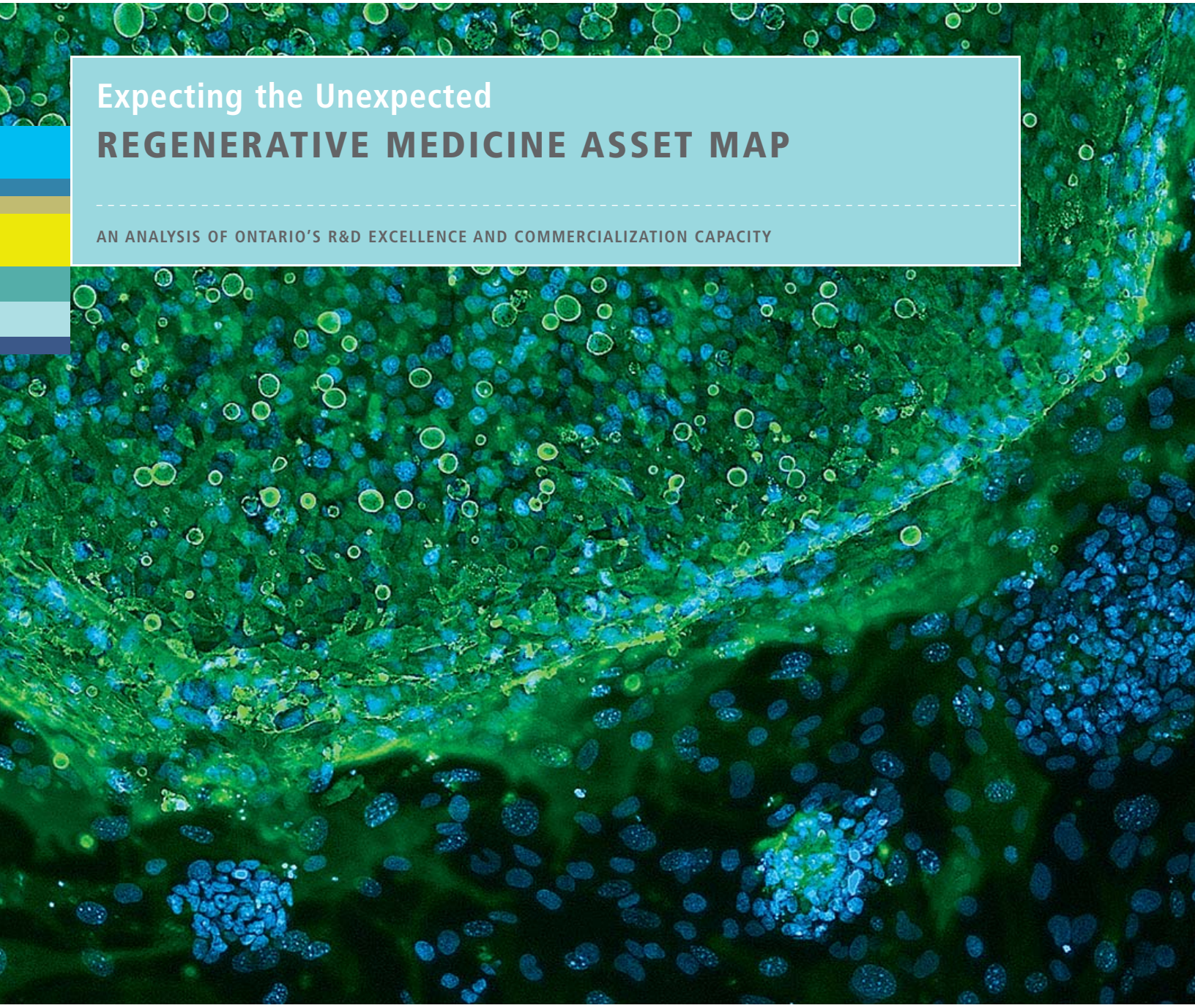
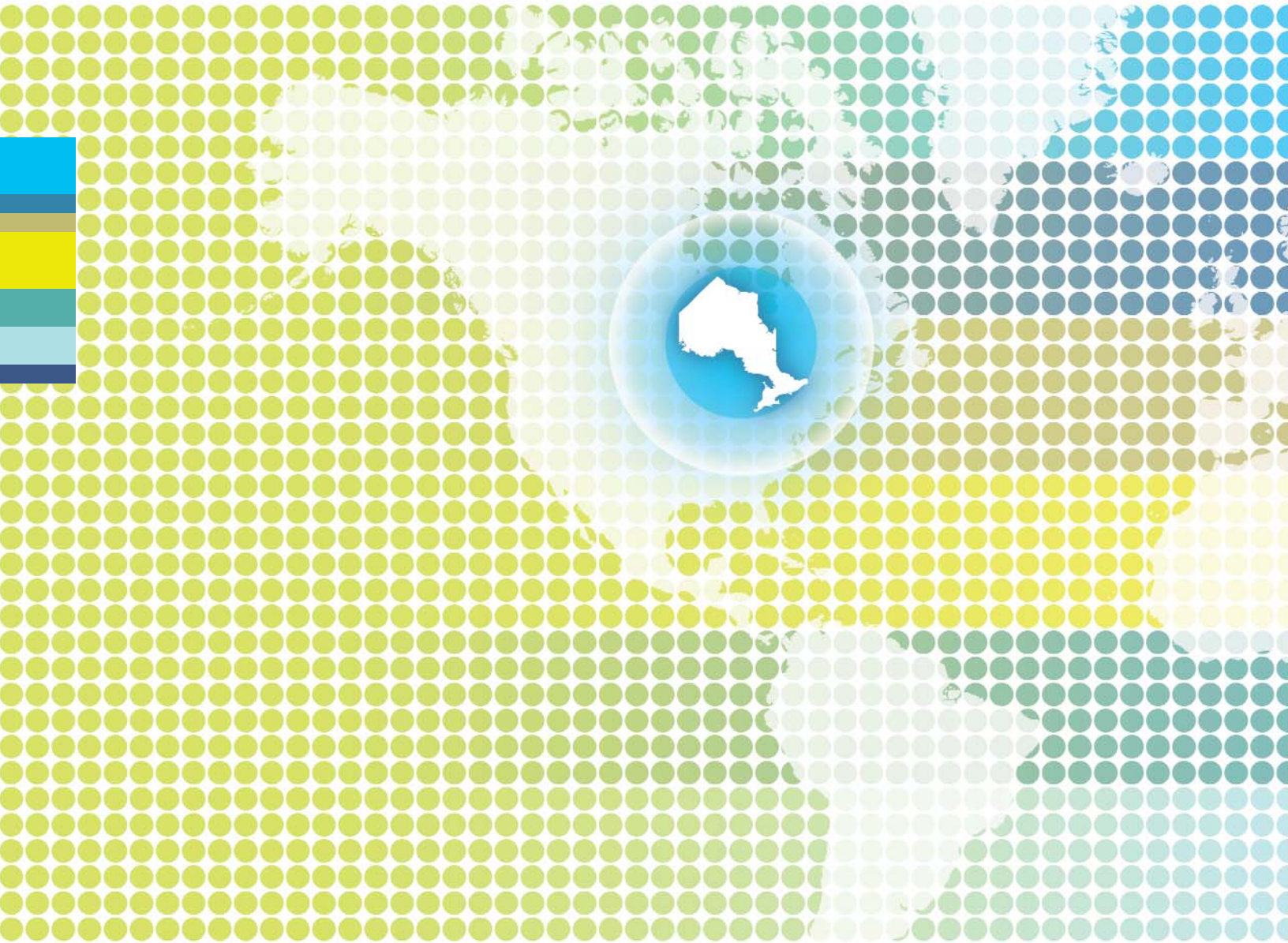


Expecting the Unexpected

REGENERATIVE MEDICINE ASSET MAP

AN ANALYSIS OF ONTARIO'S R&D EXCELLENCE AND COMMERCIALIZATION CAPACITY

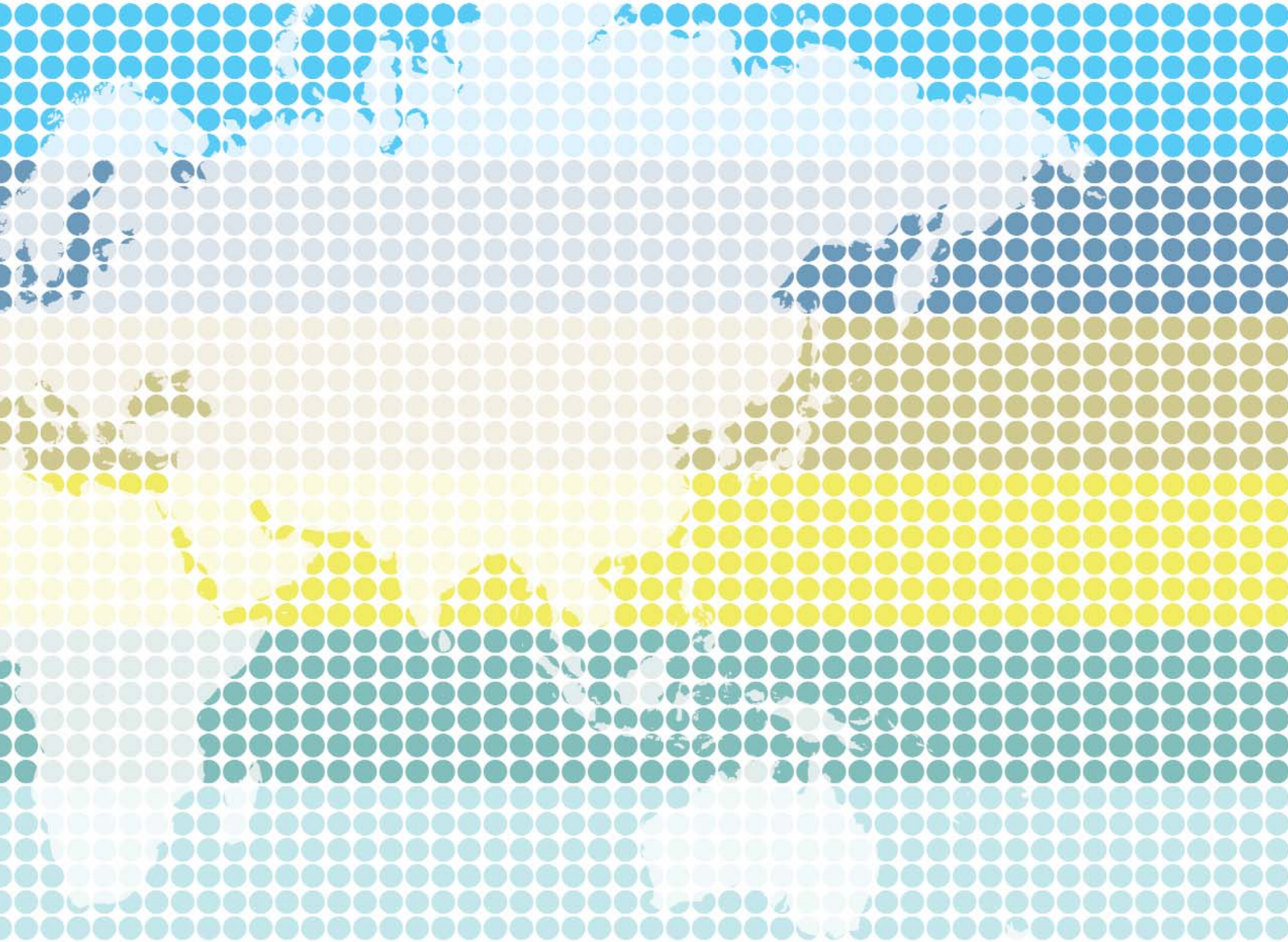
TABLE OF CONTENTS



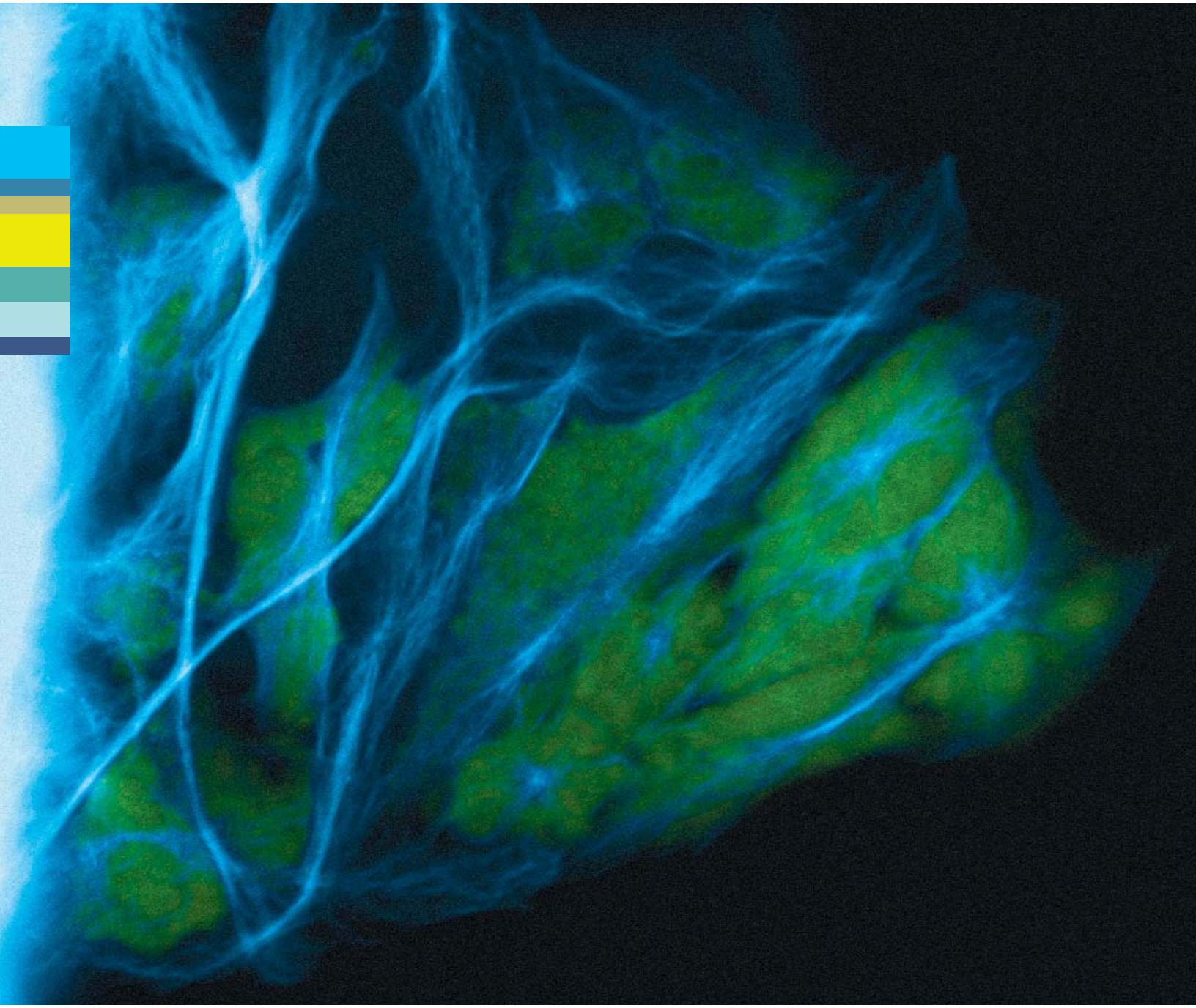
Cover image: Colony of induced pluripotent stem cells (iPSCs) derived from skin fibroblasts of a patient with Ehlers-Danlos syndrome. Green represents a pluripotent stem cell marker SSEA-4, whereas blue indicates the cell nuclei. (Image courtesy of Kamal Garcha (W.L. Stanford Lab) and the Ontario Human iPS Cell Facility)

"If you are in the stem cell space, you've got to come to Ontario.
We have all the skills and infrastructure you need. We get things done here."

– Dr. James Ellis, Senior Scientist, The Hospital for Sick Children, Toronto



Differentiated mouse iPS cells stained with marker indicating tubulin expression. (Image courtesy of Andrey Shukalyuk/W. L. Stanford Lab)



EXECUTIVE SUMMARY

EXPECTING THE UNEXPECTED. Scientists with a keen eye for breakthrough discoveries inherently understand this, as the "failed" experiment can provide a source of novel observation and potentially paradigm-shifting insight.

But it's not simply serendipity that is driving one of the most exciting and commercially promising research fields in Ontario. A deep pool of scientific talent. Outstanding facilities. Catalytic investments from the government and the private sector. A well-established collaborative culture. All of these combine to position the province in the top tier of international regenerative medicine centres.

