

SCIENCE

SCIENCE

Science is the foundation for discovery, the opportunity to consider life's big questions, and the catalyst for inventions that will shape the future of humanity.

THIS IS WESTERN SCIENCE.

Introduction

Western Science was established more than a century ago, one of three foundational areas of research and training at Western, to begin building institutional research capacity and thereby contribute concretely and significantly to the research-intensive profile, a profile that Western University enjoys today.

Western Science's mission is to be a cornerstone of society's development through the education of students, the creation and dissemination of knowledge, and the establishment of innovative partnerships with industry, government and other educational institutions in the global community.

In our continued drive toward operational efficiency, increased research intensity and interdisciplinarity, as approved by our Faculty Council in the spring of 2013, Western Science has amalgamated our signature research assets into three focus areas:

1. Sustainability and the Environment
2. The Science of Information
3. Materials and Biomaterials

Focusing on these areas forms the basis of a new organizational strategy that will underpin our ability to meet our priorities and, more globally, the university's strategic objectives.



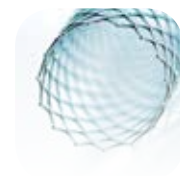
Sustainability and the Environment

7



The Science of Information

13



Materials and Biomaterials

21

WESTERN SCIENCE SIGNATURE RESEARCH

Actuarial & Computational Sciences

Environmental Science & Ecology

Financial Mathematics

Functional Genomics & Evolution

Materials & Biomaterials

Planetary Science

Resource Geoscience

Re-Energizing Western Science: Passion, Purpose and Priorities

Elevating the productivity, impact and profile of Western Science through the purposeful design and nurturing of a team environment and the removal of barriers to interdisciplinary research are critical to our success in an evolving global research and training paradigm.

To be considered on the international plane, Western Science will continue to develop a distinctive environment comprised of 21st century research facilities designed to serve interdisciplinary and advanced research needs; an array of tools to address complex and multi-faceted questions; and people who seek opportunities to transcend disciplinary, institutional and national boundaries to innovate in both the research and training arenas. Such an environment is key to positioning Western as a destination of choice for outstanding faculty, graduate and undergraduate students.

The Faculty will continue to align the Western Science community so that faculty members consider Western as an institution where they can achieve their aspirations while contributing to the strategic objectives of the University. Faculty members will be encouraged to bring their unique brand of creativity and energy to bear, individually and in multidisciplinary cadres, and will be acknowledged and encouraged, both morally and financially, for achieving their goals and furthering those of the Faculty and the institution. This environment will allow us to attract and retain both outstanding researchers and students.

Our success is the direct result of the innovative, and in some cases unique, facilities, expert teaching methods, and experiential learning opportunities offered.

Continuing a Tradition of Excellence

Western Science is currently home to more than 5,000 students. According to the Globe and Mail Canadian University Report 2013, Western achieved “Top-of-Class” results in the areas of student satisfaction; student-faculty interaction; quality of teaching and learning; career preparation; and in reputation with employers. This success is the direct result of the innovative, and in some cases unique, facilities, expert teaching methods, and experiential learning opportunities offered at the graduate and undergraduate levels.

Maintaining such a stellar performance will rely on the continued distinction of our instructors and academic counsellors, eight of whom have been recognized for their excellence in teaching since 2010. Novel programs, embracing inter- and multidisciplinary knowledge and skill development through applied learning methods in laboratories and in the field, and the advanced use of digital technologies to facilitate and expedite online learning, will continue to position Western Science as the venue of choice for 21st century domestic and international students.

In addition, strengthening our relationships with agencies and industry will build robust linkages and result in immersive learning opportunities, internships and extended potential for professional accreditation. An extraordinary academic environment coupled with strong external partnerships will confer a distinct advantage as we redouble our efforts to attract outstanding candidates for admission.

Strengthening our relationships with agencies and industry will build robust linkages and result in immersive learning opportunities, internships and extended potential for professional accreditation.

INDUSTRY AND AGENCY LINKAGES

Agriculture Canada
Environment Canada
Ministry of Transport of Ontario
A & L Biologicals
Aon Hewitt
Autodata Solutions
BASF
Big Blue Bubble
Chemtura
Glaxo Smith Kline
Hydro One
Ingredian
Labatt
London Life
3M
Manulife
OPG
Parmalat
Phoenix Interactive
Photon Technology Inc

› 47% of all Western-MITACS industry internships, with a potential value of 1.2 million over five years, have been awarded to Western Science graduate students.

Graduate enrollment has increased substantially since 2011, in particular at the MSc level, placing Western Science among the forefront of faculties addressing student recruitment. The recruitment of doctoral and domestic candidates remains a challenge and will be a focus of faculty effort and investment.

The funding model for post-secondary education in Canada has changed substantially in this decade. Establishing greater financial independence through the diversification of income sources is a significant priority for Western Science. Proactive measures, undertaken with the collaboration and dedication of outstanding faculty, will be key to ensuring continued excellence in research, recruitment and training in a dynamic political and economic environment.

About This Document

The following document details Western Science's vision, strengths and proactive plans. It is the result of an extensive reporting and consultative process within our Faculty as well as externally with key stakeholders from the broader university, government and industry partners, and the local community. The descriptions of our focus areas are provided as well as priorities, and mechanisms for achieving them, in the areas of research, undergraduate education and graduate training. The resulting objectives and measurement benchmarks respond to the aspirations of our Faculty while moving in synergy with the directions charted by the University.

