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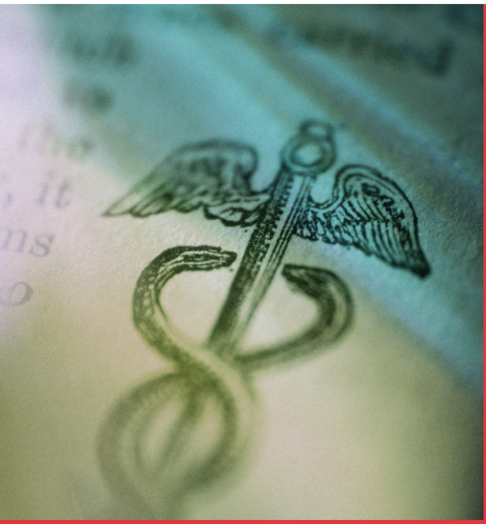
EUREKA!

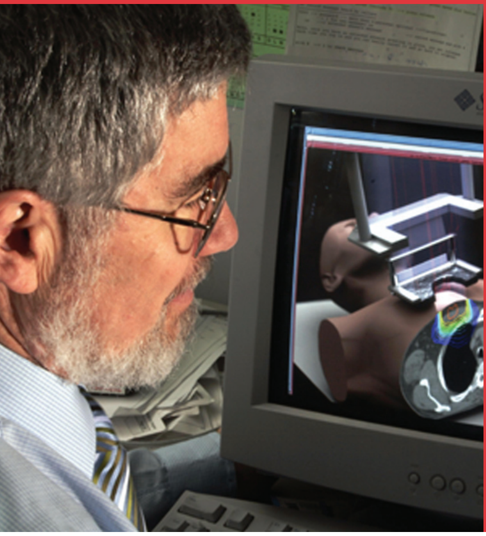
NEWSLETTER OF THE FACULTY OF SCIENCE

Spring 2007



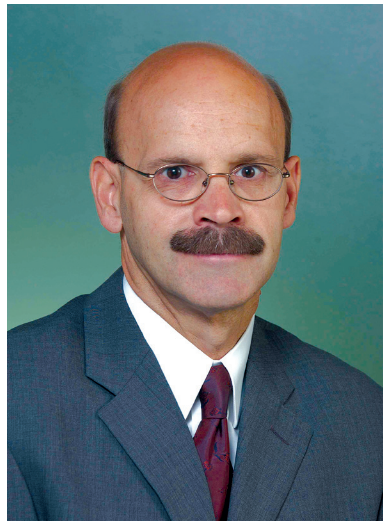
Doctors without stethoscopes

Improving health and medical care



- Medical physics tackles cancer treatment
- Biochemistry preserves organs

Carleton UNIVERSITY SCIENCE



To your health!

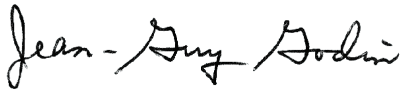
When sitting in a doctor's office or clinic, you will not likely be thinking of the environmental toxins that might have caused you to be there, the chemistry involved in the development of therapeutic drugs, the algorithms used in dose calculation, or the physics underlying the functioning of sophisticated medical scanning devices. Your doctor might not either.

But doctors—chemists, physicists, biologists, mathematicians—at Carleton are. Researchers in our Faculty of Science are making fundamental scientific discoveries and developing innovative tools and technologies to improve human health and medical care. Some of their leading-edge research is highlighted in this issue. For example, you will read about physicists working on safer and more effective methods of cancer treatment and the quest of biochemists to preserve organs. The family of alumna toxicologist Claire Franklin is profiled, and David Miller, NSERC Industrial Research Chair on Fungal Toxins and Allergens, highlights some of the issues surrounding environmental toxins in the Hot topic section.

In addition, this issue summarizes some recent and forthcoming events and news, which reflect the vigorous "health" of the Faculty, such as the upcoming anniversary celebrations for the Department of Chemistry, several on-campus Science public lectures and conferences, announcements of research funding and awards, and new appointments.

After serving as Dean for five years, I will be stepping down at the end of June and returning full time to teaching and research as Professor of Biology at Carleton. The formal search for my successor is ongoing, and we anticipate an appointment to be made shortly. This space will therefore carry a message from the new Dean in the fall issue of the newsletter!

It has been a privilege and a rewarding experience for me to have served the Faculty of Science and the University as Dean. There have been many positive developments in the Faculty over the past five years that have contributed significantly to its mission in teaching, research and community service. I have had the pleasure of meeting many alumni and friends of the Faculty during my term as Dean, and am grateful for the generous support of numerous donors to the Faculty and the University. I hope that you will continue to look forward to reading future issues of *EUREKA!* and to staying in touch with our Faculty through this medium wherever you may reside.



Jean-Guy Godin
Dean, Faculty of Science

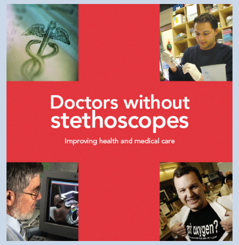
EUREKA!
NEWSLETTER OF THE FACULTY OF SCIENCE

carleton.ca/science/

Newsletter Mission Statement
EUREKA! is published for the alumni, faculty, staff, friends and partners of the Faculty of Science. The newsletter is intended to communicate the Faculty's goals, strategic direction and activities in order to connect alumni to each other and the university. It is published in collaboration with the Department of University Advancement.

On the cover

Clockwise from top right: Undergraduate student Tarek Abd El Halim, Associate Professor Bill Willmore, and Canada Research Chair in Medical Physics David Rogers.



Your input is important!

Please send your feedback, letter to the editor or story ideas to *newsletter_editor@carleton.ca.*

Take our online survey

Visit eureka.carleton.ca to share your opinions.