Undoubtedly, Ontario is on the vanguard of stem cell biology. Dr. Andras Nagy of Mount Sinai Hospital in Toronto, for example, recently discovered a technique to create pluripotent stem cells without the use of viral vectors (*Nature*, April 9, 2009), which has been hailed as a monumental step forward in the field of new stem-cell-based therapies (see page 6). Another seminal study (*Nature*, April 23, 2008), by Dr. Gordon Keller of Toronto's University Health Network (UHN), identified for the first time a cardiovascular progenitor cell that could give rise to the three main cardiac cell types (see page 10).

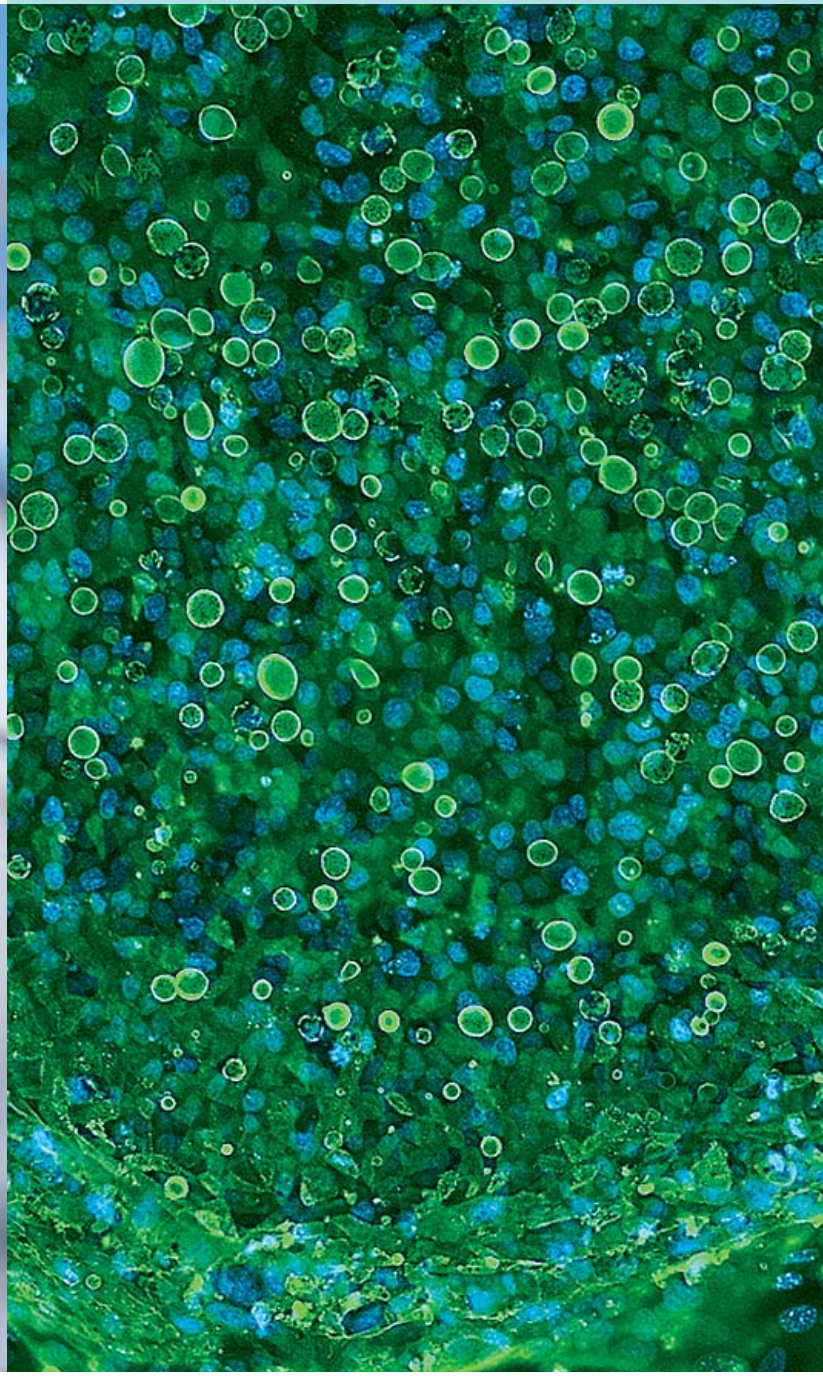
Such research leadership spans not only across a cluster of major Ontario institutions (see page 8) – including Toronto's Hospital for Sick Children, Hamilton's McMaster University and the Ottawa Health Research Institute – but also across disciplines that will move this field into the future, from genomics and bioinformatics, tissue engineering and biomaterials to functional imaging and clinical trials development.

As well, government-led investments in critical infrastructure – such as The Hospital for Sick Children's cell bank and Canada's first facility for human-induced pluripotent stem (iPS) cells (see page 11) – offer a significant advantage to Ontario's research community.

That advantage is further enhanced by a strong culture of collaboration in the field, perhaps embodied best by two pioneers of regenerative medicine in Toronto – physicist James Till and physician Ernest McCulloch, who first discovered the hematopoietic stem cell in 1961. Canadian clinicians continue to work hand-in-hand with the research community, pioneering clinical trials in stem cell therapies and leveraging Ontario's publicly funded healthcare system.

Talent. Infrastructure. Leadership. Collaboration. Ontario's assets provide a powerful global resource to fulfill the promise of regenerative medicine for patients worldwide.

DISCOVERY

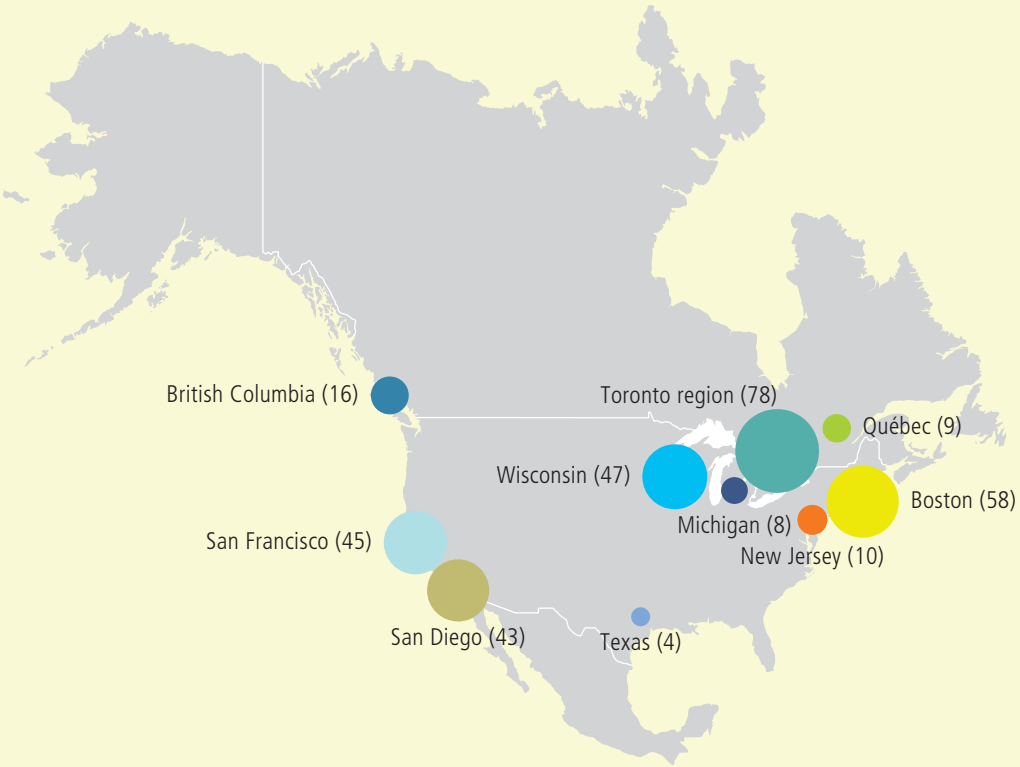


Critical Mass of Talent and Infrastructure

NORTH AMERICAN STEM CELL RESEARCH ACTIVITY

The stem cell capacity of the Toronto region alone is comparable to that of Boston and California.

Figure 1: NUMBER OF PRINCIPAL INVESTIGATORS CONDUCTING STEM CELL RESEARCH



Data compiled by TRRA. Sources: Institute for Scientific Information (ISI) citation analysis, as of August 2008; research association reports; primary research.
Note: Capacity for Maryland, New York and Pennsylvania was not plotted, as there are fewer than four PIs in those jurisdictions.

ONTARIO RESEARCH LABORATORIES SPEND MORE THAN $100 MILLION ANNUALLY ON LAB SUPPLIES FOR CELL BIOLOGY RESEARCH

Ontario has more than 95 principal investigators working in stem cell research laboratories, which corresponds to a market size of more than $10 million in research supplies and consumables. This market category totals more than $100 million because other biology labs purchase similar supplies.

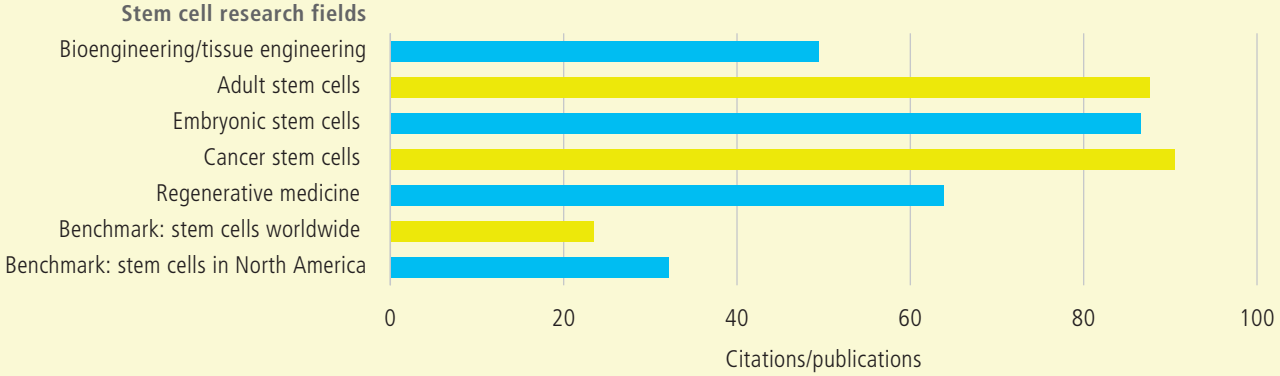
Figure 2: NUMBER OF PRINCIPAL INVESTIGATORS IN ONTARIO CONDUCTING STEM CELL RESEARCH AS OF SUMMER 2008

Data compiled by TRRA, August 2008. Sources: Departmental websites of Ontario universities; primary research; University of Toronto Faculty of Medicine Annual Report and interview with the Vice-Dean, Research & International Relations, Faculty of Medicine.

PROMINENT STEM CELL RESEARCH ACTIVITIES

The Toronto region's stem cell expertise spans five broad areas.

Figure 3: CITATIONS/PUBLICATIONS OF PRINCIPAL INVESTIGATORS IN THE TORONTO REGION (1998–2008)



Data compiled by TRRA. Source: Institute for Scientific Information (ISI) citation analysis of specific principal investigators in Toronto, Guelph, Waterloo and Hamilton (as of August 2008).

Unique Ontario Opportunities

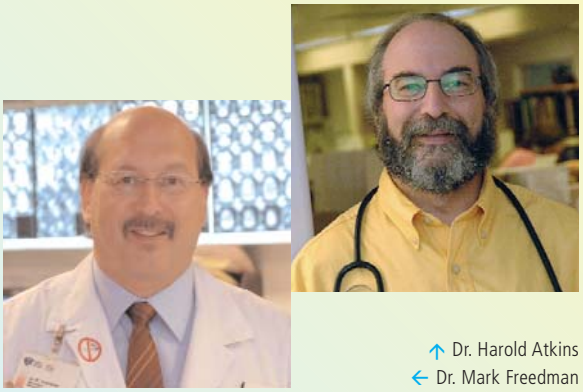
Dr. Andras Nagy

DR. ANDRAS NAGY PIONEERS NEW METHOD FOR CREATING STEM CELLS

A little more than one year after Dr. Shinya Yamanaka first converted adult cells into pluripotent stem cells, another significant breakthrough made news in Toronto. Dr. Andras Nagy and his colleagues at the Samuel Lunenfeld Research Institute of Mount Sinai Hospital discovered a new virus-free approach to generate iPS cells. The new technique (results were published in *Nature* on April 9, 2009) allows for the reprogramming genes to be removed after the induction phase. Reprogramming without the use of viruses prevents any damage to DNA and is a major advance towards safe stem cell therapies. It is hoped that this elegant protocol will facilitate widespread adoption of iPS cells in basic and applied research and help make iPS cell therapy a near-term prospect.

Dr. Nagy has been a principal investigator at Mount Sinai Hospital since 1994. In 2005 he created Canada's first embryonic stem cell lines from donated embryos – a collaborative project with Dr. Keisuke Kaji from the Medical Research Council Centre for Regenerative Medicine at the University of Edinburgh.

DR. ANDRAS NAGY | nagy@mshri.on.ca
http://www.mshri.on.ca/nagy/



↑ Dr. Harold Atkins
← Dr. Mark Freedman

DR. MARK FREEDMAN AND DR. HAROLD ATKINS CONDUCT CLINICAL TRIAL TO TEST STEM CELL THERAPY FOR MULTIPLE SCLEROSIS

Two scientists at the Ottawa Health Research Institute (OHRI), Dr. Mark Freedman and Dr. Harold Atkins, are leading a clinical trial to test an experimental stem cell therapy for multiple sclerosis. The therapy involves replacing the patient's damaged immune system with a new one derived from the patient's own bone-marrow stem cells, which are taken from the patient, purified and frozen. The patient then undergoes chemotherapy to destroy the existing immune system. The purified stem cells are transplanted back into the patient, eventually forming a new immune system free of multiple sclerosis. The clinical trial aims to stop or slow progression of the disease.

The therapy is highly experimental with potentially serious side effects; however, the treatment seems to be working. In many patients, disease progression has either slowed or stopped. Scientists have even recorded improvements in the ability of some patients to see and walk. The knowledge gained from this study could lead to significant improvements in treating multiple sclerosis and is an early demonstration of the promise of stem cell therapies.

The goal of the study, which began in 2001, is to treat 24 patients.

Dr. Freedman is a senior scientist at OHRI and the director of the Ottawa Hospital MS Clinic. Dr. Atkins is a scientist at OHRI and a physician with the Ottawa Hospital Blood and Marrow Transplant Program.

DR. HAROLD ATKINS | hatkins@ohri.ca
DR. MARK FREEDMAN | freedma@uottawa.ca

Dr. Mick Bhatia

DR. MICK BHATIA DIFFERENTIATES BETWEEN HEALTHY STEM CELLS AND CANCER STEM CELLS

One of the major challenges of current cancer therapy is targeting the destruction of malignant cells without damaging healthy cells. Dr. Mick Bhatia and his team at the McMaster Stem Cell and Cancer Research Institute (SCC-RI), which opened in 2006, have revealed the difference between healthy stem cells and cancer stem cells. The discovery will allow scientists to define the differences between normal cells and cancer cells in gene expression and response to drugs. This model for drug discovery could use robotic screening to find molecules that have the ability to destroy cancer cells. With access to the McMaster High-Throughput Screening (HTS) Laboratory and robust chemical libraries, Dr. Bhatia's team is in a strong position to meet the ultimate goal of eradicating cancer.

The HTS facility is an innovative biomolecular screening resource for McMaster University scientists and the broader research community. Dr. Bhatia holds a Canada Research Chair in human stem cell biology and is the inaugural director of the SCC-RI, where research is focused on using human stem cells as models to understand the underlying molecular mechanisms that cause cancer.

