

RESEARCH FOR A BRIGHTER WORLD

McMaster University

**Strategic Plan for Research
2018-2023**

The Difference Research Makes

University research is the foundation of knowledge. It is the driver of innovation and critical to the social, cultural and economic fabric of our society. Research is the tool that supports evidence-based decisions—decisions that inform policy, impact organizations, and influence the lives of citizens locally and globally.

Research also has the power to bring diverse groups of people together behind a common, focused goal. It develops our understanding—socially, culturally, and physically—of the world in which we live. It teaches us how to teach and guides how we learn on our own and with others. It empowers individuals and groups, and advances our understanding of cultures and social relations.

At McMaster, it is our goal and responsibility to use our evidence-based knowledge to support understanding, enable positive change, and, ultimately, advance human and societal health well-being.

Overview

In the spring of 2011, McMaster University released a document that would serve as a calling card for the next chapter of our illustrious history. Titled *Forward with Integrity*, it reaffirmed McMaster's commitment to strengthening the excellence of our research while, at the same time, seeking opportunities to integrate research more purposefully into our academic mission.

Since then, we have been engaged in an institution-wide process that has brought faculty, staff, and students together to review our research mission in detail. The goal was not merely to preserve McMaster's enviable position as a Canadian research powerhouse, but to ensure that we continue to make a difference—in the competitiveness of our researchers, in the quality of our teaching, and in the impact we have on the world around us.

Research for a Brighter World — Strategic Plan for Research 2018-2023 lays out a vision and plan to bolster McMaster's research mission and to take our institution's research excellence to an even higher level.

The Face of a Great Research University

***Our purpose is the discovery, communication
and preservation of knowledge.
Our vision is to achieve international distinction
for creativity, innovation and excellence.***

These excerpts from McMaster's Mission and Vision Statement underscore the pre-eminent role that research plays in the life of our University. At McMaster, research is a living, breathing entity. It elevates the student experience, energizes our faculty, and stimulates the kind of original thinking that has made McMaster a national leader in research excellence and earned us a place as one of the top 100 universities in the world:

- McMaster consistently ranks among Canada's most research-intensive universities.
- Along with our hospital partners, we are globally recognized and consistently ranked among the top 50 universities in the world for health and medicine.
- Our research is strengthened by the strong collaborations within our faculties and with our hospital partners.
- Our regional communities benefit through unique initiatives like the David Braley Health Sciences Centre – Canada's first facility to fully integrate teaching, research, public health services and academic primary care services.
- Nearly a quarter of our full-time faculty members have been awarded Canada Research Chairs, endowed or industry sponsored chairs, or professorships based on the strength of their research.
- We have more than 70 high-impact research institutes and centres, many with state-of-the-art facilities equipped with powerful new technologies to drive the next important discovery.
- McMaster has built a 30-year relationship based on community partnerships and research projects with Six Nations of the Grand River, the Mississaugas of the New Credit First Nation, and the Hamilton urban Native populations, resulting in several national and international Indigenous research initiatives.
- McMaster is expanding its international reach, collaborating with global researchers and world-leading organizations to build research partnerships and academic programs.
- We are a leader in knowledge transfer, particularly in the area of copyrighted materials, entering into more license agreements annually than any other Canadian university.
- McMaster Innovation Park is at the heart of the region's innovation ecosystem and will soon boast new incubator space and facilities for spin-off companies to translate our discoveries into world-changing applications.

Ours is an impressive record of achievement. But research excellence is about more than statistics and accolades. It's about influence and impact. About advancing the greater social good—in our communities, in our country, and around the world.

And that's where McMaster really shines.

Living Our Core Values

McMaster's commitment to research excellence is informed by a set of core values from which we will not waver:

- We insist on ethics, equity, and excellence in scholarship in all research programs.
- We regard the work of educating students, and of extending the boundaries of knowledge through research, as inseparable and mutually reinforcing activities.
- We conduct research that advances society, using the best practices and cutting-edge technologies available to us.
- We support collaborative work and thinking across Faculties and disciplines as an essential driver of innovation.
- We partner with hospitals, governments, institutions, and businesses locally, nationally, and globally to share resources and expertise, solve complex problems, spur economic growth, and create a more skilled workforce.
- We share our knowledge widely to help shape policies and practices that will strengthen communities and improve lives in Canada and around the world.

Our Commitment to Fundamental Research

Fundamental research is the backbone of what we do as a university. Generating new knowledge lays the foundation for our capacity to understand. It sparks curiosity and drives exploration, offering up new perspectives and observations to advance human knowledge and test new ideas.

Improving our understanding can have far-reaching and unpredictable implications. Indeed, some of the world's greatest inventions have been total happenstance, never even dreamed of by their creators. In other cases, basic research conducted decades earlier has laid the groundwork for an invention or breakthrough by someone who later applied the information. The whole point of exploration is you don't know what you're going to find.

Curiosity and inquiry are essential to scientific advancement and must be supported and nurtured among our faculty—particularly young faculty who represent the future of our research enterprise—and students across all disciplines.

Our commitment is to foster and support foundational research across the disciplines and to create an environment where interdisciplinary collaboration refuses to pigeonhole creativity and innovation. We understand the critical role fundamental research plays in advancing our society and its important contribution in the journey of discovery.

Research for a Brighter World — Strategic Plan for Research 2018-2023 pays testament to McMaster's unwavering belief in the long-term impact of fundamental research and our ongoing commitment to provide the freedom and resources that will allow it to thrive and flourish across our campus.

