

Strategic Research Plan for the University of Toronto



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STRATEGIC RESEARCH PLAN (SRP) FOR THE UNIVERSITY OF TORONTO AND ITS FORMAL AFFILIATES

Introduction

The advancement of excellence in research and innovation is a defining feature: our mission is to rank among the top 10 public research-intensive universities in the world and provide answers to the world's most significant questions. The development of scholarship, research, innovation and research training is an integral element of the academic planning and budgeting process. Our plans reflect consultations within and across the divisions of our three campuses and with our ten fully affiliated teaching hospitals. This process has defined academic and related infrastructure objectives which form the basis for the Strategic Research Plan (SRP) for the Canada Foundation for Innovation (CFI) and Ontario Ministry of Research and Innovation (MRI) programs, the Canada Research Chairs (CRC), as well as other government research and infrastructure programs. These programs are essential to attract and retain outstanding researchers, to develop new areas of excellence in research, and to strengthen synergies between teaching and research. They provide an exceptional opportunity to increase Canada's talent pool and research infrastructure and thus boost Canada's productivity and international competitiveness.

The University of Toronto encompasses 18 divisions, 117 departments, three campuses, and ten fully affiliated teaching hospitals. There are approximately 3,500 faculty members engaged in research. Academic programs span the disciplines and professions, supporting approximately 70,000 students, including 12,000 at the graduate level. The University and its affiliated teaching hospitals attract over \$800M per year in external research funding, and more than 100 productive Canadian companies owe their origins to research conducted at the University of Toronto and its affiliates.

Although this scale of operation is large, the strategic planning process fosters distinctiveness as well as excellence; collaboration and synergy are strongly encouraged and the selective investment of resources is consistent with these aims. Resources to support research and innovation derive from government programs, private-sector partners, and other organizations in Canada and around the world. In spite of considerable success, the challenge remains to create a resource base that is competitive with the great public research-intensive universities in other countries. A significant gap still remains in this regard.

Major Objectives of the Strategic Research Plan (SRP)

- Maximize opportunities for discovery and innovation;
- Strengthen internationally competitive research and scholarship in highly promising areas;
- Foster excellence in selected areas of research that are currently undeveloped;
- Foster collaborations across disciplinary and institutional boundaries;
- Strengthen the capacity to disseminate new knowledge and innovations;
- Ensure the most effective use of our research and scholarship resources and realize the full value of intellectual property and commercialization;
- Enhance the education of undergraduate students and research training of graduate students and postdoctoral fellows; and
- Enhance our ability to attract, retain, and develop outstanding faculty, students, and research staff.

Research Areas and Themes

Our high-priority research **themes** fall into four major **areas**, encompassing major fields of inquiry in the humanities, the social sciences, the physical sciences and engineering, and the health and life sciences. The range of disciplines and departmental units varies by theme; some themes are entirely or almost entirely located within a given discipline or sub-discipline, while others are multi-disciplinary in nature. Themes that bridge across multiple areas are listed within a major or "home" area. Given the size and complexity of the University of Toronto and its excellence in a wide range of research fields, the listing of high-priority research themes is longer than might be expected at a smaller institution:

1. Humanities

- 1.1. Literature, Arts, and Culture
- 1.2. Medieval Studies
- 1.3. Values: Their Origin and Transmission
- 1.4. History and Culture

2. Social Sciences

- 2.1 Urban Environment
- 2.2 Public Policy
- 2.3 Economics, Finance, and Competitiveness
- 2.4 Global Development
- 2.5 Peace, Conflict, and Security
- 2.6 Groups, Networks, and Localities

3. Science and Technology

- 3.1. Information Technologies
- 3.2. Advanced Materials and Manufacturing
- 3.3. Biotechnology
- 3.4. Nanoscience and Nanotechnology
- 3.5. Planet Earth and the Environment
- 3.6. Aerospace Science and Technology
- 3.7. The Structure of the Universe
- 3.8. Mathematical and Computational Sciences

4. Health and Life Sciences

- 4.1 Molecular Biology and Applied Genomics
- 4.2 Models and Mechanisms of Disease
- 4.3 Neurosciences
- 4.4 Improvement in Health and Function
- 4.5 Health Information and Knowledge Transfer
- 4.6 Medical Imaging

1. Humanities

1.1 Literature, Arts, and Culture

This theme encompasses the study of cultural structures and discourse in the context of ancient and modern societies. Research strengths include identity and nation, print culture, visual structures as a component of performance, and body representation. This theme brings together many disciplines (architecture, literary studies, music, drama, and physical education) and complements the other themes in the humanities.