DR. MICK BHATIA | mbhatia@mcmaster.ca
http://fhs.mcmaster.ca/SCCRI/faculty/bhatia.html

Dr. Peter Zandstra

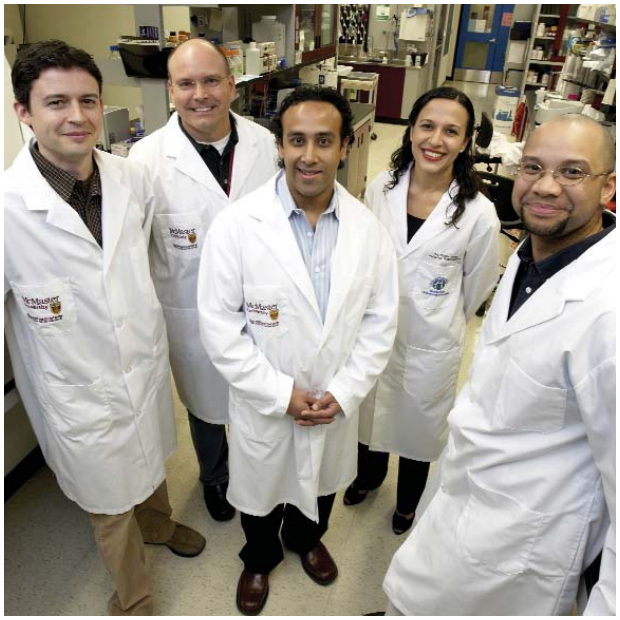
DR. PETER ZANDSTRA USES ENGINEERING PRINCIPLES TO GUIDE THE GENERATION OF BLOOD AND CARDIAC CELLS

Led by Dr. Peter Zandstra, the Stem Cell Bioengineering Lab at the Institute of Biomaterials and Biomedical Engineering (IBBME) of the University of Toronto is tackling the problem of how to mass-produce stem cells. From a bioengineering perspective, Dr. Zandstra explores how the cellular environment governs stem cell growth and differentiation. By learning how to control the environment around cells, scientists can guide embryonic stem cells to form blood and cardiac cells. Dr. Zandstra is also working on the design of clinical bioreactors to control stem cell microenvironments. The ability to guide cells to act in certain ways and make specific decisions could lead to the eventual generation of tissues from small populations of stem cells.

Dr. Zandstra is a professor and principal investigator at IBBME. He holds a Canada Research Chair in stem cell bioengineering.

DR. PETER ZANDSTRA | peter.zandstra@utoronto.ca
http://stemcell.ibme.utoronto.ca/

Groups of Principal Investigators Working Together



Dr. Mick Bhatia and his team of scientists at the Stem Cell and Cancer Research Institute at McMaster University. (Photo by Michael Lalich)

BRALEY HUMAN STEM CELL LIBRARY (HSCL)
STEM CELL AND CANCER RESEARCH INSTITUTE (SCC-RI) – HAMILTON

Michael DeGroote Centre for Learning and Discovery
McMaster University
1200 Main St. W.
Hamilton, ON L8N 3Z5
905-525-9140, ext. 28686
dlilley@mcmaster.ca
http://fhs.mcmaster.ca/SCCRI/

In 2007, McMaster University received a $15-million private donation for the establishment of HSCL. Under the leadership of Dr. Mick Bhatia, HSCL has a mandate to create a platform for innovation in replacement and regenerative therapy through high-content screening of human stem cells. With access to a 190,000-compound library of commercially available and novel chemicals, advanced high-throughput screening and biophotonics, as well as more than 15 iPS cell lines, this screening facility has become an acclaimed platform for innovations in regenerative medicine. Since its inception, HSCL has been developing novel drug discovery and drug-screening platforms based on the assessment of stem cell toxicity, pluripotency and differentiation with a particular focus on hematopoietic stem cells, cancer stem cells (tumour-initiating cells), blood derivation and leukemia.

The McMaster SCC-RI is renowned for its work in human stem cell biology and regenerative medicine. Supported by an international team of more than 50 highly regarded researchers and state-of-the-art infrastructure, SCC-RI aims to advance the understanding of cancer stem cells, blood development, pluripotency, differentiation and lineage determination in humans. Under the directorship of Dr. Bhatia, a leader in the field of human stem cell biology who has published 75 reports in prestigious journals such as *Nature* and *Cell*, SCC-RI has attracted millions of dollars in research funding from government agencies, industrial partners and private donations.

INSTITUTE OF BIOMATERIALS AND BIOMEDICAL ENGINEERING (IBBME) – TORONTO

Roseborough Building
164 College St., Rm. 407
University of Toronto
Toronto, ON M5S 3G9
416-946-8258
director.ibbme@utoronto.ca
http://www.ibbme.utoronto.ca/

IBBME at the University of Toronto is a unique multidisciplinary organization of scientists and practitioners from the faculties of Applied Science & Engineering, Medicine and Dentistry collaborating to pursue research and teaching mandates within the context of biomedical engineering. Biomedical engineering involves the integration of engineering and the physical sciences with the life sciences in order to address medical problems.

IBBME conducts research in four areas, including sensory systems, biomedical nanotechnology and medical devices. The program in biomaterials, tissue engineering and regenerative medicine explores the following five fields:

1. Orthopaedic, dental, cardiovascular and soft tissue biomaterials
2. Stem cell bioengineering and functional genomics
3. Tissue engineering, scaffolds, host response and functional integration
4. Hemodynamics, cellular and tissue biomechanics
5. Cellular engineering.

IBBME is comprised of about 35 core faculty members. The Stem Cell Bioengineering Laboratory, led by Dr. Peter Zandstra, aims to develop descriptions on stem cell fate processes to better design and implement stem-cell-based technologies. Dr. Milica Radisic leads the Laboratory for Functional Tissue Engineering, conducting work in cardiac tissue engineering and regenerative medicine. She is focused on designing advanced bioreactors for cardiac tissue engineering and developing strategies to engineer cardiac tissue to be used as a model system for cardiac cell therapy or drug testing. Dr. Molly Shoichet's lab is investigating different methods of enhancing and guiding nerve regeneration and incorporating these methods into devices for in vivo investigations. The lab has designed novel injectable hydrogels for local delivery to the injured spinal cord and brain.

LAWSON HEALTH RESEARCH INSTITUTE (LHRI) – LONDON

St. Joseph's Hospital
268 Grosvenor St., Rm. F4-106
London, ON N6A 4V2
519-646-6005
info@lawsonresearch.com
http://www.lawsonresearch.com

LHRI – the research arm of London Health Sciences Centre and St. Joseph's Health Care in London – is one of the largest hospital-based research organizations in Canada and is affiliated with the University of Western Ontario. LHRI has 97 scientists and more than 400 clinician scientists and scholars conducting biological, clinical, health services and population health research. In 2007, LHRI scientists published more than 900 peer-reviewed original articles and attracted more than $60 million in external grants and contracts.

LHRI organizes its research around 11 themes, which range from aging, rehabilitation and geriatric care to vascular health and chronic disease. The neurological disorders program examines regeneration after spinal cord injuries, while the transplantation program conducts basic and applied clinical research related to transplantation and the body's immune response. Investigators study stem cell development, cell-based therapies for organ regeneration and xenotransplantation as an alternative source of cells and organs for transplantation.

Dr. Mansoor Husain is a senior scientist at the McEwen Centre for Regenerative Medicine and associate director of the Cardiac Intensive Care Unit at Toronto General Hospital. He studies the development of heart cells derived from embryonic stem cells for possible use in transplantation. (Photo by Gary Rhijnsburger)

McEWEN CENTRE FOR REGENERATIVE MEDICINE (MCRM) – TORONTO

University Health Network (UHN)
MaRS Centre, Toronto Medical Discovery Tower
101 College St., 8th Fl., Rm. 701
Toronto, ON M5G 1L7
416-581-7713
mcewencentre@uhn.on.ca
http://www.mcewencentre.com/

MCRM, which is based at the MaRS Centre, was established at University Health Network (UHN) in 2003. It seeks to accelerate the development of more effective treatments for life-threatening conditions such as heart disease, diabetes and spinal cord injury.

Investigators actively pursue the following three areas of regenerative medicine R&D:

1. Repair and regeneration of cells, tissues and organs: Scientists conduct work on heart disease, diabetes, spinal cord injury and neurodegenerative diseases, as well as blood cell disorders.
2. Origins and models of disease: Investigators examine normal and cancer stem cells and model human diseases by using embryonic stem cells to study the processes that cause cells and tissues to malfunction.
3. New tools for drug discovery: Scientists explore the creation of new stem-cell-based tools for drug screening and refine stem-cell-derived models of human disease.

Led by Dr. Gordon Keller, MCRM brings together Toronto's top cell differentiation experts, creating a mass of critical talent to accelerate embryonic stem cell and iPS cell technologies. In April 2008, scientists performed a medical first when they coaxed embryonic stem cells to transform into immature heart cells, known as heart progenitor cells. Scientists differentiated the cells further into three major types of heart tissue – cardiomyocytes, endothelial cells and vascular smooth muscle cells. Their work (results were published in *Nature*, April 2008) provides a limitless supply of tissue to allow scientists to study cell development and function and conduct drug testing. Eventually, therapies may be developed to repair heart damage resulting from heart attacks.

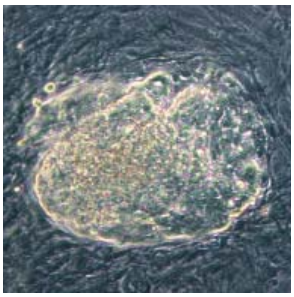
McLAUGHLIN CENTRE FOR MOLECULAR MEDICINE (MCMM) – TORONTO

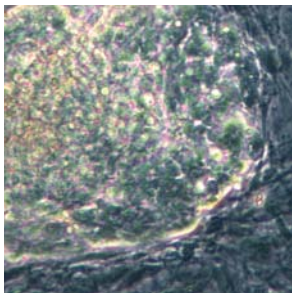
MaRS Centre, Toronto Medical Discovery Tower
101 College St., 14th Fl., Suite 701
Toronto, ON M5G 1L7
416-813-7654, ext. 1574
mcmm.escells@utoronto.ca
http://www.mcmm.ca/

MCMM, housed at the MaRS Centre, was established in 2003 as a joint initiative of the University of Toronto and four partnering hospital institutions – Mount Sinai Hospital, Sunnybrook Health Sciences Centre, The Hospital for Sick Children and University Health Network. Research at MCMM is multidisciplinary across seven programs aimed at speeding the application of molecular discovery to clinical care: computational genomics, drug discovery, education, ethics and policy, global health, immunogenomics and regenerative medicine.

The regenerative medicine program, led by Dr. Derek van der Kooy, conducts research in cardiac cell therapy, spinal cord repair and regeneration and stem cell biology. Dr. van der Kooy's lab published the first report of stem cells in the adult mammalian eye (*Science*, March 17, 2000). Further work documented how embryonic stem cells differentiate directly into neural stem cells through a default mechanism. The lab continues to investigate the nature of stem cells (embryonic and adult), the concept of immortal cells and the differentiation of embryonic stem cells into neural stem cells.

MCMM has established three core facilities for use by the general research community to provide access to biological screening, high-throughput monoclonal production and human embryonic stem cells. The Human Embryonic Stem Cell Core Training Facility of MCMM builds and maintains a library of embryonic stem cells for distribution to researchers within the broader scientific community. It also provides scientists with expert training in the handling of these cells, guiding researchers to become competent in cell manipulation, passaging, feeding and media preparation.





These images depict a fully reprogrammed mouse iPS colony after three weeks of formation time. The cells have grown into a distinct mass (shiny lump) on top of the skin cells which did not reprogram (grey area seen around the edges). (Image courtesy of Knut Woltjen at the Ontario Human iPS Cell Facility, MaRS centre, Toronto)

ONTARIO HUMAN INDUCED PLURIPOTENT STEM (iPS) CELL FACILITY – TORONTO

MaRS Centre, Toronto Medical Discovery Tower
101 College St., Rm. 13-603
Toronto, ON M5G 1L7
416-813-7654, ext. 4655
contact@ontarioips.ca
http://www.ontarioips.ca

The Ontario Human iPS Cell Facility, which is located in the MaRS Centre in Toronto and established with seed funding from the Ontario Ministry of Research and Innovation, opened in June 2008. The mandate of the facility – jointly led by Dr. James Ellis, a scientist at The Hospital for Sick Children, and Dr. Bill Stanford from the University of Toronto – is to position Ontario at the cutting edge of new technologies and applications in iPS cells. Its steering committee includes highly regarded scientists from top Ontario institutions in regenerative medicine, such as the McEwen Centre, the Samuel Lunenfeld Research Institute and McMaster University. The facility has a collaborative agreement with Kyoto University in Japan and the Gladstone Institute at the University of California, San Francisco.

The facility develops best practices in the technologies of reprogramming with a focus on the establishment and banking of patient-specific primary fibroblast cell lines, and the subsequent generation and characterization of iPS cells. It has banked about 20 disease-specific cell lines. In addition to generating cell lines, which have been made available to the broader research community, it has an important role in providing Ontario researchers with training and access to cutting-edge iPS technologies for their own research endeavours.

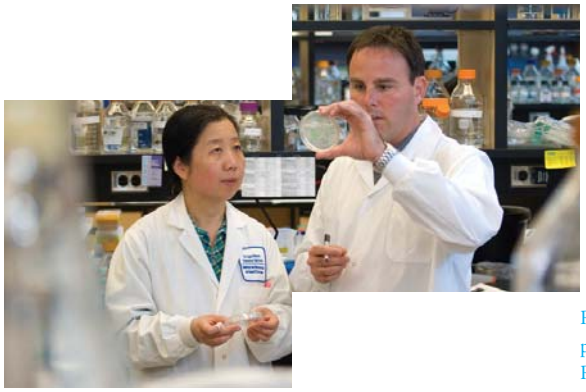
RESEARCH INSTITUTE AT THE HOSPITAL FOR SICK CHILDREN (SICKKIDS) – TORONTO

555 University Ave.
Toronto, ON M5G 1X8
416-813-5058
http://www.sickkids.ca/Research/index.html

The Developmental and Stem Cell Biology Program at SickKids has a major stem cell research component aimed at elucidating the molecular and genetic mechanisms that underlie embryonic development and tissue regeneration. Basic developmental biology research is used to further understand developmental disorders such as childhood cancers and other congenital diseases. Disciplines within the program devoted predominantly to stem cell research include the characterization of stem cells and cancer cells, as well as regenerative medicine and tissue engineering.

Scientists at SickKids have contributed greatly to the stem cell knowledge base, and their research has led to many important discoveries, including the following:

- Generation of early endoderm cells from human embryonic stem cells: The Rossant lab was able to understand how to influence cell fate determination by manipulating the expression of transcription factors.
- Discovery of the SIRPalpha gene: The Danska lab identified the type of cell that expresses SIRPalpha and is responsible for either destroying or supporting growth of human blood stem cells.
- Advances in repairing spinal cord injuries by using skin-derived stem cells: The self-renewing skin-derived precursors (SKPs) identified by Dr. Freda Miller and her colleagues share characteristics with embryonic neural crest stem cells.
- Isolation and characterization of a cancer stem cell from human brain tumours of different phenotypes that express neural stem cell markers and exhibit stem-cell-like behaviour in vitro and in vivo: Cells were isolated by the Dirks lab from both low-grade and high-grade primary brain tumours.



Research technician Lifang Li and scientist Dr. Jeff Dilworth examine proteins expressed by stem cells at the Sprott Centre for Stem Cell Research at the Ottawa Hospital.

The hospital is also home to the following stem cell patents and intellectual property:

- method for stimulating the proliferation of endogenous retinal stem cells in vivo;
- SKP technology, which provides methods and compositions for the isolation and proliferation of mammalian neural crest stem cells; and
- novel therapy for acute cardiac damage and a stable endoderm progenitor cell line established from hES cell lines.

As a research institute embedded in a working hospital, SickKids has the advantage of being able to translate knowledge into clinical practice. Already underway are clinical applications such as stem cell therapy using cord blood as well as stem cells derived from peripheral blood for the purposes of bone marrow transplantation.

SPROTT CENTRE FOR STEM CELL RESEARCH – OTTAWA

Ottawa Health Research Institute (OHRI)
725 Parkdale Ave.
Ottawa, ON K1Y 4E9
613-761-4395
info@ohri.ca
http://www.ohri.ca/programs/Regenerative_Medicine/default.asp

OHRI is the research arm of the Ottawa Hospital and is affiliated with the University of Ottawa. Approximately 100 scientists and 300 investigators conduct research in one of the six core programs at OHRI: cancer therapeutics, chronic disease, clinical epidemiology, neuroscience, regenerative medicine and vision.

The Sprott Centre for Stem Cell Research is the hub of a large interdisciplinary group of stem cell and regenerative medicine researchers at OHRI. Scientists conduct basic research in stem cell biology, molecular genetics and molecular biology, as well as applied sciences such as transplantation and tissue engineering. The following are among the 18 scientists and approximately 200 trainees and staff involved in groundbreaking research:

- Dr. Michael Rudnicki, director of the Sprott Centre, was the first to discover adult muscle stem cells and continues to make important discoveries on how these cells are controlled.
- Dr. Duncan Stewart has developed several novel cell and gene therapies for cardiovascular disease and has initiated the world's first clinical trials in this area.
- Dr. Harold Atkins has developed a novel bone-marrow stem cell transplantation therapy that has shown great promise in multiple sclerosis patients.
- Dr. Lynn Megeney was the first to describe cardiac stem cells in the adult heart and the first to identify a role for caspases (cysteine-aspartic acid proteases) in cell differentiation.
- Dr. May Griffith has developed the first biosynthetic corneas that promote regeneration in the eye, which are currently being tested in early-phase clinical trials.