David Miller participates in the World Health Organization bodies that evaluate carcinogens and toxic compounds and is on the Board of Directors of the Toxicology Forum in Washington, D.C.

The modern legacy of Rachel Carson

By J. David Miller

Forty-five years ago, Rachel Carson published *Silent Spring*, a book in which she challenged the practices of agricultural science and the government, focusing attention on the effect of pesticides on human and animal health. In retrospect, it is hard to believe that 50 years ago, little testing of chemicals was done in a way that would be useful to the current regulatory process. Indeed it took until the early 1980s to frame the early modern response to regulatory toxicology. In 1999, Canada responded fully to Carson's appeal with the passage of the *Canadian Environmental Protection Act,* which sets out to protect human health and the ecosystem on which life depends.

Seldom does a day pass that there is not a media report suggesting that some man-made chemical results in increased human disease. Most often the report is contradicted in short order by a new study, or the chemical is not used or does not occur in Canada, leaving decision-makers and the public confused.

In March, our colleagues at the Institute of Population Health at the University of Ottawa published a series of papers on the effects of environmental chemicals on child health in Canada. Briefly, they examine a number of organic and inorganic pollutants in relation to the reliable evidence. The conclusions they reach are worth pondering.

The authors summarize knowledge of associations between child health and development outcomes and a number of environmental exposures including lead, methylmercury, pesticides, environmental tobacco smoke (ETS), allergens, outdoor air pollution, sunlight, residential proximity to hazardous waste disposal sites, and paternal workplace exposure to solvents. After a great deal of systematic effort in reviewing the literature, the authors conclude that the priority assigned by government agencies to outdoor (traffic pollution) and indoor quality (allergens, air contaminants from outdoors), lead, water contaminants, and ETS is "well justified". There is clear evidence that taking action on these would improve population health and quality of life, and reduce current and future health care costs.

Most of the evidence for the health effects of organic chemicals, including pesticides, comes for those that persist in the environment, many of which were not permitted or seldom used in Canada when they were in production. Most of these are banned and such bans make a difference. Although there are few comparable Canadian data, the US tracks blood levels of a large number of contaminants in a representative sampling of its population. For example, metabolites of DDT were about 10 times lower in 2001–2002 compared to 1976–1980 among Americans aged 12 years or older.

The *Canadian Environmental Protection Act* did mark a turning point because Parliament asked that both human and environmental health be considered in the management of chemicals. Additionally, the legislation directs against the approval and continued use of persistent compounds that bioaccumulate. This is important because although regulatory toxicology has improved a great deal in 50 years, common sense dictates that if the chemical cannot persist in the environment or accumulate in the food chain or human body, we are on inherently safer ground.

Lead, mercury, abandoned waste disposal sites and persistent pesticides are all examples of public health issues stemming from past actions that require our urgent attention today. Traffic pollution and indoor air quality, especially allergens, soil and outdoor air contaminants ending up indoors, are examples of major environmental health problems that we are still compounding and that require much more effort.

Despite our progress in philosophy and science, there is still much to be done in protecting the health of the ecosystem and all living within it.

J. David Miller is a Professor of Biochemistry and an NSERC Industrial Research Chair on Fungal Toxins and Allergens.

Fast fact...

For more information, the Institute of Population Health papers can be found in *Journal of Toxicology and Environmental Health*, Part B, 10 (1):1-

EUREKA!'s Hot topic is a place for Carleton faculty to educate readers on some of the big-picture issues shaping Science today. Share your thoughts at eureka.carleton.ca.

Air Supply

Bill Willmore's research into the effects of low oxygen on proteins has implications for endurance athletes as well as clinical conditions such as anemia, neurocognitive deficits and cerebrovascular disease.

Situations as diverse as being at a high altitude, having anemia, sleep apnea, cardiac arrest, or a stroke deprive the human body or its organs of oxygen, a condition known as hypoxia. Understanding how the body adapts to hypoxia could lead to new therapies for patient recovery from cardiovascular disease.

That's why Dr. Bill Willmore, PhD/97, Associate Professor of Biochemistry, is searching for the alterations in protein structure and function that enable cells to survive hypoxia.

"When oxygen is present it can be combined with hydrogen and be added to a protein, in a process known as hydroxylation," says Willmore. "Hydroxylation modifies proteins in a way that can change their structure and function. Without oxygen, hydroxylation does not occur, and we can see which proteins function differently without it."

Willmore's research is being assisted by a $150,000 Early Researcher Award from the Ontario government, matched by the Ontario Ministry of Research and Innovation, Carleton and other sources.

"The Early Researcher Award will provide secure funding for incoming graduate students," says Willmore. "The increase in funding will help to attract highly qualified students who can help to accelerate the pace of research."

After taking leads from bioinformatics—the mathematical extraction of information from data—and screening yeast genes for low-oxygen tolerance with colleague Dr. Ashkan Golshani, Assistant Professor in the Department of Biology, Willmore identified human proteins on which to focus. Using human cell lines, he examines changes in protein expression, function and stability under varying oxygen conditions. He can knock genes out of commission to see what role they play in surviving hypoxia, or add genes using recombinant DNA technology to increase protein production.

"It gives us insight into which proteins are involved in responding to and surviving low oxygen conditions. The majority of proteins may not change, so we go after the ones that do," Willmore says.

After treating the cells with 1 per cent oxygen—a substantial decrease from air's 21 per cent—proteins are extracted for in vitro studies measured against proteins extracted from cells in normal atmospheric oxygen: are they hydroxylated? Does their function—catalytic activity, DNA-binding, ligand binding or protein-protein interactions—change?