Paradigm-shifting Research for the Greater Global Good: Setting the Stage for our Future Direction

From the outset, McMaster has been known for its pioneering spirit and ability to look at the world in new and unique ways.

From becoming the first university in the Commonwealth to house a nuclear reactor to our radical notion of problem-based learning and evidence-based medicine that revolutionized the way health professionals learn and practice, McMaster's outstanding researchers have had extraordinary success in achieving outcomes that have deep- and far-reaching impact on health, prosperity, and the future of our planet. We've achieved success on the strength of our researchers and the deployment of Canada Research Chairs in these areas of excellence.

While not exhaustive, here are some of the key areas where our researchers are delivering new knowledge, new tools, and new solutions to meet our most pressing global challenges:

Human Health and Social Determinants

From basic science to drug screening, from clinical research to policy development, McMaster is a leader in advancing global health. Our researchers have developed cutting-edge surgical procedures, discovered new molecules, and conducted scores of clinical trials to ensure the safety and efficacy of novel therapies and technologies. They're also leading some of the world's largest population health studies; addressing policy issues related to childhood disability and mental health; shedding light on the role of microbes in disease; improving healthcare delivery and management; and helping people live well for longer.

Working at the interface of chemistry and biology, medicine, engineering, management, the social sciences, and environmental and life sciences, multifaceted teams of researchers are devising breakthrough solutions to some of our most complex health challenges. Many are partnering with local community health care agencies, ensuring best practices derived from their research are benefitting the end user and having a profound impact. A few of many prominent examples include:

- Researchers in McMaster's Stem Cell and Cancer Research Institute are turning blood cells into brain cells to create new treatments for cancer and autism;
- The Michael G. DeGroot Institute for Infectious Disease Research is a leader in the global fight against some of the world's deadliest superbugs, including *C. difficile* and antibiotic-resistant staph infections;
- Researchers in the Farncombe Family Digestive Health Research Institute are revolutionizing patient care for diseases of the gastrointestinal tract;

- Researchers in the McMaster Institute for Healthier Environments are providing leadership to partner organizations to develop informed policy and action on environmental and health issues;
- The McMaster Health Forum is a World Health Organization Collaborating Centre for Evidence-Informed Policy committed to strengthening health systems around the world;
- Researchers at McMaster's Institute for Music and the Mind are exposing the profound effect of music on the brain that could lead to new therapies for autism and Parkinson's;
- The McMaster Institute for Research on Aging, together with the Labarge Centre for Mobility in Aging, is conducting cutting-edge interdisciplinary research to enhance optimal aging;
- The Population Health Research Institute is Canada's premiere global health research institute with an unmatched capacity to conduct several international studies concurrently, having enrolled almost 1,000,000 participants worldwide;
- Researchers in McMaster's Physical Activity Centre of Excellence are improving the health and well-being of older adults and people with chronic disease and disability;
- Researchers in the Offord Centre for Child Studies and the Institute for Clinical Evaluative Sciences are leaders in patient care and health policy related to mental health and addiction;
- The Michael G. DeGroot Health Leadership Academy aims to revolutionize healthcare through entrepreneurship, change management, digital transformation, innovation and education;
- McMaster's Centre for Health Economics and Policy Analysis brings numerous disciplinary perspectives to its work with specific emphases on the economic, political, sociological, and historical analysis of health, health care, and health systems;
- McMaster is home to several large-scale longitudinal cohort studies with national and international reach including the Canadian Longitudinal Study on Aging, the Canadian Healthy Infant Longitudinal Development Study, and the Prospective Rural and Urban Epidemiological Study.

These on-going, multidisciplinary research activities within our unique research centres and institutes ensure that our work is making a difference in the health and well-being of citizens at home and around the world.

Indigenous Research and Inquiry

Indigenous research has been part of the academic landscape at McMaster since the inception of the University's Indigenous Studies Program in 1992.

In response to the Calls to Action put forth in the federal government's Truth and Reconciliation Report, released in June 2015, this research is now rapidly expanding. We have added six tenure track Indigenous faculty members over the past decade, and a diverse range of projects are currently underway across our faculties, examining such topics as:

- Indigenous Theories, Methodologies and Ways of Knowing
- Indigenous Health and Well-Being
- Indigenous Ecologies, Land and Environment
- Self-determination, Policy and Governance
- Retention and Sustainability of Language and Culture

This work offers all members of the McMaster community and beyond a unique opportunity to learn about the history and contemporary lives of Indigenous peoples, while helping to shape a renewed relationship between Canada and First Nations, Métis and Inuit peoples.

Materials and the Built Society

Everything is built from something. The materials we produce and the way in which they are used, affect every aspect of our lives—our health, home, work, and play. From the study of new steel alloys to neutrons and silicon chips, from the safety and efficacy of our roads to the strength of our bridges, from advanced robotics to smart cars, our ability to understand the behaviour of materials and how they are produced is fundamental to the modern world.

Our technologies are helping in the development of safe, smart communities. We're creating new materials and devising innovative applications for them. And we continue to be called upon by industry and government leaders for our manufacturing expertise.

