Carleton UNIVERSITY
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EUREKA!

NEWSLETTER OF THE FACULTY OF SCIENCE

Get into the lab

Involving students and teachers in research

Fall 2006

- New faces, a new course and a new "Hot topic"
- Follow Graham Walker from Carleton to MIT

Carleton UNIVERSITY SCIENCE

In the community

The difference between watching a science demonstration and a magic show — both of which capture the imaginations of children and astound audiences — is that magicians never reveal their tricks. They keep their knowledge to themselves, lest the trick be spoiled. Scientists, on the other hand, are eager to explain their work, share the joy of discovery and encourage others to explore the mysteries of Nature. They commonly work collaboratively, cross disciplines, and disseminate and apply their hard-earned knowledge for the good of society. And sometimes, they use Mentos candies to make bottles of cola explode to explain scientific principles because Science can't always be serious.

Creating a pop bottle fountain is one of the demonstrations that Master's student Rob Smith uses to get the attention of school children in his volunteer work aimed at making Science accessible. As coordinator of Carleton's Let's Talk Science program, featured on page 4, he takes Science out into the community. Carleton also brings the community to campus, through public lectures and open courses such as the Mineralogy and Geology of Gemstones course. For Ottawa teacher Susan Dubois, the chance to come to Carleton to learn about the work of Dr. David Sinclair, and then accompany him to the Sudbury Neutrino Observatory, is helping to fuel an interest in Science for her Grade 6 class. Her story is told on page 5.

Community also plays a role in making Science happen. From government awards to private donations, much of the research and learning opportunities featured in this issue were made possible by external funding. Find out what a difference summer research opportunities have made to third-year student Nigel Tan, why alumnus and cancer researcher Dr. Graham Walker created a research fellowship, and how research funding has helped molecular biologists Dr. Shelley Hepworth and Dr. Owen Rowland.

In this issue, we introduce a new section, Hot topic, on page 3, which we hope will stimulate interest and debate about current hot topics in Science.

Within our Faculty community, Faculty news introduces our newest teachers and researchers, and celebrates the achievements of award winners.

I hope you will find this issue interesting and engaging.

Jean-Guy Godin
Dean, Faculty of Science

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carleton.ca/science/

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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

Third-year Biochemistry student Nigel Tan is co-authoring three publications as a result of his summer research. Find out what he's doing on page 8.

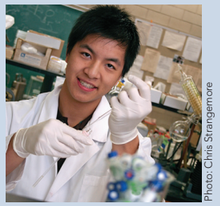


Photo: Chris Strangemore

Your input is important!

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

Professor Tom Sherratt walks us through the complex theories of senescence — a hot topic for scientists, ethicists and philosophers.

Why do we age?

BY TOM SHERRATT

Harriet, a much-loved giant tortoise born in the Galápagos Islands a few years before Charles Darwin's visit, died this year at the Australia Zoo. At 175 years of age, her longevity was enough to make world news, but her ultimate demise (from heart failure) is all too familiar. Age-related degeneration in bodily function — known as senescence to scientists and ageing to everybody else — is commonplace in nature, including us humans. While the elderly eventually die of something specific, such as cancer or heart attack, old age can be considered the ultimate cause.

Senescence is a hot topic in evolutionary biology, which seeks to understand why ageing occurs at all, and why the rate of ageing varies so dramatically among and within species. Why, for instance, do tortoises tend to live more than 10 times as long as hares? Even within a species there is remarkable variation in longevity — during the northern summer breeding season, adult monarch butterflies live for only 2-6 weeks, but late summer migratory monarchs live for 6-8 months.

Could ageing simply be a reflection of inevitable wear and tear, like rust on car or a klunk in the dryer? Unlike appliances that accumulate performance-impairing faults, organisms are capable of self-repair: they can potentially do something about the damage they accumulate. In fact, many asexual amoeba have a mend-as-you-go strategy and show little or no signs of ageing. Furthermore, if aging were only a function of the environment, then scientists wouldn't have been able to extend a nematode worm's maximum lifespan by six times by mutating a single gene.

Perhaps ageing has been selected to prevent species from over-exploiting their resources? It's hard to believe in this "programmed death" theory because cooperative individuals would rapidly be out-competed by individuals that cheat the system by living longer.

Today, the most popular senescence theory is antagonistic pleiotropy, wherein individual genes have multiple competing effects, so that the beneficial effects of a trait at one time of life are sometimes offset by costs at other times of life. Evolutionary biologist G.C. Williams first realized in 1957 that genes which enhance reproductive success when young will be selected for even if they come at the expense of fitness later in life — an adaptive "live well now, pay later" strategy, with ageing as the downside.

The essence of this trade-off is seen in the Pacific salmon, which die from exhaustion soon after spawning. If the chances of returning successfully to freshwater are slim, then natural selection may favour going out with a reproductive big bang, no matter the consequences.