> "Air is 21 per cent oxygen. Mammals can't live with less than five per cent, but their cells can survive at one per cent in the lab.

One such protein, a transcription factor known as Hypoxia-Inducible Factor-1 (HIF-1), controls the expression of genes responsible for hypoxia survival, such as those involved in increasing blood flow to tissues and switching from aerobic to anaerobic biochemical pathways. HIF-1 is not present in cells under normal atmospheric conditions as hydroxylation causes it to be rapidly broken down.

Willmore, who began working with HIF-1 as a post-doctoral fellow at Harvard Medical School, describes it as a difficult protein to work with.

"We have a window of about five minutes to get the protein out of the cell before it degrades," he says. "When students harvest cells, I stand behind them with a stopwatch."

Willmore's focus is currently on erythroid-specific 5-aminolevulinate synthase, the first and most critical protein in the pathway that leads to heme synthesis—heme that is incorporated into hemoglobin for maturing red blood cells.

"I'm interested in how well the enzyme performs under low oxygen because it will provide insight into some diseases with anemia as a symptom," says Willmore. "It is expected that the enzyme will perform better under hypoxia when the body is actively making more red blood cells."

Willmore hopes his research will lead to the development of a chemical therapy that would precondition cells to respond to low oxygen. By tricking the cell to respond as if it was receiving less oxygen, the therapy would trigger the production of adaptive (hypoxia-inducible) genes and proteins. If the cell is later deprived of oxygen, such as during a heart attack or stroke, it will be better protected from damage than if it hadn't been preconditioned.

"The ultimate goal is to benefit people," says Willmore. "We're finding leads that will help others develop treatments."

Winging it

Mother Nature is the ultimate engineer—her blueprints are all around us. Take the hook and loop fastener (trademarked as Velcro) invented by a Swiss engineer who took a close look at the thistle seeds stuck to his clothes and his dog's fur. Sonar and ultrasound imaging imitate the echolocation system of bats. But flight, with the efficiency, maneuverability and payload carrying capacity of flying insects, has proved tricky.

"According to conventional aerodynamics theory, bumblebees can't fly," says Dr. Jeff Dawson, Assistant Professor of Biology. "Fortunately for insects, they don't know this. After 350 million years of evolution, they are the best fliers on the planet."

Unlike a helicopter that gets lift from the constant motion of its propellers, insects flap their wings at rapidly changing speeds and directions. Beating wings create vortices of air, and the resulting low pressure helps lift the wing. To understand the neuroethology and biomechanics of four-winged insect flight, Dawson combines traditional biology and engineering in his research on African migratory locusts.

On the biology side, graduate student Scott Whitehead is examining the organization of locust neural circuits, testing how locusts change wing kinematics in response to high frequency sounds, like those emitted by a predatory bat.

"The way a locust avoids predators and maintains stability in flight can teach us about flight control," says Dawson. "There might be spin offs for plague and swarm control too."

Understanding flight itself veers into engineering. Dawson builds models of insect wings—varying the shape, surface and angle of motion—to study aerodynamics. By dotting the wings with dye and rotating them underwater, Dawson can control the elements and record the dye streams that reveal the vortices.

His research attracted the interest of undergraduate student Katharina Schnackenburg from the University of Applied Sciences Bremen, Germany, which offers a unique program in biomimetics. Required to study abroad for a semester, Schnackenburg already had her eye on Canada, the native country of her great-grandmother, when she found Dawson's interdisciplinary lab.

"It was coincidence that I read about Jeff's research projects on the internet, but I was interested in them immediately," says Schnackenburg. "He's doing research in an interdisciplinary field considering engineering and biological aspects, which is exactly what my field of studies in Germany is about: biologically inspired engineering."

Armed with knowledge of propulsion, materials, sensors, fluid dynamics and experience using a wind tunnel and water channel, Schnackenburg joined Dawson for a semester—and plans to return for the summer—to delve into the complexity of wing-wing interactions.

"We invent things on the fly in the aerodynamics work, and Katharina's ideas and approaches were a big benefit to the project," says Dawson. "She was able to confirm that the presence of the fore wing alters airflow over the hind wing, enhancing its lift."

"I'm still evaluating the data," says Schnackenburg, "but while the flow on the fore wing wasn't influenced by the presence of the hind wing at all, the hind wing changed dramatically depending on the speed and angle of attack of both wing models."

The next step in the project is to visualize the mechanisms of interaction. As the research team continues to discover the secrets of four-winged flight, their findings will enable the development of better propeller blades, improved flight control systems and micro-mechanical devices for search and rescue, surveillance, and even space exploration.

In the near future, we may be able to say a micro-vehicle collecting samples on Mars was inspired by a locust.

Jeff Dawson, who worked in Germany as a graduate student, found the opportunity invaluable. In the fall, he welcomed German undergraduate student Katharina Schnackenburg to his lab. "Jeff is always excited about his research and you can feel that he loves what he is doing," says Schnackenburg. "He was always concerned about my well being in Canada. I couldn't have wished for a better supervisor for my semester abroad."

Lab DIY

In studying locust flight, Jeff Dawson combines low- and high-tech equipment. He uses bikini wax to affix a removable harness made from pop can strips to a locust so the test subject can be suspended in front of a fan to prompt flight. A high-speed camera and multi-channel amplifier allows recording of activity in 16 muscles to capture motor output.

In fact, Dawson knows enough about locust flight muscles controlling steering that he can insert electrodes into the muscles to enable a suspended locust to drive a "car". The mini-vehicle, which contains Lego pieces, has an onboard computer that translates the muscle movements and turns the car as the locust flies.

He hopes a future student will explore whether locusts can learn by using stimuli avoidance to improve their driving.