SUSTAINABILITY AND THE ENVIRONMENT

Research in the **Sustainability and the Environment** focus area examines the biotic and abiotic processes that occur within the biosphere, geosphere and atmosphere. These environmental systems are inherently complex, constantly evolving and subject to influence from climate change. Environmental sustainability in our interconnected world is considered by many to be this century's greatest challenge.

Understanding environmental systems requires integrated scientific knowledge gained from physical and virtual simulation. In the past decade, Western Science has built research infrastructure at a scale unparalleled at other Canadian Universities. Facilities offer state-of-the-art analyses of geosphere and atmosphere processes (past and present) and their subsequent affect on the biosphere and human infrastructure, as well as the ability to simulate different environments.

World-class facilities include the Advanced Facility for Avian Research and the Biotron Facility for Experimental Climate Change Research. In combination with a wide range of related research infrastructure including Environmental Sciences Western Field Station, Purple Crow LiDAR, Centre for Planetary Science and Exploration, Surface Science Western, Laboratory for Stable Isotope Science, SHARCNET, and SOSCIP, faculty at Western Science are positioned to answer humanity's critical questions about sustainability and the environment.

Environmental sustainability in our interconnected world is considered by many to be this century's greatest challenge



Research Strengths

Adaptation and Resilience

The Earth is an evolving dynamic system, and the study of past environments provides valuable insight into the dynamics of current environmental systems. Research at Western is addressing the impact of climate change on agriculture, ecosystems and the atmosphere. Past and future effects of climate and environmental change on the biosphere, at all temporal and spatial scales, are of central importance to understanding environmental processes. Within this spectrum, understanding the adaptation of plants and animals to changing environmental conditions is critical.

KEYWORDS:

stress response • conservation biodiversity • ecosystem services

Extreme Environments

Western Science has the capability to study the entire atmospheric and solid earth system, from its shallow interior to the surface, and out to the edge of the magnetosphere. We can also perform comparative studies of other planetary atmospheres and their interaction with their parent star (or stars). Many of these environments are seemingly uninhabitable, though they represent possible future climate scenarios and provide vital information on the nature and development of life itself.

Faculty are engaged in research that aims to understand how extreme environments such as the Arctic actually function, as well as how biotic organisms function within them.

KEYWORDS:

biogeoscience • space science • astrobiology • atmospheric science • thermal biology

Natural Hazards

Hurricanes, earthquakes, floods, fires, droughts and landslides often result in catastrophic impacts to humans, plants and animals, as well as landscapes, ecosystems and world economies. Natural hazards like these are increasing as a result of urbanization near vulnerable areas, climate change, and infrastructure vulnerabilities.

Researchers at Western are conducting ground-breaking studies into earthquake fault dynamics, seismic hazards, volcanic processes, man-made hazards and risk analysis. Ultimately, our research seeks to reduce losses to property or habitat due to natural phenomena, including extraterrestrial impacts and space weather that increasingly define our changing environment.

KEYWORDS:

risk management • water and water remediation • remote sensing space weather ecosystem services • mineral and water resources • biodiversity and conservation

Sustainable Exploration

The global demand for minerals, metals and fossil fuel continues to grow. Canada is rich in natural resources and mineral exploration is a pillar of our economy, contributing over \$30 billion annually to the GDP.

Exploration for new resources is increasingly taking place in some of the most remote and fragile places on Earth, from the Arctic to deep ocean basins. This requires new methodologies and tools as well as new environmental and social management practices for planning, design and implementation of exploration and development activities. Western Science is providing important insights into sustainable exploration through research into sustainable mining practices, characterization of minerals and petroleum deposits, the process and safety of hydraulic fracturing operations, and groundwater contamination and mitigation.

KEYWORDS:

robotics • remediation • remote sensing and GIS • mineral deposits biogeoscience • resource geoscience • hydrocarbons

Cross-fertilization: The Potential for Interdisciplinary Research

Research into Sustainability and the Environment is deeply embedded in the Faculty of Science and extends far beyond, into many departments and faculties University-wide, including:

- **Ivey School of Business, Engineering** – energy and sustainability
- **Social Sciences** – urban development, policy, and economics of the environment
- **Schulich School of Medicine & Dentistry, Health Sciences** – healthy cities, healthy societies, including public health, clean water, doctors without borders, disease control, and food safety
- **Law** – environmental law, sustainable mining
- **Arts & Humanities, Education** – philosophy of resource development, perception and value of the environment, teaching and communication about the environment

Only through this broader collaboration can we take the focus on Sustainability and the Environment to an international level of competitiveness. We believe that by bringing multiple disciplines together, Western can be a world leader in providing informed, innovative solutions to current and future challenges facing humanity.



The **BIG** Questions

How do we feed a growing population in the face of climate change impacts on agricultural lands?

What are the impacts of global climate change on ecosystems and ecosystem services?

What are the effects of global climate change on all levels of the atmosphere including its impact on the coupling mechanisms between the different atmospheric layers?

How do we keep natural disasters from becoming catastrophes?

How do we provide the natural resources that fuel growth and prosperity for Canada's future, while preserving our value and condition of our natural environment?



THE SCIENCE OF INFORMATION

The world is increasingly driven by information – information about objects, events, processes, people, organizations, and the environment. Information is essential in addressing the many enormous challenges facing humanity. Central to the **Science of Information** is the very concept of information, how to define it and how to describe the nature of information. The Science of Information also deals with the acquisition, processing and delivery of information within specific contexts in order to understand and address complex problems. Fundamental to this is a sophisticated array of mathematical, statistical and computational theories and methods.