The tie between reproduction and aging can be seen throughout the animal kingdom. Castrated salmon live much longer than their intact brethren, denying male fruitflies access to females extends their longevity, and those longer-living migratory monarchs have arrested reproductive development. Another area of interest is calorific restriction. A calorie-restricted diet that avoids malnutrition reduces the rate of ageing in a range of animals, although it has yet to be demonstrated conclusively in humans. This phenomenon may in part be linked back to reproduction since poorly fed individuals may not be reproductively active, but it may also be related to reduced exposure to the toxic byproducts generated by burning up food and which inflict cellular damage.

In a nutshell, contemporary theorists tend to explain ageing as a hangover from a well-spent youth. It has been argued that if humans retained the same resistance to stress, injury and disease that we had at the age of 10, then we would live on average for 700 years. Testing theories as to why we don't live for this long, or even as long as giant tortoises like Harriet, is one of the challenges of modern evolutionary biology.

Dr. Tom Sherratt, a Professor in the Department of Biology, is an internationally renowned evolutionary and behavioural ecologist.

***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 on aging at eureka.carleton.ca.**

One of the most popular activities in the Let's Talk Science roster is Carleton's annual butterfly exhibit. In 2005, volunteers guided 410 students from 12 schools through the exhibit, teaching students about aspects of a butterfly's life and luring the insects with orange slices. From left to right, back row: Sara Brown, BScHon/04; Atif Kukaswadia, BScHon/06; Becky Lynes, BScHon/06; Shannon Mahony, BScHon/04; Abeer Sami and Hume Douglas; front row: Ed Bruggink, Zahra Arzhangi, Hannah Mirrashed, MSc/99, and Katie Harding.

Let's talk science

Bringing discovery to the classroom

There's some jostling for position as the high school science students line up for their chance to work with real DNA. Loading a pipette with a DNA sample, seeing the electrophoresis equipment separate the genetic material, and watching the stained material become visible under ultraviolet light wasn't possible for these students until the Let's Talk Science (LTS) Partnership Program came to the Ottawa secondary school.

"Our presentations are designed to be hands-on," says Rob Smith, BSc/05, a Master's student in Carleton's Department of Biology and coordinator of the University's LTS program. "We want students to experience science."

Smith is one of 50 students at Carleton who shares his passion for science by volunteering with LTS. Designed to improve science literacy through innovative educational programs, research and advocacy, Let's Talk Science is a national charitable organization. Its flagship Partnership Program, running at 23 campuses, provides graduate students and other researchers with opportunities to develop their teaching skills and be scientific role models by volunteering in elementary and secondary schools.

"The program gives teachers a chance to bring new ideas and equipment into the classroom, and students get the perspective of someone in the field," says Smith. "We have a chance to catch the interest of students and get them to enjoy science or see it in a new way."

In Ottawa, Carleton University and the University of Ottawa have teamed up to deliver science seminars to 70 schools and community groups. The in-class activities and demonstrations reflect the research interests of the volunteers drawn from all disciplines, and range from forensics to respiration to earthquake demonstrations.

To reach communities outside Ottawa, LTS is partnering with the Youth Science and Technology Outreach Program to travel to rural and northern towns including Timmins and North Bay, ON.

Since bringing the program to campus in 2001, the number of volunteers has been increasing. This year, Smith hopes to recruit 70 volunteers.

What attracts busy graduate students to the program? Beyond the obvious benefits of enhancing a student's resume or scholarship application, the social aspects, or gaining teaching experience, Smith says rejuvenation is a powerful factor.

"When I lose focus on the fun and discovery of what I'm doing, a trip to a classroom really helps," says Smith. "I can look at my research in a new light because of the reaction of the kids — it makes my daily work invigorating."

! Fast fact...

The Let's Talk Science program is supported by the Faculty of Science and it welcomes alumni participants. If you want to get out of the office, interact with students and share your science expertise, contact lts@carleton.ca.

LTS mentorship reaps awards

A Biology laboratory tour at Carleton offered through Let's Talk Science (LTS) resulted in a unique opportunity for Hillcrest High School students Michaela Ritchie and April Doreleyers. After touring Carleton labs and speaking to experts, the pair took advantage of a mentorship opportunity with Hannah Mirrashed, MSc/99, a PhD candidate and former coordinator of Carleton's LTS program, Associate Professor Myron Smith, Biology greenhouse manager Ed Bruggink, and lab coordinator Claudia Buttera.

For two months, the students worked in Carleton's Biology research labs, testing different types of chemical pesticides and natural alternatives for removing weeds to determine their effects on the environment. The result of their research was presented at the 2006 Sanofi-Aventis Biotech Challenge, Eastern Ontario division, and won a sixth place award.

Mirrashed and Assistant Professor Shelley Hepworth also mentored the "Hot Potato" project that earned a merit award in the same competition for students Adam Biggs and Iaroslav Kourzenkov from St. Patrick's High School.

"It's rewarding to guide young students through the research and experiments that they design themselves," says Mirrashed. "I'm proud that LTS can provide this experience for our volunteers and for the students."

Teaching the teacher

When teacher Susan Dubois donned mining gear and a helmet, stood chest-to-chest with 44 people in an open elevator 2,133 meters underground, and walked the two-kilometer long tunnel to visit the Sudbury Neutrino Observatory (SNOLAB) underground laboratory, Science took on a whole new perspective.

