University of Toronto Research Expertise

Regenerative Medicine

UNIVERSITY OF TORONTO

March 2023

U of T Global Rankings

#1 in Canada	#18 worldwide	#1 in Canada | #6 worldwide
THE World University Rankings (2022)	NTU World University Rankings (2022)	

A POWERHOUSE FOR INNOVATION & ENTREPRENEURSHIP

600+ Startups

More than **$2.5B** in investment secured by **600+** startups over the past decade.

350+ Private Sector Partners

U of T's global reputation as a top research university and its vibrant innovation and entrepreneurship culture attracts industry partners from across Canada and worldwide.

1100+ Patent Applications

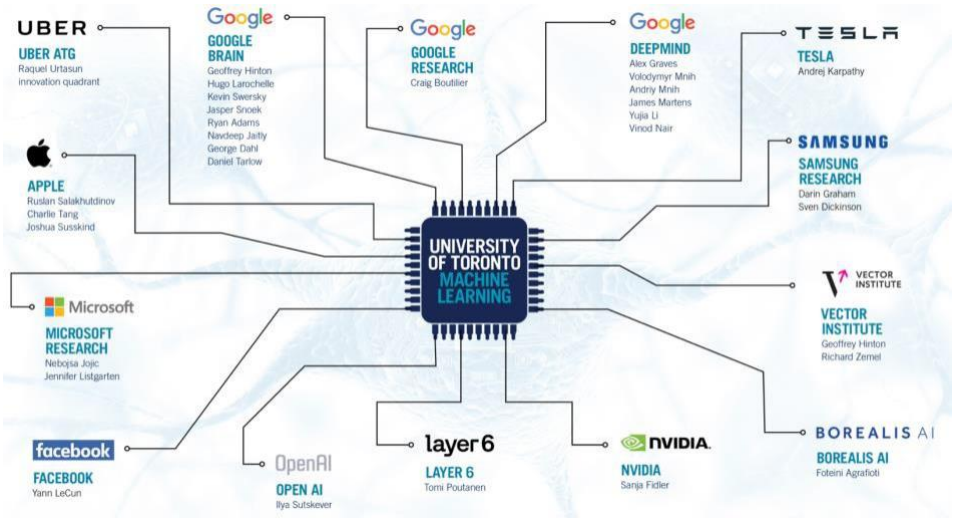
U of T is a leader among North American universities for research-based startups, inventions, licenses and options.

U of T & Affiliated Academic Hospitals

A Dynamic Network of Academic Health Organizations Providing Leading Edge Research, Teaching & Clinical Care

U of T Expertise Sought by Global Giants

U of T Faculty & Alumni are Hired by Some of the Most Influential Tech Companies Worldwide



The Toronto Region is home to one of the most vibrant life sciences, human health sciences, and biotechnology ecosystems in the world. ***Over half of Canada's life sciences, pharmaceutical and medical device, companies are located in the region including 50 of the world's top 100 multinational corporations.***

IMPACT STORIES

U of T launches new hub to strengthen Canada's pandemic preparedness & increase biomanufacturing capacity

Mar 02, 2023

Researchers explore gene therapy model using zinc finger proteins

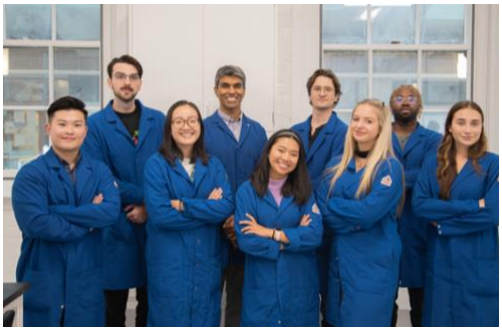
Feb 02, 2023

Clinical trials delivers chemotherapy to pediatric brain tumours using MRI-guided focused ultrasound

Jan 23, 2023

U of T and UHN researchers rapidly revolutionizing lung transplant surgery

Nov 29, 2022



U of T lab partners with Moderna to develop RNA-based tools to treat and prevent disease

Oct 21, 2022

Researchers shrink brain tumours with gold nanoparticles, develop 'mini brains' for study

Oct 18, 2022

U of T Partners with Moderna to Advance Research in RNA Science & Technology

Apr 07, 2022

More thank vaccines: U of T researcher investigates future of mRNA therapeutics

Feb 23, 2022

U of T's Molly Shoichet joins team developing new treatments for spinal cord injuries

Jan 14, 2022

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KEY U of T RESEARCH CENTRES & INFRASTRUCTURE

Centre for Research and Applications in Fluidic Technologies [Microfluidics]

http://www.torontomicrofluidics.ca/craft/

The **Centre for Research and Applications in Fluidic Technologies (CRAFT)** is a unique long-term partnership between the University of Toronto (U of T) and Canada's National Research Council to advance the field of microfluidics — the manipulation of fluids at micron length scales by developing devices with improved precision, lower detection limits, and the capacity to parallelize procedures. This partnership positions Canada to become a world-leader in developing and translating microfluidic solutions, such as point-of-care diagnostics, organ-on-a-chip devices and organ-scale tissue substitutes, that will improve the health of all Canadians and lay the foundation of a thriving, internationally competitive industry sector.