The physical body

Applying physics to problems of human health has resulted in the invention of the computed tomographic (CT) scanner, the use of high-energy photon and electron beams for cancer therapy, and the development of the magnetic resonance (MR) imager. Medical physics holds promise for improvements in the diagnosis and understanding of disease and for patient care.

Carleton's Dr. David Rogers and Dr. Tong Xu are using physics to make the treatment of cancer more precise. Members of the Ottawa Medical Physics Institute (OMPI), an organized research unit of the Department of Physics, they are part of a dynamic network of 30 medical physicists—at Health Canada, the National Research Council, the Ottawa Heart Institute, the Ottawa Hospital and Cancer Centre, Nucletron Canada, and Carleton University—collaborating on common research and academic matters.

Calculating a cure

Brachytherapy seems straightforward: place a radioactive source inside or next to a tumour in the prostate or breast to kill it. But like all cancer treatments, finding the dose that will kill cancer with minimal harm to the patient is tricky. The complex interactions inside a human body, and variables such as body fat and the location of the tumour, make precise dose delivery a Herculean task.

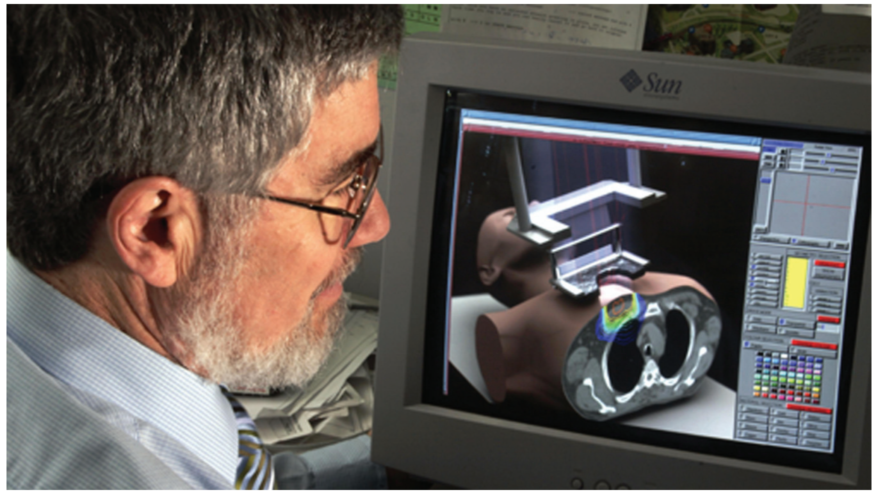
That's why David Rogers, Canada Research Chair in Medical Physics and head of the Carleton Laboratory for Radiotherapy Physics, is developing a faster Monte Carlo code—an algorithm using random numbers—for more accurate dose calculations.

"By understanding the physics of photon interaction in the body—the angle it bounces, when it creates an energetic electron—we can simulate a photon's movement billions of times over to see what it will do," says Rogers. "Knowing where the radiation goes helps doctors to better position the radioactive seeds in the body to deliver a uniform dose and to minimize exposure to other areas."

The commercial treatment planning system in use by medical physicists to calculate dose has the advantage of speed, at the expense of accuracy. Rogers' code is so fast that it can calculate in three minutes what other codes take six hours to do—and it is within two per cent statistical accuracy.

Using random numbers, knowledge of the probability of various interactions, information from CT scans and the initial amount of radioactivity, the Monte Carlo simulation predicts where the energy is deposited. Running the simulation repeatedly removes randomness and averages the behaviour, resulting in an accurate and fast code.

Rogers' team is running final checks and benchmarking the code against other forms of dose calculation, with the goal of releasing the calculation to collaborators at research clinics this summer or fall. With feedback from the laboratory, Rogers hopes to make the code user friendly before releasing it for general use in 2008.



David Rogers used funds from the Canadian Foundation for Innovation to purchase 60 computers on which to run his calculations. When the medical physicists aren't using them, they are available to the particle physicists to maximize their benefit to the department's research.

"Brachytherapy is easier for the protate patient than other forms of radiation," says Rogers. "There are still other uncertainties that knowing the dose won't resolve, but people are eager for ways to make the treatment process faster and more accurate."

Sighting a moving target

How do you hit a moving target? For pulmonary and abdominal cancers, the very act of breathing makes it difficult to deliver radiotherapy accurately as the tumour moves with each breath.

Tong Xu, Assistant Professor in the Department of Physics, is developing real-time tumour tracking for radiation therapy using positron emission isotopes.

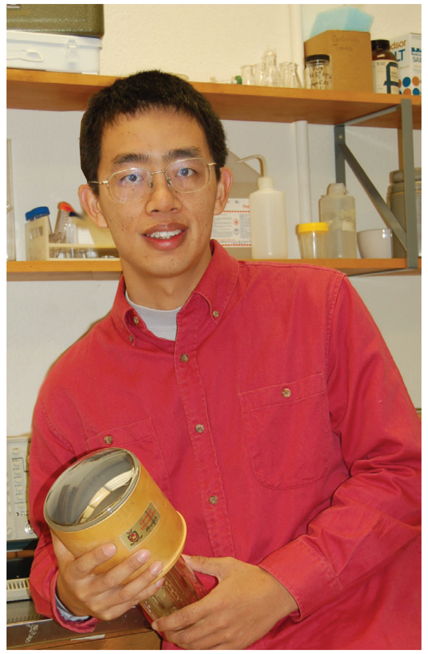
"We've reached a bottleneck in treatment accuracy, so now we need accuracy in tumour tracking," says Xu. "By tracking a tumour's exact position, the radiotherapy x-ray beam could move with it, reducing treatment time and reducing the exposure of healthy tissue to radiation."