1.2 Medieval Studies

International scholars are attracted to the world-renowned Pontifical Institute for Medieval Studies and the Centre for Medieval Studies. Projects such as the Records of Early English Drama, the Dictionary of Old English, and the Rhymed Office project in the Faculty of Music exemplify the range of disciplines. Researchers study the convergence and interdependence of different branches of medieval culture and knowledge. A particular focus is the study of religion and popular spirituality as revealed in the drama, literature, and music of medieval society.

1.3 Values: Their Origin and Transmission

This theme examines how values are shaped and transmitted throughout history, in the movement of peoples, and through changes in national identity. This area stands at the interface of the humanities and social sciences, and explores values through the perspective of writers, artists, philosophers, historians, and other arbiters and analysts of society and culture.

1.4 History and Culture

A broad range of disciplines is focused on understanding the complex interplay between history and culture. Understanding of how cultural movements are transformed as they move across nations and through time is a particular emphasis. For example, one focus concerns how the ancient Greek culture influenced other cultures and nations, and how transitions in ancient

thought and philosophy shaped medieval culture.

2. Social Sciences

2.1 Urban Environment

Linked to the rise of the new economy, urban regions are experiencing sweeping transformations related to society, culture, and health: increasing diversity, mobility of populations, and the emergence of competing forms of management, regulation, and governance. Investigations include: exploration of cultural and ethnic pluralism and its interaction with the arts; and planning culturally diverse urban communities to create effective, safe, attractive spaces in which to live, work, and learn.

2.2 Public Policy

This diverse theme encompasses studies in society, health, education, environment, public economic management, and human development throughout the life cycle. Researchers study social, ethical, and economic issues and the implications these have for public health policy and management. In studies of society and education, points of focus include social justice, diversity, socio-legal studies, educational policy, and language and literacy.

2.3 Economics, Finance, and Competitiveness

How can jurisdictions and nations prosper in the new economy? This research adapts financial risk management techniques to enhance Canada's capacity to deal with the challenges of complexity and uncertainty. Investigations focus on the structure of economies, including the Canadian economy, and how leaders in business, government, education, and healthcare can understand the complex global forces that shape them. Canada's strategy must take account of economic, cultural, and social dimensions, uniting business, government, and the academy to build knowledge and develop strategy.

2.4 Global Development

Scholars approach global development, health, and prosperity from interdisciplinary perspectives. The gap between developing and developed countries is growing and important issues include: sustainable development; public health issues; the role of legal institutions; strategies for economic competitiveness; history and culture in developing countries, including colonialism and post-colonialism; transfers in the evolution of national cultures; regionalization, globalization, and inequality; and peace-building and security.

2.5 Peace, Conflict, and Security

This theme reflects the University of Toronto's impressive capacity in peace and conflict studies, and promotes interdivisional collaboration among Arts & Science, Law, Medicine, and the Ontario Institute for Studies in Education. Researchers grapple with new variations on fundamental questions: What do peace and security mean in the aftermath of the Cold War? How can scholarly research be useful in fostering well-being and order while also analyzing their absence or collapse?

2.6 Groups, Networks, and Localities

This theme promotes the study of the evolution of social, legal, health, educational, and governing institutions in the context of heterogeneous groups, networks, and nations. New information technologies facilitate flows of information, people, groups, organizations, or capital through networks. The consequent accumulation of information, people, etc. in localities (neighbourhoods, communities, regions, nations) makes traditional analyses problematic. Global markets, new transportation modes, and information technologies which speed up and direct these flows have an impact on the stability of local units, affecting their internal organization, culture, homogeneity, and unity.

