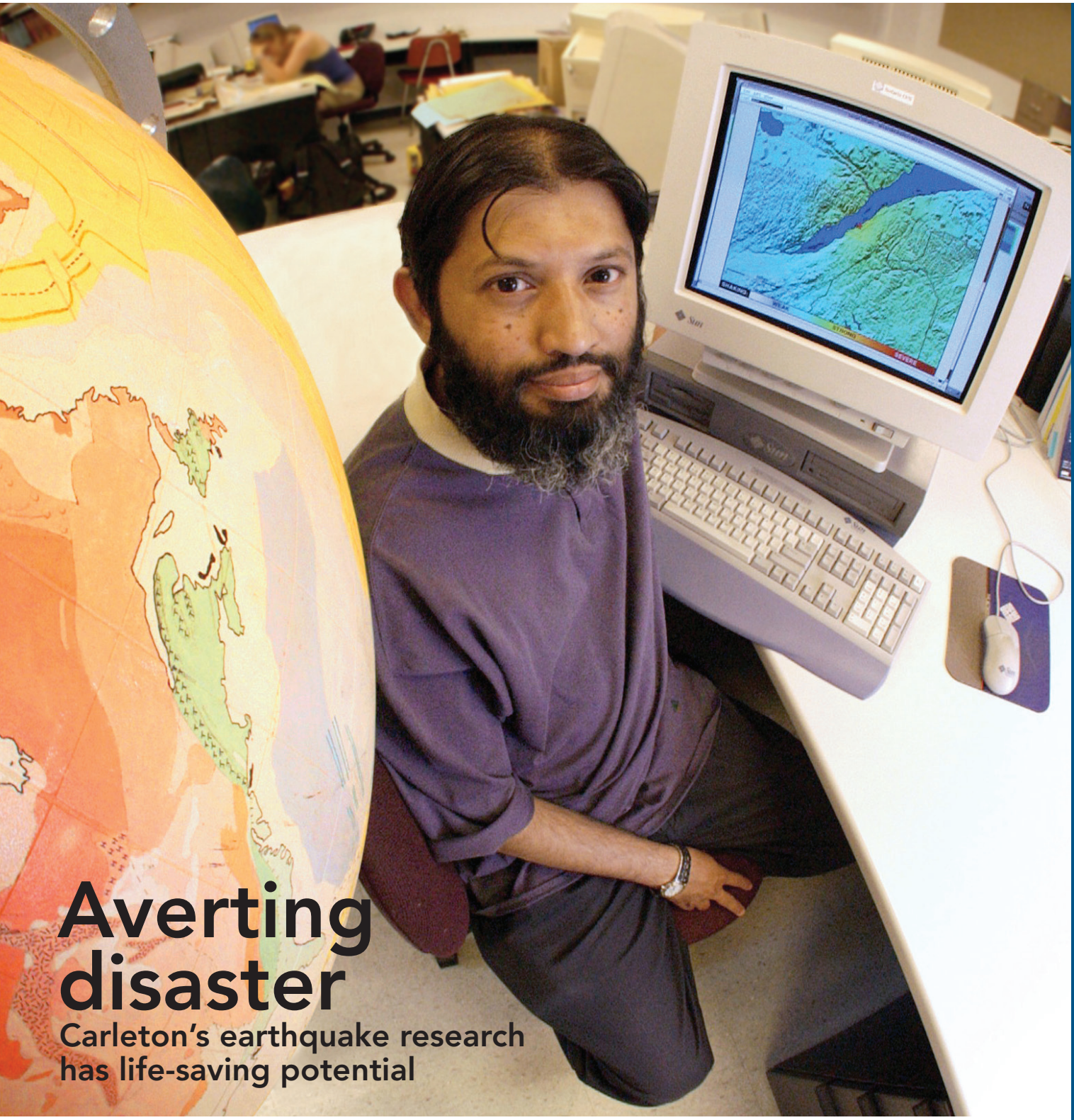
Carleton UNIVERSITY
Canada's Capital University

EUREKA!

NEWSLETTER OF THE FACULTY OF SCIENCE

Fall 2005



Averting disaster

Carleton's earthquake research has life-saving potential

- Alien invasion
- Getting to the root of radiation
- Fighting crime with genetic ingenuity

Carleton UNIVERSITY SCIENCE

Relevant research in a challenging world

Our world is becoming more complex by the day.

The fallout from natural and man-made disasters has added an unparalleled level of complexity to our surrounding environment. The impact of recent events such as last December's tsunami, as well as ongoing threats to global energy supplies and national security, has been felt around the world.