Current tracking methods involve exposing healthy tissue to x-rays that pick up markers implanted in the tumour, or using large electromagnetic transponders that can cause a lung to collapse or leak air when they are inserted.

Xu's technique, called PeTrack, uses positron emission isotopes, housed in small markers less than 0.8 millimeters in diameter. Inserted into the tumour, the emitted positron, on meeting an electron, gives out a gamma ray that is picked up by detectors positioned on each side of the body. Multiple gamma rays allow for the position of the marker to be calculated.

In initial computer simulations, PeTrack was accurate within less than a millimeter. Using a positron emission tomography detector at the Ottawa Heart Institute, Xu's experimental results showed .3 to .6 millimeter accuracy with one stationary marker. The next step is to add motion and multiple markers so that the location and shape of a tumour can be tracked in three dimensions.

"The challenge with multiple markers is to keep the necessary algorithm fast," says Xu, whose algorithm currently can locate four static markers in 20 milliseconds. He expects to have the first PeTrack prototype ready in two years for animal trials, with patient trials following a year later.



Tong Xu's PeTrack system can be applied to real-time tool tracking for surgery as well as to tumours. By embedding a positron emission marker in tools or coating tool surfaces, their position in the patient can be tracked.

Fast fact...

Established in 2004, the Robert L. Clarke Graduate Scholarship in Medical Physics is awarded annually to an outstanding student specializing in Medical Physics. This award was developed to recognize the contribution of the late Dr. Robert Clarke, Distinguished Research Professor and founder of the Ottawa Medical Physics Institute. To learn more, or to contribute to the Robert L. Clarke Scholarship in Medical Physics, see carleton.ca/science/events/Clarke.

The shape of things to come

Everyone knows their height, and most of us know our weight, but what do these two numbers tell us about our health? Plunk that data into the algorithm for the body mass index (divide weight in kilograms by height in meters squared and multiply by 100) to determine how much your weight departs from what is normal for a person of that height, and the hidden relationship between height and weight is revealed in a simple chart with bands of "underweight", "normal" and "obese" running along two axes.

But what if you want a better picture of the risk of heart disease? What kind of chart is produced if age, sex, blood pressure and waist measurement are added? How are relationships between so many dimensions discovered?

Enter Dr. Patrick Morin, computational geometer.

Pat Morin is the first professor in the Faculty of Science to receive funding from the Carty Research Fellowship program.

Morin, BCS/96, MCS/98, PhD/01, an Associate Professor in the School of Computer Science, received an inaugural Carty Research Fellowship from Carleton University to study more efficient methods for computing statistics on data with more than one dimension.

"Statisticians work on techniques for discovering relationships between data, but some of these techniques are not very computationally feasible," says Morin. "Computers offer a mechanism to explore volumes of data in multiple dimensions, so I'm trying to find ways to make those techniques run efficiently on the computer."

Because the statistics have more than one dimension, they become geometric problems. Instead of the statistician's usual distribution patterns, the recent concept of statistical data depth offers a new perspective: a centre-outward ordering of points in Euclidean space of any dimension. Morin's algorithms will exploit geometry, looking for shapes that contain the most points or separating them into classes.

"This is such a big area, I could study it for the rest of my career, but I can't do it all myself," says Morin, who has been studying this area on and off for five years. He plans to hire a post-doctoral fellow with the Carty Fellowship funding to help move the research forward. "We'll be able to contribute more and expand the breadth of the research project."

Carleton established the Carty Research Fellowship program in 2006 to provide seed funding for new faculty members to initiate innovative research and scholarly activities. The program was founded with $4 million from the endowment left by former public servant and philanthropist E. Bower Carty. Morin was among nine faculty members awarded the inaugural fellowships. Morin has also received funding from the Ontario Innovation Trust and the Canada Foundation for Innovation New Opportunities Fund.

"I'm very lucky to be working with the world-class computational geometry group here at Carleton. The Carty Fellowship is a great boost for this project," he says.

Fast fact...

Carleton's School of Computer Science is hosting the 2007 Canadian Conference on Computational Geometry from August 20 to 22. The annual international event, which attracts students and researchers alike, disseminates new results in the fields of computational and combinatorial geometry. Visit 2007.cccg.ca for details.

Another rung on the LADDER

Assistant Professor of Chemistry Maria DeRosa, BSc/99, PhD/03, investigates the use of short stretches of nucleic acid, known as aptamers, as receptors for biosensors and as building blocks for other bionanotechnology applications. Her innovative research earned her the John Charles Polanyi Award and investments from the Canada Foundation for Innovation and the Ontario Research Fund.

In October 2006, DeRosa became the first Carleton professor to receive the Polanyi Award, established by the Government of Ontario 20 years ago to honour outstanding researchers in the early stages of their career.

Her Laboratory for Aptamer Discovery and Development of Emerging applications Research (LADDER) also received an infusion of funds when the Canada Foundation for Innovation Leader Opportunity Fund for infrastructure and the research infrastructure component of the Ontario Research Fund each invested $120,000. Carleton will use the investment to create a state-of-the-art facility to support DeRosa's research.

Read more about DeRosa's research online, in the spring 2006 archive at eureka.carleton.ca

Carleton's best and brightest

The annual Carleton University Teaching and Research Achievement Awards honour the best and brightest faculty. Congratulations to Susan Aitken, Assistant Professor in the Department of Biology, on her teaching award and to Steve Cook, Assistant Professor of Environmental Science and Biology, and Professor Pudupadi (Sundar) Sundararajan, (NSERC) Industrial Research Chair of Morphology of Smart Materials and Composites, on their research awards.