A participant in the Teacher's Science and Technology Outreach Program — a pilot program offered by the Ontario Ministry of Research and Innovation to connect science teachers with research in publicly funded institutions — Dubois spent nine days in August learning about SNOLAB from its director and Carleton Physics Professor David Sinclair.

"It was an eye-opening experience," says Dubois, who teaches a gifted Grade 6 class at First Avenue Public School in Ottawa.

After spending two days at Carleton with Dr. Sinclair, learning about his research project on the single ion detection of barium atoms, familiarizing herself with the terms and concepts, and compiling information to bring back to her own classroom, Dubois traveled to the Creighton Mine near Sudbury, ON, to visit SNOLAB, where the basic nature of matter in the universe is examined.

Susan Dubois with David Sinclair. "It was a real honour for me to be at SNOLAB," says Dubois. "I was fascinated by the amount of work done there."

In addition to the memorable trip beneath the Earth, Dubois observed research in the above-ground labs, examined the equipment, and attended seminars with international researchers on future uses for SNOLAB. She also visited the Science North and Dynamic Earth science centres, taking photos all the while.

The result is a series of presentations that bring the research, facilities and sense of discovery to her students.

"I was a sponge for nine days, taking in as much as I could to bring back for my students," says Dubois. "I want to help them understand what's out there: the research, the excitement and the potential."

"The outreach program opens the door to talking about what's happening in Canada," she says.

Dubois, who participates in the Let's Talk Science program, has already invited Sinclair to speak to her class during their space unit, and has arranged for a class tour of Carleton's Department of Physics, complete with demonstrations.

"I want students to feel comfortable with science and technology," says Dubois. And if that means leaving her comfort zone to delve into one of the world's deepest mines, she's happy to do it.

A gem of a course

Before diamonds became a girl's best friend, they were carbon molecules 200 kilometers or more beneath the current surface of the Earth. With the right combination of high pressure (about 5,520,000 kilopascal) and high temperature (more than 1,100 degrees Celsius), the carbon crystallized into diamonds. In Canada, diamonds were carried to the surface by molten kimberlite magma rushing upward, about 52 million years ago. They waited there until 1991 when geologists and prospectors found North America's first major commercial diamond deposit in the Lac de Gras area of the Northwest Territories.

This past spring, Earth Sciences students and members of the public were introduced to the history, mineralogy and geology of natural gemstones in the 10-part general interest course entitled Mineralogy and Geology of Gemstones, made possible through a gift from the estate of Harry Reid Cox.

Dr. Cox, a Fellow of the Gemological Association of Great Britain, worked as a gemologist in Montreal. In 2004, his estate established an endowment at Carleton's Department of Earth Sciences to provide the Harry Reid Cox, B.Sc., Ph.D., F.G.A. Award for two undergraduate students pursuing research opportunities in gemology and to fund a sessional lecturer in gemology.

This past summer Ingrid Kjarsgaard, a consulting mineralogist for industry and the Geological Survey of Canada, delivered the first course in gemology, exploring the geological prerequisites and natural occurrences involved in creating a precious stone. The physical and chemical properties that make a mineral a gemstone and how their synthetic equivalents are produced were examined, and each participant researched and presented on one type of gemstone.

Carleton and Kjarsgaard will offer the course again in the winter term for people of all backgrounds, and a formal course in gemology will be offered for credit in the 2007–2008 academic year. (Visit earthsci.carleton.ca for more information.)

! Fast fact...

The research opportunity portion of the Harry Reid Cox, B.Sc., Ph.D., F.G.A. Award was realized over the summer when one undergraduate student worked on Carleton's collection of gemstones with curator Beth Halfkenny and a second student worked on the Museum of Nature's mineral collection with its curator. These two research scholarships will now be awarded annually.

Community outreach

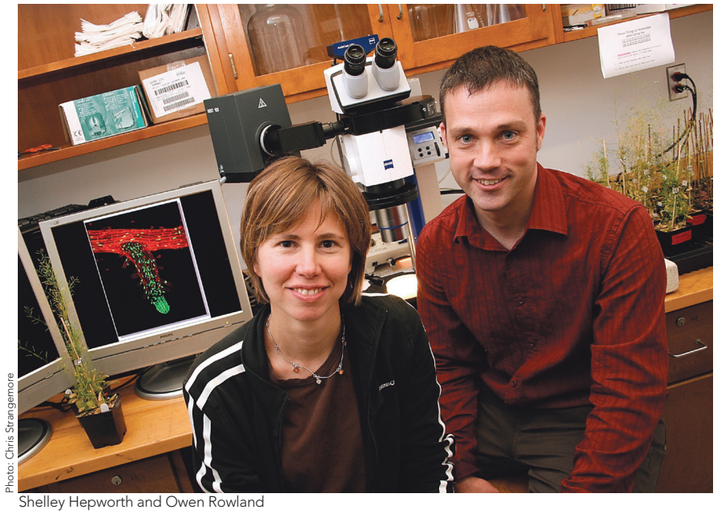


Photo: Chris Strangemore

Shelley Hepworth and Owen Rowland

Planting potential

Molecular biologists delve into processes governing plant growth and stress tolerance

Being able to order a bouquet of heart-shaped flowers for Mother's Day might not be as noble a use of research into the molecular mechanisms that control plant growth and architecture as would manipulations that increase pest resistance or improve pollination or yield, but — wow — would Mom be impressed!

