DISCOVERING
WHAT IS IN THE WORLD
Research within the Faculty of Science

The University of Western Ontario
“Science’s vision is enabled only when faculty, staff and students share a common purpose, understand and respect each other’s roles, and are collectively savvy about the larger context within which each and every one of us exists.”

-Dr. David Wardlaw, Dean of Science
Brilliant ideas can occur anywhere, what really matters are the actions after the initial spark.

Western’s Faculty of Science is enhancing an already research intensive setting to nurture discovery-driven ideas. New facilities are being built and existing buildings are being upgraded which makes more room for Graduate students who strengthen our research projects. In addition to this, we actively engage our researchers to pursue opportunities in contract research. At the same time, faculty are thinking about intellectual property with respect to the economic and social value of their inventions and software generated from university research.

This synergy of human energy, skills and commitment are the most important factors in making the Faculty of Science strong. Explore this booklet to learn about some of our outstanding faculty, facilities and initiatives.

While discipline-based research continues to thrive in individual departments throughout the Faculty of Science, the borders between each field of study have become less distinct.

To take advantage of this potential for cross-disciplinary investigation, Western Science has developed a research plan co-ordinated about five general themes:

- Materials and Biomaterials
- The Computational Sciences
- Functional Genomics and Evolution
- Environmental Science and Ecology
- Stellar Science (Planets and Stars)

This broad based approach provides a research environment that is rich in intellect, stimulation and infrastructure.
Silvia Mittler

Canada Research Chair in Photonics of Surfaces and Interfaces

Silvia Mittler develops sensitive sensors, optical tweezers and new microscopy technologies all based on evanescent fields of optical devices or gold nanoparticles.

Her research uses optical waveguides that constrain light waves to travel along a central path of micrometer-scale slabs of material. While the core of the waveguide traps most of the light, some waves escape and form a thin film of light called an evanescent field on the surface of the device. Similar fields are present on noble metal nanoparticles under certain resonance conditions.

Mittler applies immobilized specific molecular monolayers of materials within these evanescent fields so that these fields essentially become ultrasensitive detectors, for proteins, enzymes, DNA, antibodies, toxins or whatever is required.

Recently, her group developed a new microscopy technology which is able to image living cells located on a technical surface right at the interface between the biology and technical worlds. This method is now being explored for use in tissue engineering and implant surface functionalization.

T. K. Sham

Canada Research Chair in Materials and Synchrotron Radiation

T. K. Sham’s group was the first to use synchrotron techniques to identify the origin of luminescence from porous silicon, which has since proved to be an important development. This material differs from ordinary silicon wafers in that it exhibits bright luminescence at room temperature. This unusual property has already found applications in optoelectronics, biosensors and catalysis.

The innovations of bimetallic thin films, porous silicon, and the fabrication of carbon and silicon nanowires have all generated properties that were unexpected from their bulk counterparts. Sham examines the interplay of electronic structure, material properties and spectroscopy by using synchrotron light sources to study these new materials. In order to enhance his work, he takes advantage of the tunable photons, brightness, and energy resolution available from the Canadian Light Source, a national facility.
After being synthesized, most proteins fold into a unique structure which allows them to perform specific biological tasks. Unfortunately, this process is prone to errors. Misfolding events can result in various neurological disorders such as Alzheimer’s disease.

Lars Konermann is exploring the mechanisms of protein folding. Sometimes short-lived folding intermediates become populated during these processes. However, little is known about these species, as they may only be observable for a matter of milliseconds. Konermann’s laboratory uses mass spectrometry as a technique to study protein folding, which has proved to be extremely powerful.

Other research done in Konermann’s laboratory includes the study of enzyme-catalyzed reactions and the development of new methods to study how molecules bind to biological receptors. The latter has implications for the development of new drugs.

Magnetic Resonance Imaging (MRI) has yielded enormous benefits to the medical and research communities. Images produced in this way can be used to pinpoint the exact locations of tumors and tissue damage non-invasively. However, Blaine Chronik saw that the superconducting coils within each unit require the device to be always on with the resulting magnetic fields making it necessary to shield other scanners from MR devices. Existing machines are also as loud as the roar of a jet airplane taking off.

Chronik’s approach to the problem is to utilize a series of very powerful resistive magnets that can be switched on and off to generate pulses of dynamic magnetic fields. As a result, other scanning technologies such as Positron Emission Tomography (PET) and X-ray Computed Tomography (CAT scan) can be incorporated within one MRI device to operate during the “off” phase. This device would be able to image around metal implants virtually silently. Another benefit would be a substantial savings to install and maintain one device to serve three functions.
Lyudmila Goncharova
ERA Recipient Materials Analysis

Nanotechnology is poised to advance fundamental research to investigate nanoparticle design. The applications range from electronics to biomedical aspects such as gene delivery and biomedical imaging.

The pursuit of these improved materials and devices depends on utilizing existing and new methods to characterize their structure, composition and critical properties at the nanometer scale. Lyudmila Goncharova’s work has revealed that there are many fundamental material issues that limit integration of ultra-thin metal oxide films into nanoelectronic and optoelectronic devices. Goncharova is exploring the nature of these limitations, and shedding light on the means to overcome some of the practical implementation problems.

Goncharova’s laboratory is investigating novel bulk properties of oxide materials to address related interface issues at the atomic scale. At the same time, she is developing model surfaces with controlled biological activity for specific biomedical functions. This fundamental research will help unlock the potential of the nano-age world.

Paul Ragogna
NSERC Strategic Project Grant Recipient

Paul Ragogna is synthesizing new molecules with unique repelling qualities.

These materials have the potential of developing into new water-resistant surfaces. “These molecules have the very uncanny ability to repel water and oils with great efficacy,” says Ragogna, comparing it to a highly sophisticated version of a non-stick frying pan.

By identifying compounds with unusual properties, as well as chemical processes that are less detrimental to the environment, the research will have a significant impact in the area of polymer sciences and “green” chemistry.

Ragogna’s research is targeting needs in the high-tech electronics industry, for example the organic light-emitting diodes used in cell phones, watches, solar cells and billboards. “You want these devices to be able to withstand our outside environment,” he says. “A lot of what’s difficult in making these things is they are very susceptible to water and water vapour. So if we can keep that out, then these things stand a chance of functioning.”
Matt Davison

Canada Research Chair in Quantitative Finance

Matt Davison is incorporating the tools of financial mathematics (originally used to choose portfolios and hedge stock market risks) to energy issues.