New NSERC group chair

Dr. Jörg-Rüdiger Sack, already the Natural Sciences and Engineering Research Council of Canada (NSERC) Industrial Research Chair in Applied Parallel Processing in the School of Computer Science, has also been appointed by NSERC as group chair for its Mathematical, Statistical and Computational Sciences Committees for a three-year term, and as a member of the Committee on Grants and Scholarships.

As group chair, Sack monitors the quality of peer review in the selection committees under his responsibility and acts as a constructive critic. He represents their opinions and concerns to the Committee on Grants and Scholarships where he makes recommendations on program allocations, existing programs and changes, advises on international dimensions of activities and policy issues, monitors the peer review process, and periodically reviews the jurisdiction of selection committees.

The graduate

Dr. Matthias Neufang, Assistant Professor and Graduate Director in the School of Mathematics and Statistics, was appointed Associate Dean of Programs and Planning in the Faculty of Graduate Studies and Research. He chairs the Faculty's Programs and Planning Committee responsible for course changes and new graduate programs, monitors the business practices and supporting information systems, and assists managing the Faculty's role in the periodic review of graduate programs for the Ontario Council on Graduate Studies.

Neufang, who joined Carleton in 2002, co-directed the Ottawa-Carleton Institute of Mathematics and Statistics and sat on various committees having a direct impact on the operations of the university's graduate studies programs.

"Dr. Neufang's well-rounded knowledge of the operations and aspects of program planning and delivery will improve our programs and move us towards our goal of becoming one of Canada's premier graduate universities," says John Shepherd, BA/70, BMus/72, Dean of Graduate Studies and Research.

Get in the game

Figures released in January show that Carleton is making the grade with Ontario prospective students. The Ontario Universities Application Centre data showed that high school students are clamouring to get into our Bachelor of Computer Science degree program—first choice applications soared to 119 per cent over last year, largely in response to the addition of a computer game development stream.

The computer game industry doubles in size every two years. The School of Computer Science has created a challenging new stream in computer game development to meet the demand, starting in fall 2007.

"Students graduating from the computer game development stream will typically aim for a career in the fast-growing computer game industry. However, the stream also contains all of our core software engineering subjects, so students can also apply for software engineering positions in any other sector of the IT industry," says Associate Director Michel Barbeau.

Hibernating organs

If you have ever frozen a tomato, you know that it will thaw out as a mushy, imperfect version of its fresh self, its cells ripped apart by ice crystals. The same thing can happen to an organ destined for transplant, which is why, although packed on ice, it can't be frozen. Without a technique for longer term preservation, a kidney, heart or lung needs to reach a patient within hours of removal from the donor.

> "With each NSERC award, I've tried to learn something new. To understand material you learn, you really need to be in the lab.

Tarek Abd El Halim, a fourth-year Biochemistry student, thinks there might be a way to preserve organs for transplant at a low temperature—maybe for years—and he's looking at hibernating squirrels for clues.

"Many of the same genes and proteins that change in a squirrel during hibernation are found in humans," he says. "If we know what metabolic changes occur when a squirrel's heart goes from 300 to 5 beats a minute in low temperatures, we can apply that to organ preservation."

The recipient of three Natural Sciences and Engineering Research Council undergraduate student research awards, Abd El Halim has spent his summers working in Carleton research laboratories, first with Associate Professor Bill Willmore (see story on page 4) and recently with Ken Storey, Canada Research Chair in Molecular Physiology.

"Tarek is one of those rare students that you only have to point in the right direction and then just hold his coat," says Storey, a renowned researcher famous for his work with frozen frogs. "A complete self starter and voracious worker, Tarek benefited from a well-funded, fully equipped lab and from a supervisor who knew enough not to get in his way."

Given the freedom to try out new ideas, Abd El Halim looked at squirrels in all stages of hibernation rather than simply hibernating and not.

"Hibernation isn't a constant state or a case of on or off. Genes are changing throughout," says Abd El Halim.

Since squirrels build up fat to live off during the winter, lipid metabolism is key to survival. By extracting RNA and proteins from heart tissue, Abd El Halim found specific points in hibernation when changes to metabolism were dramatic. He examined messenger RNA and protein changes during early and late hibernation, identifying a transcription factor produced in those stages that is necessary for all the changes that follow.

For his findings, Abd El Halim, with secondary author Melanie Bouffard, was awarded best research/poster award at the national Annual Chemistry and Biochemistry Graduate Research Conference at Concordia University, where he competed against more than 70 graduate students.

"People see squirrels everywhere, but I was one of the first people to see this specific gene sequence in the squirrel's genome," says Abd El Halim. "That's a pretty exciting way to spend the summer."

Lead astray

The annual Varian Lecture, established in 1991 by an endowment from Varian Canada and sponsored by the Department of Chemistry, presented Dr. Bill Shotyk, Professor at the University of Heidelberg and Director of its Institute of Environmental Geochemistry, on April 30. His lecture "Pathways of lead and antimony from the atmosphere to the hydrosphere: New insights from arctic ice, ombrotrophic bogs, forest soils, streams and lakes, and groundwaters" examined the migration of lead from human activities in the Great Lakes-St. Lawrence region.

With research experience in cell death and proliferation, Tarek Abd El Halim is interested in pursuing a medical career with a focus on cancer research. "Doctors can help the community they work in, but research can have an impact around the world," says Abd El Halim, who interviewed for a unique MD/PhD program that would allow him to be both a clinician and researcher.

Running in the family

As an undergraduate, Meredith Franklin, MSc/03, realized opportunities for a trumpet player might be scarce, so she switched from music to science—a field in which her parents have enjoyed careers spanning more than 30 years.