Dr. Shelley Hepworth, an Assistant Professor in the Department of Biology, is unravelling the molecular mechanisms that control architectural diversity in plants. She hopes to bring the knowledge of how genes control plant shape and form to the point where it can be harnessed to alter the appearance of leaves and flowers. Whether for ornamental effect or to manage the behaviour of insects, her research could improve the architectural traits of commercially important Canadian crops.

It's a research vision shared by her colleague and husband Dr. Owen Rowland, an Assistant Professor of Biology who studies the "waxy skin" that covers the surfaces of plants and provides a critical protective interface between a plant and its environment. Understanding the molecular genetics and biochemistry leading to the deposition of waxes on the cuticle could lead to the controlled manipulation of waxes in crop plants.

"If it is possible to engineer plants with cuticles that lose less water to the atmosphere, we can improve crop tolerance to drought," says Rowland.

"That's particularly attractive given that changing climate conditions threaten to limit crop production in large areas of Canada and the world."

Both researchers work with the small flowering plant *Arabidopsis thaliana*, commonly called mouse-ear cress. Due to its small genome (sequenced in 2000), small size and short life cycle, the plant is a model organism for studying plant metabolism and development.

Hepworth is using a combination of genetic, genomic, molecular and biochemical approaches to learn more about a set of newly discovered genes that regulate growth patterns in leaves and flowers. These genes, which function in a signalling pathway, are responsible for controlling the growth patterns along axes of mirror-image symmetry in the plant.

Her research team is curious about how the activity of these genes is controlled and how the signalling pathway interacts with other pathways known to control the size, shape and pattern of flowers and leaves.

"There's never an end point with this work because every discovery leads to new questions," she says. "So you follow your findings and build expertise in new areas. Science is most interesting when it's driven by curiosity."

Rowland is identifying proteins involved in synthesizing and secreting the waxy coating on *Arabidopsis*, which is highly related to Canola, so that other plant species like wheat and maize can also be manipulated. The wax serves as a barrier against uncontrolled water loss, UV light, pathogens and insects. The waxes also possess unique physical properties that make them useful in a wide range of products, such as cosmetics, food additives and industrial lubricants.

"We're not at a commercial stage yet, but the research will lead to applications that add value to a crop plant, such as replacing non-renewable sources of petroleum with products such as waxes made in the seeds of plants, or altering the cuticular waxes to provide protection of crops from drought or pathogens," says Rowland.

With a recent $244,200 Leaders Opportunity Fund award from the Canada Foundation for Innovation, Hepworth and Rowland will be able to purchase specialized laboratory equipment for their research into plant metabolism and development.

This includes infrastructure for bioimaging (microscopes), metabolic profiling, plant growth facilities and molecular biology equipment.
Since joining Carleton in 2005, Hepworth and Rowland have begun securing the equipment they need, established connections in government, industrial and educational institutions in Ontario and Quebec, and recruited undergraduate and graduate research assistants.

"Since Science undergraduates at Carleton are encouraged to participate in research, we've had no trouble finding help," says Rowland. "Giving students a chance to work in a real lab environment and contribute to publications is a great aspect of Carleton's program."

As for that bouquet of flowers with modified petals, extra blooms and less need for water?

"Our research isn't applied yet, but it will be," says Hepworth. "It's our job to bring the knowledge of these aspects of plant biology to the point where it can be applied. It will be a great boon to Canadian agriculture."

Reaching the highest rank

Since 2001, the special professorial designation of Chancellor's Professor has been conferred on distinguished faculty at Carleton by the President. To earn the designation, recipients must have at least 10 years of service as a full Professor and their work must be of outstanding merit.

Computer scientists Dr. John B. Oommen and Dr. Evangelos Kranakis were appointed Chancellor's Professors on July 1, joining their Faculty of Science colleagues James Wright, Giorgio Ranalli and Gerald Buchanan in this distinguished honourary rank.

JOHN B. OOMMEN

John Oommen joined the School of Computer Science in 1981. With research interests spanning adaptive data structures, image processing, robotics and artificial neural networks, Oommen has garnered some of the highest awards in his field for his teaching and research.

The author of more than 255 refereed journal and conference publications, Oommen won a Wilkes Best Paper Award from The *Computer Journal*, the flagship journal of the British Computer Society, in 2006.

In August, Oommen was made a fellow of the International Association of Pattern Recognition, becoming the first Ontario scientist to receive the honour. He is already one of only a handful of scholars to achieve the rank, in 1996, of fellow of the Institute of Electrical and Electronic Engineers for his work in artificial intelligence. He also won a Univeristy Research Achievement Award in 1995 and 2001.

"The friendly, helpful atmosphere at the School of Computer Science has provided me with top quality students to work with over the years," he says. "I'm grateful for the great support from the Directors, Deans and senior administration at Carleton over the past 26 years."