The Science of Information theme builds on the excellence in the mathematical, statistical and computer sciences at Western and naturally complements other research themes in Science, as well as many other areas of excellence at Western: Medicine, Social Sciences, Humanities, Health Sciences, Information and Media Studies, Business and Law.

Fundamental mathematical, statistical and computational perspectives from abstract to concrete are the foundation of this theme. Novel approaches to solving problems in these areas will open opportunities for productive collaborations with data-heavy research science within the Faculty as well as with researchers in other faculties across the University. These collaborations will, in turn, generate new problems that require the invention of novel acquisition, processing and delivery methods.

Strong foundations and collaborative teams are facilitating game-changing insights into society



Research Strengths

Financial Management and Risk Modelling

Western Science has made significant contributions to creating a safe financial system for the benefit of all Canadians. Our faculty trained more than 50 of the quantitative risk managers responsible for maintaining an oasis of relative calm on Bay Street during the 2008 financial crisis. Financial Mathematics researchers work closely with the Bank of Canada and the Office of the Superintendent of Financial Institutions to understand the characteristics of systemic risk in the world reinsurance market. They are also working closely with the Bank of Canada to develop contingent capital securities and eliminate potentially expensive bank bailouts.

Western researchers are using big data analytics to improve consumer banking and insurance systems as well. Research teams are using classifier theories – algorithms that identify characteristics of borrowers who will likely repay a loan, and those who will not – to help Canada’s banks manage their loan portfolios.

Canadians rely on insurance to guard them against the financial consequences of accident, disaster, and death, and to help secure their comfortable retirement. Creating a stable and trusted system is key. Western Science actuaries are studying huge amounts of data and creating solutions to keep insurance companies solvent in the face of new challenges.

KEYWORDS:

catastrophe modelling • credit risk analysis • energy finance
option pricing • risk management • health and mortality modelling
insurance claims and surplus modelling

Cyber-Physical Infrastructure and Analytics

Information theory views information from an abstract perspective and addresses questions about the nature of information. Acquisition of information is a key element in many disciplines; questions of what data to gather and how to gather them is often discipline-specific. Within this theme, there are key research questions around data acquisition: creation and use of novel devices, the process of collection, and the efficient use of emerging computing techniques. Where data acquisition is expensive, research questions address design efficiency in order to maximize the collection of relevant information.

Processing focuses on methods for solving families of problems. This includes the development of new mathematical and statistical techniques for visualizing, summarizing and analyzing data, extracting relationships and exposing patterns, and generally providing mathematical or probabilistic models of observed phenomena based on data collected. Processing also includes development of new algorithms embodying these methods. The set of delivery activities include research into the issues surrounding the delivery of the results of information analyses to humans in such a way as to facilitate correct interpretation, insight and action.

This focus area relies on deep analysis to extract insights from the masses of data generated every day; the expertise to create equation-based models of reality that reveal insightful real-world solutions; and the algorithmic and computational techniques required to solve these difficult equations.

KEYWORDS:

data set management • geographically dispersed data sets • sampling

Environmetrics

Researchers at Western are using information science to tackle critical environmental and sustainability challenges facing our evolving planet.

Forest fires represent a danger to remote communities, a scourge to homes, and a major cost to Canada's economy. Our researchers, along with provincial government agencies, are using advanced techniques such as statistical analysis of spatial data and mathematical modelling to develop sophisticated protocols to fight this primeval danger.

Research at Western Science is improving Canada's ability to use renewable energy sources despite their variable nature. Advanced mathematical modelling allows us to create detailed algorithms for market-based solutions for industry and regulators alike that encourage the proliferation of green energy.

KEYWORDS:

fundamentals • bioinformatics • medical imaging • health informatics
data mining • exploratory data analysis • computer vision • image analysis

High Performance Computing

Western Science is focused on discovering innovative new approaches to computing. As the headquarters of the SHARCNET computing infrastructure, we have developed considerable expertise in parallel programming, distributed systems and in autonomic systems. Western mathematical and computer scientists are world leaders in computer algebra. Our high performance researchers develop novel algorithms for the efficient uses of high performance computing grids, and efficient parallel algorithms for the analysis of multiple, large multi-modal data sets.

KEYWORDS:

fundamentals • bioinformatics • medical imaging • health informatics
data mining • exploratory data analysis • computer vision • image analysis

Health Informatics and Operations Research

From antibiotic resistance and hospital wait times, to unleashing the full power of the genome, Western Science is using data analysis, visualization and bioinformatics to improve the health and wellness of Canadians and the world.

Antibiotics are the wonder drug of the 20th century. In recent years, however, many strains of antibiotic-resistant disease have begun to evolve. Western researchers are developing mathematical models of evolution that show great potential to reduce risk.

Canada's health care system is the envy of the world but many patients face significant delays for treatment. Western Science is using queuing theory to develop models that are helping hospitals improve wait times for beds and procedures.

Embodied in DNA, the genetic code provides a blueprint for all life. Western Science is using bioinformatics to mine DNA for ways to improve medical treatments and develop better crops.

The human brain may be, in part, understood as a biological computing engine. Innovative work done by Western computer scientists in the area of computational methods for brain imaging is creating profound and usable insights into neuroscience research.