Her father James Franklin, BSc/64, MSc/67, consults in exploration geology with his company Franklin Geosciences. A fellow of the Royal Society of Canada, he's an adjunct professor at the University of Ottawa, Laurentian University and Queen's University, is on the board of directors for six mining exploration companies, and is involved with non-profit organizations including the Canadian Scientific Submersible Facility.

"As an undergraduate at Carleton, I gained a passion for geology as well as knowledge," he says. With a PhD from the University of Western Ontario, Jim taught at Lakehead University before joining the Geological Survey of Canada (GSC) as regional metallogenist directing major research programs on gold and base metal deposits in the Canadian Shield.

As director of the GSC's seafloor minerals program, Jim got the International Ocean Drilling Program to focus on a Canadian mineral deposits project before he became chief geoscientist, where he coordinated the entire GSC scientific program.

When he retired in 1998, his career highlights included winning numerous major geology awards, including the Selwyn G. Blaylock Medal from the Canadian Institute of Mining and Metallurgy and the Duncan Derry Medal from the Geological Association of Canada.

Despite sharing common interests, Meredith found that following in her father's footsteps wasn't the right path. "I took a couple of geology classes and worked in a field camp," she says. "Being in the middle of nowhere, I realized that I wasn't all that wild about geology!"

Instead Meredith chose a major in chemistry, where she discovered that she was good with numbers and added math for a double major. Her attention turned to statistics during her first job, and Meredith enrolled in a master's program at Carleton.

"My parents always had positive things to say about their studies at Carleton," says Meredith. "My experience was fantastic. I got a lot out of my MSc—academically, professionally and personally."

Now completing her PhD in applied statistics at Harvard University, Meredith is bridging the fields of spatial statistics and atmospheric sciences in her thesis. "A major aspect of my research is to integrate and model earth-orbiting satellite and meteorological data to understand how particulate matter air pollution is distributed over the US for use in a public health setting," she says.

Meredith's research has echoes of her mother's work. A leader in exposure and risk assessment, Claire Franklin (nee Bailey), BSc/63, is a research fellow at the McLaughlin Centre for Population Health Risk Assessment at the University of Ottawa, where she received her doctorate in physiology, and she teaches toxicology at the Cyprus International Institute for the Environment and Public Health. She is also president of The LifeLine Group, a non-profit organization developing software models to assess exposure, risk and benefits to elements of people's diets and environments.

Dr. James Franklin, soon-to-be-doctor Meredith Franklin and Dr. Claire Franklin all studied in the Faculty of Science. Experts in three disciplines, the family also shares a musical bent. Claire played cello in the Thunder Bay symphony, Jim plays piano, and Meredith plays piano and classical trumpet.

Claire began her career as director of the Thunder Bay School of Medical Technology and chair of the Medical Sciences Program at Lakehead University before joining the Environmental Health Directorate of Health Canada. In 1995, she launched the Pest Management Regulatory Agency at Health Canada as executive director and made it an international leader in pesticide regulation. One of its major activities was developing the Pest Control Products Act.

"Not many scientists are involved in law making, so bringing the act into being was a fascinating process for me," says Claire, who received the 2003 Outstanding Achievement Award of the Public Service of Canada. She was senior advisor to the Deputy Minister, Health Canada before retiring from the public service "to get back to research".

Meredith, too, sees herself pursuing research and academia. In the fall, she starts a post-doctoral fellowship at the University of Chicago's Statistics Department and the Argonne National Labs where she will continue her research in spatial statistics and atmospheric sciences.

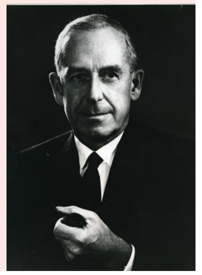
"I've learned, by taking my parents as an ideal example, that it's possible to get so much out of life if you stay positive and pursue your goals," she says.

10 things to celebrate about Chemistry at Carleton

1 The Department of Chemistry celebrates its 60th anniversary this year. It predates the creation of Carleton University by 10 years.

2 The philosophy of the department is to focus attention on excellence in undergraduate teaching, and to cover as wide an area of chemistry as possible.

3 The Steacie Building for Chemistry is named in honour of E.W.R. Steacie, a distinguished chemist who served as chair of Carleton's Board of Governors and President of the National Research Council.



4 The first PhD degrees in Chemistry were awarded in 1969. In 1981, the graduate programs in chemistry were amalgamated with the University of Ottawa. Now called the Ottawa-Carleton Chemistry Institute, it offers master and doctoral degrees in all areas of chemistry, including biochemistry, analytical, inorganic, organic, physical and theoretical.

5 In 1970, the biochemistry program was created and is run jointly by members of the Chemistry and Biology Departments. The program in environmental science was initiated in 1991, the same year that the Centre for Analytical and Environmental Chemistry was created with Varian Instruments.

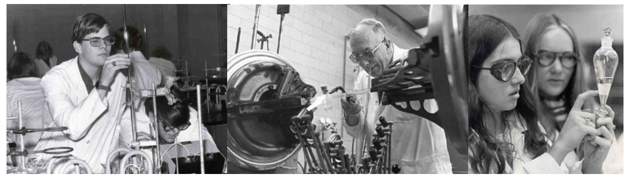
6 Thirty-five organizations participate in the cooperative education program, integrating students' academic experience in Chemistry with work experience in industry and government.

7 The Chemistry Department has one of the most generous scholarship programs in Canada, offering 12 undergraduate scholarships.

8 The department houses the NSERC Industrial Research Chair in Fungal Toxins and Allergens, the Canada Research Chair in Molecular Physiology, the Canada Research Chair in Emerging Organic Materials, and the NSERC-Xerox Industrial Research Chair.

9 Current department chair Bob Burk's CHEM 1000 course was the first in the world to become available in its entirety via iTunes video podcast.