The daunting list of challenges created by these events appear overwhelming. But scientific researchers make it their daily mission to get to the root of such challenges. Whether they are medical physicists, biochemists, or earth scientists, these researchers offer insights and lasting solutions by studying natural phenomena with a keen sense of curiosity and purpose.

It's exciting to think that students, alumni and members of the Faculty of Science are at the forefront of such cutting-edge, collaborative research — the results of which address some of society's most dire needs and demands.

Our researchers arrive at the forefront of their fields by asking such fundamental questions as: "How can we detect natural disasters at the early stages of their development and save thousands of lives in the process?", "How can we alleviate the world's reliance on fossil fuels and protect the fragile atmosphere?" and "How can we ensure the safety of individuals and businesses by preventing breaches of physical and electronic security?"

Among the many inspiring stories in this issue of *EUREKA!* is one about Edward Chouchani, a third-year Biochemistry student. Since his first year at university, Edward has worked closely with his long-time friend and research partner at McMaster University, Corey Centen. Together they are working with a bacterium they hope will produce enough electrical current to power city generators. If their research is successful, it could offer a much-needed alternative energy source.

You will also meet one of our Biology professors who is conducting cutting-edge research on ways to identify and eradicate some of the most troublesome alien plants in North America, among other faculty research stories.

As usual, you will also hear from alumni who are working on fascinating research projects in their respective fields. This issue provides a glimpse at the professional lives of a research scientist in radiology and a forensic DNA analyst and case officer in one of the RCMP's Ottawa labs.

Finally, I wish to congratulate Bob Burk in the Department of Chemistry for winning two prestigious teaching awards. This spring, he was among 15 winners of the 2005 Capital Educators' Awards. At the same time, the Ontario Confederation of University Faculty Associations placed Bob among six of the most outstanding university teachers in the province.

Jean-Guy Godin
Dean, Faculty of Science

Editor's welcome

After speaking to some of the remarkable people featured in this issue, I had a "eureka" moment: Not only can scientific research change and improve our lives, it has the power to save lives too.

Often, disasters can do the most damage when they take people by surprise. But Carleton scientists and alumni are proving that we can anticipate, predict and quickly react to an increasing number of life-threatening events, regardless of whether they are natural or manmade, intentional or accidental.

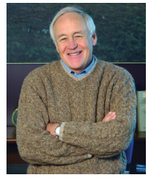
Taking the element of surprise away from such incidents are people such as SanLinn Kaka, a PhD student in the Department of Earth Sciences. Under the directions of Professor Gail Atkinson, SanLinn is working with a Web-based program that detects earthquakes. Read more about his work on page four.

Many of you gave us positive feedback on our debut issue, some of which appears on the adjacent page. We encourage you to send us even more of your thoughts on how *EUREKA!* can be improved, as well as your story ideas. Your feedback is invaluable. Please stay in touch.

Scott Foster, MJ/01
Editor
newsletter_editor@carleton.ca

Your input and feedback are very important to us. If you would like to submit a letter to the editor, story ideas, articles, or photos, please send an email to *newsletter_editor@carleton.ca*. The editor reserves the right to edit or refuse any submission. Views expressed or implied are those of the individual contributors or sources quotes and do not necessarily reflect University policy.

Congratulations



I have just finished reading the Science newsletter *EUREKA!* cover to cover. I found it both interesting and informative. The material is pitched at just the right level and, most important, is scientifically interesting. The format and presentation is great. Congratulations to all who worked on this and companion pieces for Engineering and PAM.

Richard Van Loon, BSc/61, MA/65
Past President, Carleton University

A thirst-quenching read

I was absolutely astounded and thrilled to receive the debut issue of *EUREKA!* Thank you so very much for thinking of me. I fell in love with it immediately. It gives to those of us on the "outside" the kind of information for which we thirst — what is being done and who is doing it, within Carleton's portals. The research itself is absolutely fascinating — in some cases incredible! What dauntless professors and students! What a wonderful gift to Carleton University! An elite publication. I hope I can continue to receive *EUREKA!* Right now, I am going to read it again — cover to cover.

Sincerely,
Bea Wickett-Nesbitt

A flood of memories

Well done! Outstanding inaugural issue of *EUREKA!* Finally a snapshot of happenings in Biology and Science. I went to school with Lawrence Krauss — a brilliant mind. And now we see what he has been up to with the "next dimensions." The article on butterflies brought back memories of exploring bats with Dr. Brock Fenton and the research that I did at Ottawa U on the vestibulo-ocular pathways of electric fish (a similar sonar system to butterflies and bats), not to mention the field work at Lake Opinicon with Queen's University students. A flood of memories of my fourth year in the greenhouses with Dr. John Webb and field ecology with Dr. Bailey came back to me. I look forward to issue two!