KEYWORDS:

fundamentals • bioinformatics • medical imaging • health informatics
data mining • exploratory data analysis • computer vision • image analysis

Cross-fertilization: The Potential for Interdisciplinary Research

Mathematical biology, risk analysis, visualization, statistical modelling and analytics and computing each form a core foundation for the systems approach to understanding environmental processes such as natural disasters, water availability and bird migration.

Energy finance and risk analysis form a foundation for the Ivey Centre on Policy and more broadly for financial risk management in both the Ivey School of Business and Law.

Operations research and health informatics are key areas connecting with the Schulich School of Medicine & Dentistry while theoretical physics bridges the Materials and Biomaterials theme with a particular focus on advanced materials modelling.

In the areas of cyber-physical systems that include sensors and the ability to remotely control physical devices, connections lie with the Faculty of Engineering and focus on urban infrastructure, the Schulich School of Medicine & Dentistry in e-health and the Environment and Sustainability theme with a focus on environmental monitoring.

Analytics and the related areas of computer vision, machine learning, natural language processing and cyber security bridge the Faculties of Engineering, Medicine and Dentistry, Digital Humanities, FIMS and Social Sciences, and importantly, Western's Brain and Mind Institute and the Cognitive Neuroscience cluster.

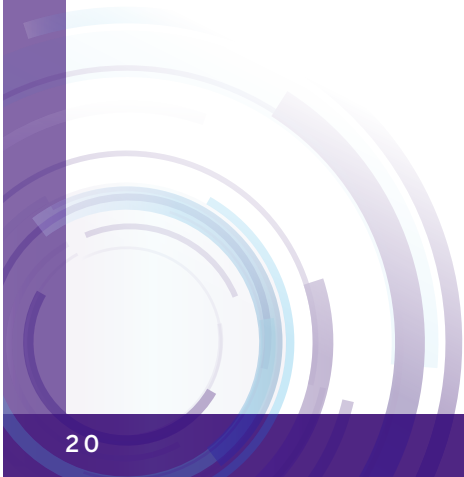
The **BIG** Questions

How can big data analytics, modelling, computation and simulation complement and enhance experimentation in Science to understand issues ranging from galaxy formation, antibiotic resistance, the financial management of loan portfolios, and the secrets of the genome and its impact in medicine and agriculture, to the relationship of brain regions and its impact on cognition?

How do we successfully incorporate analytics in decision-making and management processes to address diverse issues such as wait times in critical health care systems or best strategies for attacking and controlling large forest fires?

What are the critical applications and processes required to achieve the desired levels of system security in financial management and national security while maintaining efficient information flow?

What smart computing platforms will provide an economic edge for industries and services in Ontario and across Canada?