The 24 hour availability of reliable energy is one of the hallmarks of our standard of living. This access to oil, natural gas and electricity spawns problems related to supply and demand as well as, in the case of electricity, widely fluctuating prices. Peak demand hours during the day strain supplies while excess power is generated through the evening. As Davison describes it, “the prices become forty to fifty times what they normally are, but by midnight of that same day, the prices will come back down to normal.”

Davison studies the factors that contribute to these fluctuations:

Storage of the commodity - Once electricity is generated, it must be used. Unlike oil, electricity cannot be stored.

Logistics - Regional markets where geographical barriers limit distribution.

Means of production - Electricity can be produced through hydroelectric dams, nuclear power plants, coal and gas fired power plants or windfarms.

Lila Kari

Canada Research Chair in Biocomputing

The practical use of organisms to process information— just as cells “compute” data as part of their usual function— opens up as-yet unimagined horizons for a DNA computer that could be thousands to millions of times faster, trillions of times smaller and thousands of times more energy efficient than today’s electronic computers.

Lila Kari's research will cover three related areas: biomolecular computation, or how to employ biomolecules to perform computations; biological computation, or how biological systems process information; and bioinformatics, or how to apply data modelling and algorithmic techniques to biological problems. The result of this research will further the understanding of the workings of the cell to determine its unique algorithms and computational elements, and allow the cell's enormous capability to be explored in a controlled fashion.
Rick Jardine

Canada Research Chair in Applied Homotopy Theory

Rick Jardine uses techniques from homotopy theory to understand the relationships between processes which operate within a given framework. Homotopy theory had its origins in the study of deformations of spaces over time, and has evolved into a study of how more general geometric objects fit together. Jardine and his research group have taken a leading role in this modern form of the subject, and its applications.

Jardine’s work is used to describe and analyze stacks, as in which objects form the modern incarnation of the theory of symmetries of geometric objects. His work on the foundations of motivic homotopy theory is well known - this theory is now the leading method of applying rubbery space-like techniques in the more rigid framework of algebraic geometry. He has formulated a modern approach to cubical homotopy theory, or the approximation of spaces by pasting together cubes, and its applications in computer science.

These concepts are abstract, but they appear in a wide range of situations, from geometry, combinatorics and theoretical physics to the study of concurrent behaviours of multiple processes. These methods have solved some very real problems in parallel processing, the analysis of networks, graph theory, and quantum gravity.

Eric Schost

Canada Research Chair Computer Algebra

Eric Schost is aiming to create more efficient computers that will serve as the main tools for science and education. His research focuses on the complex processes that are involved in instructing computers to solve problems, which are referred to as algorithms. Using applications such as number theory and cryptology, Schost is developing new algorithms that will increase the speed of computers.

Since people who actually operate computers on a regular basis must be knowledgeable of these computational advances, Schost’s work also involves setting up publicly available computer libraries.
Lindi Wahl
Canada Research Chair in Mathematical Biology

Lindi Wahl uses powerful mathematical models to understand how bacteria and viruses evolve. These microbes can change very quickly, developing resistance to even our most potent drugs, or newly developing the ability to infect humans. But rather than using test tubes and microscopes, Wahl and her team use math, incorporating thousands of individual cases and studies into a broad model of microbial evolution.

Mathematical models, supplemented by extensive computer simulation, are particularly important in understanding disease threats, such as SARS, swine flu or drug-resistant superbugs, which have not been around long enough for conclusive real-world studies. This research will help us prepare for these emerging pathogens by predicting how fast microbes can evolve. The work of Wahl and her team also allows us to design less toxic, better drug regimes for people with HIV.

Miodrag (Mike) Grbic
Trailblazing a new genetic model

Mike Grbic studies the evolution and development of non-model arthropods. His current work focusses on the development of a Chelicerate (spider mite) to attempt to determine the nature of ancestral pathways that pattern all arthropod embryos. Some Chelicerates, such as ticks, are vectors of human diseases. Others, like spider mites are major agricultural pests. The developmental genetics of chelicerates is poorly understood and Grbic has taken the challenge of developing a chelicerate genetic model: the two-spotted spider mite Tetranychus urticae. T. urticae has the smallest genome of any arthropod determined so far (75 Mbp, 60% of the size of the fruit fly genome), undergoes rapid development and is easy to maintain in the laboratory. These features make T. urticae a promising reference organism for the economically important, poorly studied and species-rich chelicerate lineage.
Nusha Keyghobadi

Canada Research Chair in Molecular Ecology and Landscape Genetics

Nusha Keyghobadi studies insects to investigate, more generally, how altered geographical landscapes and destruction of natural habitats affect the genetic diversity of plants and animals. Shrinking natural habitats force organisms into smaller areas that are isolated from each other and that may contain fewer resources. Keyghobadi studies the processes by which those populations that remain in these isolated patches of habitat are likely to lose genetic diversity or, in other words, have their gene pool shrink over time. Without a substantial gene pool, it is difficult for species to adapt to various ecological changes, which may well result in the disappearance of entire species, further disturbing the natural world.

Keyghobadi hopes that by studying these processes, we will better predict the impacts that human use of the landscape, and the associated loss of natural habitats, has on the long-term survival of wild populations of plants and animals.

Shiva Singh

Genetics Society of Canada Award of Excellence recipient

Shiva Singh has explored retroviral sequences as well as the roles of methylation and epigenetics in the human genome to unravel the many facets of schizophrenia. His group is now assaying the DNA from 73 pairs of twins from all over the world. “The reason for that is very straightforward,” says Singh. “Although schizophrenia is a genetic disease, monozygotic twins who are supposed to be 100% genetically identical have a risk of developing the disease 50% of the time.” The pilot data from whole genome scans already shows that twins are not identical. “That’s one major breakthrough” says Singh. “The retroviral sequence, the methylation and now the copy number variation of genes show that there are a lot of differences that come about during their growth and development.”