- McMaster is home to North America's largest materials facility, the Brockhouse Institute for Materials Research, whose advanced equipment is being used to create new materials for everything from solar cells to drug delivery;
- The Centre for Probe Development and Commercialization, based at McMaster, is a world leader in the development and commercialization of molecular imaging probes to detect cancer;
- The McMaster Automotive Resource Centre is accelerating research on electrified and autonomous vehicles, and identifying light materials to make cars more fuel efficient;
- McMaster's Biointerfaces Institute and Fraunhofer Project Centre for Biomedical Engineering and Advanced Manufacturing are at the forefront of cutting-edge research to deliver next-generation cell therapies and point-of-care diagnostics;
- McMaster's Centre for Emerging Device Technologies is using silicon chip technology to create new, faster, and more efficient ways of processing information;

- The McMaster Manufacturing Research Institute is one of the country's most advanced and best-equipped research laboratories designed to meet the sophisticated needs of leading manufacturers;
- The macGRID Simulation Research Network houses technologies to facilitate urban planning through the development of virtual cities;
- The McMaster Institute for Multi-Hazard Systemic Risk Studies develops systemic risk-based tools to enhance the resilience of our built and natural environment systems in Canada and around the world.

These and other premier facilities combine to offer an exceptional environment for the creation of new knowledge and the incubation of new discoveries that are strengthening Canada's competitiveness and enhancing the quality of our lives at every level.

Sustainability for Global Prosperity

Building sustainable communities is more than ensuring safe water and sanitation, fighting climate change or developing innovative smart grid solutions. It engages citizens to maintain and design livable environments that provide access to infrastructure, amenities, social services, and job opportunities for all. It requires fair and just societies, where human rights are protected and where true democracy allows for freedom of speech and expression. Most importantly, it ensures we manage today's resources for the benefit of future generations. McMaster researchers are at the forefront of this global effort:

- McMaster is home to the United Nations University Institute for Water, Environment and Health, a pre-eminent think tank in the fight against the global water crisis;
- The McMaster Centre for Climate Change is connecting science, technology, and policy to deliver a broad range of local and global climate change solutions;
- Researchers in the MacData Institute are collecting data to allow communities to measure how well they serve their citizens;
- The Institute for Globalization and the Human Condition and The Wilson Institute for Canadian History are looking to the past to better understand the social inequalities, globalized economies and looming wars of the 21st Century;
- The McMaster Digital Transformation Research Centre is focused on the leadership and management of digital transformation and its impact on people, organizations, and society;
- McMaster's Research Facility for Integrated Building Energy Harvesting Systems is focusing on community energy management, integrated sustainable energy systems and energy harvesting and storage, and remains the only facility in North America testing new ways to capture energy that is lost during transport to our homes and communities;
- The McMaster Institute for Transportation and Logistics is helping industry and civic leaders develop smarter, more cost-efficient transportation strategies;

- The Canada Excellence Research Chair in Hybrid Powertrain Program is pioneering sustainable energy-efficient solutions from advanced power electronic converters and electric motor drives to electric, hybrid electric, and plug-in hybrid electric vehicles, and working to alleviate the loss of performance of lithium ion batteries over time;
- McMaster's Institute on Ethics and Policy for Innovation is working to ensure decisions around climate, food security and health are equitable shared and sustained.

Spanning disciplines as diverse as biology, economics, sociology, management, civil engineering, and public policy, our work in sustainability is leading to the development of new technologies that are not only innovative and lead to prosperity, but are also culturally and socially acceptable and will reduce our footprint on the planet and ensure its health for generations to come.

Strategic Initiatives to Meet Complex Challenges: Our Future Direction

McMaster has earned its reputation as a research powerhouse on the strength of our faculty and their ability to work collaboratively across the disciplines. Our interdisciplinary approach to research is inherent in our culture and is a hallmark of our research brand. Considered a strategic advantage in and of itself, McMaster's size—large enough to attract some of the world's best researchers, yet small enough to maintain a collegial and collaborative research environment—differentiates us from our peers and positions us to tackle some of the most complex challenges of our time.

Adhering to our Core Values and enabled by our paradigm-shifting research, McMaster has now identified strategic themes to galvanize our research efforts in the years ahead. In pursuing these themes, we recognize they are all exceedingly complex and that new developments may have unexpected and far-reaching implications.

To have a positive impact locally and globally, we're building on our research successes and using our collective expertise—considering all aspects of, and approaches to, research knowledge across our disciplines—to ensure a multi-dimensional approach. We know the whole is greater than the sum of our parts and that stellar research, combined with persistence, diligence and commitment, will deepen our shared understanding of the world and contribute to advancing human and societal health and well-being.

These following themes have been chosen because they represent both breadth and focus. They are broad enough to engage researchers across all Faculties, departments, schools, centres and institutes, yet focused enough to capitalize on the institution's existing and emerging research strengths and opportunities to build capacity to ensure sustained excellence and impact.

Addressing the Growing Burden of Chronic Disease

Chronic diseases—cardiovascular diseases, respiratory diseases, diabetes, and cancer for example—are a growing burden on our health care system. Moreover, in little more than a quarter century, they have grown to become the leading cause of death worldwide.

Children as young as five years old are now being diagnosed with Type 2 diabetes, young adults are suffering strokes, and the risk for asthma can begin in the womb. The physical, emotional and human toll is staggering, not just for the affected individuals but for their families, our health systems, and the economy.

A leader in advancing bench-to-bedside-to-community research, McMaster has amassed an enviable corps of outstanding scientists—in genomics, immunology, microbiology, medicine, population health, health policy, and biostatistics—who are characterizing the relationship between disease development and our fundamental biology, genetic make-up, environmental exposures, and social conditions.

Why is one child likely to develop asthma, but not another? Why are some people born with a higher risk of diabetes and heart disease? How does urban living affect our respiratory health? What role do diet, food insecurity, nutrition and exercise play? How do social inequities contribute to the development of chronic disease? How can we change unhealthy behaviours that put people at greater risk? How can we engage with a spectrum of stakeholders from patients to service providers to ensure improved public services for vulnerable and disadvantaged populations? Will higher taxes on cigarettes reduce smoking? How can we do a better job of educating patients, clinicians and policymakers? How can information and communication technologies help patients play a more active role in managing their chronic conditions in a true partnership with their healthcare teams? How can our built and social spaces be designed to be more accessible to all?