The Ottawa stem cell group provides leadership for major national and international research networks, including Centres of Excellence Canada's Stem Cell Network and the International Regulome Consortium (IRC). Sprott Centre researchers are also active in several start-up companies.

Researchers within the vision program are embarking on a five-year, $2.4-million collaborative project to develop stem cell therapies aimed at reversing blindness. The project brings together top stem cell researchers, innovative eye surgeons and experts in biomaterials and tissue engineering from OHRI, the University of Toronto, the University of Calgary and Linköping University in Sweden. The team hopes to develop better methods for controlling stem cells, so that these cells can be coaxed into producing different kinds of eye cells, such as retinal and corneal cells. The researchers will also develop more efficient transplantation methods that help new eye cells integrate with existing tissue to restore lost vision.

Research Highlights

Scientific Highlights 2008

Source: Regenerative Medicine Industry Briefing – "Commercial Opportunities and Ontario's Strengths," January 2009 (MaRS Centre, Toronto)

Many notable discoveries in Ontario in regenerative medicine over the past year have led to new targets for detection, therapy, understanding disease etiology and predictive outcomes.

Dr. G. Keller, director of the McEwen Centre for Regenerative Medicine, led an international team with members from the U.S. and Britain to successfully differentiate human embryonic stem cells into three types of progenitor heart cells.

The team developed human heart cells from a KDR(+) human embryonic stem cell population. Dr. Keller's group was able to induce differentiation into the three main cardiac cell types, both in vitro and in vivo, by treating cells with combinations of growth-promoting factors: DKK1, FGF2, BMP4, activin A and VEGFA. The team's endeavour is the first study to identify a human cardiovascular progenitor cell that may give rise to the three distinct mesoderm-derived lineages required for a functional heart: cardiomyocytes, endothelial cells and vascular smooth muscle cells. This advance will accelerate the understanding of adult heart repair and soon lead to the test-tube creation of functioning heart tissue (*Nature.* 2008 May; 453: 524-528).

The Hospital for Sick Children's Dr. C. Seguin and Dr. J. Rossant, chief of research for the Developmental & Stem Cell Biology Program – in collaboration with Dr. A. Nagy from the Samuel Lunenfeld Research Institute at Mount Sinai Hospital and Dr. J.S. Draper of the McMaster Stem Cell and Cancer Research Institute – discovered an important key to controlling stem cell development. By manipulating the expression of transcription factors SOX7 and SOX17, they were able to control cell fate determination of human embryonic stem cells to produce stable progenitor cells capable of producing all endoderm cell types. Since these early endoderm cells can eventually become lung, liver, pancreas and respiratory and digestive tracts and can maintain their distinct profiles and self-renewal abilities through many cell culture stages, these results will lead to new tools to understand endoderm differentiation (*Cell Stem Cell.* 2008 August. 3:182-195).

Dr. S. Keshavjee, director of the Toronto Lung Transplant Centre at Toronto General Hospital, developed an innovative method to improve the viability of unsuitable injured donor lungs for use in transplantation, as part of a clinical trial. His team of transplant surgeons was able to assess, treat and maintain unsuitable lungs with gene or cell therapy, resulting in excellent post-transplant lung function, low edema formation, and preserved lung histology after transplantation. This will increase the pool of donor hearts capable of successful transplantation (*The Journal of Heart and Lung Transplantation.* 2008 Dec. 27(12): 1319-25).

Dr. M. Bhatia's group from McMaster University's Cancer and Stem Cell Biology Research Institute developed a test with 12 criteria to reliably identify cancerous stem cells from healthy stem cells. Human embryonic stem cells with cancer-cell characteristics are difficult to differentiate from healthy stem cells since they both have the same expression of pluripotency markers, self-renewal properties, and potential for teratoma formation. Functional characterization of cancerous human embryonic stem cells makes the use of human embryonic stem cells for clinical applications significantly safer by reducing the risk of transplanting "healthy-looking," yet cancerous, rogue stem cells. (*Nature Biotechnology.* 2009 Jan. 27(1):91-97).

ONTARIO SCIENTISTS COLLABORATE WITH DR. SHINYA YAMANAKA ON IPS CELL TECHNOLOGY

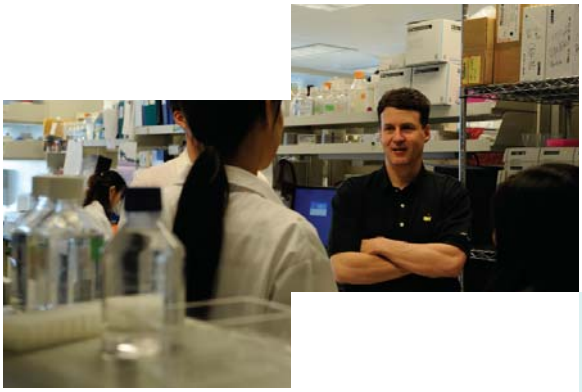
On June 16, 2008, Ontario Premier Dalton McGuinty announced an international partnership between the University of Toronto and the Gladstone Institute of Cardiovascular Disease (GICD), an affiliate of the University of California, San Francisco (UCSF). Along with $1 million in seed funding from the Ministry of Research and Innovation, the collaboration triggered the creation of Canada's first iPS core facility.

A consortium of elite Ontario scientists in regenerative medicine – jointly located at the GICD and Kyoto University in Japan – is working with Dr. Shinya Yamanaka, who created the first iPS cell. Scientists at the two locations share cell lines and protocols that will accelerate the advancement of this revolutionary science.

Since Dr. Yamanaka's discovery, labs around the world have derived cell lines using variations of his reprogramming technique. The partnership gives differentiation experts at the University of Toronto access to the most advanced technologies and protocols pioneered at Dr. Yamanaka's labs, while Toronto's diverse ethnic population provides access to a wide range of patient samples.

Dr. Shinya Yamanaka

Translational Capacity



Dr. Steve Scherer, scientific director of The Centre for Applied Genomics, discusses results with microarray facility staff.

PHILIP S. ORSINO CELL THERAPY FACILITY

Princess Margaret Hospital (PMH)
610 University Ave., Suite 5-303
Toronto, ON M5G 2M9
416-946-2843
http://www.uhnres.utoroto.ca/facilities/psoctf/

The Philip S. Orsino Cell Therapy Facility is a state-of-the-art facility offering Good Manufacturing Practice (GMP) grade cell and tissue processing capabilities. It is located at PMH, a University of Toronto teaching hospital and home to the Ontario Cancer Institute. The facility provides the necessary infrastructure and support for the implementation of clinical-scale cell manufacturing.

It supports novel cell therapy research, services the needs of the Blood and Marrow Transplant Program at PMH and provides a full array of manufacturing and consulting services to the external commercial and academic community.

The unique combination of advanced facilities and broad expertise allows the facility to accommodate a broad variety of cell therapy protocols and offers customized services, which range from the preparation and processing of cellular and tissue products for clinical applications to complete technical, clinical and regulatory support. The facility can accommodate novel phase I studies through to advanced-stage trials. A brief sampling of services includes:

- isolation and preparation of blood and marrow stem cells;
- separation of cells with specific function;
- in vitro cell expansion and manipulation;
- genetic manipulation of cells; and
- cryopreservation and long-term storage.

PMH has achieved an international reputation as a leader in the fight against cancer and is considered one of the world's most comprehensive cancer treatment and research centres. PMH also ranks among the top global centres for bone marrow transplantation and has earned a solid reputation for having some of the longest-surviving bone marrow transplant recipients in the world. The hospital's bone marrow transplant unit, established in 1971, was the first in Canada to perform allogeneic transplants (transplants from unrelated donors). PMH is the only facility in Canada devoted exclusively to cancer research, treatment and education.

THE CENTRE FOR APPLIED GENOMICS (TCAG)

The Hospital for Sick Children (SickKids)
MaRS Centre, East Tower
101 College St., Rm. 14-706
Toronto, ON M5G 1L7
416-813-8140
http://www.tcag.ca/

TCAG is the genome centre in the Research Institute of SickKids, located in the MaRS Discovery District in downtown Toronto.

It provides project support to hundreds of investigators involved in local, national and international research initiatives. This support includes laboratory experimentation, statistical analysis and comprehensive bioinformatics support, including large-scale genome comparisons, algorithm and tools development, as well as database curation, annotation and hosting. The centre supports multiple large-scale projects, including research on autism spectrum disorders, structural variation of the human genome, integrative biology, conditional mouse mutagenesis, interactions of signaling molecules, type I diabetes, cancer stem cells, cystic fibrosis and biodiversity.

TCAG also hosts and curates websites developed from the supported projects, as well as databases on the following subjects: chromosome 7, genomic variants, segmental duplication and autism chromosome rearrangement.

High-level scientific oversight of the hospital's scientific mandate and operations is provided through a prestigious scientific advisory board comprised of the following:

DR. NIGEL CARTER
Wellcome Trust Sanger Institute
Cambridge, U.K.

DR. STYLIANOS E. ANTONARAKIS
University of Geneva School of Medicine
Geneva, Switzerland

DR. ABDALLAH S. DAAR
University of Toronto Joint Centre for Bioethics
Toronto, Canada

DR. XAVIER ESTIVIL
Centre for Genomic Regulation
Barcelona Biomedical Research Park
Barcelona, Spain

DR. JUHA KERE
Karolinska Institutet
Stockholm, Sweden

DR. EDWARD M. RUBIN
Department of Energy Joint Genome Institute
Calif., U.S.

DR. LAP-CHEE TSUI
University of Hong Kong
Hong Kong, People's Republic of China

DR. CHUCK HASEL
Genome Canada
Ottawa, Canada

DR. CHRISTIAN BURKS
Ontario Genomics Institute
Toronto, Canada

PG CLINICAL TRIALS

157 Adelaide St. W., Suite 106
Toronto, ON M5H 4E7
416-565-7058
http://www.pgclinicaltrials.com/

PG Clinical Trials is a progressive Canadian healthcare company supporting the implementation of clinical trials in Canada. Working directly with clinical research organizations, biotechnology companies and investigators, it provides a full-service clinical infusion and compounding site to allow investigators and their patients access to trials outside of the hospital environment.

Medications are administered at one of the most comprehensive free-standing infusion facilities in Canada. At all levels of service delivery, from compounding of product through to infusion and patient monitoring, patient care is provided by more than 70 experienced professionals.

PG offers clinical trial services such as compounding, infusion, medical supervision, phlebotomy and pharmacokinetic sampling to support the administration of phases I, II, III and IV clinical trials. These services include clinical trial planning and implementation, logistics of drug delivery, compounding and data collection.

Through its affiliated company, Provis Inc., patients have access to leading infusion therapies and other ambulatory clinical services, including a full range of endoscopy procedures for therapies approved in Canada but not covered by provincial health plans. Provis also operates the only licensed freestanding radioimmunotherapy clinic of its kind in Canada.

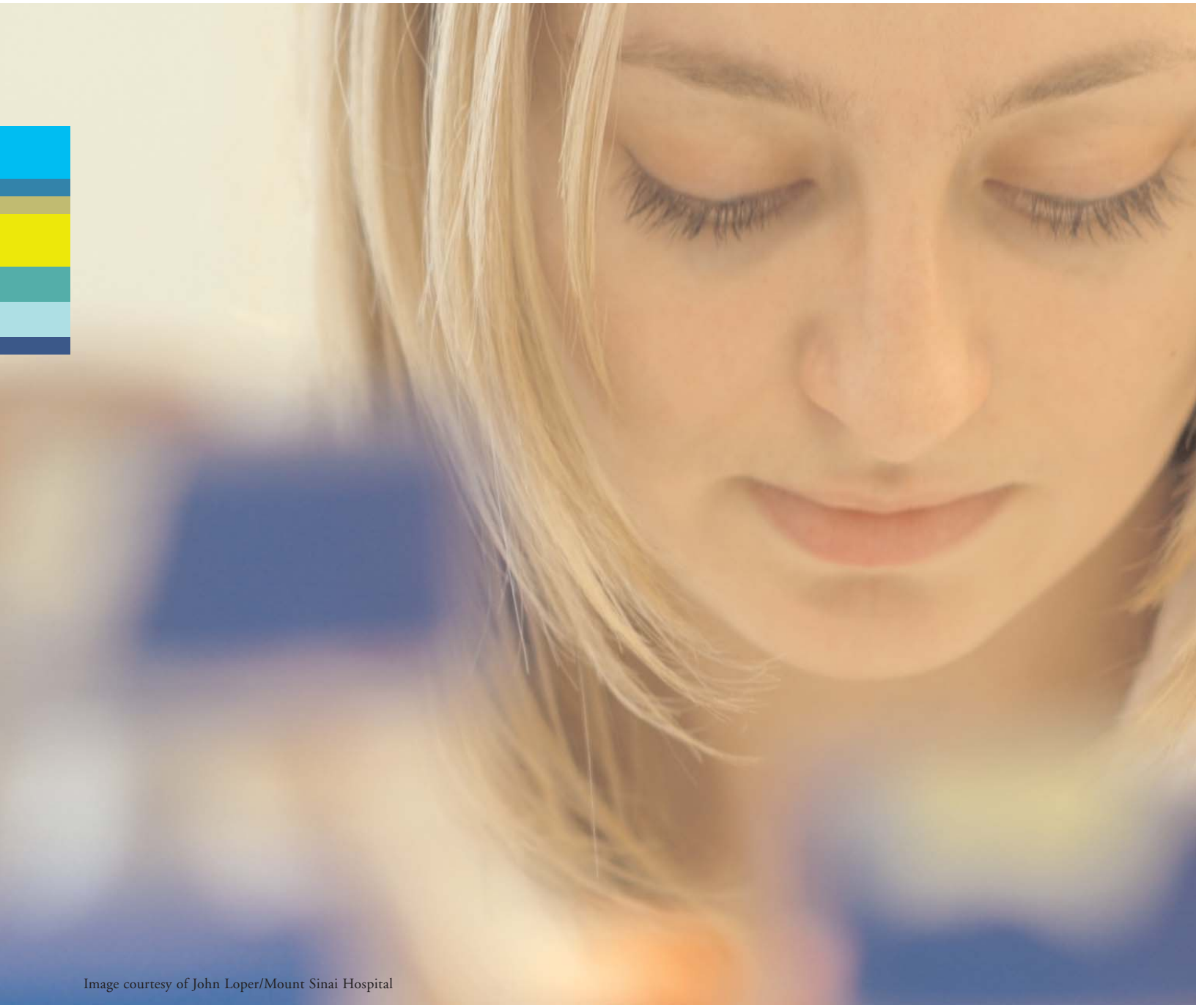
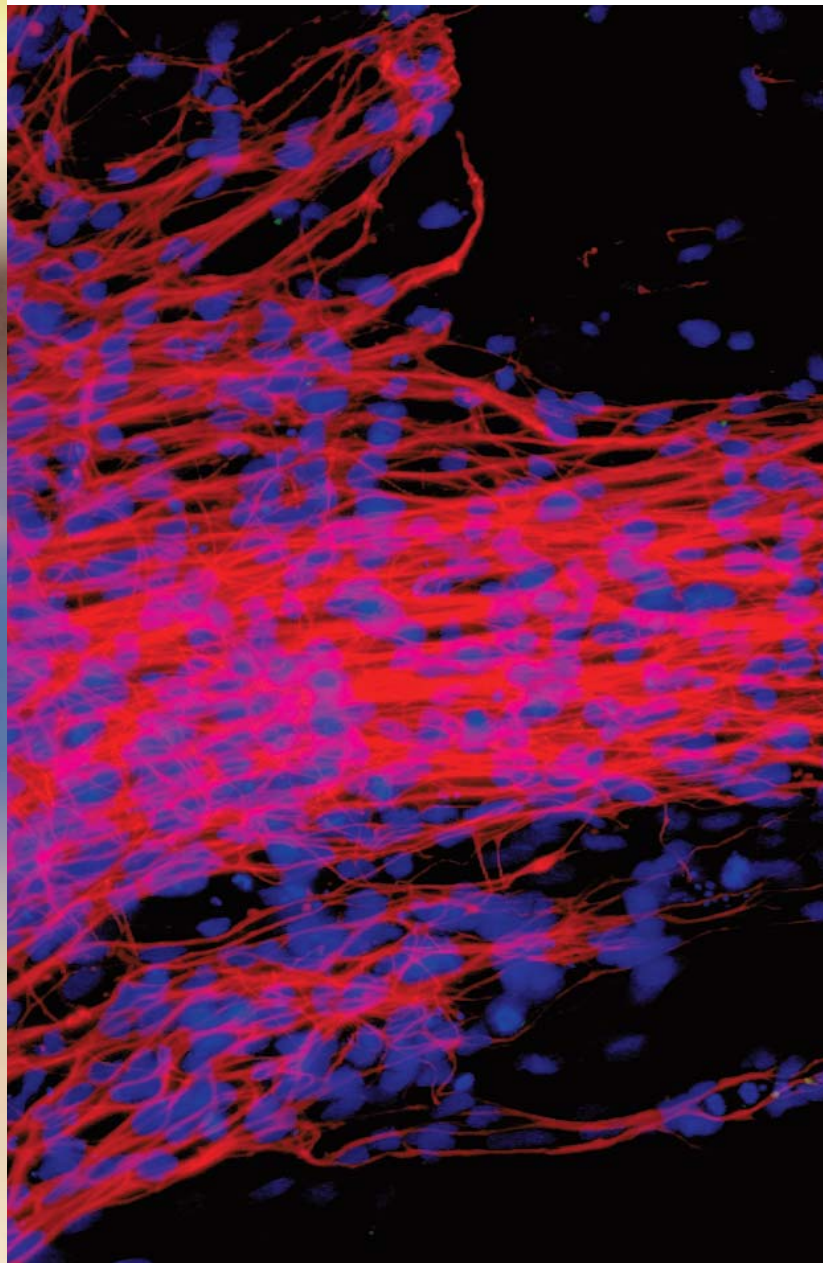