EVANGELOS KRANAKIS

Evangelos Kranakis spent 11 years teaching in The Netherlands, Germany and the U.S. before joining Carleton's School of Computer Science in 1991.

"Traveling has given me the experience to see how Science moves and changes," he says. "I've learned to adapt to new trends."

Kranakis was Director of the School of Computer Science from 1994 to 2000 and an IT theme leader for six years. He currently works as a Community, Networking Security Team Leader for the Mathematics Information Technology and Complex Systems program at Carleton. He has written one book, co-authored another, and has a third book set to hit the shelves in 2007. He has also published numerous research papers.

"I don't think research makes sense if it's not accompanied by teaching," says Kranakis, a recipient of a University Research Achievement Award whose interests include communications networks, network security and computational molecular biology. "It creates the necessary links that feed new ideas into the field."

With files from Carleton NOW.

Physics takes two

When the newly established University medals for distinguished teaching, research and service were awarded at Spring Convocation, two members of the Department of Physics were honoured.

Physics Professor Dr. David Sinclair received the inaugural University Medal for Distinguished Research in recognition of his outstanding accomplishment in research and scholarly contributions that expand the boundaries of knowledge and enrich the lives of students and the community. The principal investigator and director of SNOLAB (the Sudbury Neutrino Observatory laboratory), Sinclair and his team are conducting research that addresses fundamental questions in elementary particle physics, astrophysics and the universe.

Jim Carleton, hardware manager and departmental computer support, was presented with the inaugural University Medal for Distinguished Service for his outstanding service and contributions to the advancement of the learning and working environment. An innovative member of the University community for 27 years, Carleton began as an electronics assembler and programmer/technologist. His technical expertise has contributed to instrumentation for the ultrasound laboratory and the development of electronic laboratory apparatus for a number of departments.

! Research awards

The Spring 2006 issue of *Eureka!* profiled the award-winning research of Chemistry Professor Zhi Yuan Wang, Computer scientist Prosenjit Bose and theoretical physicist Stephen Godfrey. In addition to the accolades for which they were featured, all three are also recipients of a 2005-06 Carleton University Research Achievement Award. To revisit these stories, visit *Eureka!* online at eureka.carleton.ca.

Photo: Chris Strangemore

TAN-GIBLE success

For third-year Biochemistry student Nigel Tan, kicking back after class takes on a whole new meaning. A practitioner of Taekwondo for 15 years, Tan uses his training and sparring time to take a breather from his studies and research. He catches up with friends while kicking the heavy bag and gets involved in community activities with his club.

While Taekwondo has developed his strength, speed, balance and flexibility, Tan has also learned focus and concentration — attributes that have helped him to excel academically and prepared him for long hours in the laboratory.

Tan is one of those promising Carleton students recognized by the University as a potential leader in his field. In 2004, he was presented with a Chancellor's Scholarship — a prestigious award for students with an admission average of 90 percent or higher — and has since earned the Josef Dlouhy Memorial Scholarship in Chemistry, the Ruth Lifeso Scholarship in Science and the William H. Cook Memorial Scholarship in Science.

All of these merit-based awards both reward and encourage academic success, says Tan. "Carleton does a fantastic job at rewarding excellence. As a scholarship recipient, I am motivated to succeed and I strive to do better."

The scholarships, made possible through gifts to the University, have also alleviated the pressure to find a traditional student job, allowing Tan to pursue research opportunities in the summer through the Natural Sciences and Engineering Research Council (NSERC) Undergraduate Student Research Awards program.

Working with Dr. Peter Buist, a Professor in Carleton's Institute of Biochemistry and the Department of Chemistry, Tan has acquired hands-on lab experience and an appreciation for research.

"The labs we do in class are interesting, but independent, novel research is something else. I couldn't imagine it before I did it," he says.

"Two summers working in the lab has shown me that I enjoy doing research. It's opened my eyes to my options."

When Tan arrived in Buist's lab after his first year of university, he hadn't yet studied organic chemistry and was the youngest member of the research team. But being green didn't hold him back.

"Nigel was able to come up to speed very quickly. He's very bright, enthusiastic, hard working and has excellent lab skills," says Buist. "He will be coauthoring three publications — quite a feat for someone only entering third year!"

Tan's supervisor at Brookhaven National Laboratory in New York, where he spent a week doing some biological experiments, was similarly impressed, says Buist.

"Every day was a new learning experience," says Tan. "The research team was amazing. As fascinating as the research is, having a fantastic group of people to work with makes a huge difference."

Tan's lab work with fatty acids — synthesizing lipid analogues, exploring fatty acid desaturases, and testing the limits of Carleton's new nuclear magnetic resonance spectrometer for detecting fluorine-tagged fatty acids — has implications for health care, in helping to treat obesity and type II diabetes. It's an appealing combination for the student who knows that he wants to pursue graduate studies in medicine or in Biochemistry.

With years of studies still ahead of him, Tan strives to maintain a flexible learning style and keep a balanced life, making time for both microscopes and martial art.

