

Faculty of Science Strategic Research Plan

The Faculty of Science is McMaster University's largest faculty, with approximately 220 faculty members and over 6,500 graduate and undergraduate students enrolled across 12 departments, schools and programs. In addition, 120 staff members are supported through operating funds and approximately 1,500 additional staff are supported by all of our funding sources.

Research is at the forefront of the Faculty's activities. Our people strengthen McMaster's reputation as one of Canada's top research universities. We are among the best in innovation, creativity and excellence in education, research and scholarship. The Faculty is home to several internationally recognized research institutes and centres. Annually, our faculty garner over \$35 million dollars in research funding. The Faculty contributes over \$1.25 million to research activities through operating funds.

The research landscape on university campuses today is evolving as the funding climate becomes more challenging. We must respond to these challenges while constantly pursuing excellence in scientific research, both basic and applied. Over the next five years, the life of the present plan, we view cross-departmental and cross-Faculty research initiatives as a necessity, we see industry partnership in research as a significant opportunity for growth, and we acknowledge that the fruits of our research must contribute to society in ways that extend beyond the pursuit of basic knowledge. This contribution may be through teaching the next generation of researchers, enhancing the student experience or public education.

To thrive in the present demanding environment, it is imperative that we have a focused plan. In consultation with department chairs, directors and the Science Research Advisory Group, we have developed a Strategic Research Plan for the Faculty of Science, the Science SRP. The goal is to streamline the research enterprise while supporting key areas of growth in the Faculty. Our plan builds on our strengths and identifies emerging areas of research where we need to encourage intensity and expertise. To do this successfully during economically challenging times we must focus our efforts and our resources to support leading edge research, both fundamental and applied, while managing expenditures prudently.

Context

Several guiding principles were adopted while drafting the Science SRP. It was agreed that the SRP should acknowledge the current challenges in academic research, build on our research strengths and seek to encompass all departments and faculty members. An overarching goal of this SRP is the pursuit of excellence. This is a central guiding principle in the creation of this plan and will be a guiding principle in the execution of the SRP. The following guidelines were adopted in drafting the Science SRP.

- **The Science SRP is inclusive to encourage maximum faculty engagement.** Expertise in the Faculty of Science spans a broad landscape from the basic (e.g., differential equations, cosmology, molecular biology) through to the applied (e.g., creating bio-sensing applications to measure water quality, drug design and development of better batteries). Our strategic research plan must reflect this diversity, and we must continue to invest in historical areas of strength, while identifying emerging areas in which to create new research intensity.

- **The Science SRP must support the creation of new, fundamental knowledge.** We must not neglect critical areas of basic science. On the contrary, these areas of research should be supported and nurtured so as to maintain and strengthen the very foundation of our Faculty. “Science” by nature is basic. Discoveries do not always immediately contribute to new inventions or products; however, new inventions and projects are always built upon discovery in basic science. Addressing fundamental questions allows us to explore and better understand our physical and living environment, our humanity and our society.
- **The Faculty and its SRP must recognize external influences.** Today, there is unprecedented pressure from governments and granting agencies to link research activities to economic development, commercialization, and direct impact on quality of life. This emphasis is seen as an important and critical way to spend public dollars wisely. The Faculty agrees with this intention; however, the reality is that many areas of research are not amenable to immediate commercialization or will not have an immediate impact on economic development, public policy or health. The SRP will look for opportunities to maximize the translation of research findings into impact for the benefit of society, while supporting fundamental science. The two aims are not mutually exclusive.
- **The Science SRP must allow the Faculty to respond rapidly to strategic calls for funding.** In today’s research funding climate, calls for applications are increasingly linked to the strategic priorities of current federal and provincial governments. The result is that fewer resources available for operating applications and more resources are allocated to strategic calls. It is absolutely critical that we develop a plan that allows us to compete successfully when targeted calls are announced.

Faculty of Science Areas of Focus

Over the next five years the Faculty of Science will continue to strengthen its established areas of excellence while stimulating growth in emerging areas. Our identified four research priorities are broad and inclusive, and will serve as umbrella structures for specific research initiatives. These Areas of Focus are intended to cut across departments and research disciplines, embodying the Faculty’s tradition of interdisciplinary research. We have a long history of successful collaborative work, as evidenced by the number of institutes and centres hosted by the Faculty of Science that bring together faculty members from Science and across campus to address novel research questions.

Identifying our priorities will allow us to focus efforts and grow over the next five years. *New* programs and initiatives will be tied to our identified areas of focus. We see this effort as the cornerstone of our goal to nurture successful research programs.