Image courtesy of John Loper/Mount Sinai Hospital

CASE STUDY

Human neurons (red, BetaIII-Tubulin staining) grown on a dish, differentiated from human iPS cells (blue, cell nucleus). (Image courtesy of Dr. A. Hotta of the Hospital for Sick Children)

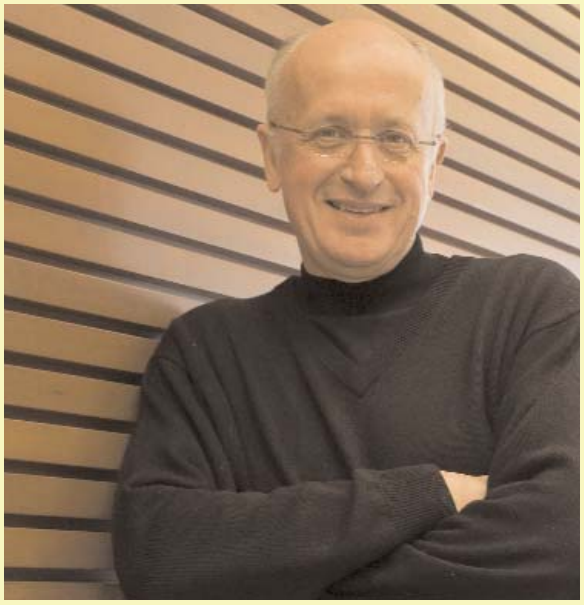


Dr. Gordon Keller

Director, McEwen Centre for Regenerative Medicine, Toronto | www.mcewencentre.com

BIOGRAPHY

Dr. Gordon Keller earned his PhD in immunology at the University of Alberta in 1979 and completed a post-doctoral fellowship at the Ontario Cancer Institute in Toronto in 1983. Following post-doctoral studies, he became a member of the Basel Institute for Immunology in Switzerland, where he worked for five years, then moved to Vienna, where he accepted the post of visiting scientist at the Research Institute of Molecular Pathology. In 1990 Keller moved to the U.S. to work at the National Jewish Center for Immunology and Respiratory Medicine in Denver. From 1999 to 2006, as a professor in the Department of Gene and Cell Medicine, he taught at New York City's Mount Sinai School of Medicine, where in 2005 he was appointed as the director of the Black Family Stem Cell Institute. In January 2007 Keller returned to Canada to accept the position of director of the McEwen Centre for Regenerative Medicine at the University Health Network in Toronto. Dr. Keller is best known for his research in lineage-specific differentiation of mouse and human embryonic stem cells.



Dr. Keller is best known for his research in lineage-specific differentiation of mouse and human embryonic stem cells.

Q Please tell us how the McEwen Centre for Regenerative Medicine was established.

For those familiar with the field of stem cell research, Toronto is where it all began over 40 years ago with Drs. James Till and Ernest McCulloch's discovery of hematopoietic stem cells at the Ontario Cancer Institute. This pioneering work established a new field with stem cell therapy as one of its cornerstones.

With the exciting developments in stem cell biology over the past decade, regenerative medicine is experiencing a surge in activity and awareness worldwide. Regenerative medicine brings together expertise from complementary fields including biology, biochemistry, medicine and engineering. It's truly multidisciplinary.

It was with this in mind that the McEwen Centre for Regenerative Medicine was established in 2003 at the University Health Network with a generous donation by prominent Canadian philanthropists Rob and Cheryl McEwen. To date, the McEwens have provided $20 million in funding for the centre.

McEwen Centre's vision is to become world renowned for stem cell biology and regenerative medicine. To achieve this ambitious goal, the team of McEwen investigators are working together to accelerate the development of more effective treatments for conditions such as heart disease, diabetes, respiratory disease, blood diseases and spinal cord injury. The centre is based in the heart of Toronto's Discovery District, at the MaRS Centre.

Q What is the current focus of research at the McEwen Centre?

The McEwen Centre aims to provide comprehensive solutions for regenerative medicine. We wish to take advantage of the remarkable capacity of human pluripotent stem cells – both ES and iPS cells – to give rise to many different functional cell types.

We have established a facility at the McEwen Centre that will provide pluripotent stem cell-derived cell populations to investigators in the

Toronto community for basic biology studies, for evaluation in pre-clinical models of human disease and for potential future commercial applications. We are working in concert with the Ontario Human iPS Cell Facility to differentiate iPS cells that they produce.

To give an idea of the breadth of research activities here, we have programs on cancer stem cells (John Dick), hematopoietic stem cells (Norman Iscove), skin-derived precursor cells (Freda Miller) and adult pancreas stem cells (Derek van der Kooy).

In the translational arena, we are working on regenerative medicine approaches for spinal cord injury (Michael Fehlings), therapies for cardiovascular disease (Ren-Ke Li, Richard Weisel and Mansoor Husain), regenerating airway epithelium (Tom Waddell) and methods for preserving lung function prior to transplantation (Shaf Keshavjee). Related to these technologies, we also have investigators working on developing methods to create bio-scaffolds to support cell maturation (Molly Shoichet) and on strategies to expand cell growth (Peter Zandstra).

Finally, a McEwen investigator recently published a powerful virus-free approach to generating iPS cells (Andras Nagy).

So it's fair to say that we offer a pretty thorough range of regenerative medicine capabilities at our centre.

Q What would you say are the major milestones in regenerative medicine over the past few years?

Without a doubt, Shinya Yamanaka's discovery of iPS cells has to rate as the major discovery in recent years, as it has opened the door to the generation of patient-specific pluripotent stem cells.

Q What's the outlook for regenerative medicine in Ontario?

I think we have an absolutely huge opportunity here. Ontario is exceptionally well positioned due to the depth and breadth of expertise we have here in the province. Locally, I think that the combination of the Ontario iPS Facility and the McEwen Centre's skills in differentiation will enable us to take on major challenges.

It's a high priority to cultivate the next generation of regenerative medicine investigators and we're taking the necessary steps to achieve that.

Q What do you predict we'll see in the next five years?

We'll see more things coming out of reprogramming, perhaps based on small molecules rather than genes. We should also be able to determine whether it's possible to switch from lineage to lineage without reverting to the pluripotent state.

We will also continue to build the infrastructure required to go from cell isolation to cell therapy – the McEwen Centre is very well placed to coordinate these translational efforts.

Basically we're going to think big and go after the big questions!

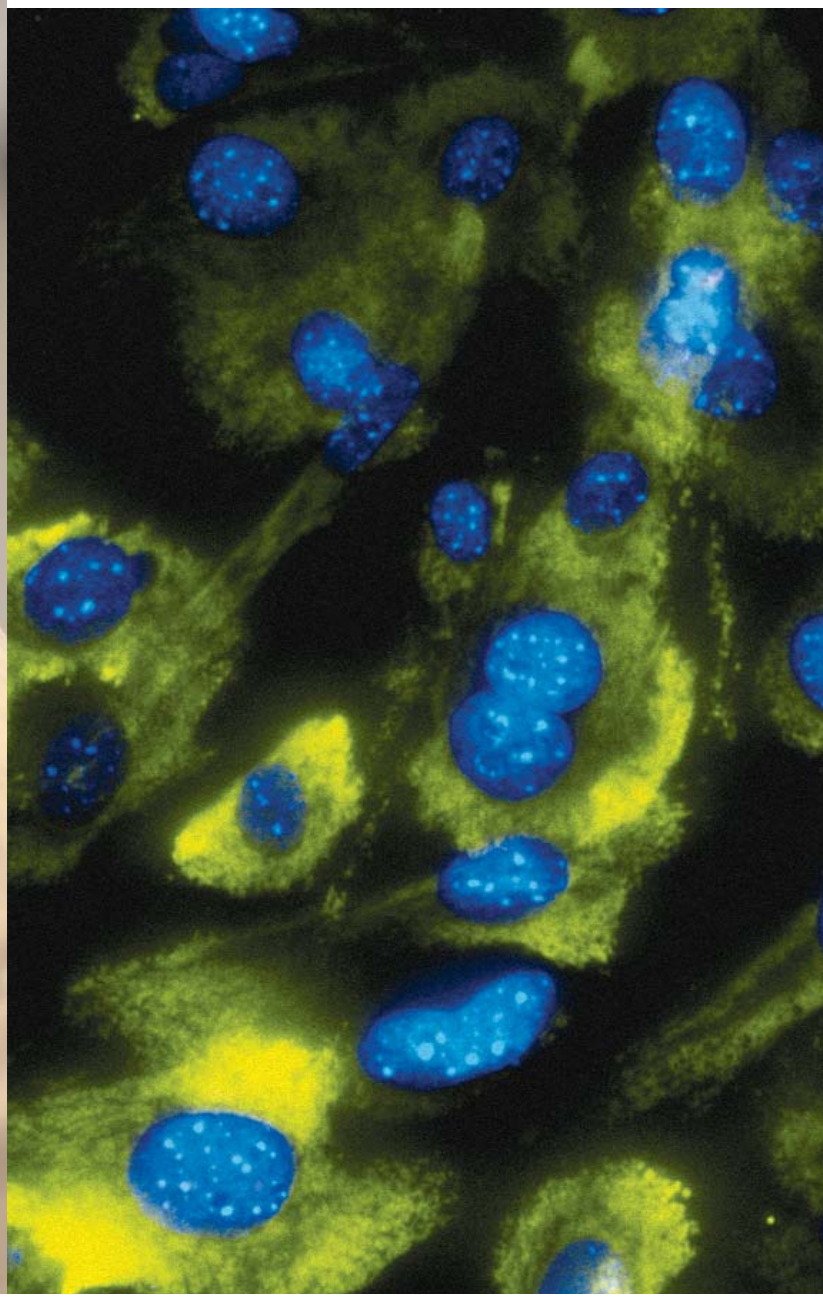
Top five recent publications by McEwen Centre investigators:

1. Woltjen, K; Michael, I.P.; Mohseni, P; Desai, R; Mileikovsky, M; Hämäläinen, R; Cowling, R; Wang, W; Liu, P; Gertsenstein, M; Kaji, K; Sung, HK; Nagy, A (2009). "piggyBac transposition reprograms fibroblasts to induced pluripotent stem cells." *Nature*. 458(7239):766-70.
2. O'Brien, C.A.; Pollett, A; Gallinger, S.; Dick, J.E. (2007). "A human colon cancer cell capable of initiating tumour growth in immunodeficient mice." *Nature*. 445:106-10.
3. Kennedy, M; D'Souza, S.L.; Lynch-Kattman, M.; Schwantz, S.; Keller, G. (2007). "Development of the hemangioblast defines the onset of hematopoiesis in human ES cell differentiation cultures." *Blood*. 109:2679-87.
4. Barabe, F,; Kennedy, J.A.; Hope, K.J.; Dick, J.E. (2007). "Modeling the initiation and progression of human acute leukemia in mice." *Science*. 316:600-4.
5. Yang, L.; Soonpaa, M.H.; Adler, E.D.; Roepke, T.K.; Kattman, S.J.; Kennedy, M.; Henckaerts, E.; Bonham, K; Abbott, G.W.; Linden, R.M.; Field, L.J.; Keller, G.M. (2008). "Human cardiovascular progenitor cells develop from a KDR+ embryonic-stem-cell-derived population." *Nature*. 453:524-8.

Image courtesy of John Loper/Mount Sinai Hospital

ROUNDTABLE DISCUSSION

Skin fibroblasts used in the reprogramming process, stained with markers to show nucleus and cytoplasm. (Image courtesy of Andrey Shukalyuk of the W. L. Stanford Lab)



iPS Cell Ontario Roundtable Discussion

PANELISTS

BILL STANFORD, PhD

University of Toronto

- Co-Founder & Scientific Director, Ontario Human induced Pluripotent Stem (iPS) Cell Facility
- Canada Research Chair in Stem Cell Biology & Functional Genomics
- Associate Professor & Associate Chair, Institute of Biomaterials & Biomedical Engineering, University of Toronto
- Director, Gene Trap Mutagenesis, Centre for Modeling Human Disease

ANDRAS NAGY, PhD

Mount Sinai Hospital, Toronto

- Senior Investigator, Samuel Lunenfeld Research Institute
- McEwen Investigator, McEwen Centre for Regenerative Medicine

Note: Dr. Nagy published a groundbreaking paper describing a powerful virus-free method for generating iPS cells (*Nature*, April 2009).

JAMES ELLIS, PhD

The Hospital for Sick Children, Toronto

- Co-Founder & Scientific Director, Ontario Human induced Pluripotent Stem (iPS) Cell Facility
- Senior Scientist, Developmental & Stem Cell Biology, Hospital for Sick Children Research Institute
- Associate Professor, Molecular Genetics, University of Toronto

MODERATOR

JOHN McCULLOCH, PhD

Venture Group Advisor, MaRS Discovery District, Toronto

Q How would you rate Ontario as a location for stem cell research?

ELLIS: Well, Ontario is where stem cells were first described; it has a long history of excellence in stem cell research. The expertise around Ontario has really enabled us to move into working with the human iPS cells and differentiating those into specific lineages. And the collaborative nature of everyone in the province makes this a fabulous first-rate place to do stem cell research.

STANFORD: I came [to Toronto] from the United States because of its reputation for stem cell research. Since I have been here, I've seen that, not only has Toronto lived up to its reputation, but I've [also] been impressed by other cities here in Ontario, such as Ottawa and Hamilton.

NAGY: The stem cell "roots" here and there's an exceptional density of excellent, well-known stem cell researchers. Also, the unique spirit of Ontario fosters collaboration and helps groups share information to move the field ahead as a team effort.

Q How has the emergence of iPS cell technology affected your research?

STANFORD: It allowed us to go from studying human disease in model organisms to studying it in the human. We can generate iPS cells from patients with diseases and then differentiate them into cells of the affected lineages. Then we can unravel the disease in that particular cell type. Although the mouse is a wonderful model, it's an approximate model and it doesn't always live up to the human in certain areas.

ELLIS: We have switched almost entirely into working on iPS cells to really study disease. You can use them to model virtually any human disease regardless of whether you know the underlying mutations [or not]. We've been developing reporter genes that turn on to indicate where the best iPS cell colonies are, so that they can be picked and expanded, and [we] have been developing "suicide vectors" also.

NAGY: Our previous work on genetic manipulation and embryonic stem cells really fed into the iPS work that we're doing now. I have to emphasize that the work on human embryo stem cells was very, very important and it had a pivotal role in developing our novel way of deriving stem cells without having to use any embryos. Our technology is not using any virus, so that's safer obviously than the previous way. If cells are going to be used in humans, it's unlikely they're going to contain reprogramming factors.

What James [Ellis] is doing is going to be important because at the end, we will need suicide genes, maybe even reporter genes to see these cells. I believe that these cells are going to be better for in vitro studies as well since we won't have to worry about the presence of interfering transgenes. The ability to remove the reprogramming factors certainly places the iPS cells to the level of embryonic stem cells as far as safety is concerned.

Q I'm just wondering if your approach may prove to be safer than embryonic stem cells.

NAGY: Yes, there are many genetic tricks that James mentioned which could actually help further improve the safety issues with embryonic stem cells and also with the iPS cells. But at this point, the current methods actually do not provide the safety level that the embryonic stem cells has with iPS cells because of that existence of the viral insertions, including the reprogramming factors in the cells.

ELLIS: It's important to say the iPS cells, of course, are a perfect immunological match with the patient whereas human embryonic stem cells are not.