Fundamental scientists in our Metabolism and Childhood Obesity Program and Stem Cell and Cancer Research Institute are making great strides in understanding the genesis of diseases, like diabetes and leukemia. Our translational scientists, like those in the Farncombe Institute, have deep experience with first-in-human studies, enabling the movement of promising new discoveries. Hospital-based institutes, like the Firestone Institute for Respiratory Health and the Thrombosis and Atherosclerosis Research Institute, bridge the divide between basic discovery and clinical implementation.

Our guidelines development teams in the Cochrane Centre and the Health Information Research Unit are globally sought for their cutting-edge approaches to finding the evidence that defines best clinical practice. Health policy and community-based researchers in the Escarpment Cancer Research Institute and the McMaster Health Forum work with governments and communities to optimize timely access and delivery of health care. And, the Michael G. DeGroote Institute for Pain Research and Care is developing new strategies for the treatment and prevention of chronic pain.

Among our greatest strengths in the battle against chronic disease, is our ability to conduct population-level studies through the Population Health Research Institute and the Population Genomics Program that provide definitive proof of health outcomes. Our world-leading cohort studies are central to our understanding of the onset, progression and outcome of chronic diseases. Cohorts such as the Canadian Longitudinal Study on Aging, Prospective Urban and Rural Epidemiological Study, and the Canadian Healthy Infant Longitudinal Development birth cohort, provide priceless data to maximize prevention, treatment and management of the most challenging chronic diseases.

Advanced Materials and Manufacturing

Canada's growth engine is under siege, battered by global competition and a decade-long struggle to ramp up productivity.

How do we mobilize our innovation and knowledge transfer to strengthen Canada's automotive, materials and manufacturing sectors? How do we help companies maximize and continue their critical investments in the development of new products, technologies, and skills that manufacturers need to succeed? How, with geopolitical forces that are increasingly protectionist, do we ensure our ability to compete and thrive alongside other industrialized nations? How do we support Canadian exports and keep our economy growing?

Success in today's fast-paced, consumer-driven, global environment requires fresh and ingenious approaches to manufacturing and the development of new materials. It depends on rapid technology transfer through every link of the supply chain from materials selection to product performance.

McMaster has exceptional expertise in materials and manufacturing research, and is leading the way in fields such as nanotechnology, ecohydrology and biomaterials. Indeed, McMaster was the federal government's first choice when it decided to relocate Canada's premier materials laboratory, CANMET-MTL, to McMaster Innovation Park, a hub for transformational research and new start-up companies.

McMaster's Automotive Resource Centre is a state-of-the-art facility where researchers, students and industry professionals work together to address the unique challenges facing the automotive industry, including the design of battery and hybrid drive-train technologies. Through our expertise in the McMaster Manufacturing Research Institute, we have been instrumental in developing a regional supercluster on Advanced Manufacturing for Southwestern Ontario, and play an integral role in a tri-university Advanced Manufacturing Consortium that will increase Ontario's capacity to compete globally in emerging areas such as next-generation additive manufacturing and digital components and devices.

McMaster's physical and intellectual assets—rooted in our fundamental research expertise—in Advanced Materials and Manufacturing and the strong relationships we have developed with government and industry will play a crucial role in strengthening Canada's capacity in this important sector.

Aging Across the Life Span

In Canada, as in many other areas of the world, a dramatic demographic shift is underway. Canadians aged 85 and over are now the fastest-growing segment of the population. This makes the study of aging more important than ever before. At McMaster, more than 100 faculty members and post-graduate students from disciplines as diverse as gerontology, biology, psychology, rehabilitation science, business, and sociology are examining the phenomenon and science of aging from every angle. McMaster is also the headquarters of the Canadian Longitudinal Study on Aging.

What aside from physical health promotes quality of health as we age? What role do our genes play? Does where we live, how many friends we have, or how much we earn make a difference? How can our cities be built and innovative technologies be used to better support the growing population of older adults? What impact does prenatal health or child obesity have on how well we age? How can older adults participate in decision making and management of their health conditions? How can we stave off dementia, improve functioning for those living with multiple chronic conditions, and address the physical, emotional and economic costs of overworked caregivers?

Our researchers are active in interdisciplinary research centres such as the Labarge Optimal Aging Initiative, the Labarge Centre for Mobility in Aging, the Gilbrea Centre for Studies in Aging, the McMaster Institute for Research on Aging, the Offord Centre for Child Studies, the CanChild Centre for Childhood Disability Research, the McMaster Physical Activity Centre of Excellence, the Neurophysiology of Fitness Lab, the Aging, the Community and Health Research Unit, the Metabolism and Childhood Obesity Program, and the McMaster Digital Transformation Research Centre. Together with our hospital partners, they are influencing prenatal and infant health development locally and around the world. They are even designing smart cars for older drivers and smart homes that can alert health professionals to the first signs of Alzheimer's or diabetes, and considering how information and communication technologies can best be designed to support the needs of older adults and improve their quality of life.

By blending scientific expertise and medical advances with social insights, engineering acumen, and appropriate management, McMaster researchers are leading the way with innovative solutions designed to support healthy living for longer, and foster active and healthy populations across the lifespan. In addition, researchers in finance and social sciences are devising new strategies to ensure that financial literacy and savings meet the challenges presented by the longevity revolution.