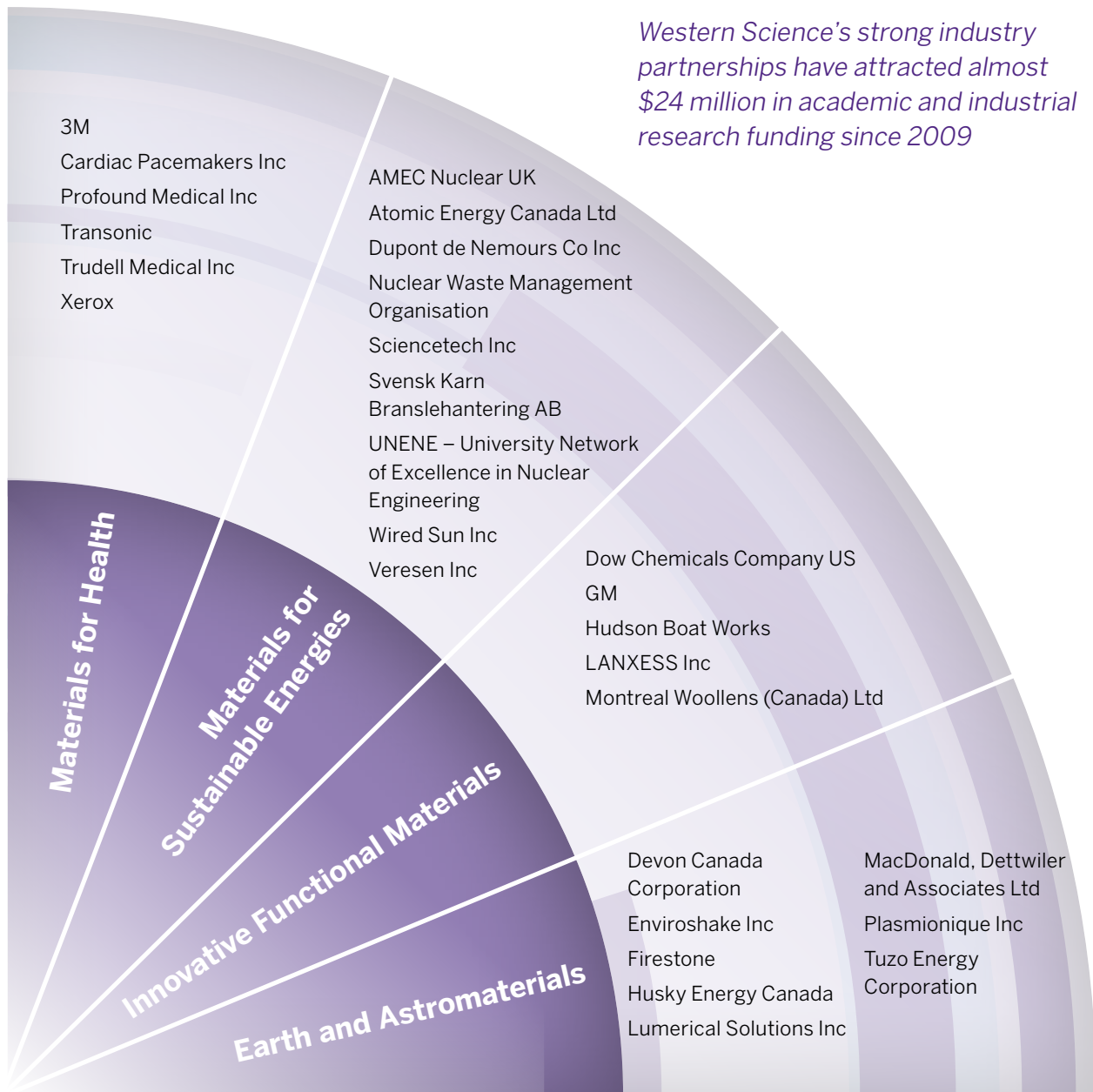


MATERIALS AND BIOMATERIALS

Materials and Biomaterials research is deeply embedded in the Faculty of Science. From many threads, a strong, interwoven network of bio/materials research has emerged, consistent with the nature of a discipline which has always crossed departmental and Faculty boundaries. Importantly, industrial connections abound in materials and biomaterials research at Western Science.

Industrial Collaborations

Western Science's strong industry partnerships have attracted almost \$24 million in academic and industrial research funding since 2009



Research Strengths

Materials for Health

Western Science researchers are advancing new materials with targeted properties for specific biomedical applications particularly in medical imaging, tissue regeneration, biomineralization and drug delivery. These include how, for example, tailored, bio-compatible polymers can be assembled into nanometer-sized containers within the body, to serve as new scaffolds for biological ligands and thereby provide new therapeutics or materials for tissue engineering. Researchers in Science are developing new molecular magnetic resonance imaging (MRI) contrast agents with improved imaging characteristics under physiological conditions, and are leading the way in understanding the intricacies of the biomolecular self assembly of proteins and their interactions with pharmaceuticals.

KEYWORDS:

medical imaging materials • protein folding and dynamics • biomineralization
drug delivery systems • tissue engineering • MRI contrast agents

Materials for Sustainable Energies

Western Science is a world leader addressing the serious challenges associated with material failures from radiation-induced corrosion processes in nuclear reactors and nuclear waste storage containers. Western's research has directly influenced strategies for the long-term stewardship of used nuclear fuel, not only in Ontario but globally. The approaches being examined must be socially acceptable, technically sound, environmentally responsible and economically feasible.

Western Science is a leader in the development of new solar cell materials for the efficient conversion of sunlight to electricity, and the design, development and fabrication of next generation devices. These hold great promise of high efficiency conversion of captured light, low cost and, in the case of devices composed of organic materials, inherent device flexibility.

KEYWORDS:

energy storage • fuel cells • batteries • solar cells • nuclear reactor materials
materials for nuclear waste storage and containment

Innovative Functional Materials

Western Science researchers aim to develop the next generation of functional materials for optoelectronic devices and smart materials which respond appropriately to the environment by changing properties and functions as needed, by self-repairing when damaged, and by degrading in an environmentally benign way once their purpose is served. New polymers are being developed that serve as superhydrophobic surfaces, as organic semiconductors, sensors or as pre-heterogeneous catalysts. Researchers at Western Science are world leaders in the utilization of the power of synchrotron radiation to understand the key interplay between electronic structure and material design. Western Science is a key player in the design of nanometer-sized particles, metals and semiconductors for applications in sensing, biolabelling, photovoltaics and electronics as well as the investigation of nanoporous materials for carbon dioxide capture and storage.

KEYWORDS:

superhydrophobic materials • redox materials • polymers and polymer composites • magnetic materials nanomaterials and nanocomposites sensors • conducting materials • optoelectronic materials

Earth and Astromaterials

Western Science is well-positioned to address challenges in exploration and extraction of Earth resources such as gold, diamonds, technological minerals, rare earth elements, and unconventional petroleum. A deep understanding of planetary materials including those stemming from Earth impacts and related to resource forming events as well as meteorites, lunar samples, and Martian data is helping us discover the location and timing of events relative to the origin and evolution of the solar system and planets, including Earth. Researchers in Western Science can investigate these materials under extreme conditions and are leaders in using advanced analytical instrumentation for deciphering the timescales of geological events, for structural strain analyses in natural materials and for establishing the parameters for metal enrichment in mineral deposits.

KEYWORDS:

meteorites • planetary interiors • petroleum geology • mineral exploration earth impacts • planetary surfaces • mineral resources

Cross-fertilization: The Potential for Interdisciplinary Research

Materials and Biomaterials research by the nature of the field, naturally extends across departmental and Faculty boundaries including tight linkages to Advanced Manufacturing and Western's Musculoskeletal Health cluster. Our core competencies extend from the synthesis of new biomaterials at the nanometer scale and upwards to the analysis and characterization of natural and synthetic materials using a variety of cutting-edge analytical techniques developed right here at Western. All research platforms are supported by state-of-the-art computational facilities for modelling the function and failure of materials, and the interaction of materials with the near field environment. World-class facilities and equipment include Surface Science Western, the Nanofabrication Laboratory, the Western-led beamlines at the Canadian Light Source, the Imaging Facility in the Biotron, the Tandetron Facility, and the Laboratory for Stable Isotope Science.