Donnelly Centre for Cellular & Biomolecular Research [Translational Medicine]

https://ccbr.utoronto.ca/

The **Donnelly Centre** is a state-of-the-art interdisciplinary research institute, where scientists take both experimental and computational approaches for mapping biological networks on a global scale, including genetic, protein-protein, and gene expression networks. The Donnelly Centre investigators have also developed new methods for engineering stem cells, tissues and organs, with the goal of advancing regenerative medicine, among other fields. These fundamental studies have translated to important foundational insights into cellular mechanics behind cancer, blindness, autism and other diseases and syndromes, opening new possibilities for diagnosis and treatment.

Medicine by Design [Regenerative Medicine]

https://mbd.utoronto.ca/

Medicine by Design (MbD) brings together >130 scientists, engineers and clinicians at U of T and its affiliated hospitals to address challenges in regenerative medicine. These research teams enhance our understanding of the human body's regenerative capacities and develop clinical solutions to improve health outcomes.

PRiME [Precision Medicine]

https://www.prime.utoronto.ca/

The **Precision Medicine Initiative at U of T (PRiME)** leverages the University's world-class expertise in biologics, omics, molecular chemistry, liquid biopsy, nanomedicine, biology-on-a-chip and related domains to develop new solutions to unmet needs in human disease. The multidisciplinary approach aims to fully understand disease biology, create new tools for disease diagnosis, and develop novel therapeutics, and thus establishing Toronto as a leading centre for next-generation precision medicine.

Schwartz Reisman Institute for Technology & Society [Technology | Integrative Research]

https://srinstitute.utoronto.ca/

The Schwartz Reisman Institute draws on U of T's signature strengths in the sciences, humanities and social sciences to explore the benefits and challenges that AI, biotechnology and other technological advances present for our economy, our society and our day-to-day lives.

U of T RESEARCHERS

TARGET AREA: REGENERATIVE MEDICINE

Stephane Angers [Oncology | Graft-vs-Host]

University Affiliations
Professor & Assoc. Dean of Research, Leslie Dan Faculty of Pharmacy
Professor & Chair, Donnelly Centre for Cellular + Biomolecular Research

Lab Website
http://angerslab.org/

Keywords
Glioblastoma, Pancreatic Ductal Adenocarcinomas, Stem Cells, CRISPR, Cas9, Signal Transduction, Wnt, Hedgehog Families, Growth Factors, Cullin Families, E3 Ligases, Proteomics

The Angers lab's research focuses on the molecular mechanisms underlying signal transduction events activated by the Wnt and Hedgehog families of secreted growth factors. The Angers Lab uses a combination of patient-derived stem cells, organoids (self-organizing tissue), and animal models of disease. Using novel proteomic and genomic tools, they investigate how the Wnt and Hedgehog pathways function in both normal and human disease contexts. The group also uses genome-wide CRISPR-Cas9 functional screens performed in patient-derived cancer stem cells to characterize the genes that are essential for tumor growth. By leveraging this knowledge, the Angers Lab is identifying novel therapies based on modulating the activity of the Wnt and Hedgehog pathways.

Prof. Angers held the Canada Research Chair in Functional Architecture of Signal Transduction from 2007 to 2017 and is the Associated Dean of Research at the Leslie Dan Faculty of Pharmacy and Director of the Donnelly Centre for Cellular + Biomolecular Research. He is also the scientific founder of two biopharmaceutical startup companies, with multiple molecules on the clinical development pathway.

Publications: Click here' for Prof. Angers' publications on PubMed.

Liliana Attisano [Oncology | Organoids]

University Affiliations
Professor, Donnelly Centre for Cellular + Biomolecular Research; Medical Biophysics; Biochemistry

Lab Website
http://attisanowranalabs.science/

Keywords
Cell Communication, Signal Transduction, Cancer Mechanisms, Neuronal Development and Disease, Multidimensional High-Throughput Screening

The Attisano lab focuses on understanding how intracellular signalling cascades receive and then transmit extracellular signals and thereby modulate complex biological responses. Current areas of particular interest are the TGFbeta, Wnt and Hippo signalling pathways, whose disruption is associated with numerous human cancers. The lab also studies pathways that regulate neuronal morphology, including the formation of axons and dendrites in primary neurons. They use mammalian cell model systems, biochemical and cell biological methods and mouse model systems to examine how pathway disruption alters cellular and developmental

processes. In addition, the Attisano lab also uses high-throughput robotics-based methods to examine the dynamics of protein-protein interactions, and to screen for alterations in signalling output using siRNA and small-molecule chemical libraries. They have also established a highly efficient pipeline to generate morphologically similar cerebral organoids with consistent cell-type compositions as assessed by single-cell sequencing. Their goal is to generate and provide cerebral organoids derived from stem cells to enable the application of state-of-the-art approaches for the study of human brain disorders.

Prof. Attisano holds the Canada Research Chair position in Signalling Networks in Cancer.

Publications: Click here for Prof. Attisano's publications on PubMed.