Data, Artificial Intelligence and the Digital Society

The benefits of 'big data' for our society are vast. We can measure and manage data more precisely than ever before. We can make better predictions and smarter decisions. We can target more-effective interventions shaped by data and rigour. Data are now an integral part of the infrastructure of our society.

But the power of 'big data' and a digital world also comes with challenges. How can we be sure the right data are reaching the right people at the right time? How do we ensure those in remote communities have equal and open access? How do we balance the benefits of new knowledge against the rights and freedoms for individuals to protect their privacy? How do we promote the sharing of data from one discipline to another for maximum impact? How do we ensure that managers are leveraging big data and analytics to practice evidence-based management? How do we provide students, researchers, and practitioners with the skills they need to traverse the big data terrain, now and well into the future? How can artificial intelligence be harnessed in key application areas related to health, manufacturing, and business?

McMaster researchers are working with enormous sets of data to improve research outcomes within and across every discipline. They're scrutinizing individual genomes to revolutionize patient care with tailored treatments and novel therapeutic discoveries. They're creating smart energy meters for homes and assessing energy consumption patterns, mapping changes in our brains, and studying the properties of stars. They're improving vehicle reliability, safety, and fuel economy, redesigning rail safety processes, and working to help banks, retailers, and other companies provide more seamless customer service. They're even attaching GPS sensors to rugby players to study game strategies and training approaches, and exploring data through art, music, and simulations.

Researchers in MacDATA, the McMaster Digital Transformation Research Centre, the Statistics Canada Research Data Centre, and the Public Economics Data Analysis Laboratory, are working to better understand how the digital revolution is impacting individuals and transforming organizations, economies, and society at large. They're engaging with researchers across the institution, as well as with industry, government, and the community, to address these larger issues and strengthen our position as an international leader on all matters related to data and digital transformation.

Fundamental research in areas like computer science, statistics, mathematics, and computational science and engineering, underpins our work. By harnessing our collective knowledge across the campus, we will ensure all the elements are in place to drive a digital path to a more enlightened and prosperous future.

Environment and Energy

The effects of climate change are altering the landscape as we know it. The devastating impact can be seen everywhere—on human health, ecosystems, economies, our natural resources, the ways we live and work, and, ultimately, the future of our planet.

How can we ensure the safety of the water we drink, the food we eat and the air we breathe? How can we preserve the health of our lakes and rivers for future generations? How do we work with Indigenous communities to address issues of water security? How can big cities manage traffic congestion and urban sprawl? Can we lower the cost of environmentally friendly products to make them more widely affordable? How can we change behaviour to make communities and citizens more environmentally responsible? How can businesses stay lean in the face of the pressure to be green? How do financial markets provide the funds to ensure that green strategies are rewarded?

These are just a few of the big questions that researchers at McMaster are tackling as they focus—across sectors and disciplines, and at many levels (villages, communities, cities, and nations)—on innovative solutions to address water crises, environmental change, and develop clean technologies.

We have already made significant strides. We've devised strategies to protect and restore forests and wetlands, and developed new technologies to detect and reverse water contamination. Through our work in photovoltaics, we're turning the sun's rays into electricity and helping Canada develop a solar industry.

Since complex challenges require a multi-faceted approach, our researchers are active in collaborative networks locally, nationally, and globally that bring innovators and policymakers together to forge solutions with real impact. From the Dofasco Centre for Engineering and Public Policy to FloodNet and the Centre for Climate Change, an NSERC Canadian Strategic Network based at McMaster, to the United Nations University Institute for Water, Environment and Health, and the Global Water Futures Program, McMaster researchers are engaged in both the technical and policy aspects of Great Lakes cleanup, flood forecasting and management, and the global water crisis.

Interest in clean energy sources has also led to a resurgence of interest in nuclear power as a means to generate electricity, and in this, we are aided by having the most powerful research reactor at any Canadian university, where our researchers are looking at nuclear safety and radioactive waste management. The reactor also provides isotopes that allow researchers to detect key nutrients in crops—improving agricultural productivity and food security in an era of climate change.

Our unique facilities have opened up an exciting world of opportunities for our environmental researchers and are enabling them to carve out a more optimistic vision for our planet.

Equitable, Prosperous and Sustainable Societies

The 21st century is witnessing a complex array of forces: fast-paced technological innovation, globalization, economic restructuring, social inequality, regional conflicts, and international migrations. This is creating enormous challenges for our political institutions, restructuring economic relationships, generating social upheaval, and posing urgent questions of justice and equity.

How do we foster opportunity, equitable prosperity, and well-being in the context of a globalized economy and technological change that promises to fundamentally alter our basic relationship to ourselves and to others, transform both the content, meaning, and role of work in our lives, and contribute to social and economic inequalities? How do we reconcile security, community, and identity to openness, pluralism, and global justice? How do we respond to those who have become alienated and left behind by social, economic, and cultural change, while shaping a fast-moving world to be more inclusive of all in society? How do we tackle a deteriorating public discourse, rising intolerance, and resurgent extremism and fundamentalism while building civic trust and engagement consistent with our democratic principles, promoting well-informed communication and deliberation, and restoring trust in political institutions?

We stand at a watershed. Understanding the forces at work and crafting effective responses to them requires our best theoretical, empirical, historical, and creative perspectives. Researchers at McMaster are bringing a wide range of disciplinary expertise to bear on these urgent questions.