With the diverse expertise present in the thriving Western materials community and the extensive capabilities of state-of-the-art analytical instrumentation on campus, Western Science is poised to play a leading role in collaborative research initiatives that address the most important materials challenges facing society today.

Links to the Science of Information research focus area are found in computationally intensive models and tools to analyze massive data sets.

Strong collaborations exist with Engineering and the Schulich School of Medicine & Dentistry in the development of bio/materials for tissue engineering and as medical imaging agents; the analysis of nanomaterials for fuel cells and batteries; and the mechanical properties of polyelectrolyte coatings.

Synergies with the Sustainability and the Environment focus area are found in the development of new materials for sustainable or green energy applications and in the field of geomicrobiology, which recognizes the importance of reactions at the microbial-mineral interface.

The **BIG** Questions

Can we achieve safe and sustainable alternative methods of powering the planet through means such as the efficient conversion of sunlight into energy, the informed use of nuclear fuels and an in-depth understanding of their post-usage container corrosion, and maintain the integrity of the environment for the foreseeable future?

How can we understand and cure or eradicate disease?

Can we provide medical practitioners with the insight and potential to impact positively on the structure and functioning of the human body by improving current imaging technologies and providing materials and methods to facilitate tissue and bone regeneration?

What can extra-terrestrial materials reveal about the origins and evolution of planetary bodies?

Priorities in Research and Education

The following matrix operationalizes our strategy to achieve enterprise-wide excellence in our identified research focus areas. As we progress toward these objectives, the benchmarks will provide measureable key performance indicators that will give a full account of our achievements.

Operational Optimization

Optimizing administrative operations will support our success in meeting identified objectives for Research, Graduate Studies and Undergraduate Studies. This requires a unified effort by all leaders in Science to ensure that there is no duplication of courses or services; that course offerings have substantial enrollments and link with learning outcomes for the program of study; and that departments and programs consider carrying capacity when making decisions on offerings. The adequate provision and efficient use of space, resources and facilities for research faculties and graduate students are also our top priorities.

Our work encompasses several distinct initiatives. Emerging communications and operations challenges require the creation of new processes and the streamlining of existing ones. Process efficiencies start with front-line staff so we will foster a culture that empowers and assists individuals to bring new ideas forward. The senior leadership team will build new, and adjust existing, processes for budgeting and human resource management. Opportunities for greater interaction between department administration leaders and the Dean's Office will be provided; these will enable effective and productive ways to work collaboratively and support each other towards the attainment of Science strategic goals.

The reality is that staff in Science, many of whom offer crucial support services, are dispersed across the departments. One cornerstone of optimizing the way we work is to build mini-communities by which isolated personnel can access peer groups and structures for information sharing and support. Current mechanisms will also be strengthened to better engage various university support staff, such as IT, building managers and facilities management, recognizing their critical roles in the smooth running of operations across the entire Faculty. Together, these initiatives will create a foundation for forward momentum.

High-level Targets

- Diversify the demographics of incoming students to make Western a destination of choice for both basic Science and Medical Science
- Procure 33% of graduate funding from external scholarship awards
- Triple the amount of partnership funding from \$2.8 million to \$8.7 million to support advancement of the Science research enterprise

Measuring Success

RESEARCH		
Objectives	Mechanisms	Benchmarks
<p>Objective 1: Drive important discoveries vital to addressing key issues facing humankind, while providing Canada with advantages emerging out of research bridges to industry, government and the wider community, nationally and internationally</p>	<ul style="list-style-type: none"> ▶ Conduct a Research Leaders Forum to share ideas and discuss high-level research direction ▶ Provide bridge funding to assist faculty to secure external funding (e.g., IRC and partnerships) ▶ Provide alternative workloads for faculty leading large team grants ▶ Work with RDS to provide institutional resources for large, collaborative grants ▶ Build team grants with global partners in strategic areas ▶ Diversify sources of revenue 	<p>Number of Research Chairs</p> <ul style="list-style-type: none"> • Canada • Industrial • Canada Excellence <p>Total number of students</p> <ul style="list-style-type: none"> • Graduate • Postdoctoral Fellows • Ratio of PhD to MSc Students • Ratio of graduate to undergraduate students <p>Total number of awards and honors received</p> <ul style="list-style-type: none"> • Society • National • International <p>Total level of annual research funding</p> <ul style="list-style-type: none"> • Tri-council • CFI • Provincial • International funding • Team Grants <p>Number of patents secured by faculty</p> <ul style="list-style-type: none"> • Start-ups • Inventions • Commercialization

Western Science ranks first in science faculties in Ontario in the number of NSERC Industry Research Chairs. Eight Western Science faculty members are among NSERC's #1 funded researchers in their subject areas.