Richard M. (Dick) Guest, BScHons/77
Etobicoke, ON

Grateful grad

I still cannot say enough great things about Carleton and am so happy to be receiving *EUREKA!* I love it! Members from my parish (St. Clement) were featured in the *EUREKA!* Spring 2005 issue and I was wondering if you would be kind enough to send me extra copies of that edition to pass around to the children featured in the article. They had such an incredible time that day and I know it would make them very happy to have a copy.

Dina Lama, BScHons/02
Ottawa, ON
(Read about Dina Lama on page 5)

On the cover

SanLinn Kaka, PhD candidate in the Department of Earth Sciences, monitors Carleton's ShakeMap progam.

Photo: Gregory Abraszko

EUREKA!
NEWSLETTER OF THE FACULTY OF SCIENCE
carleton.ca/science/

Editorial Advisory Board
Dean, Faculty of Science: Jean-Guy Godin
Associate Dean (Undergraduate Affairs): John Armitage
Associate Dean (Research): Jörg-Rüdiger Sack
Senior Development Associate (Science): Allan Weatherall, BA/77

Assistant Vice-President (Development and Alumni): Serge Arpin
Director, Alumni Services: Nancy Lewis, BA/91
Editor: Scott Foster, MJ/01
Design: Richard Bootsma
Web Site: Darin Cosgrove, BA/95
Photos: Gregory Abraszko, Chris Strangemore, computer-animated graphics courtesy of Baird & Associates, SNO Lab photos courtesy of Sudbury Neutrino Observatory Laboratory, Brigette Bouvier, *Ottawa Citizen*.

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 Development and Alumni.

! We want your opinion!

Take our online readership survey and you could win one of three Carleton Science sweatshirts or one of three Carleton Café mugs! Simply attach your email address to the completed survey and you will be eligible for the October 14th draw. To fill out a survey, please visit *eureka.carleton.ca*. Good luck!

Return undeliverable Canadian addresses to:

Department of Development and Alumni
Carleton University
1125 Colonel By Drive
Ottawa, ON K1S 5B6 Canada

Publication Mail Agreement
No. 40063314
ISSN 0226-5389

Gail Atkinson, Earth Sciences professor.

When DISASTER strikes...

You wake up with a jolt. Something isn't right. The light fixture above your head is swaying like a pendulum, your bed seems to be wobbling off its frame, and the rattling from inside your kitchen cupboards grows louder as dishes cascade onto the floor.

The earthquake you're experiencing could be minor or it could be the start of something more severe. You could be right at the epicentre, or you could be far away from something bigger. Without the help of sophisticated technology and seismological experts, you may not know … until it's too late.

Research conducted in the Department of Earth Sciences could help fill the information void when it comes to predicting and assessing the potential havoc caused by an earthquake.

Under the direction of Professor Gail Atkinson, a renowned earthquake expert, SanLinn Kaka is working on a project called ShakeMap. The PhD student and other researchers at Carleton have been developing and modifying the Web-based program for over a year and successfully tested it last spring.

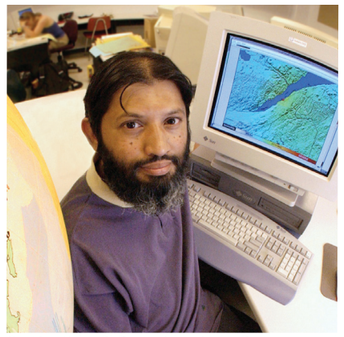
On March 6, 2005, the program successfully recorded an earthquake in Quebec that registered 5.4 on the Richter scale. While the epicentre was under the St. Lawrence River, it was felt by several surrounding towns and cities including Montreal, Ottawa and Boston.

As is routine, the Geological Survey of Canada recorded the magnitude and location of the epicentre. While these are helpful pieces of information, they don't tell the full story, says Kaka. ShakeMap fills in the blanks by telling people where more shaking will occur and where there will be less, delivering to users a more detailed snapshot of the earthquake in mere minutes.

Within three minutes after the St. Lawrence earthquake, email alerts were sent out to users, informing them of the peak ground velocity and intensity recorded at each of the surrounding earthquake stations. Four minutes later, online maps were generated that displayed this information using a variety of colours to indicate which areas were hardest hit.

This information can be especially useful to first responders whose job it is to evacuate victims and treat them for injuries. It also gives managers of critical infrastructure, such as the Pickering Nuclear Power Plant just east of Toronto, a quick snapshot of how they might be affected.