Within our interdisciplinary Institutes and Centres, researchers are forging innovative approaches that integrate ideas from across the University. Cutting-edge methods are allowing us to exploit the ever-increasing stores of data available to us. Addressing these questions and finding solutions involves engagement with wider society at local, national, and international levels. With resources to draw on such as the Centre for Community-Engaged Narrative Arts, the Institute on Globalization and the Human Condition, and Peace Studies, McMaster is well positioned to play a considerable role in addressing the profound questions facing us in the 21st century.

Indigenous Knowledge and Research

More than a century of colonial policy has resulted in Indigenous communities suffering unequal standards of living in terms of access to clean water, health services, and education compared to that of non-Indigenous Canadians. The Truth and Reconciliation Commission (TRC) describes this policy, with residential schools at its core, as “cultural genocide.” Continual underfunding of education, social and health services, and housing has affected every sphere of Indigenous peoples’ lives. Indigenous women, in particular, have withstood the worst of these impacts. Consequently, the federal government has acknowledged the racialized violence experienced by Indigenous women and recently launched the Inquiry into Missing and Murdered Indigenous Women.

The TRC Report outlines a number of principles and Calls to Action that address the inequities that Indigenous peoples have faced in this country, historically and in the present. Indigenous communities believe that the “truth” requires genuine engagement between Canadian institutions and the Indigenous populations they often underserve before real reconciliation can begin. The TRC describes “reconciliation” as an ongoing process of establishing and maintaining respectful relationships at all levels of Canadian society, and academic research is one primary site where this must occur.

Indigenous ways of knowing are differentiated by unique, sophisticated, and complex systems of knowledge across Indigenous communities within and beyond Canada. As distinctive Indigenous theories and methodologies continue to emerge, Indigenist research is becoming increasingly global, while remaining dependent on localized, community-engaged relationships. Of primary importance is the well-being of Indigenous communities and of research that emerges from cultural knowledge and Indigenous ways of knowing. Indigenous communities’ engagement also plays a primary role in guiding the ethics, parameters, and dissemination of Indigenous-focused research.

How will research questions and objectives be informed by Indigenous communities? In what ways can land-based pedagogies and ways of knowing translate into research within an academic setting? How will academic disciplines within the University be transformed by Indigenous research?

With the establishment of the McMaster Indigenous Research Institute (MIRI) in 2016, Indigenous research at McMaster will build upon its already strong relationships with local Indigenous communities and will be better supported at the development, implementation, and reporting stages. MIRI will also allow for the facilitation of an expanded body of work carried out by research teams that will support the advancement of Indigenous community-driven research in partnership with academic researchers, while working towards a more equitable environment for Indigenous researchers. Furthermore, MIRI will encourage and support research carried out by traditional cultural practitioners in addition to academics. As Indigenous-focused research continues to emerge and re-situate the voice of Indigenous peoples and communities in research questions and outcomes, MIRI will encourage and facilitate Indigenous research both locally and globally.

Understanding and Responding to Infectious Disease

The impact of infectious disease is woven throughout history. Today, infectious diseases are the leading killer of children and adolescents worldwide, and one of the leading causes of death for adults. Globalization, increased drug resistance, and climate changes are compounding the problem. Many of our existing medical practices—routine and elective surgeries, and chemotherapy, for example—will no longer be an option, for fear of infection. Experts predict that by 2050, drug-resistant infections will kill more people than cancer and cost the world \$100 trillion in lost economic output.

How does human behaviour influence the spread of infectious disease and what modelling tools are needed for further investigation? How can we harness new technologies to address the threat of viral, bacterial and other pathogens? How will we combat the global crisis of antimicrobial resistance? What can we do to ensure safe drinking water and adequate sanitation to prevent infectious disease in underdeveloped countries? How do we protect our citizens against the migration of emerging diseases like Zika, ensure the anti-vaccine movement doesn't eradicate the progress we've made, and protect our most vulnerable populations from death due to influenza? What are the related ethical, social, and economic implications and how can our research influence the required public policy decisions?

McMaster is already coming up with some of the answers. Over the past two decades, we have amassed an impressive group of world-class researchers from around the globe—scientists with expertise in the social determination of infection, in new emerging infections, bacterial immunology and the study of bioactive small molecules—who are bridging the divide between basic research and the clinic and community to develop life-altering drugs, vaccines, and prevention strategies to address the most pressing global health challenge of our time.

McMaster's Michael G. DeGroot Institute for Infectious Disease Research has become a magnet for the next generation of infectious disease specialists, fostering groundbreaking research in antibiotic resistance mechanisms, new drug discovery, and innovation in therapeutic alternatives to antibiotics. Researchers within the McMaster Immunology Research Centre are designing universal flu vaccines and running clinical trials on new TB vaccines.

Key to these successes are McMaster's facilities: a world-leading Centre for Microbial Chemical Biology that links pressing medical and biological questions with advanced chemical technology; a High Throughput Screening Lab outfitted with cutting-edge robotics, instrumentation, and research staff; the Robert E. Fitzhenry Vector Facility, a certified Good Manufacturing Practices facility for clinical drug production; and a Biosafety Level 3 lab with dedicated animal facilities and space for current and future projects.

Together, these facilities have positioned McMaster as an internationally recognized centre for excellence and allowed our researchers to develop better science and translate it into new products, changes in clinical practice, and innovative community supports and policies.

Enhancing our Research Enterprise

McMaster is recognized globally for its vibrant research enterprise—an enterprise that extends far beyond our campus boundaries and includes our partner hospitals throughout our region. This recognition is a testament to the quality of our researchers and their unrelenting commitment to excellence.