Dr. Andras Nagy examines freshly induced human pluripotent stem cells from skin. (Photo by Rick Eglinton/*Toronto Star*, March 2, 2009)

Q One other thing that sets Ontario apart is the creation of a dedicated facility – the Ontario Human induced Pluripotent Stem Cell Facility, spearheaded by Drs. Stanford and Ellis. Perhaps you could tell us a little bit about that.

STANFORD: This initiative is the core facility to generate a bank of patient-specific fibroblasts and iPS cells with the purpose of getting these cells into the hands of investigators to model human disease. Ontario iPS will also provide training for generating these iPS cells. An important part is getting the right protocols for differentiating iPS cells into various germ lineages, so we're working together with Gordon Keller and others to utilize the best protocols available to optimize the generation of these various cell types.

Q Could you share what groups are currently members of Ontario iPS?

STANFORD: It's part of the University of Toronto and the Hospital for Sick Children, funded by the Ministry of Research and Innovation and a donation by the SickKids Foundation. James and I are the scientific directors, and the steering committee is made up of Drs. Janet Rossant, Ben Alman, Andras Nagy, Mick Bhatia, Peter Zandstra and Gordon Keller. There is input from all the major institutions in Ontario, including the McEwen Centre, the Samuel Lunenfeld Research Institute (Mount Sinai Hospital) and McMaster University in Hamilton. Also, Ontario iPS is part of our affiliation with MaRS from the very beginning. Through this, we have developed a relationship with Shinya Yamanaka and we've initiated scientific meetings with Shinya's group at Kyoto University and the Gladstone Institute at the University of California, San Francisco. We are meeting several times a year.

Q It was quite striking that leading researchers in Japan and California decided to enter into partnerships with Ontario. What do you think was their motivation for partnering with us?

STANFORD: We provide a critical mass of people who are at the forefront of iPS cell research. When we met with Shinya Yamanaka, he was impressed with the types of technologies that we had developed and he knows of our longstanding capabilities in stem cell research. Also, in modeling human disease, it's not only the generation of iPS cells that counts but [also] the ability to differentiate these cells into the affected cell types, and our skills in that area are second to none. We also have unique access to patient populations in Ontario through the many clinicians who are part of our team effort.

Q I would like to ask the panel about the collaborations and infrastructure for stem cell research that we have in the province of Ontario.

NAGY: It comes back to the community spirit here. We hold bimonthly meetings on iPS issues in the MaRS Building – probably it's more than 200 people jammed into the room. Also I've seen lots of local collaborations between institutions developing very rapidly and spontaneously. That's what's happening in Toronto, but as well, it's further extended. For example, Mick Bhatia's group in Hamilton – it's very unique. I don't think this type of collaboration exists anywhere else, including the Boston area or even Japan. So, I think [Ontario] is really the number one place where things are going to happen very rapidly in this field.

ELLIS: The McEwen Centre has infrastructure for expanding pluripotent stem cells and differentiating them, and that's essential for people to be able to use iPS cells. To make them, of course, we have to have access to the patient samples and there's a tremendous number of high-quality clinical researchers around. There is a provincial infrastructure for biobanks. Another strength in Ontario is genomics. Here at SickKids, Steve Scherer's TCAG [The Centre for Applied Genomics] group is world renowned for their copy-number variation analysis and description of many disease-causing genes. The infrastructure is all here.

Q Can you share something more about the collaborations we have in Ontario between stem cell scientists and clinicians?

STANFORD: We have an excellent group of clinician scientists here that have been really turned on by iPS cells. [Senior scientist] Ben Alman got excited immediately by iPS cell technology and he has been most helpful from the very beginning. Our clinician scientists see that this is an area that may be transformative and they are anxious to be involved.

ELLIS: Not only are the clinician scientists excited about it, they're also bringing access to and interest in models for cardiac disease, respiratory disease, musculoskeletal disease, neurological disorders – all sorts of different interests that can be applied and studied jointly.

Q Sticking with the clinical theme, do you anticipate that patient care will be impacted by iPS cell technology any time in the foreseeable future?

ELLIS: I think the iPS cell technology will affect the future of patient care, but the timing is, of course, hard to predict. Even just establishing models of disease allows one to test possible therapeutic approaches, including in vitro screening of drugs for toxicity. Once transient reprogramming technologies become easily available, I think the prospects of using iPS cells derived from the patient for repair of injuries like spinal cord injury is really promising.

NAGY: Because of the new technology that we developed, I feel very positive about the future and even near-future possibility that the iPS cells are going to take over the role of embryonic stem cells.

STANFORD: Certainly, the fact that [California-based biotechnology company] Geron is taking ES cells into clinical trials bodes well for the use of iPS cells in the clinic.

Q One of the promising applications for iPS cells is in drug discovery and development. There has been a fair amount of recent activity in this space with a number of pharmaceutical companies having entered into academic research partnerships.

Could you comment on how you anticipate Ontario will be able to engage in these sorts of activities?

ELLIS: iPS cells have a tremendous role for drug development, including the assessment of patient-specific responses and drug toxicities. Clearly, that is going to be one of the first applications for the patient-specific iPS cell lines. In Ontario, there are stem-cell-based drug-screening facilities already available.

NAGY: Yes, we have now the possibility of testing drugs, including individual differences in the drug response. We can actually provide genetic background variation in disease-related iPS cells, so that I see that the iPS cells will change the depth of information that we can generate when we are screening for drugs for treating disease.

STANFORD: I think certainly that iPS cells will make a huge impact on the ability to take patient-derived cells and then screen for drug targets via genetic screens or siRNA, identify a pathway and then work with drug companies using a target-based approach.

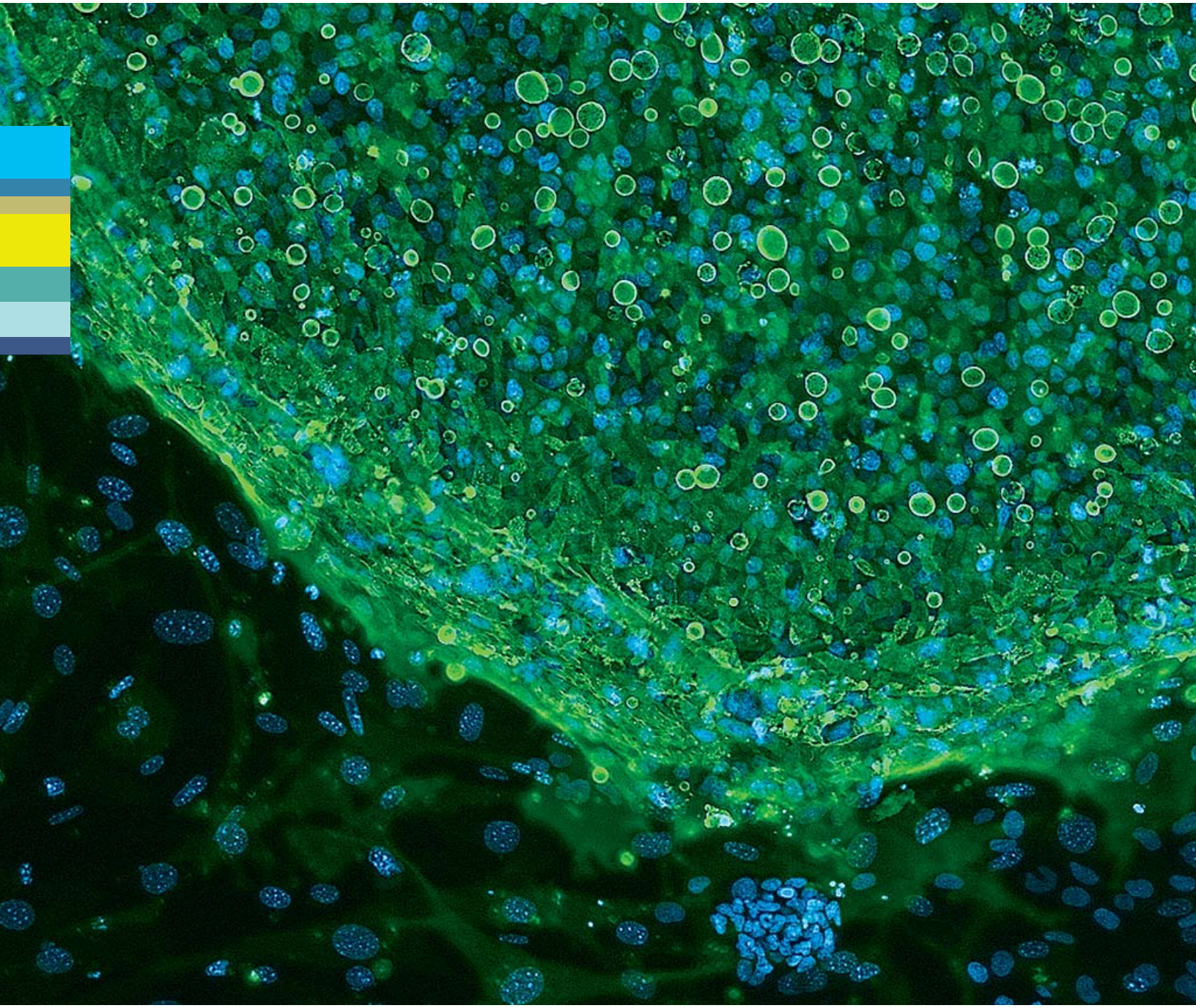
Another strategy is to identify drugs that will induce endogenous stem cells to induce healing. My lab is working on an accelerated aging disorder. Those patients die by the age of 13 and their cardiovascular systems resemble those of an 80- or 90-year-old by that point. We are differentiating iPS cells from these patients into vascular smooth muscle cells that we will use for target identification. We hope to identify drugs that that would not only help these patients but also patients with more common forms of cardiovascular disease.

Q Your closing remarks?

ELLIS: There's really been a revolution in stem cell research over the past three years on iPS cells. I think the real point of our discussion is to emphasize that by partnering with Ontario, anyone can really get everything they'll need – all the infrastructure, all the collaborative skills ranging from the clinic to the phenotyping itself and the therapies. We can get things done.

STANFORD: Yes, I think that we have a wealth of expertise here in Ontario, and I think the provincial government has certainly demonstrated that they are on board and are great partners. And they are very interested in working with companies. It's a very fertile environment here in Ontario.

NAGY: What I would like to say is that the iPS cell breakthrough was a surprise to the scientific community; no one expected reprogramming to be so simple. But besides that surprise, the scientific community and the medical researchers also understood immediately the implications of this discovery for future medicine. This has become a very competitive, very fast-growing field. Therefore, those who would like to be involved in it should carefully consider where is the place that things are going to happen. We have the opportunity in Ontario to do good research and be on the front line and I think we are in a good position to attract public and private investment into this field.



APPENDICES

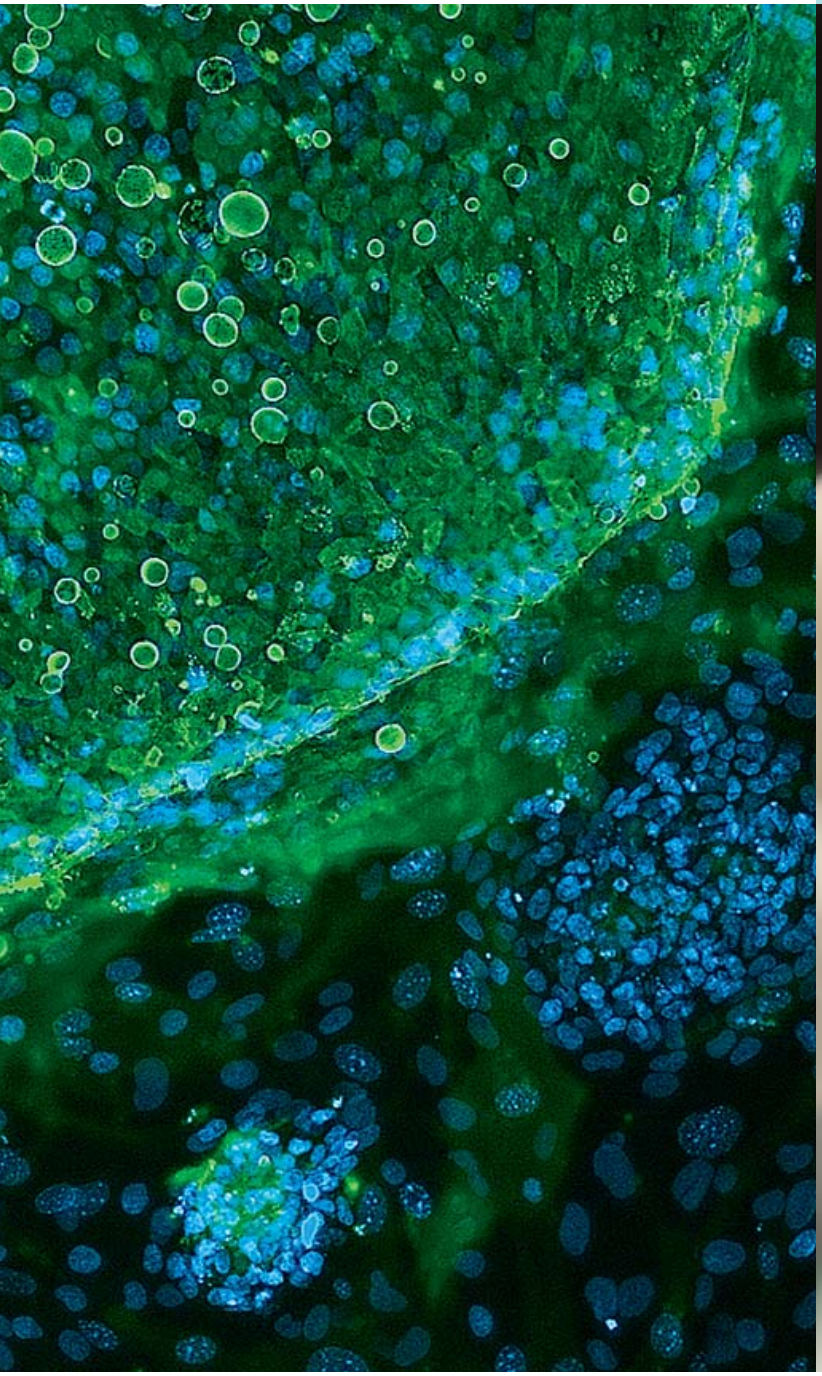


Image courtesy of John Loper/Mount Sinai Hospital

Global Regenerative Medicine Companies

Note: Currently, 173 companies have products in U.S. clinical trials. Of those products, 112 are in preclinical (PC) trials, 59 are in phase I, 96 are in phase II, 41 are in phase III, and 64 products are in market (M).