RESEARCH		
Objectives	Mechanisms	Benchmarks
<p>Objective 2: Integrate research to drive transformative societal benefits as well as the student educational experience at Western</p>	<ul style="list-style-type: none"> › Organize and host problem-solving workshops that connect business, researchers and students' skills in interdisciplinary problem-solving within a multidisciplinary, team-based environment › Initiate an Industry Expert in Residence Program › Arrange connector events that bring together research and industry with common interests <ul style="list-style-type: none"> • Connector events • Showcases • Workshops › Develop a leadership program targeted to junior faculty › Employ an industry grant officer to develop connections between industry and faculty and increase the impact and clarity of grant submissions › Host information sessions with NSERV, OCE, MITACS and Connect Canada on partnership programs › Promote grant-writing mentorship, including peer review 	<p>Number of multi-stakeholder activities</p> <ul style="list-style-type: none"> • Team Grants • Partnerships <p>Number of papers published</p> <ul style="list-style-type: none"> • Total number • Total per faculty member <p>Quality of papers published</p> <ul style="list-style-type: none"> • Total h-index • Mean h-index • Number in top tier journals <p>Percentage of thesis-based graduate students with at least one publication, patent or technical report</p> <ul style="list-style-type: none"> • Average number of publications per student • Total number of patents held by students • Total number of student technical reports <p>Number of licenses awarded to faculty</p> <p>Number of start-up ventures lead by faculty</p> <p>Level of success of incubators</p> <ul style="list-style-type: none"> • Total number of incubators established • Average number of employees • Number of HQP employed • Total revenue accrued

RESEARCH		
Objectives	Mechanisms	Benchmarks
<p>Objective 3: Actively encourage flourishing multidisciplinary research communities that focus on complex, challenging problems requiring multi-faceted expertise</p>	<ul style="list-style-type: none"> ▶ Utilize performance management mechanisms to recognize faculty and staff contributions and to communicate expectations ▶ Leverage Research Leaders Forum ▶ Organize group meetings, workshops and retreats involving faculty and staff to develop new collaborations or address barriers ▶ Develop and utilize a research map, visual and analytical tools to map research clusters 	<p>Number and total value of partnerships</p> <ul style="list-style-type: none"> • In-kind with public sector/ government organizations • In-kind with private sector groups • Contract relationships with public sector/ government organizations • Contract relationships with private sector groups <p>Number of cross and jointly appointed faculty</p> <p>Number of jointly supervised students</p> <p>Number of multidisciplinary-authored papers</p>
<p>Objective 4: Provide leadership on scientific issues in Canada and globally through linkages and partnerships with national and international professional societies, agencies, industry and other institutions</p>	<ul style="list-style-type: none"> ▶ Build relationships with contacts at key professional societies, agencies and industry sectors ▶ Demonstrate leadership in faculty publications and communications (e.g., www.uwo.ca/sci); in Western University publications (Western News); and beyond in the popular science and mainstream media ▶ Leverage Research Leaders Forum 	<p>Number of extra-university positions held by faculty</p> <ul style="list-style-type: none"> • Editorships • Positions on review panels • Seats on government/private advisory boards • Positions on conference steering committees <p>Number of external presentations by faculty</p> <ul style="list-style-type: none"> • National keynote speeches • International keynote speeches • Plenary presentations at national conferences • Plenary presentations at international conferences <p>Number and quality of media mentions in</p> <ul style="list-style-type: none"> • Faculty communications • University communications • Popular science/mainstream media <p>International activity levels</p> <ul style="list-style-type: none"> • Number of international conferences organized by Western Science faculty • Number of long term (> 1 week) international visits to campus

GRADUATE		
Objectives	Mechanisms	Benchmarks
<p>Objective 1: Attract the highest quality domestic and international graduate students</p>	<ul style="list-style-type: none"> 】 Offer incentives such as Western Science Entrance Scholarships and Western Science Doctoral Scholarships to help recruit top-calibre students 】 Develop an awards committee to mentor and encourage our students and postdoctoral fellows to secure external scholarships and other funding opportunities 】 Continue to expand research-based, collaborative, and interdisciplinary graduate programs to provide our students with research experience and experiential learning and to provide an avenue for students to participate in emerging research areas 】 Offer undergraduate students summer research opportunities in order to accelerate the research potential of the lab, as well as to give students an opportunity to consider graduate training 】 Provide opportunities for students to study abroad and build on the Emerging Leaders in the Americas Program, Canada-Brazil awards, and Indo-Shastri Foundation awards 	<p>Total graduate enrollment</p> <ul style="list-style-type: none"> • Ratio of PhD to MSc students <p>Total number of external awards and scholarships for graduate students</p> <ul style="list-style-type: none"> • Number of NSERC awards/scholarships (including but not limited to: Alexander Graham Bell Canada Graduate Scholarship – Doctoral Program; NSERC Postgraduate Scholarships – Doctoral Program; Vanier Canada Graduate Scholarship Program; Canada Graduate Scholarship – Master Program) • Number of Ontario Graduate Scholarships • Number of Banting Postdoctoral Fellowship Program Awards • Number of Trillium Awards • Number of international students who are supported through their home country through national awards <p>Number of Western graduate students successfully recruited from Western's undergraduate pool of students</p>

Over the past five years, half of all Western-MITACS industry internships, with a potential value of \$1.2 million, have been awarded to Western Science graduate students.

Notably, in the past year Western Science's uptake of MITACS awards grew from \$179,000 to \$795,000, reflecting our recent strong emphasis on partnerships.