3. Science and Technology

3.1 Information Technologies and Services

These include high performance computing, innovations in computational technologies, and new

forms of information-based services, such as digital media, human-computer interaction, intelligent infrastructure, information access, knowledge management, and fair use. Specific projects include understanding human communications and developing techniques for solving large-scale information processing problems, providing open access to information services, and developing an inclusive agenda for an information-based society. Studies of fibre-optic systems, real-time monitoring of complex systems, wireless transmission of information inclusive information design, knowledge organization, and information policy are critical elements. Research in computational and information sciences melds with many other fields of research, including biology, physics, advanced materials, design, education, psychology, sociology, philosophy, communications, and engineering.

3.2 Advanced Materials and Manufacturing

Close interaction among materials scientists and engineers, physicists, and chemists is required to develop advanced materials with novel properties and function for use in applications ranging from traditional transportation and consumer goods, to new clean technologies and alternative energy. Innovative advanced manufacturing technologies and processes for materials synthesis will result in advanced alloys, polymers, composites, semiconductors and superconductors that are fundamental to the development of new engineering materials of higher quality and/or lower cost in the microelectronics, photonics, biomaterials and manufacturing sectors.

3.3 Biotechnology

This theme includes molecular and functional imaging, biomaterials, tissue engineering and regeneration and the development of novel bioproducts. Scientists in the Faculties of Applied Science & Engineering, Arts & Science, Dentistry, and Medicine investigate replacement tissues and their biocompatibility, study the physiology and genetics of biofilms, including their relation to infection, and advance knowledge in diverse areas such as nerve regeneration, orthopaedic and dental implants, vascular grafts, biodegradable polymers, and artificial organs. This theme also encompasses efforts in bioremediation, the development of new products from underutilized biomass and research focused on improving the viability of crop and livestock under changing environmental conditions.

3.4 Nanoscience and Nanotechnology

Multidisciplinary groups from physics, chemistry, and engineering interact in order to understand and develop new materials. Focusing on structures at the atomic and molecular levels, this research unites physicists, who are developing the underlying microscopic descriptions of the physical phenomena; chemists, who are exploring the techniques by which such nanostructures can be formed through processes such as self-assembly; and engineers, who are applying these new materials to develop technologies in areas such as photonics and optical devices. Related research in microelectronics ranges from the design and fabrication of semiconductor devices and integrated circuits to the effective assembly and packaging of such devices. Important aspects include manufacturing processes, electrical design and modelling, photonics packaging, and packaging materials development

3.5 Planet Earth and the Environment

This theme focuses on the earth, its environment and natural resources. Particular emphasis is placed on climate change science, energy sustainability and associated clean technologies. Also encompassed are atmospheric chemistry and dynamics and studies of the earth's crust and deep mantle. Research activities range from understanding the complex physical and biological interactions that occur at multiple levels—from the molecular and cellular to individual organisms within the integrated ecosystem. Researchers employ diverse techniques ranging from proteomics at the biomolecular level to the use of sophisticated remote sounding satellite observation of the planet.

3.6 Aerospace Science and Technology

This interdisciplinary theme focuses on the fundamental understanding and engineering design of aircraft and spacecraft flight systems. The core disciplines include: flight dynamics, control, and

simulation; experimental and computational aerodynamics; fluid, gas, and plasma dynamics; combustion and propulsion; materials and structures; satellite technology; space robotics; and systems simulation and integration.

3.7 The Structure of the Universe

The fundamental structure of our universe, at its most microscopic level, is intricately connected with the very largest scale structures in our universe and their evolution since the Big Bang. This theme integrates the study of our universe, bringing together theoretical and experimental studies of new unified models such as string theory, astrophysical studies of the early universe, and astronomical observations of current galactic and stellar structure.