Singh’s work on alcoholism is somewhat different, that work totally focuses on the RNA. “Our hypothesis is that alcohol itself affects the gene expression. It’s the response to ethanol on your DNA that really determines what’s going to happen or how you’re going to respond.”
Andre Lachance

*World renowned expert on yeasts*

Andre Lachance has traveled to most of the biogeographic regions on Earth to observe the relationship involving yeast, flowering plants and Sap Beetles. He has gathered samples of yeast for genetic analysis here at Western. Now with a powerful apparatus that allows him to determine the genotype of many isolates rapidly, Lachance can pursue his dream of determining the amount of genetic interplay in natural yeast populations.

As busy as Lachance is in the lab, his teaching duties have occupied an important part of his career, he has taught introductory biology as well as newer courses in evolutionary genetics and established an undergraduate version of his graduate course in molecular systematics. On top of all that, Lachance is also writing chapters for the next edition of the treatise “The Yeasts.”

Amanda Moehring

*Canada Research Chair in Functional Genomics*

One of the major hurdles in understanding species isolation is that species, by their very definition, do not want to mate together or, if they can be mated, will produce sterile offspring. As most genetic studies require crossing pairs of individuals, prevention of crossing impedes our ability to identify genes involved in species isolation. To overcome this obstacle, Amanda Moehring approaches these questions using the model system of Drosophila—the fruit fly. This system has the advantage of having a wide array of genetic and genomic tools available, as well as having species pairs that can be crossed together in the laboratory and produce fertile offspring.

By identifying the genes related to reproductive traits, Moehring’s research will provide new insight into the mechanisms by which new species arise, as well as enhance our general understanding of how variation in behavioural traits arise. Her work with the humble fruit fly may allow us to one day understand how individuals recognize members of their own species and why some individuals are fertile while others are not.
Sheila Macfie

Mechanisms of Metal Tolerance in Plants

Thirty years ago, accumulation of toxic metals in crop and forage plants was rarely of concern. Today, metal pollution is a global problem due to the application of phosphate fertilizers, pesticides, and sewage sludge in agricultural areas. Sheila Macfie is working on monitoring the effects of these toxins on edible crops and a way to diminish metals in soils.

Many plants have a remarkable ability to withstand high concentrations of potentially toxic metals in their environment. Some plants can thrive in the presence of toxic metals either by preventing their uptake or by sequestering them where they will not damage the plant. Macfie is working toward a better understanding of the biochemical and physiological mechanisms that permit such tolerance. These studies may provide valuable information regarding the use of plants to restore contaminated areas. Certain plants may even forage for metals. These traits have been applied to phytoremediation, the cleanup of contaminants from soil, sediments or water using plants.

Gordon Southam

Canada Research Chair in Geomicrobiology

Gordon Southam studies life in extreme environments, such as Yellowstone National Park and the 4 km deep gold mines in the Republic of South Africa. Southam’s research is at the interface between microbiology, geochemistry and mineralogy, and includes the likelihood of finding life elsewhere in the solar system (astrobiology) and the vital roles that bacteria play in diamond exploration, the bioremediation of metal pollution, the growth of gold nuggets, and in carbon sequestration. Samples come from paleoenvironments that are billions of years old to contemporary mining environments.
Norm Hüner

**Canada Research Chair in Environmental Stress Biology**

Norman Hüner’s research has shown that the photosynthetic apparatus has a dual function: not only is it the only sustainable process able to convert light energy to useable chemical energy in support of living ecosystems but it also acts as a general molecular energy sensor that detects changes in environmental temperature, light and nutrient levels.

Hüner’s work has also provided important applied breakthroughs in agriculture as well as health and medicine. His laboratory has uncovered important biochemical and biophysical markers useful in breeding plants with increased resistance to freezing as well as to high light. In addition, Hüner’s laboratory has established that plants, green algae and cyanobacteria can be exploited for the formulation of natural sunscreen creams which provide significant protection from both UVA and UVB radiation.

Irena Creed

**Canada Research Chair in Watershed Science**

Irena Creed says that she first developed “a strong need for working on applied problems for humanitarian reasons,” after working in China on soil and water conservation issues. She adds, “I realized that I didn’t just want to work with test tubes and in labs but over in landscapes and with more global or regional problems.” The growing concern surrounding climate change has placed considerable focus on available forest and water resources. This emphasis will impact on Canadian social, economic and environmental decisions.

Creed’s research program explores the science to create the sustainable technologies that will enable governments, industries and communities to meet their needs while managing forests and their waters.
Chris Guglielmo

Unlocking the mystery of avian physiology

Migrating birds can fly more than 1,000 miles at a time and up to seven kilometers in the thin atmosphere above the ground. Unlike exercising mammals, migratory birds fuel very high intensity exercise (e.g., flight) with fatty acids delivered from the fat tissue to the working muscles by the circulatory system.

Chris Guglielmo’s work focuses on this lipid metabolism and the physiology of endurance flight and stopover refueling in migratory birds and bats. He analyses metabolite concentrations in blood to assess physiological and/or health status. One of the great advantages of metabolites is their potential to indicate rates and direction of change in body condition.

Guglielmo’s research integrates physiology, biochemistry, behaviour, ecology, evolution and conservation biology. Physiology, in concert with morphology and behaviour, influences how animals interact with the environment, and understanding its flexibility will help us to predict how species may respond to natural or man-made perturbations.

Sarah Gallagher

Finding interstellar dust in unexpected places

Sarah Gallagher has done extensive research on the dust black holes create. The dust is needed to form stars efficiently in the early universe, says Gallagher, which is ultimately necessary for life on Earth to exist. She and a team of researchers investigated a quasar located in the centre of a galaxy about eight billion light-years way.

Although not in the early universe, this nearby target is easier to study for addressing the question of whether quasars can make dust. The team used an infrared spectrograph instrument to split apart infrared light from the quasar and look for signs of various minerals.

What they found was a mix of the ingredients that make up glass, sand, marble and even rubies and sapphires. The glass was expected, but the minerals for sand, marble and rubies were a surprise since they are not typically detected floating around galaxies, suggesting they could have been freshly formed in the winds rushing away from the quasar.
Martin Houde  
*Canada Research Chair in Star Formation*  

Martin Houde studies how molecular clouds of hydrogen gas and dust condense to form stars. Houde is developing methods to study how such factors as the mass of a molecular cloud, gravity and magnetic field strength interact to create not only the mass and types of stars but where they are distributed. His work will endeavour to find ways of mapping the initial mass and magnetic field strength with greater sensitivity. This will help him to find out how important and efficient the magnetic field is on impeding gravitational collapse.