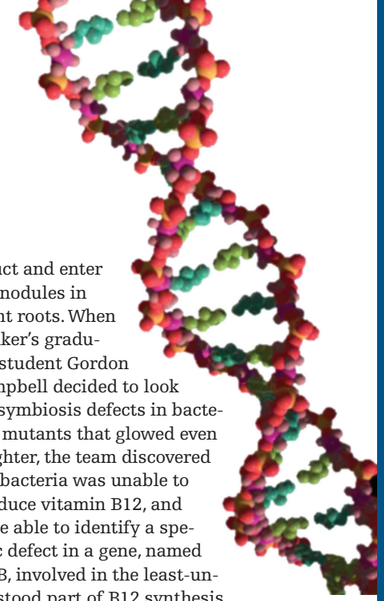
Advancing the Faculty of Science

Carleton's growth is made possible by the generosity and commitment of its volunteers and donors. Whether providing financial assistance to students, or enhancing teaching innovation and opportunities, they are vital members of the University community. As the Faculty of Science's Senior Development Associate, Dave Timms, BA/85, facilitates opportunities for and matches interests of volunteers and donors who want to support students and Faculty priorities.

"To connect the Carleton and broader community to help advance education and research is a tremendous privilege," says Timms. "Our volunteers and donors are great champions for our students, the Faculty and Carleton."

Photo: Chris Strangemore

Timms, an Ottawa native and former Officer in the Canadian Navy, joined the Faculty in May 2006. He was previously the Senior Manager of Major Gifts and Corporate Campaigns for Breakfast for Learning, Canadian Living Foundation, the Director of Alumni at an independent school, and the Campaign Director for a capital fundraising campaign at St. Lawrence College in Brockville, ON.



Close encounters of the DNA kind

Can you pinpoint the moment you found your calling? For Dr. Graham Walker, an American Cancer Society Research Professor in the Department of Biology at the Massachusetts Institute of Technology (MIT), that moment was at Carleton in the 1960s, when the Chemistry major encountered DNA in a first-year Biology class.

"I thought it was a cool molecule and I wanted to work on it," recalls Walker, BScHon/70. That decision shaped the academic course Walker took and led to his 30-year research and teaching career at MIT.

Walker, who experienced his eureka moment at Carleton, is helping others here and at MIT to find their callings too.

Under now-retired Associate Professor Dr. Robert Wightman, Walker turned his attention to organic chemistry at Carleton in the hopes of being able to synthesize DNA. He worked on nucleic acid synthesis and biochemistry at the University of Illinois, where he earned his PhD, and then added genetics to the mix as a postdoctoral fellow at the University of California–Berkeley.

"I wanted to work on science problems by approaching them from more than one discipline," he says.

A leader in the field of DNA repair and mutagenesis, Walker has published more than 250 scientific articles and a textbook, is a fellow of the American Academy of Microbiology, serves on the editorial boards of *DNA Repair*, *Current Opinion in Microbiology*, *Life Science Education* and is former editor-in-chief of the *Journal of Bacteriology*.

Since joining MIT in 1976, he has carried out basic research on DNA repair and mutagenesis in bacteria. He first demonstrated that a regulatory network of more than 40 genes were turned on in *E. coli* as a result of DNA damage. Initially thought to be a property specific to bacteria, similar elaborate responses to DNA changes have since been shown in mammalian cells. In fact, several of the DNA repair genes Walker has worked on have turned out to have human homologs that play roles in cancer prevention. Since being named an American Cancer Society Research Professor in 2001, Walker has used the award's funds to initiate a project on DNA repair and mutagenesis in yeast and mammals.

"By using simple systems like bacteria and yeast that can mutate overnight, I can move research along faster, push harder and use a variety of techniques," says Walker. "I've found genes and processes that have implications for cancer, but I didn't set out to solve cancer."

Walker's lab also studies the symbiosis between alfalfa roots and the nitrogen-fixing bacterium *Rhizobium*. He has uncovered commonalities between this symbiosis and the chronic intracellular infections caused by the human pathogen *Brucella*.

"The way that bacteria are taken into the membrane of the legume and the molecular conversation between the bacterium and the plant, is analogous to some human pathogens that get taken up by white cells," says Walker. "I'm interested in how they get in and how they live there."

In 2005, Walker's team made a striking discovery thanks in part to a lab trick he used with undergraduate students. When Walker added a laundry whitener to a lab dish, the symbiotic bacteria he studied glowed in ultraviolet light.

The gimmick proved a useful lab tool in the symbiotic research, when researchers noticed that some of the bacteria did not light up. They were missing key genes needed to construct and enter the nodules in plant roots. When Walker's graduate student Gordon Campbell decided to look for symbiosis defects in bacterial mutants that glowed even brighter, the team discovered the bacteria was unable to produce vitamin B12, and were able to identify a specific defect in a gene, named bluB, involved in the least-understood part of B12 synthesis.

"The initial breakthrough came from teaching," says Walker, who as a Howard Hughes Medical Institute (HHMI) Professor from 2001-2005 received a $1-million grant to find ways to bring the excitement of the research lab into classrooms. "My career was helped by undergraduate research at Carleton and I'm committed to helping my students."