Company Name	Symbol	PC	I	II	III	M
Aastrom Biosciences Inc	ASTM	–	–	5	1	–
Access Pharmaceuticals Inc	ACCP	1	–	–	–	–
Acologix, Inc.	Private	–	1	1	–	–
Advanced Biohealing Inc	Private	–	–	1	–	–
Advanced Cell Technology Inc	ACTC	2	–	1	–	–
Aegera Therapeutics Inc.	Private	1	3	1	–	–
Aldagen, Inc (formerly Stemco Biomedical, Inc)	Private	–	–	3	1	–
Alizyme plc	AZM (London Stock Exchange)	–	–	1	–	–
Alseres Pharmaceuticals, Inc.	ALSE	2	–	–	–	–
Amgen Inc	AMGN	–	2	3	3	4
Amorcyte Inc.	Private	–	1	–	–	–
Amoytop Biotech	Private	–	–	–	–	1
AM-PHARMA B.V.	Private	–	2	1	–	–
Angioblast Systems, Inc.	Private	3	1	2	–	–
Angiotech Pharmaceuticals Inc	ANPI	–	1	–	–	1
Apogenix GmbH	Private	1	–	–	–	–
Arteriocyte Medical Systems, Inc.	Private	4	1	–	–	–
Astellas Pharma Inc	ALPMF	–	3	–	–	1
Athersys, Inc.	ATHX	2	1	–	–	–
Axcan Pharma Inc.	Private	–	–	–	2	–
Baxter International Inc	BAX	–	–	1	–	–
Bayer Schering Pharma AG	Private	–	–	–	–	2
Benitec Ltd	BNIKF	–	1	–	–	–
Biocad	Private	–	–	–	–	1
BioCancell Therapeutics, Inc.	Private	1	–	1	–	–
BioCardia, Inc.	Private	–	2	–	–	–
Bioheart, Inc.	BHRT	1	–	–	1	–
BioMimetic Therapeutics Inc	BMTI	–	–	–	1	–
Bionovo Inc	BNVI	–	–	1	–	–

Company Name	Symbol	PC	I	II	III	M
BioSante Pharmaceuticals Inc	BPAX	1	–	–	–	–
Biosyntech Inc	BSYI	2	–	–	1	–
Biothera.	Private	–	1	1	–	–
Biovitrum AB	Private	–	–	–	–	2
Bolder BioTechnology, Inc.	Private	1	–	–	–	–
BrainCells, Inc.	Private	–	–	1	–	–
Bristol-Myers Squibb Company	BMY	–	–	1	–	1
Capstone Therapeutics	CAPS	1	–	–	–	–
CardioVascular BioTherapeutics Inc	CVBT	1	–	–	–	–
Celgene Corporation	CELG	1	1	2	–	2
Cell Genesys Inc	CEGE	–	–	1	–	–
Cell Therapeutics Inc	CTIC	–	–	–	–	1
Cellerant Therapeutics, Inc.	Private	2	–	–	–	–
Cellerix	Private	1	–	–	2	–
Celltran Limited	Private	–	–	1	–	–
Celsus Laboratories, Inc.	Private	1	–	–	–	–
Ceregene	Private	2	1	1	–	–
Chemgenex Pharmaceuticals Ltd	CXSFF	–	–	–	1	–
Chemokine Therapeutics Corp	CHKT	1	1	–	–	–
Cleveland Biolabs Inc	CBLI	2	–	–	–	–
CSL Limited	CSL (Australian Stock Exchange)	–	1	–	–	–
CureTech Ltd.	Private	–	–	1	–	–
Curis Inc	CRIS	1	–	–	–	–
Cyathus Exquirere Pharmaforschungs GmbH	Private	1	–	–	–	–
Cytheris SA	Private	–	2	–	–	–
Cytori Therapeutics Inc	CYTX	1	–	–	–	–
Daiichi Sankyo Company, Limited	Global (Osaka and Tokyo Stock Exchange)	–	–	–	–	1
Derma Sciences Inc	DSCI	–	–	1	–	–
DRAXIS Health Inc	Private	–	1	1	–	–
Eleos Inc.	Private	–	–	1	–	–
Enkam Pharmaceuticals A	Private	–	1	–	–	–
EntreMed Inc	ENMD	–	1	–	–	–

Company Name	Symbol	PC	I	II	III	M
Enzo Biochem Inc	ENZ	–	–	1	–	–
Enzon Pharmaceuticals Inc	ENZN	–	–	1	–	–
Epeius Biotechnologies Corporation	Private	1	–	–	–	–
EUSA Pharma Inc.	Private	–	1	–	–	2
FivePrime Therapeutics, Inc.	Private	2	–	–	–	–
Fresenius AG	FRE (Frankfurt Stock Exchange)	–	–	–	1	–
Gamida Cell Ltd.	Private	–	1	–	1	–
Genetix Pharmaceuticals, Inc.	Private	–	–	2	–	–
Genmab A	GEN (Copenhagen Stock Exchange)	–	–	1	–	–
Gentium S.p.A	GENT	–	–	–	2	–
Genzyme Corporation	GENZ	1	–	6	3	2
Geron Corporation	GERN	8	1	1	–	–
GlaxoSmithKline plc	GSK	–	1	1	1	2
GNI Ltd.	Private	–	–	–	–	1
Hana Biosciences Inc	HNAB	–	–	1	–	–
Hangzhou Jiuyuan Gene Engineering Co. Ltd	Private	–	–	–	–	2
Histogen, Inc.	Private	2	1	–	–	–
Hospira Inc	HSP	–	–	–	–	1
ImmunoCellular Therapeutics, Ltd.	IMUC	1	–	–	–	–
Incitive Ltd	ICV (Australian Stock Exchange)	1	–	–	–	–
Intas Pharmaceuticals Ltd.	Private	–	–	–	–	1
Intercytex	ICX.L (London Stock Exchange)	–	1	2	–	–
IR Biosciences Holdings Inc	IRBS	1	–	–	–	–
Janssen-Cilag S.p.A.	Private	–	–	1	–	2
Johnson & Johnson	JNJ	–	–	1	4	2
Kaken Pharmaceutical Co., Ltd.	Private	–	–	3	–	–
Keryx Biopharmaceuticals Inc	KERX	–	–	1	–	–
Kiadis Pharma B.V.	Private	–	–	1	–	–
Kuhnil Pharmaceutical Co., Ltd.	Private	–	–	–	1	–
Kuros Biosurgery AG	Private	–	–	1	–	–
Kyowa Hakko Kirin Co., Ltd. (formerly Kyowa Hakko Kogyo Co., Ltd.)	4151 (Tokyo Stock Exchange)	–	–	–	–	3

Company Name	Symbol	PC	I	II	III	M
Laboratoires Pierre Fabre SA	Private	–	–	–	–	1
Living Cell Technologies Ltd.	Private	1	–	1	–	–
Medistem, Inc.	MEDS	1	–	–	–	–
Merck & Co Inc	MRK	–	3	–	–	1
Merck Frosst Canada Ltd.	Private	–	–	–	–	1
Mesoblast Limited	MSB (ASX Operations Pty. Ltd.)	4	1	1	–	–
MethylGene Inc	MYLGF	–	–	2	–	–
MicroIslet Inc.	MIIS	2	–	–	–	–
Millennium: The Takeda Oncology Company	4502 (Tokyo Stock Exchange)	–	–	–	3	1
Mirna Therapeutics Inc.	Private	5	–	–	–	–
MolMed S.p.A.	Private	–	–	1	–	–
NatImmune A	Private	–	–	1	–	–
Nektar Therapeutics	NKTR	–	1	–	–	–
NeuroNova AB	Private	2	1	–	–	–
Nippon Shinyaku Co., Ltd.	4516 (Tokyo Stock Exchange)	–	–	–	–	1
Northern Therapeutics Inc.	Private	–	–	1	–	–
Norwood Immunology Limited	NIM (London Stock Exchange)	–	–	2	–	–
Novartis AG	NVS	–	–	–	–	1
Novocell, Inc.	Private	1	–	1	–	–
Novogen Ltd	NVGN	1	–	–	–	–
NsGene A/S	Private	1	1	–	–	
Oncomed Pharmaceuticals Inc	Private	–	1	–	–	–
Opexa Therapeutics Inc	OPXA	1	–	–	–	–
Organogenesis	Private	–	–	–	–	4
Orcrist Bio Inc.	Private	1	–	–	–	–
ORLING spol. s r.o.	Private	–	–	–	–	1
Orphan Australia Pty Ltd.	Private	–	–	–	–	1
Osiris Therapeutics Inc	OSIR	1	–	4	3	–
Otsuka Pharmaceutical Co., Ltd.	Private	–	–	–	–	1
Pharmagenesis Inc	Private	1	–	1	–	1
PharmaMar	Private	1	–	–	–	–
Pfizer Inc	PFE	–	–	1	–	–

Company Name	Symbol	PC	I	II	III	M
Pluristem Therapeutics, Inc.	PSTI	5	–	–	–	–
Polyphor Ltd	Private	–	1	–	–	–
ProCertus BioPharm Inc	Private	–	1	–	–	–
ProNeuron Biotechnologies (IS)	Private	1	–	1	1	–
Prospect Therapeutics	Private	–	–	1	–	–
Reliance Life Sciences Pvt. Ltd.	Private	–	–	–	–	1
ReNeuron Group plc	Private	5	–	–	–	–
Repligen Corporation	RGEN	–	–	1	–	–
Roche Holdings Ltd	RHHBY	–	–	–	–	2
Rottapharm SpA	Private	2	–	–	–	–
Samaritan Pharmaceuticals Inc	SPHC	4	–	–	–	–
Sangamo BioSciences Inc	SGMO	2	–	1	–	–
Schering-Plough Corp	SGP	–	–	–	–	1
Scil Technology GmbH	(Private)	2	–	2	–	–
Seattle Genetics Inc	SGEN	–	2	1	–	–
Shanghai CP Guojian Pharmaceutical Co., Ltd.	Private	–	–	–	–	1
Shanghai Dongbao Biopharmaceutical Co., Ltd.	Private	–	–	–	–	1
Shionogi & Co., Ltd.	Private	–	–	–	–	2
Sigma-Tau S.p.A.	Private	–	–	–	1	–
Sinobiomed Inc.	SOBM	–	1	–	–	–
SkinMedica, Inc.	Private	–	–	–	–	1
Stem Cell Innovations Inc	SCLL	1	–	–	–	–
Stem Cell Therapeutics Corp.	Private	–	–	1	–	–
StemCells Inc	STEM	7	1	–	–	–
Stemline Therapeutics, Inc.	Private	1	1	–	–	–
Stryker Corp	SYK	–	–	–	–	1
SuperGen Inc	SUPG	–	2	–	–	–
Sygnis Pharma AG	SYGWF	1	–	–	–	–
TaiGen Biotechnology Co., Ltd.	Private	–	1	–	–	–
Taiho Pharmaceutical Co., Ltd.	Private	–	–	2	–	–
Takeda Pharmaceutical Company Limited	4502 (Tokyo, Osaka and Nagoya Stock Exchanges)	–	1	3	2	–

Company Name	Symbol	PC	I	II	III	M
Targa Therapeutics Corp.	Private	–	1	–	–	–
Teva Pharmaceutical Industries Ltd	TEVA	–	–	1	2	1
TheraVitae Ltd.	Private	–	2	1	–	–
TiGenix N.V.	Private	1	–	–	1	–
Topotarget A	Private	–	–	1	–	–
TorreyPines Therapeutics, Inc.	TPTX	–	1	–	–	–
Transition Therapeutics	Private	–	–	1	–	–
Tzamal Medical Group Ltd	Private	–	–	–	–	1
UCB S.A.	UCB (Euronext Brussels Stock Exchange)	–	–	–	–	1
United Therapeutics Corporation	UTHR	–	–	1	–	–
Vical Inc	VICL	–	–	1	–	–
Vion Pharmaceuticals Inc	VION	–	1	–	–	–
Viropharma Inc	VPHM	–	–	–	1	–
Wellstat Therapeutics Corporation	Private	1	–	–	–	–
Wyeth	WYE	–	–	1	1	2
XOMA Ltd	XOMA	–	–	1	–	–
Yissum Research Development Company	Private	1	–	1	–	–
Zelos Therapeutics Inc.	Private	1	–	–	–	–

Source: MaRS Regenerative Medicine Report 2009. *Canadian companies are highlighted.

Notable Ontario Scientists

Name	Title	Affiliation	City	Email
Akimenko, Marie-Andrée	Senior Scientist	Ottawa Health Research Institute	Ottawa	makimenko@ohri.ca
Allan, David	Associate Scientist	Ottawa Health Research Institute	Ottawa	daallan@ohri.ca
Alman, Benjamin	Senior Scientist	Hospital for Sick Children	Toronto	benjamin.alman@sickkids.ca
Anderson, Michele	Scientist	Sunnybrook Research Institute	Toronto	michele.anderson@sri.utoronto.ca
Andrade, Miguel	Affiliate Investigator	Ottawa Health Research Institute	Ottawa	mandrade@ohri.ca
Andrews, David	Professor	McMaster University	Hamilton	andrewsd@mcmaster.ca
Atkins, Harold	Scientist, Medical Director	Ottawa Health Research Institute	Ottawa	hatkins@ohri.ca
Aubin, Jane	Professor	University of Toronto	Toronto	jane.aubin@utoronto.ca
Audet, Julie	Assistant Professor	University of Toronto	Toronto	julie.audet@utoronto.ca
Bennett, Steffany	Associate Professor	University of Ottawa	Ottawa	sbennet@uottawa.ca
Betts, Dean	Principal Investigator	University of Guelph	Guelph	bettsd@uoguelph.ca
Bhatia, Mick	Director, Senior Scientist	McMaster University	Hamilton	mbhatia@mcmaster.ca
Boreham, Doug	Associate Professor	McMaster University	Hamilton	boreham@mcmaster.ca
Brand, Marjorie	Scientist	Ottawa Health Research Institute	Ottawa	mbrand@ohri.ca
Brash, John	Professor	McMaster University	Hamilton	brashjl@mcmaster.ca
Bulman, Dennis	Senior Scientist	Ottawa Health Research Institute	Ottawa	dbulman@ohri.ca
Casper, Robert	Senior Investigator	Samuel Lunenfeld Research Institute	Toronto	casper@mshri.on.ca
Cordes, Sabine	Senior Investigator	Samuel Lunenfeld Research Institute	Toronto	cordes@mshri.on.ca
Courtman, David	Scientist	Ottawa Health Research Institute	Ottawa	dcourtman@ohri.ca
Cregan, Sean	Assistant Professor	University of Western Ontario	London	scregan@uwo.ca
Davies, John	Professor	University of Toronto	Toronto	jed.davies@utoronto.ca
Dick, Alexander	Scientist	Sunnybrook Research Institute	Toronto	alexander.dick@sunnybrook.ca
Dick, John	Senior Scientist	Toronto General Research Institute (UHN)	Toronto	jdick@uhnres.utoronto.ca
Dilworth, Jeffrey	Scientist	Ottawa Health Research Institute	Ottawa	jdilworth@ohri.ca
Dirks, Peter	Scientist	Hospital for Sick Children	Toronto	peter.dirks@sickkids.ca
Doble, Bradley	Scientist	McMaster University	Hamilton	dobleb@mcmaster.ca
Downey, Gregory	Vice-Chair, Professor	University of Toronto	Toronto	gregory.downey@utoronto.ca
Doyle, John	Clinician-Teacher	University of Toronto	Toronto	john.doyle@sickkids.ca
Draper, Jon	Scientist	McMaster University	Hamilton	draperj@mcmaster.ca
Dumont, Dan	Director, Senior Scientist	Sunnybrook Research Institute	Toronto	dan.dumont@sri.utoronto.ca

Name	Title	Affiliation	City	Email
Egan, Sean	Senior Scientist	Hospital for Sick Children	Toronto	segan@sickkids.ca
Ellis, James	Senior Scientist	Hospital for Sick Children	Toronto	jellis@sickkids.ca
Farhat, Walid	Associate Scientist	Hospital for Sick Children	Toronto	walid.farhat@sickkids.ca
Fehlings, Michael	Senior Scientist	Toronto Western Research Institute (UHN)	Toronto	michael.fehlings@uhn.on.ca
Flynn, Lauren	Assistant Professor	Queen's University	Kingston	lauren.flynn@chee.queensu.ca
Foster, Stuart	Senior Scientist	Sunnybrook Research Institute	Toronto	stuart.foster@sri.utoronto.ca
Gauldie, Jack	Professor	McMaster University	Hamilton	gauldie@mcmaster.ca
Glogauer, Michael	Assistant Professor	University of Toronto	Toronto	michael.glogauer@utoronto.ca
Gommerman, Jennifer	Scientist	University of Toronto	Toronto	jen.gommerman@utoronto.ca
Griffith, May	Senior Scientist	Ottawa Health Research Institute	Ottawa	mgriffith@ohri.ca
Hassell, John	Professor	McMaster University	Hamilton	hassell@mcmaster.ca
Hess, David	Assistant Professor	University of Western Ontario	London	meparker@robarts.ca
Hill, David	Scientific Director	London Health Sciences Centre	London	dhill@lhrionhealth.ca
Hoare, Todd	Assistant Professor	McMaster University	Hamilton	hoaretr@mcmaster.ca
Hough, Margaret	Scientist	Sunnybrook Research Institute	Toronto	margaret.hough@sri.utoronto.ca
Hughes, Timothy	Professor	University of Toronto	Toronto	t.hughes@utoronto.ca
Hui, Chi-chung	Head and Senior Scientist	Hospital for Sick Children	Toronto	cchui@sickkids.ca
Husain, Mansoor	Scientist	Toronto General Research Institute (UHN)	Toronto	Mansoor.Husain@uhn.on.ca
Iscove, Norman	Senior Scientist	Ontario Cancer Institute (UHN)	Toronto	iscove@uhnres.utoronto.ca
Jervis, Eric	Associate Professor	University of Waterloo	Waterloo	ejervis@uwaterloo.ca
Johnston, Miles	Senior Scientist	Sunnybrook Research Institute	Toronto	miles.johnston@sri.utoronto.ca
Jones, Kim	Assistant Professor	McMaster University	Hamilton	kjones@mcmaster.ca
Julius, Michael	Senior Scientist	Sunnybrook Research Institute	Toronto	michael.julius@sri.utoronto.ca
Jurisicova, Andrea	Associate Scientist	Samuel Lunenfeld Research Institute	Toronto	jurisicova@mshri.on.ca
Kandel, Rita	Professor	University of Toronto	Toronto	rkandel@mtsinai.on.ca
Kaplan, David	Senior Scientist	Hospital for Sick Children	Toronto	david.kaplan@sickkids.ca
Karimi, Soheila	Assistant Professor	University of Toronto	Toronto	skarimi@uhnres.utoronto.ca
Kawaja, Michael	Professor	Queen's University	Kingston	kawajam@post.queensu.ca
Keating, Armand	Senior Scientist	Toronto General Research Institute (UHN)	Toronto	armand.keating@uhn.on.ca