Gail Atkinson  
*Canada Research Chair in Earthquake Hazards and Ground Motions*  

Canada has experienced some of the largest earthquakes in the world. Fortunately, these have only occurred in remote areas and had little effect on the population. Gail Atkinson is working to predict the next major earthquake. Such information will lead to better emergency plans and building codes that will help minimize damage and loss of life should an earthquake strike in a more densely populated area. Building on a previous project called Portable Observatories for Lithospheric Analysis and Research Investigating Seismicity (POLARIS), Atkinson is able to track every earthquake in Canada using data from more than 100 satellite-linked observatories. Using this technology, future ground shakes can be predicted and processed in real-time, allowing emergency managers to better target areas in need of immediate disaster relief.
Neil Banerjee

*Exploring the early Earth*

Volcanic glass from the upper oceanic crust of the earth can host extensive microbial activity. When these colonizing microbes actively dissolve glass to extract nutrients they form channel-like tubular structures.

Neil Banerjee and his associates kept these facts in mind as they examined well-preserved ancient pillow lavas from the 3.35 billion year old Basalt of the Pilbara Craton, Western Australia.

These rocks contained micron-sized tubular structures with residual organic carbon preserved along their margins. These tubular microstructures are identical to microbial structures in modern basalts. Banerjee and his team interpreted these structures as a biogenic signature as old as these ancient rocks. Microbial colonization of basaltic glass thus appears to have been part of a deep subsurface biosphere established early in Earth’s history.

Kristy Tiampo

*NSERC and Benfield/ICLR Industrial Research Chair in Earthquake Hazard Assessment*

Kristy Tiampo is studying how to make finding hazard zones and measuring earthquake risk easier. About 20 years ago there were significant improvements and expansion of the charting of seismic waves caused from seismic activity deep within the earth. Researchers are now starting to see activity patterns, Tiampo says, which has allowed them to learn more about what’s going on under the earth’s surface.

Within the past 10 years Tiampo and her colleagues have noticed a time-dependent aspect of earthquakes, meaning discovering how they evolve over time. This helps with discovering not only where they may occur but when they may occur.

With all the research currently underway, she says, and the discovery of a time-dependent nature of seismic activity, the prospects are looking up for unlocking the mysteries of earthquakes and seismic activity.
Mark Perry
Exploring the interface of Science and Law

Mark Perry’s legal research focuses on the intersection of law and technology, with particular emphasis on Open Innovation, intellectual property rights, software licensing, and the blossoming field of biotechnology law.

In the 21st century, intellectual property laws need to ensure open access to the academic and research sectors. There is an increasing recognition that access to knowledge is a key driver of social, cultural, and economic development and that publicly funded research should be openly accessible. Perry is working to develop clear protocols for intellectual property management for implementation in the academic and research sector.

Perry is also considering the multifaceted problems which are raised by biotechnology, most of which revolve around the genetic modification of life. Wide ranging issues include the acceptability of patenting lifeforms, the monopolization of basic food production with genetically modified foods, the risk and allocation of risk with the introduction of modified materials into the ecosystem, also cloning and stem cell use, and will look at possible policy directions.

Beth Gillies
Using macromolecules in Medicine

Beth Gillies investigates using polymer and supramolecular assemblies to interact directly with biological systems. Her research is finding ways that these materials can serve as new biomaterials and therapeutics.

Gillies explores the potential applications of polymeric assemblies in biology and medicine. The benefits range from the delivery of small molecules, proteins, and DNA in vivo, to their use as scaffolds for tissue engineering. Furthermore, macromolecules are of increasing interest in the development of biological imaging contrast agents that are capable of targeting and responding to specific disease states.

Biodegradable polymers are of increasing interest for a wide range of applications including tissue engineering, drug delivery, and medical devices.
Desmond Moser

Finding tiny crystals that yield old secrets

Desmond Moser determines the age of continents, meteorites and ore deposits using Uranium bearing microminerals no wider than a human hair.

Moser is developing one of Canada’s leading laboratories for revealing the growth history and evolution of these tiny crystals that grow slowly in the deep Earth and record the genesis of continents and oceans and yet survive giant meteorite impact events.

Moser’s Zircon and Accessory Phase laboratory will soon host an electron nanoscope, one of the first in a university in Canada, that promises to reveal new windows into the evolution of the solar system, our planet and the formation of mineral resources.

CAMBR
Centre for Advanced Materials and Biomaterials Research

CAMBR provides a cohesive presence and a collective vision for the departments, laboratories and facilities that presently work on nanomaterials and biomaterials.

In the nanoscale (measured in the billionths of a metre), it is possible to build structures atom by atom. The resulting materials show unique properties that can be applied to computer technology, electronic and optical devices, communications and even medicine. The prospect of such advances has encouraged the Faculty of Science to adopt the study of materials and biomaterials as one of its five major research themes.
Nanofabrication Laboratory

The Western Nanofabrication Facility opened in September 2004 and was built at a cost of $23 million. Scientists using the laboratory are working on research that can be measured on the nanoscale—one-billionth of a metre or one thousand times smaller than the width of a human hair.

The laboratory’s cutting-edge research focuses on photonics, or the harnessing of light. Sophisticated new lithographic tools, including a focused ion beam, allow for pattern and feature definition of materials below the wavelength of light. This may lead to significant advances in the information technology and engineering sectors by enabling smaller and more powerful components to be fabricated.

Another advance involves expanding the technology into the design, fabrication and characterization of nano- and micro-structured surfaces for leading-edge biological applications. The facility is currently developing biosensor chips that detect specific molecules such as those associated with disease or pollutants.

SSW

Surface Science Western (SSW) is a consulting and research laboratory specializing in the analysis and characterization of surfaces and materials. SSW is one of Canada’s most comprehensively equipped surface analysis laboratories. Using state-of-the-art techniques, it has been providing the academic community and industry with analytical solutions for 30 years.