Walker used those funds to establish an education group composed of postdoctoral fellows, graduate students, and undergraduates to work on curriculum development, including web-based materials. His commitment to teaching saw Walker run the MIT undergraduate program in Biology for 15 years and direct MIT's HHMI-funded program in undergraduate education in the biological sciences since its inception in 1989. Among his several awards is the Arthur C. Smith Award for contributions to undergraduate life.

At Carleton, Walker is also helping to provide undergraduates with research opportunities. In 1998, he endowed the Margaret Biehn Walker Summer Fellowship in memory of his mother. The Fellowship funds Bachelor of Science students so they can gain summer research experience with a research group in the Biological Chemistry or Biochemistry programs.

"I saw I could try to help people do what I had been able to do," says Walker. "I wanted to help young, excited students because I know what difference a research experience can make to their careers."

Faculty "frosh"

A leader in discovery and innovation, the Faculty of Science is committed to ensuring an outstanding learning experience for its students. Here's what the newest tenure-track teachers and researchers in our dynamic Faculty are working on.

Dr. Susan Bertram — Assistant Professor, Department of Biology

In organisms that reproduce sexually, those favoured traits (such as a moose's large antlers or a peacock's colourful tail) which are passed to offspring should not vary much. After all, that's what made the parents successful breeders! But instead of the expected best phenotype, more variation is observed among sexually selected traits than is expected. Using laboratory- and field-based techniques and working primarily with insects, Bertram investigates how this variation in sexually selected traits is maintained.

Dr. Root Gorelick — Assistant Professor, Department of Biology

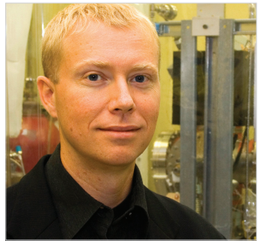
Gorelick's research in evolutionary theory focuses on evolutionary changes mediated by inherited signals other than DNA, so-called epigenetic signals. Since epigenetic signals are responsible for development and can be modified by environmental factors, Gorelick's work explores links between evolution, genetics, ecology and development. He is examining the origins of separate female and male individuals, the origin of shorter Y chromosomes, and the origin of sex (meiosis) itself. He also focuses on quantifying multi-entity interactions, such as between multiple genes and epigenes. Although a botanist at heart, Gorelick tries to work with all animals, plants, fungi and protists.

Dr. Jeffrey Manthorpe — Assistant Professor, Department of Chemistry

Like your left and right hands — alike but different — some of Nature's common atomic building blocks (carbon, sulfur, phosphorus and others) can be mirror images of each other. The "handedness" of these chiral molecules and atoms can produce vastly different effects. To make medicines safer, organic chemists work to improve their ability to control the handedness of atoms as they build molecules to interact with biological targets like proteins. This work has focused on molecules containing mainly carbon atoms, yet most of the drugs and agrochemicals on the market contain large amounts of nitrogen, oxygen and sulfur. Manthorpe targets this problem by developing methods to induce handedness in atoms connected to sulfur, nitrogen and oxygen that should aid in the development of new and cheaper pharmaceuticals.

Dr. Rouslan Krechetnikov — Assistant Professor, School of Mathematics and Statistics

Krechetnikov's research is centered on the fundamental questions in fluid dynamics and mechanics. In fluid dynamics, he has studied problems of aerodynamics and the physics of interfaces, important to aerospace and chemical engineering. In mechanics, Krechetnikov has done work on dissipation-induced instabilities with implications for mechanical systems and geophysics. An underlying theme in these studies — geometric approach — underpins his current research interests, which include control of mechanical systems with dissipation and modern geometric formulation of physical field theories.

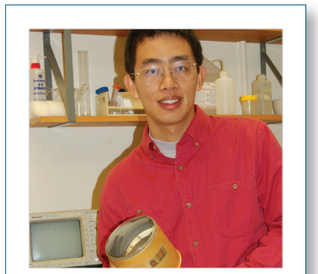


Dr. Kevin Graham — Assistant Professor, Department of Physics

More than 85 percent of the universe consists of some unknown dark matter. Graham, a particle physicist, is working to directly detect dark matter particles with the Dark matter Experiment with Argon and Pulse shape discrimination (DEAP) — a discovery that would be one of the most exciting of recent times. He is also seeking to identify the unknown, fundamental properties of neutrinos using data from the Enriched Xenon Observatory for double beta decay and from the Sudbury Neutrino Observatory, where it was proven that neutrinos have mass.

Dr. Tong Xu — Assistant Professor, Department of Physics

For pulmonary and abdominal tumors, delivering accurate radiation therapy is limited by the motion of the tumor as the patient breathes. Xu is a medical physicist whose research on real-time tumor tracking, using positron emission markers instead of the standard and more harmful x-ray fluoroscopy, could help to deliver the dose to the tumor while sparing normal tissue. By implanting positron emission markers into the tumor, and using pairs of position-sensitive detectors to track the resulting annihilation gamma rays, the position of the tumor can be tracked in real-time with high accuracy. Xu's technique would deliver a lower radiation dose to normal tissue than x-ray fluoroscopy, and the smaller size of the positron emission markers reduces risk to the patient during implantation.