10 The Department of Chemistry is hosting the Ottawa-Carleton Chemistry Institute Day on May 11. In addition to graduate students from Carleton and University of Ottawa presenting posters, the event is a chance to kick off celebrations of the department's 60th anniversary.

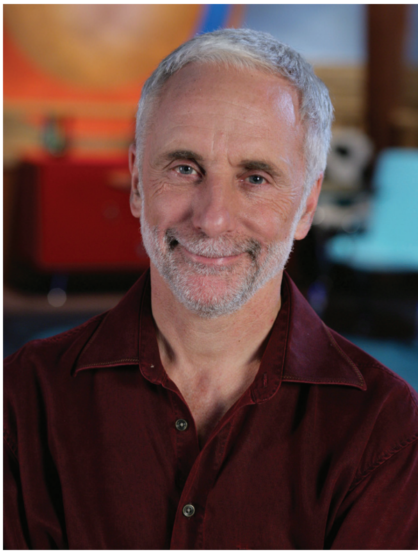


A student agenda

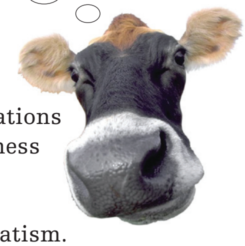
What better way to give graduate students an opportunity to explore themes in biology than to have them organize their own symposium? The fourth annual Ottawa-Carleton Institute for Biology (OCIB) Symposium, organized entirely by graduate students at Carleton and the University of Ottawa, was held at Carleton on May 1.

"It's a great way for the two universities to work together, as the OCIB is a joint biology program between the two universities, and for grad students to get involved in their department," says Stacey Lee-Jenkins, who co-chaired the symposium with Carleton's Stacey Robinson and Ottawa's Vicky Filion and Carolina Ogrodowczyk.

Three speakers talked about their research as it applies to the chosen theme: bridging the gap between theory and reality. This year's speakers were Dr. Duncan Irschick, University of Massachusetts at Amherst; Dr. Locke Rowe, University of Toronto; and Dr. Moshe Szyf, McGill University. The symposium talks were followed by a discussion panel and a reception for biology graduate students, faculty and speakers to interact.



Can animals think?



"They're smarter than we thought," says Jay Ingram, host of the Discovery Channel's *Daily Planet* and author of several bestselling books including *Theatre of the Mind: Pulling Back the Curtain on Consciousness* and *The Science of Everyday Life*. Ingram posed the question "Can animals think?" and provided answers at the Discovery Lecture on March 7.

Summing up 30 years of research into animal intelligence, Ingram explored questions about and the implications of animal self-awareness and the line between intelligent thinking behaviour and automatism.

The free public lecture, designed to showcase and promote excellence in science journalism, is co-sponsored annually by the Faculty of Science and the School of Journalism and Communication.

Add-itional events

Carleton becomes a Mecca for mathematicians and statisticians this spring as the School of Mathematics and Statistics hosts two events supported by the Fields Institute for Research in the Mathematical Sciences.

Founded in 1992, the Fields Institute is a center for mathematical research activities where mathematicians can carry out research and formulate problems of mutual interest. The Institute supports research in pure and applied mathematics, statistics and computer science, and collaboration between mathematicians and those applying mathematics.

One of seven principal sponsoring universities of the Fields Institute, Carleton is hosting the Ottawa-Carleton Discrete Mathematics Workshop 2007 from May 25-26 and the Probability and Stochastic Processes Symposium in honour of Donald A. Dawson's work from June 5 to 8.

The workshop on discrete mathematics, an annual event alternately hosted by Carleton and the University of Ottawa, consists of a colloquium talk followed by five invited talks on graph theory, combinatorial structures, optimization, combinatorial enumeration and algorithms.

"The talks are intended to be accessible to graduate students," says Associate Professor Daniel Panario. "Students receive an overview of cutting-edge research in several branches of discrete mathematics and have a chance to interact with renowned specialists. This in turn has helped to attract graduate students to work in this area."

The symposium in probability and stochastic processes features 29 speakers focusing on population and evolutionary models, stochastic analysis, measure-valued processes, hierarchical mean-field analysis and stochastic networks. This symposium enhances the ongoing series of workshops at Carleton in this research area. Dr. Donald Dawson, Professor Emeritus and Distinguished Research Professor, will deliver a one-hour keynote address.

"These events stimulate interaction among research groups at Carleton, strengthen collaboration between universities in and around the Ottawa region, and also provide an ideal opportunity for continued international collaboration of researchers in these areas," says Dr. Yiqiang Q. Zhao, Director of the School of Mathematics and Statistics.

! Upcoming events

The Ottawa Photonics Cluster, dedicated to rallying photonics companies and other stakeholders to strengthen Ottawa's ability to attract employees, investment, funding and facilities, is hosting **Photonics North 2007**, from June 3 to 7 at the Ottawa Congress Centre. The week of photonics events includes the Photonics North Conference and Exhibition, the International Conference on Education and Training in Optics and Photonics, the Executive Symposium on Photonics Commercialization and the OIDA Workshop on Photonic Sensors. It is hosted by the Canadian Photonics Consortium, of which Carleton is a member. Associate Dean John Armitage is chairing the technical committee.

Calling classes of 1957, 1962, 1967, 1982 and 1997—and all grads from the Carleton College years! From May 4 to 6, return to campus for **Alumni Reunion Weekend**, a fun-filled weekend with old friends and former classmates. Revisit old haunts and tour new facilities. Go back to class for an afternoon — no tests! Celebrate over a grand dinner in the new dining hall.
Visit alumni.carleton.ca/reunion for details.

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Department of University Advancement
Carleton University
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Ottawa, ON K1S 5B6 Canada

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