The facility has strong research programs in the areas of separation and extraction mineralogy, corrosion, materials for the nuclear industry, polymer modification, medicine, and green technology. In addition to sponsoring numerous graduate students and post-doctoral fellows, SSW provides analytical services, training, and guidance to over 200 professors and students at Western annually.

SSW’s research scientists, with their extensive experience and unparalleled interpretive skills, have assisted clients in diverse industry sectors, facilitating development and production, decreasing costly returns, innovating processes and increasing profitability.
The LSIS opened in 1987 to support work across the entire spectrum of stable isotope science in areas such as bioarchaeology, biology, environmental science, geochemistry, geology, hydrology and hydrogeology, and meteoritics and paleoclimatology.

The LSIS is engaged in environmental geochemistry, anthropology, and sedimentary and petroleum geology. Our scientists actively collaborate with each other and with colleagues from government agencies, research institutes and industry to support their thriving research programs. The work undertaken at the LSIS is both fundamental and applied, revealing important information about relevant topics such as climate change in relation to carbon cycling in wetlands, cultural variability in infant feeding behaviour and its relationship to population health, and the origin, evolution and exploitation of the Alberta oil sands.

All of this is done with the laboratory’s access to an extremely comprehensive collection of instruments and facilities.
**ORCAA**

*The Ontario Research Centre for Computer Algebra*

The current research done in the ORCCA lab emphasizes MathML and, in general, XML technologies for the communication of mathematical content over the Internet and among applications.

The objective of the Pen based interfaces for mathematics is to identify, investigate and solve key problems in developing effective pen-based computer interfaces for doing mathematics. This includes a broad range of questions, ranging from portability of digital ink architectures, to semantically-defined direct manipulation of mathematical expressions.

Pen-based interfaces for mathematics can incorporate various techniques such as menu and palette selection, prompting areas, editing gestures, dictionary-based methods, as well as hand writing recognition.

ORCCA along with the MONET framework will be accessible from existing software so users will not have to abandon their existing tools but will have access to a wider range of mathematical technology. Software agents will help them to make use of that technology where necessary.

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**CES**

*The Centre for Environment and Sustainability*

The Centre for Environment and Sustainability (CES) was formed in recognition of Western’s dedication to, and support for, environmental studies. Dynamic growth in the areas of environmental and sustainable research, across a broad spectrum of disciplines, necessitated a need to consolidate research talent into a single collective and to foster environmental education.

The Centre is made up of acclaimed researchers from the Faculties of Science, Engineering, Social Science, Arts and Humanities, Information and Media Studies, The Schulich School of Medicine and Dentistry, The Richard Ivey School of Business and The Faculty of Law, as well as other environmental groups and affiliates across the Western campus. The CES provides a vital stage for the exchange of interdisciplinary research and perspectives.

Researchers bring an impressive scope of expertise as they respond to the great challenges faced by today’s environment, including water, energy, renewable resources, ecosystem health, and sustainable business practices.
Biotron Experimental Climate Change Research Centre

The Biotron is an environmental biotechnology consortium which supports academic and industrial research ranging from basic physiology to applied agriculture, soil remediation and medical applications. International in scope, the Biotron laboratories support research and development programs from all over the world.

This state-of-the-art facility is dedicated to investigating the impact of climate changes and emerging biotechnologies on various organisms in controlled, enclosed aquatic and terrestrial ecosystem simulations. An imaging centre features new electron, confocal and digital light microscopes. Measurement instruments, growth chambers and imaging devices, networked to a secure central server, afford a broad range of international research for worldwide observation and control.

www.thebiotron.ca/

AFAR
The Advanced Facilities for Avian Research

The Advanced Facilities for Avian Research (AFAR) is designed specifically to give scientists a better understanding of everything from bird physiology and aerodynamics to the effects of high altitude conditions on avian flight.

AFAR has the world’s first hypobaric climatic wind tunnel for bird flight that allows research into the physiology and aerodynamics of bird flight in high altitude conditions. In combination with specialized indoor and outdoor holding rooms and cutting edge experimental and analytical facilities, AFAR is a leading centre for the study of avian neurobiology, physiology and behaviour.

AFAR fosters interdisciplinary studies and houses research by scientists from the Faculty of Social Science, the Faculty of Engineering and the Faculty of Science in fields ranging from biological conservation and environmental quality to human health.

birds.uwo.ca/AFAR
POLARIS
Portable Observatories for Lithospheric Analysis and Research Investigating Seismicity

POLARIS is a Canadian geophysical research consortium focused on the investigation of structure and dynamics of the Earth’s lithosphere and the prediction of earthquake ground motion.

The POLARIS project consists of 96 portable geophysical observatories each equipped with the Libra VSAT satellite system grouped in five satellite-telemetry arrays throughout Canada. These arrays are all connected through the Internet to provide live data for research, education and continuous monitoring of earthquakes throughout Ontario, British Columbia, the North West Territories, Quebec, Nunavut and Nova Scotia.

A group of ten magnetotelluric (MT) field systems permanently co-installed at selected seismograph observatories also provide live data through the Internet for research and education. Five are already installed in the NWT and another five are planned for installation in Ontario. As well, another group of twenty MT field systems constitute a mobile array that will co-locate at the seismograph observatories for a few weeks at a time before being moved to other locations in the seismograph networks.

CPSX
Centre for Planetary Science and Exploration

The goal of the Centre for Planetary Science and Exploration is to make Western the focus for planetary science and exploration research in Canada and to establish Western as a leading school for space systems design. This will enable the training of highly qualified personnel and provide Canadian industry with the necessary expertise and potential partners in future planetary mission activities. The vision is that the establishment of such a Centre at Western will benefit the entire Canadian space community as we inspire and train the next generation of scientists and engineers. We will partner with the Canadian Space Agency by hosting workshops, summer schools, and short courses that will strengthen and grow the Canadian community.
The Canadian Lunar Research Network is a new organization of Canadian scientists, engineers, and entrepreneurs from all across Canada. Their goal is to promote lunar research, foster collaboration among Canadian researchers and international partners, and extend their enthusiasm of lunar exploration to the general public. CLRN is the first NASA Lunar Science Institute (NLSI) affiliate outside of the United States conducting this world-class research.