Benjamin Blencowe [Functional Genomics | Neuroscience]

University Affiliations
Professor, Molecular Genetics, Temerty Faculty of Medicine
Professor, Donnelly Centre for Cellular + Biomolecular Research
Faculty Member, PRiME

Lab Website
http://sites.utoronto.ca/intron/index.html

Keywords
Alternative Splicing, RNA, Functional Genomics, Bioinformatics, Platform Technologies, Autism Spectrum Diseases, SARS-CoV-2, CRISPR

Prof. Blencowe's research focuses on mechanisms underlying the regulation of gene expression and how these mechanisms are disrupted in human diseases and disorders. One of the primary focus of their research is directed at understanding how alternative splicing is regulated and integrated with other layers of gene expression to control fundamental biological processes. The Blencowe lab has pioneered the development and application of technologies for the genome-wide quantitative profiling of transcriptomes, RNA interactomes, as well as new CRISPR-based methods designed to comprehensively elucidate RNA regulatory networks.

Prof. Blencowe holds the Banbury Chair in Medical Research and serves as Director of the U of T's Donnelly Sequencing Centre. He was recently elected Fellow of the Royal Society of London (UK) in 2019.

Publications: Click here for Prof. Blencowe's publications on PubMed.

Maryam Faiz [CNS | Gene Therapy]

University Affiliations
Assistant Professor, Surgery, Temerty Faculty of Medicine

Lab Website
https://www.faiz-lab.com/

Keywords
Astrocytes, Brain Injury, CNS, Reprogramming, Therapeutics, Demyelination, Gene Therapy, Gut-Brain-Axis

The Faiz lab is interested in brain repair. Their research group is especially interested in astrocyte heterogeneity and how it is established, the roles of astrocytes in the injured/diseased brain, and how this

knowledge can inform future therapeutic interventions. They are also fascinated by the gut-brain axis, and how the gut can mediate recovery from brain injury. The three main areas of research in here at the Faiz Lab: 1) Generating neural stem cell-derived astrocytes; 2) Direct lineage reprogramming of astrocytes to other neural cell types and; 3) Investigating the gut-microbiota-brain axis in CNS disease/injury.

Publications: Click here for Prof. Faiz's publications on PubMed.

Rodrigo Fernandez-Gonzalez [Bioengineering | Wound Repair]

University Affiliations
Associate Professor, Biomedical Engineering, Faculty of Engineering

Lab Website
https://www.quantmorph.ca/

Keywords
Cardiac, Wound Repair, Cell Biology, Developmental Biology, Quantitative Modelling, Bioengineering, Translational Biology

The Fernandez-Gonzalez lab uses a combination of bioengineering, molecular and cell biological tools to determine the mechanisms that integrate the behaviors of multiple cells to generate specific changes in tissue organization. They investigate the molecular and cellular mechanisms of wound healing using; screening for molecules that mediate the assembly of force-generating structures during wound healing; and lastly how wound repair is influenced by the mechanical properties of the wounded tissue, and how these properties are regulated during the healing process.

Prof. Fernandez-Gonzalez holds the Canada Research Chair in Quantitative Cell Biology & Morphogenesis.

Publications: Click here for Prof. Fernandez-Gonzalez's publications on Pubmed.

Penney Gilbert [Tissue Engineering | Endogenous Repair]

University Affiliations
Assoc. Professor, Biomedical Engineering, Faculty of Engineering

Lab Website
https://thedonnellycentre.utoronto.ca/faculty/penney-gilbert

Keywords
Stem Cells, Skeletal Muscle, Regenerative Medicine, Endogenous Repair, Cell & Tissue Engineering, Aging, Duchenne Muscular Dystrophy

The Gilbert lab has developed a way to use stem cells to build miniature models of human skeletal muscle tissue in a dish. This process allows them to create different cellular models to observe specific interactions, for example, communication between nerve and muscle cells. This type of model is more physiologically relevant than traditional techniques and allows them to see whether a certain drug or treatment has a positive or negative impact on human neuromuscular junction.

A more recent model developed in Gilbert's lab has shown great potential in employing culture techniques to test if new drugs or treatments to improve muscle regeneration can move closer to clinical trials.
Prof. Gilbert holds the Tier 2 Canada Research Chair position in Endogenous Repair.

Publications: Click here for Prof. Gilbert's publications.

Jennifer Gommerman [Multiple Sclerosis | Neuroinflammation]

University Affiliations
Professor, Immunology, Temerty Faculty of Medicine

Lab Website
https://www.immunology.utoronto.ca/faculty/jennifer-gommerman

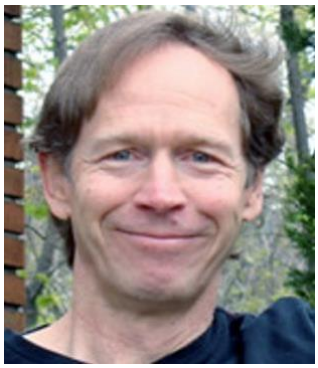
Keywords
Multiple Sclerosis, Cell Therapy, Gut Immunology, Plasma Cells, COVID-19, CNS, Gut Microbiome, Gut-Brain Axis, Neuroinflammation

The Gommerman lab is focused on (1) mechanisms of immune dysregulation in autoimmune disease, particularly MS and how immune cells become activated with the CNS environment; (2) understanding the reason for the rapid increase in autoimmune disease observed in Canada and (3) determining the role of TNF family members in immune cell biology. Using an animal model of MS, they have been studying immune cell rich structures found in the meninges. In collaboration with a multi-disciplinary team of neuroimmunologists and using animal and human model systems, they are currently exploring how pro- and anti- inflammatory B cells impact MS pathogenesis. Lastly, they are particularly interested in how the mucosal immune system in the gut influences autoimmune responses in the CNS.