To ensure we remain competitive, continue to innovate and positively impact the broader community of which we are a part, we need to make strategic investments in support of research and our researchers. To this purpose, we have developed the following enabling strategies:

Quality of Researchers

A heightened international competition for top-ranked faculty and graduate students, combined with a provincial mandate to demonstrate differentiation, has led to a pressing need to hire and retain faculty and graduate students of the highest calibre.

The most important factor affecting the excellence of our research enterprise is the quality of the faculty we hire and retain.

- We will continue to recruit, promote, and retain talent of the highest calibre.
- We will promote the hiring of new faculty into research “clusters” that will best enable us to build research capacity and excellence at the international level.
- We will work to attract and retain the highest caliber of researchers through deployment of Canada Research Chairs and reach the goals described in McMaster’s Canada Research Chair Equity, Diversity, and Inclusion Action Plan.
- We will promote a deeper understanding of the importance of diversity to strengthen our research programs and teams, and develop specific programs that commit to gender equity.
- We will ensure that Indigenous ways of knowing are recognized as valid forms of research.
- We will develop stronger mentoring programs for young researchers to ensure they develop to their fullest potential, to achieve McMaster’s expectation of research excellence, and to build strong, flexible, long-term research programs capable of attracting widespread industry and government funding.
- We will direct more funds to newly tenured professors to encourage the development of new lines of exploration focused on strengthening their research careers through interdisciplinary research teams and larger external grant applications.
- We will create a central pool of funds, to be adjudicated by the Provost and Vice-President, Research, that can be accessed to provide additional research funding and attract truly outstanding researchers with competing offers from other institutions.
- We will provide increased support to faculty members applying for highly-regarded awards, prizes and honours.

- We will work with the School of Graduate Studies to support its efforts to recruit more high quality international students to selected programs through such channels as Mitacs, China Scholarships Council, Erasmus+, and other scholarship programs around the world.

Major Research Platforms

McMaster recognizes that access to research platforms with specialized equipment and technical expertise is essential to advancing basic research and competing on the world's research stage. Across our campus—from department-based laboratories to suites of equipment housed within centres and institutes to state-of-the-art national research facilities—our platforms provide our researchers the cutting-edge methods and tools required to impact their fields of research, and enhance Canada's national research landscape.

Housed within the Brockhouse Institute for Materials Research, the Canadian Centre for Electron Microscopy (CEEM) provides world-class microscopy capabilities, expertise and training to researchers and industry from across Canada. CEEM is living up to its vision: serving as one of the leading electron microscopy facilities in the world for the quality of scientific research, promoting interactions amongst researchers in various fields on an international level.

McMaster serves as the headquarters of the Canadian Research Data Centre Network (CRDCN), recognized and funded as one of Canada's major science initiatives. This network provides a high-performance computing platform to meet national needs on data processing, security, and storage. In partnership with Statistics Canada, the CRDCN provides a vast array of social, economic, and health confidential microdata to universities, governments, and collaborators.

McMaster University also serves as the National Coordinating Center for the Canadian Longitudinal Study on Aging (CLSA). The CLSA is a Canada-wide, long-term study that will follow 50,000 Canadians aged 45 and above for at least 20 years, with the goal of finding ways to help Canadians live long and live well.

The McMaster Nuclear Reactor (MNR) is one of the University's most unique research platforms. Built in 1959, it was the first university reactor in the British Commonwealth, and it remains the most powerful research reactor at a Canadian university.

The MNR supports research across a range of disciplines, from biological and medical research and the production of medical isotopes—one of only two producers of iodine-125, a radioisotope used to treat prostate cancer—to material composition and neutron and gamma scattering. It's where researchers and students study nuclear safety and where the aerospace industry tests for flaws in turbine blades and corrosion of aircraft components. And, it's the core research facility from which two new Canadian biotech start-ups were born.

MNR is a central feature of Canada's scientific landscape. With the closure of the National Research Universal (NRU) reactor at Chalk River Laboratories—Canada's primary facility for neutron-based research—MNR will be the country's sole nuclear research facility above low

thermal power. Plans are underway to increase the MNR's capacity in order to support research programs that will be lost with the closure of the NRU.

Research platforms allow us to make paradigm-shifting discoveries but, regardless of whether they are housed within a department, faculty, or serve as Canada-wide centres, they come with significant capital and operating costs.

- We will develop a university-wide approach to manage and support research platforms in a sustainable fashion.
- We will develop an inventory of all major research equipment and its use and strategically consolidate infrastructure and associated expertise to ensure maximum use of resources and appropriate planning for renewal.
- We will connect researchers with professional writers, paid external reviewers, and others who can assist in the development of high-quality grant applications for major infrastructure.
- We will work with business officers and the Office of the Vice-President, Administration, to calculate, for each major platform, the true total operating costs, projected use, and sources of funding to ensure sustainable business models.
- We will enhance the core services offered by the Research and High-Performance Computing Support group to better support the burgeoning use of research and advanced computing by developing a more cohesive and comprehensive digital research strategy that is aligned, across the institution, across the province, and across the country.

Research Institutes and Centres

High-quality research often stretches well beyond administrative boundaries to include research institutes, centres, and groups that encourage and support interdisciplinary research. These institutes are key to attracting the best and brightest talent to McMaster and supporting research at the highest level.

- We will facilitate Research Groups, Centres and Institutes in maintaining a high level of excellence through development of supportive policies and guidelines for their development, operation, and review.
- We will evaluate the effectiveness of some interdisciplinary institutes reporting to the Vice-President, Research, versus reporting to a coalition of Deans.
- We will investigate, in partnership with faculties, the School of Graduate Studies, and relevant international partners, opportunities for interdisciplinary graduate programs related to research institutes.
- We will consider the creation of a fund to attract renowned visiting researchers to Institutes and Centres for terms of 1-2 years.