Both the CLRN and NLSI support collaborative science and provide technical perspectives to NASA's lunar missions and developing future scientific investigations.

The Moon is a high-priority scientific target for exploration. In particular, the Moon, unlike the Earth, records approximately 4.5 billion years of solar system history in near-Earth space. As a result, the Moon offers unique insights into the early history of the Earth and the other terrestrial planets.

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Day, A.W.
de Bruyn, John
Denham, Graham
Denniston, Colin
Dhillon, Anjeet
Ding, Zhifeng
Dobinson, Katherine F.
Fenton, Brock
Fleet, Michael
Flemming, Roberta
Foth, Tatiana
Gallagher, Sarah
Gillies, Beth
Goncharova, Lyudmila
Gray, David
Grbic, Miodrag
Grbic, Vojislava
Guglielmo, Christopher
Guthrie, J. Peter
He, Wenqing
Henry, Hugh
Hicock, S.R.
Hocking, Wayne
Holt, Richard
Houde, Martin
Huang, Yining
Hudson, Robert
Huner, Norman
Hutter, Jeffrey
Illie, Lucian
Jardine, J. F. (Rick)
Jeffrey, David
Jiang, Dazhi
Jiang, Xing
Jin, Jisuo
Jones, Carol
Jones, Nathan
Jurgens, Helmut
Karagianis, Jim
Kari, Lila
Kartunen, Mikko
Katchabaw, Michael
Kelly, Gregory
Kerr, Michael
Keygobadi, Nusha
Khalkhali, Masoud
Konermann, Lars
Kraatz, Heinz-Bernhard
Krishna, Priti
Kulperger, Reg
Lachance, Marc-Andre
Lagugne-Labarthet, Francois
Lau, Leo
Lemire, Nicole
Lennard, William
Lenz, Alfred
Ling, Charles
Lipson, Robert
Liu, Xiaoming
Longstaffe, Fred
Low, Robert
Lutfyia, Hanan
Luyt, Leonard
Macdougall-Shackleton, Elizabeth
Macle, Sheila
Macneill, Ian
Madhavji, Nazim
Mamon, Rogemar
Marsolais, Frederic
Martin, Ronald
Maxwell, Denis
McIntyre, N. Stewart
McLeod, Allan
McNeil, Jeremy
Meath, W.J.
Mercer, Robert
Millar, Jack (John)
Milligan, Louise
Min, Paul
Minac, Jan
Mittler, Silvia
Moehring, Amanda
Morbey, Yolanda
Moreno, Maza, M.
Moser, Desmond
Mueser, Martin
Murdoch, Duncan
Neff, Bryan
Nesbitt, Wayne
Norton, Peter
Osborn, Sylvia
Osinski, Gordon
Pagenkopf, Brian
Peeters, Els
Pericival-Smith, Anthony
Perry, Mark
Phipps, James
Pinsonnault, Martin
DISCOVERY ACCELERATOR SUPPLEMENT PROGRAM

Atkinson, Gail
Boykov, Yuri
Konermann, Lars
Neft, Bryan
Southam, Gordon

Engineering Seismology Toolbox for Canadian Seismic Hazards Research (Leaders Opportunity Fund) Project Leader: Gail Atkinson

Laboratory for Image-based 3D Modeling Technologies (On-going New Opportunities Fund) Project Leader: Yuri Boykov

Physical Survey of Near-Earth Objects (Canada Research Chairs Infrastructure Fund) Project Leader: Peter Brown

Meteorite Environment
Optical Research Observing Stations (On-going New Opportunities Fund) Project Leader: Margaret Campbell-Brown

Information for the study of naturally disordered proteins and diseases (On-going New Opportunities Fund) Project Leader: Wing-Yiu Choy

Magnetic Resonance Systems Development Laboratory (Canada Research Chairs Infrastructure Fund) Project Leader: Blaine Chronik

High Performance Computing Cluster for Advanced Molecular Modeling and Computational Chemistry (On-going New Opportunities Fund) Project Leader: Styliani Constas

Catalysis, luminescence Spectroscopy, Sample Preparation and Analysis Facility (On-going New Opportunities Fund) Project Leader: Patrica Corcoran

The Catchment Research Facility: Monitoring and Modelling of Ecosystems (On-going New Opportunities Fund) Project Leader: Irena Creed

Catchment Research Facility: Tracking water and nutrient flows in forests in natural and controlled biomes under changing environmental conditions (Leaders Opportunity Fund) Project Leader: Irena Creed

Scanning electrochemical microscopy, near-field spectroscopy and microscopy of single semiconductor nanoelectronic devices (On-going New Opportunities Fund) Project Leader: ZhiHong Ding

X-ray Diffraction and Microdiffraction Facility (On-going New Opportunities Fund) Project Leader: Roberta Fleming

Molecular biology facility for embryo manipulation and genetics transformation (On-going New Opportunities Fund) Project Leader: Modrag Gavic

A mobile field laboratory for integrative ecological research (Western FLIER) (Leaders Opportunity Fund) Project Leader: Christopher Guglielmo

Heating, soil monitoring and nutrient analysis infrastructure for long-term climate simulations in the field (Leaders Opportunity Fund) Project Leader: Hugh Henry

Mutation Load Index: Critical parameters of DNA damage relevant to aging, cancer and neurodegeneration (On-going New Opportunities Fund) Project Leader: Kathleen Hill

A Millimeter and Submillimeter Instrumentation Laboratory (Canada Research Chairs Infrastructure Fund) Project Leader: Martin Houde

Molecular structure and Dynamics by Solid-State NMR Spectroscopy and X-ray Crystallography (New Opportunities Fund) Project Leader: Yining Huang

Photosynthetic Fluorescence Spectroscopy / Imaging Facility (Canada Research Chairs Infrastructure Fund) Project Leader: Norm Hunter

Atomic-Force Microscopy System for In-Situ Crystallization Studies (On-going New Opportunities Fund) Project Leader: Jeffrey Hunter

Mathematics Computation Network (Canada Research Chairs Infrastructure Fund) Project Leader: John Jardine