Prof. Gommerman holds the Tier 1 Canada Research Chair position in Tissue-Specific Immunity. In March 2021, Prof. Gommerman and her collaborator Prof. Kullervo Hynynen received $13.9 million in Canada Foundation for Innovation (CFI) funding for a platform technology focused on neuroimmunology and neuroimaging for dementia, stroke, mental health and addiction, multiple sclerosis and cancer.

Publications: Click here for Prof. Gommerman's publications on PubMed.

David Hampson [Neuroscience | Gene Therapy]



University Affiliations
Professor, Leslie Dan Faculty of Pharmacy
Professor, Pharmacology and Toxicology, Temerty Faculty of Medicine

Lab Website
http://pharmsci.utoronto.ca/hampson/

Keywords
Autism, Epilepsy, Dravet Syndrome, Genetic Disorders, Gene Therapy, Neural Developmental Disorder, Fragile X Syndrome, AAV, Biologics

The Hampson lab studies the application of viral vector-mediated gene therapy to the neurodevelopmental disorders Fragile X Syndrome and Dravet Syndrome. Using biochemical and behavioural tests in animal models, his lab examines whether gene therapy can reverse the phenotypic abnormalities associated with these disorders. His research includes elements of molecular biology, protein chemistry, neuroscience and neurology, drug delivery of viruses, and behavioral pharmacology. The team is currently studying whether an adeno-associated virus (AAV) engineered to include genes that code for therapeutic proteins can induce therapeutic benefits. Using a variety of biochemical and behavioural tests, they quantify the therapeutic

changes seen in the mutant animals by comparing treated knockout animals with untreated knockout and wild-type animals.

Publications: Click here for Prof. Hampson's publications on Pubmed.

Omar F. Khan [Oncology | Gene Therapy]

University Affiliations
Assistant Professor, Temerty Faculty of Medicine, Immunology, Institute of Biomedical Engineering
Member, MbD

Lab Website
https://ofklab.com/

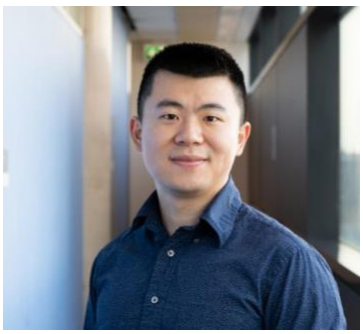
Keywords
mRNA, Adaptive Immunity, Autoimmunity, Cancer, Developmental Immunology, Innate Immunity, Transplantation, Vaccines, Tissue inflammation

The OFK Lab combines engineering, immunology and chemistry fundamentals to create new nanotechnologies. Prof. Khan's lab works with nanomaterials for the delivery of nucleic acids and combines these nucleic acids' distinctive effects to control complex diseases caused by multiple aberrant genes that cannot be treated with small molecule drugs. They are currently applying their RNA nanotechnologies to the treatment of chronic inflammation, autoimmune diseases, cancer immunotherapy and the clearance of viruses in incurable infections. Furthermore, the platform technologies developed in the OFK Lab have many application, including non-traditional vaccines, the treatment of musculoskeletal diseases, cellular and gene therapies, vascular engineering and regenerative medicine.

Prof. Khan has also spun out a startup company called Tiba Biotech, which centres around a programmable RNA vaccine platform for the rapid production of a new generation of safer vaccines against multiple diseases.

Publications: Click here for Prof. Khan's publications on Pubmed.

Bowen Li [Biomaterials | Gene Therapy]



University Affiliations
Assistant Professor, Faculty of Pharmacy

Lab Website
https://www.li-bowen.com/

Keywords
mRNA Vaccines, Cancer Immunotherapy, Gene Editing, Type 1 Diabetes, Nucleic Acid Delivery, Drug Delivery, Biomaterials, Genetic Medicines, Nanomedicines, Immunoengineering, Regenerative Medicine

The Li lab explores new biomaterials and nanoparticles for the safe and effective delivery of nucleic acids including mRNA, circular RNA, siRNA, miRNA and CRISPR-Cas9. The overall objective of Li lab is to develop novel nucleic acid-based vaccines and therapeutics for a range of human health applications including vaccination, immunotherapy, and regenerative medicine. The Li lab uses nonviral biomaterial-centric approaches to facilitate the development of nucleic acid-based vaccines and therapy, which includes: combinatorial synthesis of novel biomaterials and nanoparticles for the delivery of nucleic acids (siRNA, miRNA, mRNA, CRISPR-Cas9); investigating the influence of biomaterial chemical structure on in vivo transport to target cells and tissues using high-throughput screening platforms; and nonviral delivery techniques for in vivo gene editing.

Prof. Li holds the Tier 2 Canada Research Chair position in RNA Vaccines and Therapeutics. In 2022, he was also awarded the Gairdner Early Career Investigator Award.

Publications: Click here for Prof. Li's publications on Google Scholar.