The four Areas of Focus are not ranked in order of importance. All areas are equally critical to the Faculty’s efforts to achieve scientific excellence; however, ***Fundamental Exploration*** is the first priority area presented to show its critical role as a foundation to all science. Nor are any of the areas intended to define firm boundaries since the answers to research questions are often found beyond fixed and defined limits. After each Area of Focus we highlight one illustration of the pioneering and creative work undertaken by our faculty members. These illustrations are examples that embody our aims to encourage cross-departmental and cross-Faculty research initiatives, to fully develop the potential of

industry partnerships where appropriate, to nurture fundamental research, and to ensure the results of research contribute to bettering society.

Fundamental Exploration

Fundamental research is the foundation of the research enterprise in the Faculty of Science. It is where the development of theory, experiment and advanced computation provides the raw materials to create a better understanding of ourselves and the world – past, present and future – around us. Fundamental research is also the source of insight that often leads to new technologies and methodologies that will change our world, similar to the ways that computers, wireless networks, the internet and greater knowledge of cell biology – all products of basic, curiosity-driven research – have transformed our lives today. To feed and nurture open scientific discovery and innovation, we need to protect and preserve basic and fundamental research. By supporting the focus area of ***Fundamental Exploration***, the Faculty will work to strengthen these efforts.

Spotlight on Fundamental Exploration

McMaster is home to many researchers whose goal is the understanding of the very nature of the universe and life and the big questions of 21st century science. These researchers are working together to explore the origins of space-time, the chemical elements, the structure of the cosmos, species and biodiversity, and the origins of humanity among other important, related questions. Coming from fields as diverse as mathematics, astrophysics, computational science, molecular biology and evolutionary psychology, among others, these researchers are creating new knowledge about our world, and original approaches to open new frontiers in basic science.

Biological Systems and Health

The Faculty of Science is home to many faculty members whose work has an impact on human health. “Human health” in this context is defined in the broadest of terms as any research question with the potential to impact human health and quality of life. This work ranges from research into creating greater understanding of basic biological function to developing medical probes and better diagnostic tests to treat and follow disease; from the studying the effects of music, culture and society on the brain and body to data driven exploration of issues in urban planning. Moreover, the basic adaptive response of a cell or organism to its environment or other stimuli may have an impact on human health. Under the priority area of ***Biological Systems and Health***, this pioneering work will continue to be supported and innovative collaborative work that cuts across traditional perspectives will be encouraged.

Spotlight on Biological Systems and Health

McMaster has unique facilities and instrumentation, and substantial expertise to make significant breakthroughs in advanced biotechnology. Working with colleagues in the Faculty of Engineering and private sector, our researchers are finding ways to transform the way we look at health through new applications to improve medical implants and detect disease. Researchers are exploring the interface of biological and synthetic materials to develop the next generation of medical devices and implants, such as contact lenses, breast implants and hearing aids, and developing tests to detect bacterial contamination.

Environmental Science

Environmental research can be defined as research aimed at understanding, restoring or maintaining the environment. Within the Faculty of Science, environmental research efforts extend beyond this simple definition to encompass modeling and predicting changes in the environment, and understanding our impact on the environment and conversely the impact of the environment on humans and other species. Under the focus area of ***Environmental Science*** we will strive to study our changing environments using data-driven approaches and to create better understanding of the impact of those changes.

Spotlight on Environmental Science

Climate change research has long been a Faculty strength, as evidenced by interdisciplinary and interdepartmental collaborations within the Faculty. Understanding how our environment is changing, the impact that this will have on society today and in the future, and ways to mitigate the effects of change, are of paramount importance, and need to be driven by empirical evidence. At McMaster, scientists are examining how multiple stressors, such as heat, humidity and pollution, combine to affect people and other organisms. Other researchers are mapping change as humans move into cities and demand for limited resources such as oil and minerals increases. By better understanding these and other dynamics, we will be better placed to mitigate changes in our world.

Materials Discovery and Characterization

McMaster has a rich history of exploring the fundamental structure of new and existing materials. Our researchers are internationally known for innovations in this area. McMaster Nobel prize winner, Bertram Brockhouse, led the way with breakthroughs in neutron scattering techniques. At the world renowned Brockhouse Institute for Materials Research, over 40 members of the Faculty of Science continue to expand the science of material synthesis and characterization. ***Materials Discovery and Characterization*** is essential to expanding our understanding of the behaviour of new materials and the development of new products that can transform the way we live.

Spotlight on Materials Discovery and Characterization

Our faculty use McMaster's unique resources such as the McMaster Nuclear Reactor and the Tandem Accelerator to explore material structure at the smallest scale to understand the properties of materials. Studying solid-state materials, and their physical, chemical, electronic, electrochemical and magnetic properties, is at the heart of several research programs within the Faculty. Investigation of such materials and their performance for alternative energy devices, such as thermoelectrics, lithium ion batteries and fuel cells, are providing critical insight to the development of such devices for tomorrow's society.