DISCOVERY ACCELERATOR EXCEPTIONAL NEW OPPORTUNITIES GRANTS

Karttunen, Mikko
Moehring, Amanda Jean
Pagenkopf, Brian L

Engineering Seismology Toolbox for Canadian Seismic Hazards Research (Leaders Opportunity Fund) Project Leader: Gail Atkinson

Laboratory for Image-based 3D Modeling Technologies (On-going New Opportunities Fund) Project Leader: Yuri Boykov

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Molecular structure and Dynamics by Solid-State NMR Spectroscopy and X-ray Crystallography (New Opportunities Fund) Project Leader: Yining Huang

Photosynthetic Fluorescence Spectroscopy / Imaging Facility (Canada Research Chairs Infrastructure Fund) Project Leader: Norm Hunter

Atomic-Force Microscopy System for In-Situ Crystallization Studies (On-going New Opportunities Fund) Project Leader: Jeffrey Hunter

Mathematics Computation Network (Canada Research Chairs Infrastructure Fund) Project Leader: John Jardine
Equipment for Integrated Research on Deformation Structures in the Continental Lithosphere (Leaders Opportunity Fund) Project Leader: Dazhi Jiang

Laboratory for Asymmetric Catalysis Research (On-going New Opportunities Fund) Project Leader: Nathan Jones

Quantitative Live-cell Fluorescence Microscopy and Digital Imaging Laboratory (Leaders Opportunity Fund) Project Leader: Jim Karagiannis

Biocomputing Laboratory (Canada Research Chairs Infrastructure Fund) Project Leader: Lila Karl

Landscape Genetics Laboratory (Leaders Opportunity Fund) Project Leader: Greg Thorn

A Quadruple Time-of-Flight (Q-TOF) Mass Spectrometer for Exploring Protein Structure (Canada Research Chairs Infrastructure Fund) Project Leader: Lars Konemann

Molecular Structure and Dynamics Studied by Electropray Mass Spectrometry (New Opportunities Fund) Project Leader: Lars Konemann

Radiolotope Facility (On-going New Opportunities Fund) Project Leader: Herbert Kranzucker

Characterization, Manipulation and Molecule-Spectroscopy: Imaging and Spectroscopy of Meso- and Nanostructured Materials (Leaders Opportunity Fund) Project Leader: François Lagugnilet-Labarthet

Installation of a scanning tunneling microscopy system for the development of molecular surface engineering of novel microfluidics (Leaders Opportunity Fund) Project Leader: Leo Lau

Stable-Isotope Science Western: A University Center for Continuous-Flow, Stable-Isotope Mass-Spectrometry in the Anthropological, Biological, Earth, Environmental, Health and Physical Sciences (Innovation Fund) Project Leader: Fred Longstaffe

VESPERs (Very Sensitive Elemental and Structural Probe Facility Employing Radiation from a Synchrotron) at the Canadian Light Source (Innovation Fund) Project Leader: Stewart McIntyre

Facility for Nanoscale Patterning, Growth and Functionalization of Surfaces (Innovation Fund) Project Leader: Ian Mitchell

Photonic surfaces and interfaces laboratory (Canada Research Chairs Infrastructure Fund) Project Leader: Silvia Mitter

Molecular and Behavioural Genetics Laboratory (Leaders Opportunity Fund) Project Leader: Amanda Moehring

Nanobeam Materials Analysis for Probing Planetary Evolution and Resources (NanoMAPPER); an innovation in Planetary Materials Science (Leaders Opportunity Fund) Project Leader: Desmond Moser

Centre for Analytical and Theoretical Studies of Solid Surfaces, Boundaries and Interfaces (Innovation Fund) Project Leader: Wayne Nesbitt

Triclinobender and Scanning Probe Facilities for Nanoscale Mechanical and Electrical Studies of Materials and Interfaces (Innovation Fund) Project Leader: Peter Norton

Ultrafast Systems Development Laboratory (Leaders Opportunity Fund) Project Leader: Tamie Poepping

Molecular Structure and Dynamics by High Resolution Nuclear Magnetic Resonance Spectroscopy (Institutional Innovation Fund over $350,000) Project Leader: Richard Puddephatt

Maid-top mass spectrometer for characterization of molecular materials (Canada Research Chairs Infrastructure Fund) Project Leader: Richard Puddephatt

Soft X-ray Beamline for Microcharacterization of Materials at the Canadian Light Source (Innovation Fund) Project Leader: Tsun-Kong Sham

A Window into Planetary Interiors: A Laboratory for Extreme Temperature and Pressure Studies (Leaders Opportunity Fund) Project Leader: Sean Sheehy

Synthetic Laboratory for the Discovery of Inorganic Materials (Leaders Opportunity Fund) Project Leader: Paul Ragozzino


Multimode Scanning Probe Microscope for the Study of Charge Distribution in Materials on the Nanoscale (On-going New Opportunities Fund) Project Leader: Oleg Semenkin

Scanning Probe Microscope (SPM) and Optical Spectrometer for XEOL (X-ray Excited Optical Luminescence) (Canada Research Chairs Infrastructure Fund) Project Leader: Tsun-Kong Sham

A Window into Planetary Interiors: A Laboratory for Extreme Temperature and Pressure Studies (Leaders Opportunity Fund) Project Leader: Sean Sheehy

Synthetic Laboratory for the Discovery of Inorganic Materials (Leaders Opportunity Fund) Project Leader: Paul Ragozzino


National Neutron Reflectometer Facility (Innovation Fund) Project Leader: David Shoessmith

Physiological performance of overwintering insects in a changing climate (Leaders Opportunity Fund) Project Leader: Brent Sinclair

Laboratory for Chemistry and Material Research under Extreme Conditions (Leaders Opportunity Fund) Project Leader: Yang Song

Facilities and equipment to establish a fundamental and applied geomicrobiology laboratory for astrobiology and mining related research (Canada Research Chairs Infrastructure Fund) Project Leader: Gordon Southam

Environmental Fluid Flows: Modelling and Experimentation (Innovation Fund) Project Leader: Paul Sullivan

Nuclear Waste Management and Geological Assimilation (On-going New Opportunities Fund) Project Leader: David Shoessmith

Computational Laboratory for Fault System Modeling, Analysis, and Design (On-going New Opportunities Fund) Project Leader: Kristy Tampo