Name	Title	Affiliation	City	Email
Keeley, Fred	Senior Scientist	Hospital for Sick Children	Toronto	frederick.keeley@sickkids.ca
Keller, Gordon	Senior Scientist	Ontario Cancer Institute (UHN)	Toronto	gkeller@uhnresearch.ca
Keshavjee, Shaf	Senior Scientist	Toronto General Research Institute (UHN)	Toronto	shaf.keshavjee@uhn.on.ca
Khan, Zia	Assistant Professor	University of Western Ontario	London	zia.khan@schulich.uwo.ca
King, Allan	Professor	University of Guelph	Guelph	waking@uoguelph.ca
Lajoie, Gilles	Professor	University of Western Ontario	London	glajoie@uwo.ca
Levy, Gary	Senior Scientist	Toronto General Research Institute (UHN)	Toronto	glfgl2@attglobal.net
Li, Ren-Ke	Senior Scientist	Toronto General Research Institute (UHN)	Toronto	renkeli@uhnres.utoronto.ca
Lillicrap, David	Professor	Queen's University	Kingston	lillicrap@cliff.path.queensu.ca
Lorimer, Ian	Senior Scientist	Ottawa Health Research Institute	Ottawa	ilorimer@ohri.ca
Mak, Tak	Director, Senior Scientist	University Health Network	Toronto	tmak@uhnres.utoronto.ca
McBurney, Michael	Senior Scientist	Ottawa Health Research Institute	Ottawa	mcburney@med.uottawa.ca
McCulloch, Ernest	Senior Scientist	Ontario Cancer Institute (UHN)	Toronto	mcculloc@uhnres.utoronto.ca
Meakin, Susan	Investigator	Robarts Research Institute	London	smeakin@robarts.ca
Megeney, Lynn	Senior Scientist	Ottawa Health Research Institute	Ottawa	lmegeney@ohri.ca
Merrifield, Peter	Associate Professor	University of Western Ontario	London	peter.merrifield@schulich.uwo.ca
Miller, Freda	Senior Scientist	Hospital for Sick Children	Toronto	freda.miller@sickkids.ca
Morshead, Cindi	Professor	University of Toronto	Toronto	cindi.morshead@utoronto.ca
Mueller, Christopher	Professor	Queen's University	Kingston	muellerc@queensu.ca
Nagy, Andras	Senior Investigator	Samuel Lunenfeld Research Institute	Toronto	nagy@ mshri.on.ca
Neel, Benjamin	Director, Senior Scientist	Ontario Cancer Institute (UHN)	Toronto	bneel@uhnres.utoronto.ca
Paige, Christopher	Vice-President Research, Senior Scientist	Ontario Cancer Institute (UHN)	Toronto	paige@uhnres.utoronto.ca
Pang, Stephen	Professor	Queen's University	Kingston	pangsc@post.queensu.ca
Parks, Robin	Senior Scientist	Ottawa Health Research Institute	Ottawa	rparks@ohri.ca
Pawson, Anthony	Senior Investigator	Samuel Lunenfeld Research Institute	Toronto	pawson@mshri.on.ca
Pelletier, Marc	Professor	University of Toronto	Toronto	marc.pelletier@swchsc.on.ca
Perkins, Theodore	Scientist	Ottawa Health Research Institute	Ottawa	tperkins@ohri.ca
Picketts, David	Senior Scientist	Ottawa Health Research Institute	Ottawa	dpicketts@ohri.ca
Pilliar, Robert	Scientist	University of Toronto	Toronto	bob.pilliar@utoronto.ca

Name	Title	Affiliation	City	Email
Postovit, Lynne-Marie	Assistant Professor	University of Western Ontario	London	Lynne.Postovit@schulich.uwo.ca
Prato, Frank	Imaging Program Leader, Assistant Scientific Director	Lawson Health Research Institute	London	prato@lawsonimaging.ca
Puri, Mira	Scientist	Sunnybrook Research Institute	Toronto	puri@sri.utoronto.ca
Quaggin, Susan	Principal Investigator	Samuel Lunenfeld Research Institute	Toronto	quaggin@mshri.on.ca
Radisic, Milica	Assistant Professor	University of Toronto	Toronto	m.radisic@utoronto.ca
Roderick, McInnes	Senior Scientist	Hospital for Sick Children	Toronto	mcinnes@sickkids.ca
Rogers, Ian	Associate Scientist	Samuel Lunenfeld Research Institute	Toronto	rogers@lunenfeld.ca
Rossant, Janet	Chief of Research, Senior Scientist	Hospital for Sick Children	Toronto	janet.rossant@sickkids.ca
Rottapel, Robert	Head, Senior Scientist	Ontario Cancer Institute (UHN)	Toronto	rottapel@uhnres.utoronto.ca
Rudnicki, Michael	Director, Senior Scientist	Ottawa Health Research Institute	Ottawa	mrudnicki@ohri.ca
Ruel, Marc	Associate Professor	University of Ottawa Heart Institute	Ottawa	mruel@ottawaheart.ca
Sabourin, Luc	Senior Scientist	Ottawa Health Research Institute	Ottawa	lsabourin@ohri.ca
Santerre, Paul	Director, Professor	University of Toronto	Toronto	paul.santerre@utoronto.ca
Schoichet, Molly	Professor	University of Toronto	Toronto	molly.shoichet@utoronto.ca
Schuh, Andre	Senior Scientist	Ontario Cancer Institute (UHN)	Toronto	andre.schuh@utoronto.ca
Scott, Fraser	Senior Scientist	Ottawa Health Research Institute	Ottawa	fscott@ohri.ca
Sefton, Michael	Professor	University of Toronto	Toronto	michael.sefton@utoronto.ca
Seguin, Cheryle	Associate Scientist	University of Western Ontario	London	cheryle.seguin@schulich.uwo.ca
Semple, John	Associate Scientist	Sunnybrook Research Institute	Toronto	john.semple@sunnybrook.ca
Sheardown, Heather	Assistant Professor	McMaster University	Hamilton	sheardow@mcmaster.ca
Shoichet, Molly	Professor	University of Toronto	Toronto	molly.shoichet@utoronto.ca
Simmons, Craig	Assistant Professor	University of Toronto	Toronto	c.simmons@utoronto.ca
Singh, Sheila	Scientist	McMaster University	Hamilton	ssingh@mcmaster.ca
Slack, Ruth	Affiliate Investigator	Ottawa Health Research Institute	Ottawa	rslack@uottawa.ca
Stanford, William	Scientist	University of Toronto	Toronto	william.stanford@utoronto.ca
Stanisz, Greg	Senior Scientist	Sunnybrook Research Institute	Toronto	stanisz@sri.utoronto.ca
Stewart, Duncan	CEO, Scientific Director and Senior Scientist	Ottawa Health Research Institute	Ottawa	djstewart@ohri.ca
Suuronen, Erik	Assistant Professor	University of Ottawa Heart Institute	Ottawa	esuuronen@ottawaheart.ca

Name	Title	Affiliation	City	Email
Tator, Charles	Senior Scientist	Toronto Western Research Institute (UHN)	Toronto	charles.tator@uhn.on.ca
Tropepe, Vince	Assistant Professor	University of Toronto	Toronto	v.tropepe@utoronto.ca
Tsai, Eve	Associate Scientist	Ottawa Health Research Institute	Ottawa	etsai@ottawahospital.on.ca
Tsilfidis, Catherine	Senior Scientist	Ottawa Health Research Institute	Ottawa	ctsilfidis@ohri.ca
Turksen, Kursad	Senior Scientist	Ottawa Health Research Institute	Ottawa	kturksen@ohri.ca
van der Kooy, Derek	Professor	University of Toronto	Toronto	derek.van.der.kooy@utoronto.ca
von Harsdorf, Rudiger	Senior Scientist	Toronto General Research Institute (UHN)	Toronto	rudiger.vonharsdorf@uhn.on.ca
Waddell, Thomas	Scientist	Toronto General Research Institute (UHN)	Toronto	twaddell@uhnres.utoronto.ca
Waldman, Stephen	Assistant Professor	Queen's University	Kingston	waldman@me.queensu.ca
Wallace, Valerie	Associate Director and Senior Scientist	Ottawa Health Research Institute	Ottawa	vwallace@ohri.ca
Wang, Lisheng	Assistant Professor	University of Ottawa	Ottawa	lwang@uottawa.ca
Weisel, Richard	Director, Senior Scientist	Toronto General Research Institute (UHN)	Toronto	richard.weisel@uhn.on.ca
White, David	Scientist	Robarts Research Institute	London	david.white@robarts.ca
Whyne, Cari	Senior Scientist	Sunnybrook Research Institute	Toronto	cari.whyne@sunnybrook.ca
Woodgett, James	Director of Research and Senior Investigator	Samuel Lunenfeld Research Institute	Toronto	woodgett@mshri.on.ca
Woodhouse, Kimberly	Dean	Queen's University	Kingston	kim.woodhouse@queensu.ca
Wrana, Jeffrey	Senior Investigator	Samuel Lunenfeld Research Institute	Toronto	wrana@mshri.on.ca
Wynder, Christopher	Scientist	McMaster University	Hamilton	wynderc@mcmaster.ca
Yee, Albert	Associate Scientist	Sunnybrook Research Institute	Toronto	albert.yee@sunnybrook.ca
Yeger, Herman	Senior Scientist	Hospital for Sick Children	Toronto	herman.yeger@sickkids.ca
Yip, Christopher	Associate Professor	University of Toronto	Toronto	christopher.yip@utoronto.ca
Zandstra, Peter	Professor	University of Toronto	Toronto	peter.zandstra@utoronto.ca
Zúñiga-Pflücker, Juan Carlos	Senior Scientist	Sunnybrook Research Institute	Toronto	jczp@sri.utoronto.ca

Ontario Service Providers

Company Name	Address	Telephone	Fax	Primary Service
Acclaim Pharma Research Inc.	1486 Richmond St., London, ON N6G 2M3	519-657-6574 ext. 277	519-657-4233	Clinical Trial Management/Monitoring
Activation Laboratories Ltd.	1336 Sandhill Dr., Ancaster, ON L9G 4V5	905-648-9611	905-648-9613	Analytical Chemistry
Allied Research International Inc.	4520 Dixie Rd., Mississauga, ON L4W 1N2	905-238-0599	905-238-0682	Bioanalytical
Allphase Clinical Research	1145 Hunt Club Rd., Suite 600, Ottawa, ON K1V 0Y3	613-228-1990	613-228-8493	Clinical Trial Management/Monitoring
Alphora Research Inc.	2395 Speakman Dr., Suite 2001, Mississauga, ON L5K 1B3	905-403-0477	905-403-8744	API Synthesis
Applied Health Research Centre	St, Michael's Hospital, 80 Bond St., Toronto, ON M5B 1W8	905-841-7776	905-727-0605	Clinical Trial Management/Monitoring
Ashuren Health Sciences	2233 Argentia Rd., Suite 308, Mississauga, ON L5N 2X7	877-244-4844		Toxicology
Biovail Contract Research	460 Comstock Rd., Toronto, ON M1L 4S4	416-752-3636	416-752-7610	Clinical Trial Management/Monitoring
CanReg Inc.	4 Innovation Dr., Dundas, ON L9H 7P3	905-689-3980	905-689-1465	Regulatory
Carexa incorporated	2536 Ridgeside Lane, Oakville, ON L6L 6W3	905-338-0909	905-338-1010	Regulatory
Chemi Pharmaceutical Inc.	1435 Bonhill Rd., Units 37–38, Mississauga, ON L5T 1V2	905-670-7600	905-670-8006	Toxicology
Clinimetrics	2655 North Sheridan Way, Suite 120, Mississauga, ON L5K 2P8	905-403-9901	905-403-9083	Clinical Trial Management/Monitoring
Custom Biologics	2585 Meadowpine Blvd., Mississauga, ON L5N 8H9	416-798-9919	416-798-9331	Bioanalytical
Dalton Chemical Laboratories Inc.	349 Wildcat Rd., Toronto, ON M3J 2S3	416-661-2102	416-661-2108	API Synthesis
gap strategies	67 Glenview Ave., Toronto, ON M4R 1P7	416-545-1211	416-545-0249	Clinical Trial Management/Monitoring

Company Name	Address	Telephone	Fax	Primary Service
Global Tox	367 Woodlawn Rd. W., Unit 6, Guelph, ON N1H 7K9	519-766-1000	519-766-1100	Toxicology
Hemostasis Reference Laboratory	4520 Dixie Rd., Mississauga, ON L4W 1N2	905-238-0599	905-238-0682	Bioanalytical
Intrinsik Health Sciences Inc.	6605 Hurontario St., Suite 500, Mississauga, ON L5T 0A3	905-364-7800	905-364-7816	Toxicology
Keata Pharma Inc./ PharmEng Technology Inc.	3760 14th Ave., Suite 201, Markham, ON L3R 3T7	905-415-3922 ext. 127	905-415-3966	Analytical Chemistry
McDougall Scientific Ltd.	789 Don Mills Rd., Suite 305, Toronto, ON M3C 1T5	416-424-2092	416-424-2095	Data Management /Statistics
Nucro-Technics	2000 Ellesmere Rd., Unit 16, Scarborough, ON M1H 2W4	416-438-6727	416-438-3463	Analytical Chemistry
Ozmosis Research Inc.	MaRS Discovery District, 101 College St., South Tower, Suite 404, Toronto, ON M5G 1L7	416-673-6522	416-598-4382	Clinical Trial Management/Monitoring
Patheon Inc	111 Consumers Dr., Whitby, ON L1N 5Z5	905-821-4001		Formulation Development
PG Clinical Trials	157 Adelaide St. W., Suite 186, Toronto, ON M5H 4E7	416-565-7058		Clinical Trial Management/Monitoring
Pharma Medica Research Inc.	6100 Belgrave Rd., Mississauga, ON L5R 0B7	905-624-9115	905-624-4433	Bioanalytical
SciAn Services Inc.	4174 Dundas St. W., Suite 300, Toronto, ON M8X 1X3	416-231-8008	416-231-1422	Data Management /Statistics
SGS Canada Inc.	310 Brunel Rd., Mississauga, ON L4Z 2C2	905-890-4880	905-890-4890	Bioanalytical
Stiris Research	650 Birchwood Pl., London, ON N6K 4X3	519-471-6211	519-471-6277	Clinical Trial Management/Monitoring
Therapure Biopharma Inc.	2585 Meadowpine Blvd., Mississauga, ON L5N 8H9	905-286-6232	905-286-6300	Formulation Development
Torealis Research Inc.	48 George St., Aurora, ON L4G 2S2	905-841-7776	905-727-0605	Clinical Trial Management/Monitoring
Ventana Clinical Research	720 King St. W., Toronto, ON M5V 2T3	416-963-9786	416-963-9732	Clinical Trial Management/Monitoring

References

REPORTS

MaRS and the Ontario Ministry of Research and Innovation. *Collaborate and Discover: Ontario's Biopharma Cluster.* 2008.

MaRS Advisory Services. *Regenerative Medicine Industry Briefing: Commercial Opportunities and Ontario's Strengths.* 2008.

PRIMARY RESEARCH

Toronto Region Research Alliance
http://www.trra.ca

WEBSITES

The Applied Centre for Genomics
http://www.tcag.ca

Institute of Biomaterials and Biomedical Engineering
http://www.ibbme.utoronto.ca/

Lawson Health Research Institute
http://www.lawsonresearch.com

McEwen Centre for Regenerative Medicine
http://www.mcewencentre.com/

McLaughlin Centre for Molecular Medicine
http://www.mcmm.ca/

Nagy Lab
http://www.mshri.on.ca/nagy/

Ontario Human Induced Pluripotent Stem Cell Facility
http://www.ontarioips.ca

Ottawa Health Research Institute
http://www.ohri.ca/

PG Clinical Trials
http://www.pgclinicaltrials.com

Philip S. Orsino Cell Therapy Facility

http://www.uhnres.utoronto.ca/facilities/psoctf/

Research Institute at The Hospital for Sick Children

http://www.sickkids.ca/Research/index.html

Stem Cell and Cancer Research Institute

http://fhs.mcmaster.ca/SCCRI/

Stem Cell Bioengineering Lab

http://stemcell.ibme.utoronto.ca/

Designed by **FIZZZ DESIGN CORP.**

Ontario

Printed in Ontario, Canada 05/09