Cindi Morshead [Neuroscience | Gene Therapy]

University Affiliations
Professor & Chair, Division of Anatomy
Professor, Donnelly Centre for Cellular + Biomolecular Research; Faculty of Medicine, Institute of Biomaterial and Biomedical Engineering
Member, PRiME

Lab Website
https://morsheadlab.technology/

Keywords
Stem Cells, Gene Therapy, Stroke, Cell Biology, Neural Repair, Rare Disease

The Morshead lab works primarily on neural stem cell biology, throughout development and into the aging brain, with the goal of treating of stroke, acquired brain injury (including cerebral palsy) and spinal cord injury. They employ cell transplantation paradigms as well as activate stem cells residing in the nervous system to promote self-repair. Towards this goal they are creating tools to promote stem cell migration to sites of injury. Prof. Morshead's work aims to treat a number of neurodegenerative and injury states in the central nervous system.

Publications: Click here for Prof. Morshead's publications on Pubmed.

Keith Pardee [Synthetic Biology | Proteins]

University Affiliations
Professor, Faculty of Pharmacy, U of T
Co-Director, PriME

Lab Website
https://www.pardeelab.org/

Keywords
Synthetic Biology, Point-Of-Care Diagnostics, Sensors, Gene Circuits, Cell-Free, Portable, Virology, Bioproduction, Protein, Biomanufacturing

The Pardee lab is dedicated to the development of molecular technologies to manipulate & probe genetic material, with a focus in portable sensing & manufacturing (e.g. vaccines, small molecules, cell/gene based therapies). In addition to Dr. Pardee's previous work, the past few years have also seen the development of other point-of-use molecular sensing technologies with impressive features such as: pathogen detection at clinically relevant concentrations & potential for the multiplexed detection of diseases.

Prof. Pardee holds the Canada Research Chair in Synthetic Biology & Human Health and is co-founder of three biotech startups.

Publications: Click here for Prof. Pardee's publications on Pubmed.

Paul Santerre [Regenerative Medicine | Biomaterials]

University Affiliations
Professor, Biomedical Engineering, Faculty of Engineering
Professor, Faculty of Dentistry

Lab Website
http://www.santerrelab.com/

Keywords
Cardiovascular Diseases, Biomaterials, Biomedical Engineering, Wound Healing, Tissue Biology, Drug Delivery, Dental Materials, Antimicrobials

The Santerre group in collaboration with biomaterials, biomechanics and engineering scientists are exploring the application of tissue engineering principles for the development of cardiovascular tissue that has mechanical, cellular and physiological properties comparable to that of native healthy tissue. The Santerre Lab is investigating the use of polymers for drug delivery strategies in the regenerative medicine space.

Prof. Santerre's contributions has led to many successful inventions and startups. He is the recipient of the Governor General's Innovation Award (2017). He also holds the Baxter Chair of Health Technology and Commercialization, and drives entrepreneurship initiatives at U of T and UHN.

Publications: Click here for Prof. Santerre's publications on Pubmed.

Milica Radisic [Cardiometabolic Diseases | Organ-on-a-Chip]

University Affiliations
Professor, Chemical Engineering & Applied Chemistry; Institute of Biomedical Engineering
Member, PRiME

Lab Website
https://www.labs.chem-eng.utoronto.ca/radisic/

Keywords
Tissue Engineering, Cardiovascular, Biomaterials, Myocardial Infarction, Regenerative Medicine, Cardiac Regeneration, Organ-on-a-Chip

Prof. Radisic's research programs broadly fall under the cardiac tissue engineering and regenerative medicine umbrella. The Radisic lab is focused on pursuing molecular mechanisms governing the formation of contractile cardiac tissue *in vitro* as well as on practical strategies for treatment of myocardial infarction and heart failure through development of new biomaterials. They pursue the research programs alone (e.g. advanced bioreactors and cell tri-culture) or in collaboration with other PIs (e.g. microfluidic separation of heart cells). The research programs are categorized as: tissue engineering of cardiac patches; injectable biomaterials; microfluidic cell separation; and microfabricated systems for cell culture.

Prof. Radisic holds the Canada Research Chair position in Functional Cardiovascular Tissue Engineering and is the co-founder of two biotech startup companies, Quthero Inc. and TARA Biosystems.

Publications: Click here for Prof. Radisic's publications on PubMed.

Molly Shoichet [CNS | Drug Delivery]

University Affiliations
Professor, Donnelly Centre for Cellular + Biomolecular Research; Chemical Engineering; Institute of Biomedical Engineering
Member, PRiME

Lab Website
https://shoichetlab.utoronto.ca/

Keywords
Hydrogels, Stem Cell Transplantation, Stem Cell Stimulation, 3D Cell Culture, Targeted Drug Delivery, Cancer, Stroke, CNS

The Shoichet laboratory works on cell and drug delivery strategies, which includes nanotechnology for targeted delivery in cancer. The four main themes of the lab are: (i) cell delivery of biomolecules directly to the brain or spinal cord for a prolonged time using a patented injectable hydrogel; (ii) an injectable hydrogel for local and sustained delivery of biomolecules to injured spinal cord and stroke-injured brain; (iii) designing biomimetic strategies to grow cells in 3-D environments to better understand disease progression and development and drug screening; (iv) and targeted delivery of antibodies and other chemotherapeutics to tumour cells via novel multifunctional polymeric nanoparticles.