Small Animal Image Guided Radiation Research Laboratory (Leaders Opportunity Fund) Project Leader: Eugene Wong

Laboratory for the Study of Radiation Induced Chemical Processes and Transport (On-going New Opportunities Fund) Project Leader: Jongsook Whan

Mobile Solar Video (MSV) systems for wildlife monitoring (On-going New Opportunities Fund) Project Leader: Liana Zanette

CANADA FOUNDATION FOR INNOVATION (CFI) FUNDED PROJECTS
CANADA RESEARCH CHAIRS

TIER 1 CHAIRS
Norman Hüner - Environmental Stress Biology
Rick Jardine - Applied Homotopy Theory
T. K. Sham - Materials and Synchrotron Radiation
Silvia Mittler - Photonicsof Surfaces and Interfaces
Gail Atkinson - Earthquake Hazards and Ground Motions

TIER 2 CHAIRS
Gordon Southam - Geomicrobiology
Peter Brown - Meteor Science
Lila Kari - Biocomputing
Lindi Wahl - Mathematical Biology
Yining Huang - Materials Characterization
Blaine Chronik - Medical Physics
Lars Konermann - Biophysical Protein Mass Spectrometry
Martin Houde - Star Formation
Matt Davison - Quantitative Finance
Elizabeth Gillies - Biomaterials Synthesis
François Lagugne-Labarthet - Nanomaterials and Photonics
Eric Schost - Computer Algebra
Nusha Keyghobadi - Molecular Ecology and Landscape Genetics
Irena Creed - Watershed Science
Amanda Moehring - Functional Genomics
Giovanni Fanchini - Carbon-based Nanomaterials and Nano-optoelectronics

ONTARIO EARLY RESEARCHER AWARDS

2005
Xingfu Zou - Dynamics And Patterns In Structured Populations: Modeling, Analysing And Predicting
Kathleen Hill - Predicting Disease Risk Based On DNA Mutation Load In A Single Cell
Kristy Tiampo - Large-Scale Computational Simulations And Data Assimilation Of Earthquake Fault Systems

2006
Christopher Guglielmo - The Physiological Ecology Of Migratory Birds And Bats
Nathan Jones - Laboratory For Asymmetric Catalysis And Nanomaterials Research
Paul Ragogna - New Inorganic Molecules And Materials
Blaine Chronik - Combined Magnetic Resonance Imaging And Positron Emission Tomography Imaging Systems
Paul Wiegert - Meteor Observation And Analysis: Investigating The Solar System's Early Ingredients

2007
Alex Buchel - Physics Of Strongly Coupled Quark-Gluon Plasma From String Theory
Yang Song - Chemistry And Materials Science Under Extreme Pressure Conditions
James Wariner - Advanced Materials Based On Hydrogen-Bonded Double Helices
Sean Shell - New Phases And Materials Under High Pressure And High Temperature

2008
Colin Denniston - Multi-Scale Modelling Of Nano And Micro-Scale Particle Suspensions In Complex Fluids
Miiko Karlutnen - Using Computer Simulations To Understand Biology: From DNA Sequencing To Drug Targeting
Elizabeth Gillies - Advanced Biomaterials Through Chemical Synthesis And Self-Assembly
François Lagugne-Labarthet - Advanced Optical Imaging For Nanomaterial Characterization
Pauline Bamby - Star Formation Histories Of Nearby Galaxies
Martin Houde - A Polarimeter And Dsp-Based Spectrometer For Submillimetre Astronomy
Silvia Mittler - All-Optical Analytical Lab On A Chip: A Fast And Reliable Analytical Tool For Making Quick Appropriate Decisions In The Case Of A Threat By Hazardous Material

2009
Elizabeth MacDougall-Shackleton - Birdsong As An Indicator Of Genetic Diversity And Local Adaptation
Brent Sinclair - Insect Low Temperature Performance In An Era Of Climate Change
Olga Veksler - Image Based 3D Modeling From Multiple Cameras
Gordon Osinski - Impact Craters On The Earth And Moon: Exploration Strategies And Techniques
Lyudmila Goncharova - Enabling The Nano-Age World
Leonard Luyt - Advances in the Design of Cancer Targeted Molecular Imaging Probes
FACULTY OVERVIEW

CORE DEPARTMENTS
- Applied Mathematics
- Biology
- Chemistry
- Computer Science
- Earth Sciences
- Mathematics
- Physics & Astronomy
- Statistical & Actuarial Sciences

RESEARCH CENTRES AND GROUPS
- The Biotron
- AFAR Advanced Facility for Avian Research
- LSIS Laboratory for Stable Isotope Science
- Western Nanofabrication Facility
- ORCCA Ontario Research Centre for Computer Algebra
- POLARIS Portable Observatories for Lithosphere Analysis and Research
- SHARCNET Shared Hierarchical Academic Research Computing Network
- SSW Surface Science Western
- CAMBR Centre for Advanced Materials and Biomaterials Research
- CPSX Centre for Planetary & Space Exploration
- CLRN Canadian Lunar Research Network
- CES Centre for Environment and Sustainability

INTERDISCIPLINARY PROGRAMS
- Planetary Science
- Environmental Science
- Bachelor of Medical Sciences

STATISTICS
- Number of Alumni: approximately 35,000
- Full-time students enrolled 2009-2010: 3800 undergraduate
- 330 part time undergraduate
- 666 graduate students
- Full-time faculty: 216
- Part-time faculty: 39
- Post Doctorate Researchers: 85
- Research Scientists and Associates: 24
- Staff: 114

RESEARCH EXPENDITURES

<table>
<thead>
<tr>
<th>Year</th>
<th>Research Expenditures (including SSW)</th>
<th>Number of Active Grants</th>
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</thead>
<tbody>
<tr>
<td>2003-04</td>
<td>$20,102,370</td>
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</tbody>
</table>

G-13* NSERC FUNDING PER ELIGIBLE RESEARCHER, 2007-2008

G-13* NSERC DISCOVERY GRANTS PER ELIGIBLE RESEARCHER, 2007-2008

* G-13 denotes the group of 13 top Canadian research intensive universities.
Faculty of Science
Office of the Dean
Room 191, Western Science Centre
London, Ontario N6A 5B7
CANADA
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