3.8 Mathematical and Computational Sciences

The University of Toronto is a world leader in mathematical and computational sciences and is host to the national Fields Institute in Mathematical Sciences, where mathematical scientists from Canada and around the world gather for periods of intensive collaborative research. Research includes the study of mathematical foundations, mathematical modeling, and scientific computation. Important applications include processing and exploring large data sets, mathematical finance, and the development of fast, reliable algorithms. Mathematicians interact with a broad spectrum of scholars in Applied Science & Engineering, Arts & Science, and the Rotman School of Management

4. Health and Life Sciences

4.1 Molecular Biology and Applied Genomics

The focus is on fundamental and applied research in plant and animal proteomics and bioinformatics, functional genomics, and molecular medicine. Researchers investigate the interaction of genes with environmental, behavioural, nutritional, and psychosocial factors in health and disease; the design and safety of new drugs; and the associated ethical and social issues. Long-term objectives include understanding the mechanisms of enzyme catalysis, ion channel and transporter function, and drug activity.

4.2 Models and Mechanisms of Disease

This theme encompasses inflammation, infection, trauma, repair, and vascular and metabolic biology. The research involves the use of transgenics, “knockouts,” and other models, such as isolated cells, tissues, tissue culture, and computer modelling, in order to study gene functions in health and disease. Strategic scientific goals include developing a platform of vertebrate and non-vertebrate models of human disease, along with appropriate imaging and telemetry monitoring techniques for the purpose of gaining a better understanding of the natural history of disease processes in humans to advance prevention and treatment.

4.3 Neurosciences

Modern neuroscience, including neurobiology, involves multiple departments in several Faculties and Divisions on all three campuses, and at the institutes of the affiliated hospitals, such as the Rotman Research Institute at the Baycrest Centre. The spectrum of projects ranges from molecular to functional. Molecular neuroscience includes the study of the molecular genetics of the brain and nervous system in animals and humans, in both normal and clinical states. Functional neuroscience examines how neural systems support functions and behaviours like perception, learning, memory, and action. Research on the neurochemical causes of pain, as well as its assessment and management, is an important focus.

4.4 Improvement in Health and Function

Emphases include developing and testing: new modalities of diagnosis and management of disease; fetal, neonatal, and maternal health; diet and nutrition; approaches to promote maximum function among those who develop disease and disability; health-system-related strategies; and the promotion of health and wellness for large populations. Specific objectives include: to develop and apply clinical databases combined with genotyping to identify and manage vulnerable patient

populations; and to apply mathematical and epidemiological methods to the study of health outcomes in such areas as cancer, cardiovascular disease, and stroke.

4.5 Health Information and Knowledge Transfer

Health systems and knowledge transfer shape fundamental and applied research in the delivery of clinical care through many different avenues, including home care. The University is committed to developing, refining, and applying a range of policies and information technologies in health care. Long-term objectives are: to afford the potential for long distance provision of health services for diagnosis, surgical care, education, and prevention; and to develop multidisciplinary strategies to deliver health care and educational and rehabilitation services to the geriatric population.

4.6 Medical Imaging

The focus is on the development of preclinical models for visualizing molecules, cells, tissues, organs, and the whole body, with an emphasis on relating and interpreting images in normal and disease conditions. A long-term project will investigate quantitative non-invasive approaches for the diagnosis and evaluation of disease states. This process will require the development of a tool kit of chemical and physical probes, mathematical and computer models, and the use of state-of-the-art detection systems (MRI, PET, gamma spectrometers, etc.) for real-time monitoring of whole organ function.

Institutional Planning and Approval Process (including Affiliated Institutions) and Investment

The University's existing planning process takes account of CRC, CFI, MRI and other government research and infrastructure programs. This integration has been extensively documented, and the Academic Board and Governing Council have endorsed this planning framework.

The Research Services Office (RSO) on behalf of the Vice President (Research) coordinates and facilitates the development of research strategy and proposals. Proposals are vetted first at the departmental and faculty levels, and then reviewed by RSO to ensure excellence and compliance with the SRP. The President, with his Executive Committee, then approves those proposals that advance the University's priorities and comply with the SRP.

Conclusion

The University of Toronto has a critical role to play in Canada's future in a wide range of areas, involving intellectual, social, cultural, health, scientific, commercial, industrial, and national security issues. The strategic research plan and research planning process helps to guide the University's involvement in programs that advance our research capacity and productivity by enabling the University to attract and retain superb talent; to build strategic research programs and linkages of research, education, and training; and to leverage strategic partnerships and resources for the benefit of Canada.