Prof. Shoichet holds the Canada Research Chair in Tissue Engineering, amongst numerous other awards, and has also founded 3 start-ups. She is also the recipient of multiple awards for her invaluable contributions to science and technology, including Gerhard Herzberg Canada Gold Medal for Science and Engineering, NSERC; Fellow, Royal Society UK; Order of Canada, Governor General of Canada; and Killam Prize.

Publications: Click here for Prof. Shoichet's publications on PubMed

Craig Simmons [Cardiovascular | Drug Testing]

University Affiliations
U of T Distinguished Professor of Mechanobiology, Mechanical & Industrial Engineering; Institute of Biomedical Engineering, Faculty of Engineering

Lab Website
https://cml.mie.utoronto.ca/

Keywords
Cellular Mechanobiology, Tissue Engineering, Stem Cells, Cardiovascular, Cellular & Molecular Biology, Biomaterials, Therapeutic Drug Testing, Microfluidics

Prof. Simmons is an expert in cell and tissue engineering, with a research focus on understanding the processes by which biomechanical forces regulate tissue regeneration and disease. His research team applies this knowledge to develop new treatments for heart valve and blood vessel diseases, including strategies to regenerate cardiovascular tissues using stem cells and biomaterials.

Prof. Simmons is the recipient of numerous research awards and holds the Canada Research Chair in Mechanobiology. He is also the Scientific Director of U of T Translational Biology & Engineering Program (TBEP), Ted Rogers Centre for Heart Research.

Publications: Click here for Prof. Simmons' publications on PubMed.

Edmond Young [Oncology | Organ-on-a-chip]

University Affiliations
Associate Professor, Mechanical & Industrial Engineering, Faculty of Engineering

Lab Website
https://ibmt.mie.utoronto.ca/

Keywords
Microfluidics, Biofluid Mechanics, Microscale Cell-Based Systems, Cellular Microenvironments, Microfabrication, Cell Biology, Cell Imaging and Microscopy, Biomedical Engineering, Cancer

The Young laboratory is developing several organ-on-a-chip models. Their group has developed lung airway-on-chips, enabled by in-house micromilling and solvent bonding techniques. Their system enables long-term (> 4 weeks) co-culture of airway epithelial and smooth muscle cells on a suspended hydrogel layer, and exhibits expected cell surface markers and functional properties that support its use as an appropriate lung airway tissue model. The lab is now actively developing methods to deliver air pollutants into the airway-chip to simulate inhalation of pollutants, and to monitor the effects of pollutants on the living cells in the model by live-cell microscopy and molecular biology techniques.

Publications: Click here for Prof. Young's publications on Google Scholar.

SELECT TECHNOLOGY OPPORTUNITIES

For all U of T technologies available for licensing, visit http://uoft.me/tech-opps. For the latest on active investment opportunities and developments at companies emerging from U of T Research, sign up for the Deep Tech Download newsletter.

TARGET AREA: REGENERATIVE MEDICINE

Design of Short Promoters for Gene Therapy

https://research.utoronto.ca/technology-opportunities/db/design-short-promoters-gene-therapy

Researchers at the University of Toronto have developed an algorithm to design synthetic short promoters by concatenating predicted transcription factor binding motifs. The algorithm works by identifying probable palindromic sequences, that transcription factors generally bind to, through utilizing an individual nucleotide scoring system. A high density of probable palindromes (Figure 1) is usually correlated to the key elements of the enhancer or repressor regions responsible for promoter function. Concatenation of these regions upstream of the transcription start site to a core promoter is used to generate the synthetic short promoters. Using this algorithm, greater than 20 model short promoters have been tested in cells and a library of putative synthetic short promoters has been generated for all promoters in the human and mouse genomes.

Hi-Efficiency Protection of Linear DNA for Cell Free Protein Synthesis

https://research.utoronto.ca/technology-opportunities/db/hi-efficiency-protection-linear-dna-cell-free-protein-synthesis

Our researchers have developed a high-efficiency method for protection of linear DNA for cell-free protein synthesis. It uses a protecting protein which tightly binds to a particular 23-bp DNA sequence guide, the latter positioned flanking the gene of interest. This inhibits exonucleolytic degradation of linear DNA templates and allows for protein yields at least as high as plasmid-based expression.

Human Culture Assay to Assess Muscle Stem Cell Potency

https://research.utoronto.ca/technology-opportunities/db/human-culture-assay-assess-muscle-stem-cell-potency

Our researchers have developed an in vitro stem cell mediated skeletal muscle repair platform referred to as "MEndR" (Muscle Endogenous Repair), that accurately recapitulates the timing of key phases of the stem cell (SC) mediated skeletal muscle repair process in a dish (SC-expansion, SC cell cycle exit, SC nascent fiber formation, fiber maturation). Furthermore, this in vitro platform accurately predicts the performance of stem cells at mediating in vivo repair in standard in vivo mouse transplantation assays and has the potential for parallel stratification of the potency of many (100s) drug or cell therapy candidates at enhancing muscle regeneration.

Kidney-on-a-Chip Model with Glomerular Structural Features

https://research.utoronto.ca/technology-opportunities/db/kidney-chip-model-glomerular-structural-features

Researchers at the University of Toronto have developed an organ-on-a-chip system to reflect the fractal, branching nature of the glomerulus. They started with the glomerular structure and, through a sequence of steps, generated a slice of the branching glomerular pattern. This pattern can be molded into the base of cell culture wells in an out-of-plane fashion to give a 2.5-Dimensional system.

