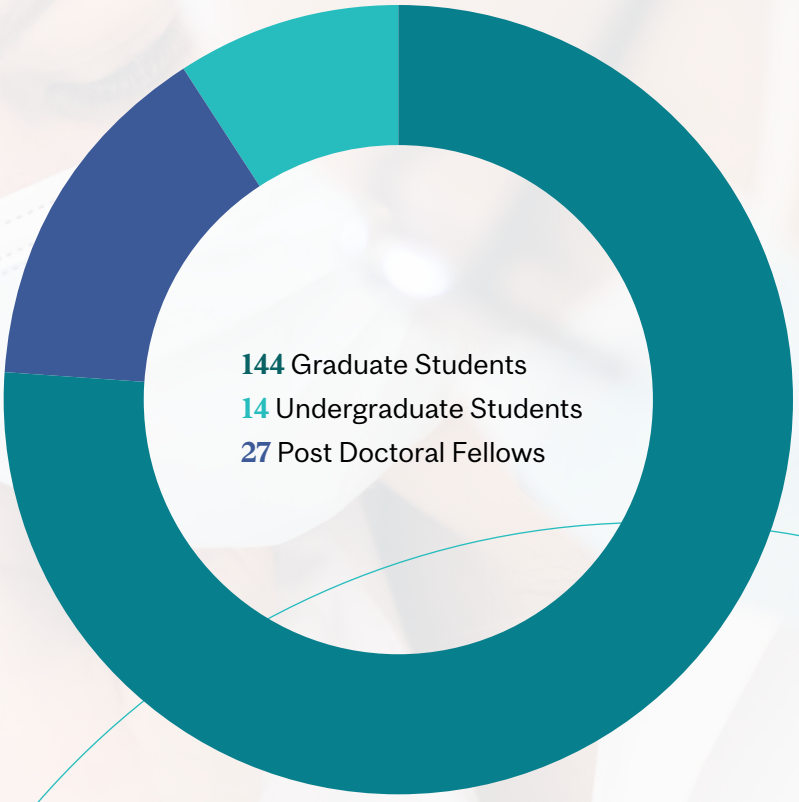
185

UNDERGRADUATES, GRADUATES AND POST-DOCTORAL TRAINEES

+$1.1

MILLION

in scholarships and fellowships from diverse foundations and agencies



"Doing cancer research here feels like you have a chance to provide meaningful work and possibly even save someone's life."

SHERI MCDOWELL

PhD student from the Quail lab

Thank you to our donors

Today, the Goodman Family continues to support our Institute and our endeavour to make cancer a disease of the past. If it were not for their incredible time and generosity, we simply would not be here today. Thanks to the Morris and Rosalind Goodman Family Foundation (MRGFF), philanthropists, institutions, and corporations come together with the goal of funding research excellence. We continue to be motivated by Rosalind Goodman's conviction that, "Hopefully one day, there will be a cure for cancer."

The GCI thanks Mr. Jonathan Wener, the Défi Canderel team and all the donors and volunteers who have supported us for over 30 years in our mission to train the next generation of leaders and recruit world-class cancer researchers.

Thanks to the generosity of The Dr. John A. and Mrs. Clara M. Fraser Memorial Trust, the GCI has been able to invest in cutting-edge technology and outstanding research personnel. We are deeply grateful for their support of our scientific programs in cancer metabolism and other key areas.

The GCI is also grateful to the many other private foundations and individual donors whose generous gifts have allowed our research and training programs to thrive.

Your support makes our research breakthroughs possible.
mcgill.ca/gci/donate

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