Knowledge Transfer and Commercialization

McMaster Innovation Park is a critical asset to the University's research efforts. We need to ensure that its mandate aligns with and leverages our overall strengths, furthers economic and social development, and increases experiential learning opportunities for our students.

- We will develop space specifically designed for the development and launch of spin-off companies, and setup a process and committee for allocating space on the strength of the potential for commercial success and opportunities for diverse teams of researchers.
- We will develop space for more established firms that relate directly to the University's research priorities and whose presence will aid the development of spin-offs and further interest in research at the university.
- We will develop specific programs that commit to equity and diversity in entrepreneurship to foster fresh ideas and perspectives that will lead to business success.
- We will ensure that knowledge transfer activities and impacts (e.g., commercialization or public policy improvements) are fully recognized and rewarded in tenure, promotion and annual performance reviews.
- We will establish a network of successful entrepreneurs to facilitate faculty members' efforts to commercialize their research.
- We will better support effective knowledge and technology transfer between our researchers and their industry, government and community partners.
- As part of our commitment to the long-term sustainability of innovation at McMaster, we will continue to promote an understanding of the critical importance of foundational research to knowledge transfer, commercialization, and development of public policies.

Major Research Applications

Applications for large, complex, and interdisciplinary projects demand a significant commitment of time and energy. Additionally, such projects often require administrative support in their application preparation. We are committed to assisting our researchers produce innovative, comprehensive, and competitive applications.

- We will initiate a competitive fund to support major grant applications, particularly for those which demand more time and effort than traditional Tri-Council applications.
- We will continue to provide competitive internal funding for interdisciplinary research programs that are designed to lead to much larger, externally funded programs.
- We will develop robust mentoring programs to assist all faculty seeking partners; with heightened mentoring opportunities for SSHRC-based partnership programs.
- We will develop a stronger, more competitive, internal review process designed to maximize the success of researcher applications to major granting programs and funding competitions that place a limit on the dollar amount and/or number of applications the university can submit.
- We will ensure that all researchers and all Faculties have access to these initiatives.

Outreach, Communication and Partnerships

McMaster recognizes the importance of communication and outreach activities related to our research programs. Indeed, some Tri-Agency programs now require that a certain proportion of allocated funding be dedicated to such work. Our efforts to improve our activities in this area will be directed to increasing collaboration and cooperation across the University, as well as with external partners.

- We will strengthen relationships between the Office of the Vice-President, Research, Associate Deans of Research, and Research Facilitators.
- We will build synergies between the Office of the Vice-President, Research, the Faculties, the Office of Graduate Studies, and the Community Engagement Office to capitalize on knowledge mobilization efforts and outreach opportunities—through both faculty and graduate student opportunities.
- The Office of the Vice-President, Research, will leverage opportunities with the Office of University Advancement to ensure our success stories are told and to help attract research support.
- We will work to increase our level of partnership with Hamilton Health Sciences and St. Joseph's Health Care and focus cross-institutional research teams on some of the major concerns affecting the health of Canadians and people around the world.
- We will work to strengthen existing university partnerships with our sister institutions (e.g., the Advanced Manufacturing Consortium with the University of Waterloo and Western University) and build relationships with other potential partners (e.g., University of Guelph and University of Toronto), in an effort to support large, complex research programs and make effective use of research infrastructure.
- The Office of the Vice-President, Research, will work with the Office of International Affairs to build on existing, and identify potential, global research partnerships.

Measuring for Success

It is critically important that we monitor our progress as we work to build on our world-leading research enterprise. Resting on our laurels is not an option if we are to retain—indeed, increase—our status in the global rankings. Simply put, we need to be at the top of our game. Ensuring that we perform at our best will require effective and reliable methods by which we can measure ourselves against against our peers.

We will develop a series of metrics to allow us to extract relevant and useful data about our research progress, compare ourselves to peer institutions, and evaluate the results of our efforts by department, faculty, and at an institutional level. For some research areas, these metrics will include information on citation rates, external funding, and research awards. However, such metrics do not necessarily provide an accurate representation of research excellence in other areas and McMaster recognizes that some areas of research are difficult to evaluate in quantitative terms. This is particularly so in cases where the impact of the research is felt most strongly in communities, related policy changes, and works of art.

One approach to monitoring progress that cuts across all areas of research is a system of self studies and regular external reviews. By periodically requiring a self study, the directors of institutes and centres, chairs of departments, and deans of Faculties will need to evaluate the research programs within their own area of study and have their studies reviewed by external, high quality reviewers, who have a strong sense of the relevant disciplines around the world.

The Provost and Vice-President, Research, will review each Faculty's progress on a regular basis and, where warranted, approach deans for plans on how they will work to improve their Faculty's research programs.

Conclusion

Research for a Brighter World — Strategic Plan for Research 2018-2023 confirms the University's commitment to all research pursuits across the disciplines and identifies opportunities to enhance our research stature.

Building on our individual strengths and interdisciplinary capacity, it outlines our commitment to a broad range of research approaches and methodologies, and our responsibility to place our knowledge in the hands of those who can put it to its best use, through knowledge mobilization and translation, technology transfer, and commercialization.

It is intended to nurture our culture of collaboration with our hospital, government, and industry partners; advance our dynamic research enterprise; and guide our development of key, strategic research initiatives of local, national, and global importance, to further advance human and societal health and well-being.