Photos by Meghan Thomas and Chris Strangemore.

The Faculty of Science extends its appreciation and best wishes to the following faculty members who have retired from Carleton in 2006.

Dr. Bryan Hollebone	Department of Chemistry
Dr. Marlene McCallum	School of Mathematics and Statistics
Dr. Giorgio Ranalli	Department of Earth Sciences
Dr. Luis Ribes	School of Mathematics and Statistics
Dr. James Wright	Department of Chemistry

Teaching with technology

Innovative prof receives 3M Teaching Fellowship

Although it's dubbed "Killer Chem", Carleton's first-year general Chemistry course is one of the best on offer thanks to its award-winning, innovative teacher.

Associate Professor Bob Burk, BScHon/80, MSc/82, PhD/91, took the class himself when he was a student at Carleton. Now he devotes most of his efforts to taking the fear out of introductory chemistry and developing new learning tools — incorporating technology in demonstrations, broadcasting all lectures and tutorials, video streaming via the Internet and on portable devices such as iPods.

"Many students have pre-conceived notions relating to the difficulty of chemistry courses," says Burk. "Having them begin chemistry within the familiar forum of their own technology helps alleviate their fears and open their minds to the content and exciting nature of the field."

Bob Burk with Chemistry students

In June, Burk was awarded a 3M Teaching Fellowship for excelling in the teaching of his own courses and demonstrating an exceptionally high degree of leadership and commitment to the improvement of university teaching across disciplines.

Burk has been instrumental in curriculum and course design in the Department of Chemistry, where he has developed and delivered three new undergraduate courses and one graduate course. He has also spent countless hours creating one of the most comprehensive web-based resources for introductory chemistry.

A contributor to Carleton's Educational Development Centre, Burk both sharpens his own pedagogical skills and coaches newer faculty members and teaching assistants. He also makes a point of reaching out to high school students and delivering professional development seminars to high school teachers.

In addition to the 3M Teaching Fellowship, Burk has won numerous teaching awards in his 15-year career, including the Ontario Confederation of University Faculty Association's 2004 Teaching Award for his innovative teaching practices.

"Students now bring a different set of study and communication skills than students in the past." says Burk. "By offering their preferred learning methods, students are more likely to effectively engage with the content itself."

For more on Burk's accomplishments, see the Fall 2005 edition of Eureka! *at eureka.carleton.ca.*

Around the WORLD in 700 nodes

Dr. Larry Peterson

Creating a global network infrastructure is no small feat. In the case of PlanetLab, a global platform for evaluating and deploying network services, the infrastructure includes 700 nodes spanning 340 sites and 35 countries. There are more than 275 active research projects running on PlanetLab, which allows researchers to experiment with new services under real-world conditions, and at large scale.

On October 3, 2006, the second Cognos Innovation Lecture at Carleton featured Dr. Larry Peterson, Professor and Chair of Computer Science at Princeton University, Director of the Princeton-hosted PlanetLab Consortium and chair of the planning group for the Global Environment for Network Innovations (GENI) initiative, on "PlanetLab: Evolution vs. Intelligent Design in Global Network Infrastructure". The free public lecture identified the requirements PlanetLab addresses, presented the design principles that follow from them, and outlined the resulting PlanetLab architecture.

The Cognos Innovation Lecture series is provided for Carleton students in the Computer Science and related programs. The Faculty of Science is pleased to co-sponsor this lecture series with Cognos Inc.

Precious medals

Carleton's Faculty newsletters *Eureka!* and *Pamorama* took silver and gold awards, respectively, at the 2006 Canadian Council for the Advancement of Education (CCAE) Prix d'Excellence competition. CCAE is an organization comprised of advancement professionals from colleges and universities across Canada. Judges referenced the newsletters' excellent design and writing as well as the "thought-provoking" content and "personable and inviting style".

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! Recent event

The annual **Gerhard Herzberg Lecture** emphasizes the relationship between Science and society and addresses an aspect of Science that has an impact on our daily lives. Dr. Erik Demaine, a mathematical prodigy and Associate Professor of Electrical Engineering and Computer Science and Alfred P. Sloan Research Fellow at the Massachusetts Institute of Technology, delivered the 2006 free public lecture entitled "Origami, Linkages and Polyhedra: Folding with Algorithms" on November 16, 2006.

! Upcoming events

The annual **Discovery Lecture**, designed to showcase and promote excellence in science journalism, is scheduled for March 2007. Watch the event calendar (carleton.ca/events) for details.

From its beginning, Carleton has been international in outlook — welcoming the world to campus, exploring global issues in every field of study, and embracing the obligations of global citizenship. Learn about Carleton's vision for its future global presence and how it will embrace its identity as "Canada's Capital University" — and how alumni can help — from Dr. David W. Atkinson, President and Vice-Chancellor. Now's your chance to meet him and learn about this bold plan as he takes the **Global Engagement Tour** coast to coast. Visit alumni.carleton.ca/presidentstour for cities and dates.