Long-Term Cell Tracking using Magnetic Resonance Imaging

https://research.utoronto.ca/technology-opportunities/db/long-term-cell-tracking-using-magnetic-resonance- imaging

Researchers at the University of Toronto have developed a "bright-contrast" method that can reliably and sensitively track the fate of cellular therapeutics. This technique relies upon the production of two proteins; a metal transporter which is used to pump manganese ions across the cell membrane, whereafter the ions are synthesized into a contrast generating metal ball housed within an organic ferritin cage. The metal nanoparticle produces "bright-contrast" in an MRI instrument.

Maturation Medium for Induced Pluripotent Stem Cell-Derived Cardiomyocytes
https://research.utoronto.ca/technology-opportunities/db/maturation-medium-induced-pluripotent-stem-cell- derived-cardiomyocytes
Our researchers have developed a novel and defined culture medium for the functional maturation of iPSC- CMs using an iterative, directed-evolutionary algorithm that screened 17 factor additives simultaneously and converged to a high-performing formulation for further characterization.

Microfluidic Platform for Uniform Spheroid Growth, Release, and Drug Screening
https://research.utoronto.ca/technology-opportunities/db/microfluidic-platform-uniform-spheroid-growth-release- and-drug
Researchers at the University of Toronto have developed a method of rapidly producing uniformly-sized multicellular aggregates in biomimetic hydrogels using a microfluidic platform for high-throughput screening of compounds. Using an aqueous suspension containing high-density cells and matrix-forming components, uniformly sized cell-laden droplets were formed in microwells organized in multiple parallel rows. Crosslinking of the matrix-forming components in the droplet led to the formation of cell-laden microgels. Finally, a continuous stream of cell culture media through the supplying channel resulted in the formation of multicellular spheroids.

Novel Substrates for Chemically Defined Culture of Human Pluripotent Stem Cells
https://research.utoronto.ca/technology-opportunities/db/novel-substrates-chemically-defined-culture-human- pluripotent-stem
Our researchers have developed a novel culture substrate combination that robustly supports human pluripotent stem cell (hPSC) proliferation and pluripotency in chemically defined conditions. hPSCs grown on this novel substrate culture display higher proliferation rates and pluripotency marker expression than current gold-standard culture substrates Geltrex- and vitronectin-coated plastic.

Organ-on-a-Chip for Airway Tissue Modelling
https://research.utoronto.ca/technology-opportunities/db/organ-chip-airway-tissue-modelling
Researchers at the University of Toronto have developed a microfluidic lung airway-on-a-chip device that
allows for easy downstream analyses using conventional techniques (e.g. immunohistochemistry, PCR). The device is called E-FLOAT, an acronym standing for “Extractable Floating Liquid gel-based Organ-on-a-Chip for Airway Tissue Modelling”. It consists of three vertically stacked microfluidic compartments; one to contain cell culture media, a second to contain a “floating” hydrogel, and the last through which physiological air can be flowed.

Portable Automated Manufacturing of Protein-Based Therapeutics
https://research.utoronto.ca/technology-opportunities/db/portable-automated-manufacturing-protein-based-therapeutics
Our researchers have developed molecular and hardware technologies for automated production and purification of protein-based products. Importantly, the production platform is programmable and can be used to produce virtually any protein-based therapeutic (e.g. vaccines), countermeasure (e.g. toxin neutralizing antibodies and antivenoms) or lab reagent (e.g. cytokines and polymerases). This automated cell-free protein manufacturing platform can rapidly produce and purify cytokines and antibodies at various scales and within a few hours. The platform allows just-in-time production and agile scaling, which significantly minimizes capital and inventory costs. This will in turn provide cost savings to researchers who would obtain cytokines and antibodies manufactured through the use of this technology.

Serum-Free Cell Culture Media Design Using an Artificial Intelligence Algorithm
https://research.utoronto.ca/technology-opportunities/db/serum-free-cell-culture-media-design-using-artificial-intelligence
Researchers at the University of Toronto had previously constructed a high dimensional-differential evolution (HDDE) algorithm to optimize media containing as many as 15 different chemical factors. They

used it to produce serum-free media for the expansion of both TF-1 and CAR-T cells that is comparable to gold standard media. More recently, they have added an artificial neural network module to the HDDE algorithm (HiDiNeu) enabling both faster determination of optimal media composition and optimization of exponentially larger search spaces.

Tunable Activation of Gene Expression for Therapeutic Use

https://research.utoronto.ca/technology-opportunities/db/tunable-activation-gene-expression-therapeutic-use

Researchers at the University of Toronto have discovered a set of 248 human transcription activators that can be used as part of the CRISPRa system to provide tunable protein expression for therapeutic use. These activators were isolated by conducting a genome-wide screen of ~ 15,000 human proteins to identify the top 1% of activators.

U of T ENTREPRENEURSHIP

The U of T Entrepreneurship community is Canada's leading engine for research-based startups and a global leader in transforming ideas into products and services that create jobs and impact the world. More than 500 research-based startups have been launched from U of T, outpacing every other Canadian university, and generating more than $1.5 billion (CAD) in investment in the past 10 years.