GRADUATE		
Objectives	Mechanisms	Benchmarks
<p>Objective 2: Provide unique training contexts and opportunities, building upon linkages with Canadian industry, governmental agencies, and other research partners to broaden the career choices of graduate students and equip them to become responsible global leaders</p>	<ul style="list-style-type: none"> ▶ Expand internship programs and utilize programs offered through MITACS to provide ties to industry and further research collaborations, and offer our students and postdoctoral fellows a leading edge by providing career mentorship and job expertise in their chosen field ▶ Offer professional programs in key sectors that provide students with education and skills in leadership and communication in addition to sector-specific skills sought by industry ▶ Introduce online training modules to build professional skills for all graduate students for the performance of their TA duties and for their future success 	<p>Number of graduate students leveraging high-impact learning opportunities</p> <ul style="list-style-type: none"> • MITACS awards • Co-ops • Internships • Research exchanges <p>Enrollment in professional training activities</p> <ul style="list-style-type: none"> • Number of internships • Number of co-ops • Number of online modules • Professional programs <p>Level of graduate student satisfaction with training (SGPS exit survey)</p> <ul style="list-style-type: none"> • Relationship of program content to research/professional goals • Quality of course instruction • Number who would select same supervisor <p>Total number of graduate students employed in their field of study</p>
<p>Objective 3: Enable the timely completion of graduate studies</p>	<ul style="list-style-type: none"> ▶ Provide funding for year X students only in exceptional cases in which special circumstances apply (e.g., equipment failure) to enable the student to complete graduate studies according to their approved plan ▶ Remove barriers which impede the timely completion of degrees (e.g., course availability; administrative tasks not related to the completion of the degree) 	<p>Timeline trend to graduation compared to the provincial averages for MSc and PhD students</p> <p>Number of year X students as a proportion of the total number of graduate students</p> <p>Rate of graduation compared with provincial averages for MSc and PhD students</p>

UNDERGRADUATE		
Objectives	Mechanisms	Benchmarks
<p>Objective 1: To shape our students by providing them with innovative classroom instruction and online delivery, as well as national and international research, industry, and field experience</p>	<ul style="list-style-type: none"> ▶ Provide incentives for development of innovative curricula using online or blended methods, for instance a competition to provide support (e.g., technical and TA support) to faculty members developing innovative teaching methods and course delivery ▶ Increase the participation in mentored research projects, e.g., by providing funding for additional summer research assistantships beyond the NSERC USRA allotment ▶ Grow the Science Internship program, which provides 8–16 month industry placements to gain on-the-job experience and establish connections with potential employers ▶ Build interdisciplinary undergraduate programs which form a synergy with interdisciplinary research, provide students with a leading edge in tackling complex problems through a variety of approaches and supply tools to contribute to interdisciplinary teams/projects in an industrial setting ▶ Energetically pursue development activities (e.g., exchanges, community service, collaborative projects) to enhance national and international opportunities provided to students ▶ Introduce mandatory online modules to develop key attributes of students not normally addressed in a Science curriculum (e.g., academic integrity at an early point in their program, and career skills near the end of their program to facilitate the transition to the workplace) 	<p>Level of course satisfaction</p> <ul style="list-style-type: none"> • Average level of learning experience satisfaction identified in Course and Instructor evaluations • Satisfaction as indicated in the NSSE • Proportion of students that would recommend Western University to a friend (NSSE) <p>Number of teaching awards granted to Western Science faculty</p> <ul style="list-style-type: none"> • International awards • Provincial awards (e.g., OCUFA) • National awards (e.g., 3M Teaching Fellows; Society Awards) • Internal Awards (e.g., Pleva; USC Teaching Honor Award) <p>Total number of undergraduate research opportunities</p> <ul style="list-style-type: none"> • USRAs awarded • Internal research awards • Supervisor-funded research opportunities <p>Level of success of internship activities</p> <ul style="list-style-type: none"> • Number of internships available • Number of students applying for student internships • Number of students offered an internship • Number of students placed <p>Uptake in the Western Integrated Science curriculum (WISC)</p> <p>High-impact learning experiences</p> <ul style="list-style-type: none"> • Number of exchanges • Number of community service opportunities • Number of new field courses • Number of group projects <p>Development of non-Science skill sets facilitating classroom to workplace transition (NSSE)</p> <ul style="list-style-type: none"> • Level of awareness of ethical issues • Level of awareness of rights and responsibilities of citizenship • Level of satisfaction with Career Services

UNDERGRADUATE		
Objectives	Mechanisms	Benchmarks
<p>Objective 2: To develop global citizens by increased emphasis on experiential and community-service learning by recruiting international students and by providing opportunities for international exchanges and other international experiences</p>	<ul style="list-style-type: none"> ▶ Work closely with Western’s recruitment efforts to increase the undergraduate international student enrollment in the Faculty of Science ▶ Promote opportunities for students to engage in international exchanges and field training, as well as non-curricular activities such as “Alternate Spring Break” and “Western Heads East” 	<p>International student enrollment</p> <ul style="list-style-type: none"> • Proportion of international students to total number of undergraduate students • Grade average of international students • Year 1 to year 2 retention rate
<p>Objective 3: To continue to support our students post-graduation by providing alumni with opportunities to engage with us, our students and our community, as well as providing them with opportunities to network with other Western alumni leaders</p>	<ul style="list-style-type: none"> ▶ Establish annual sessions where students can interact with industry leaders: CEOs, Presidents, etc. ▶ Host alumni events with recent graduates 	<p>Level of interaction between recent graduates (<5years) and industry leaders</p> <ul style="list-style-type: none"> • Number of interactive events with industry leaders • Average number attending events with industry presence <p>Number of professional training activities for intermediate alumni to facilitate their transition into management/leadership positions</p>

At 90.3%, Western Science has the highest average grade for incoming students of any Faculty of Science in Ontario, as well as the highest proportion of students with admissions averages of 95% or higher.





Western  Science

westernu.ca/sci