The University of Toronto is also home to 11 accelerator/incubator programs that serve students, alumni, and faculty from all disciplines and levels of experience.

UTEST

http://utest.to/

The University Early Stage Technology (UTEST) is a startup development program for nascent companies supported in partnership by the University of Toronto Connaught Fund and MaRS Innovation. UTEST provides investments of up to $100,000 per company in addition to intensive entrepreneurial education, advisory support, and dedicated incubation space.

Click here for a list of all UTEST companies.

Health Innovation Hub

http://h2i.utoronto.ca/

The Health Innovation Hub (H2i) facilitates early-stage entrepreneurs with translation and commercialization of ideas into problem-solving designs on health matters. It works to align, connect, and leverage the significant mass of life science research expertise, facilities, programs and funds of the University and its partners towards effective and efficient health innovation ventures. H2i provides open and flexible educational and mentorship opportunities and serves as a conduit for innovation throughout the Toronto Academic Health Science Network.

Click here for a list of all H2i companies.

SELECT HEALTHCARE COMPANIES

REGENERATIVE MEDICINE

AntlerA Therapeutics
https://www.antlera.co/
AntlerA Therapeutics are the developers of a precision-engineered programmable Wnt pathway agonist platform intended to develop drugs that address large unmet needs in the regenerative medicine area. The company's solution is focused on developing novel protein therapeutics that function by modulating Wnt signaling and other developmental cellular signaling pathways, enabling them to control tissue stem cells and unleash tissue repair and rejuvenation.

BlueRock Therapeutics
https://bluerocktx.com/
BlueRock's primary focus is on stem-cell research. The company's services develop induced pluripotent stem cell therapies to cure a range of diseases with the help of regenerative medicines across neurology, cardiology and immunology indications, enabling healthcare professionals to deliver advanced care and ensure fast recovery of the patients suffering from intractable diseases.

ExCellThera
https://excellthera.com/
ExCellThera is an advanced clinical stage biotechnology company delivering molecules and bioengineering solutions to expand blood stem and immune cells for therapeutic use. ExCellThera's lead technology, ECT-001, combines a proprietary small molecule, UM171, and an optimized culture system. In pursuit of better treatments for patients, the company is building out its portfolio of products, as well as supporting best-in-class clinical trials.

Insception Lifebank
https://www.insception.com/
Insception Lifebank is a provider of stem cells from the umbilical cord blood to healthcare professionals intended to advance their effectiveness in transplantation and cellular therapy. The company's cord blood bank allows expecting parents to access two different types of stem cells by offering both Cord Blood and Cord Tissue banking as well as offers online patient education webinars and online enrollment, enabling expecting parents to bank umbilical cord tissue, a rich source of mesenchymal stem cells (MSCs) as well as purchase cord blood and tissue banking online.

Notch Therapeutics
https://notchtx.com/
Notch Therapeutics is a developer of immunotherapy drugs designed to generate T cells and other immune cells from clonal stem cell lines. The company's products uniform, stem cell-derived, gene-edited immune cell therapies and differentiation of induced pluripotent stem cells in fully defined, feeder-free, and serum-free cultures into mature T cells, enabling doctors to create cell banks for thousands of patients

Perfusia Biosciences
http://www.perfusiabio.com/
Perfusia is developing next generation in vitro disease models for pharmaceutical drug testing. The company's platform allows for implantation and vascular support of various tissues within a microfluidic platform to be used to model a wide range of organs and diseases from brain cancer to drug absorption in the gut, thereby providing hospitals with stem cell-derived vitro disease 3D organ models for assistance in drug discovery.

Quthero
https://quthero.com/
Quthero is committed to disrupting the ways we treat wounds today – from passive 'dressing' of wounds to active, rapid, healthy healing. We are developing novel efficacious and safe treatments for all types of wounds

including surgical wounds, burns, chronic ulcers to both accelerate healing and minimize scarring, while reducing complications and risks of slow healing (infection, pain, amputation and mortality).

Tara Biosystems

https://tarabiosystems.com/

Tara Biosystems is a provider of a platform designed to pioneer predictive cardiac tissue models that enable faster, safer, and reliable development of new medicines. The company's platform uses stem cells to produce heart cells so that realistic changes in human cardiac function can be measured without human testing, enabling physicians to address specific heart issues for better health and longer life.

TissueX Technologies

http://www.tissuextechnologies.com/

The mission of TissueX Technologies is to accelerate the discovery, development, and validation of therapies with its cell- and tissue-based technologies. TissueX's platforms provide unique predictive data sets to indicate effectiveness in patients much earlier in the pipeline compared to other models which are not as predictive. The company aims to expand its predictive human tissue models to a wide range of human organs and transform into a drug and cell-based therapy company by leveraging the insights gathered during its first two major phases of company development.

Trillium Therapeutics

https://trilliumtherapeutics.com/

Trillium Therapeutics Inc is a clinical stage immuno-oncology company which is engaged in developing therapies for the treatment of cancer. The lead program of the company is TTI-621 which is designed to act as a soluble decoy receptor, preventing CD47 from delivering its inhibitory signal. The company has proprietary medicinal chemistry platform, using fluorine chemistry which permits the creation of new chemical entities with pharmacological properties. The company operates through the single segment being Research and development of therapies for the treatment of cancer.