Such facilities have a direct link to seismological stations equipped with the ShakeMap program. Roughly 90 of these stations are installed across Canada as part of the Portable Observatories for Lithospheric Analysis and Research Investigating Seismicity (POLARIS). The project is led by Carleton under the direction of Professor Atkinson and has five other Canadian universities as members, as well as the Geological Survey of Canada.



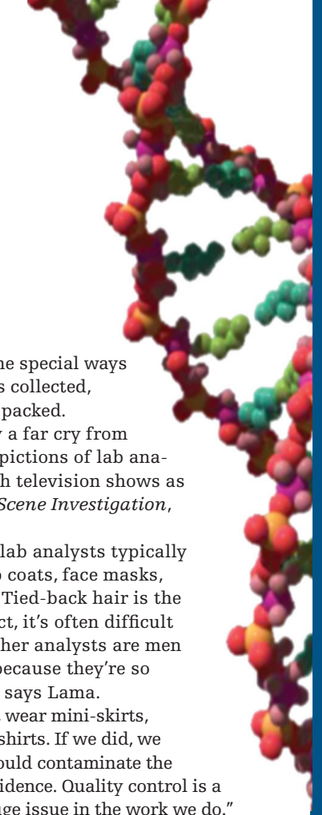
SanLinn Kaka, PhD candidate in the Department of Earth Sciences.

"I'm very proud of our ShakeMap team, which has developed the first working ShakeMap application outside of the western United States," says Atkinson. "We have demonstrated that it can provide reliable and timely information on the strength of ground shaking and its likely effects throughout southern Ontario — almost as soon as the shaking stops."

While the ShakeMap product originated from California, Kaka and others have modified it to suit the local landscape, proving the tool can be used anywhere in the world.

"Once this gets off the ground, we'll probably see more ShakeMaps crop up," Kaka says, adding the tool would be useful for seismologists in coastal B.C. "The challenge is that it has to be region-specific. So you have to tailor it to your region."

Kaka and Atkinson have co-published related research work in the Seismological Society of America's academic journals, including the *Bulletin of the Seismological Society of America* and *Seismological Research Letters*. Please visit Carleton's ShakeMap project at *shakemap.carleton.ca*. Visit POLARIS at *polarisnet.ca*.



Fighting crime with genetic ingenuity

Sometimes the smallest things in life can have the biggest impact. According to Dina Lama, BScHons/02, this is certainly the case with deoxyribonucleic acid, or DNA.

As a forensic DNA analyst and case coordinator with the Royal Canadian Mounted Police (RCMP), she has first-hand experience with those tiny genetic identifiers that make us who we are and record where we have been.

Lama frequently examines and processes evidence from high-profile crime scenes from across Canada. And, if summoned, she uses her expertise in DNA analysis to testify in criminal court proceedings, including cases before the Supreme Court of Alberta.

"We find evidence that may aid the prosecution of someone or exonerate an individual who is wrongfully accused," she says of the DNA derived from nucleated skin or blood cells. This precious evidence is carefully collected from murder scenes by identification officers and delivered to the Ottawa labs where Lama works.

"The data we get from this evidence can help a lot of people," she says. "It can give the family members (of murder victims) a sense of closure. And it gives me such a huge feeling of gratification and satisfaction to know I have the ability to help them."

While Lama cannot go into specifics about the highly-confidential cases she has worked on, her lab unit continues to receive DNA samples from the B.C. pig farm of Robert Picton. The man accused of being Canada's worst serial killer was charged last spring with 12 additional counts of first-degree murder, bringing the total number of charges to 27.

Currently, Lama works in the fast-paced position of case co-ordinator, screening the exhibits brought in from the field and selecting the ones that may yield the strongest and most significant clues. Deliveries of evidence run the gamut from spent firearm cartridges, to counterfeits, to DNA swabs, autopsy samples, and forgeries.

"Investigators just don't drop exhibits off at the lab's door, they have to get my okay first," she says, adding the evidence must meet strict criteria before being admitted for analysis, including the special ways in which it's collected, stored, and packed.

Dina Lama, BScHons/02

It's really a far cry from the sexy depictions of lab analysts in such television shows as *CSI: Crime Scene Investigation*, Lama says.

Real-life lab analysts typically don full lab coats, face masks, and gloves. Tied-back hair is the norm. In fact, it's often difficult to tell whether analysts are men or women because they're so covered up, says Lama.

"We don't wear mini-skirts, shorts or T-shirts. If we did, we would contaminate the evidence. Quality control is a huge issue in the work we do."

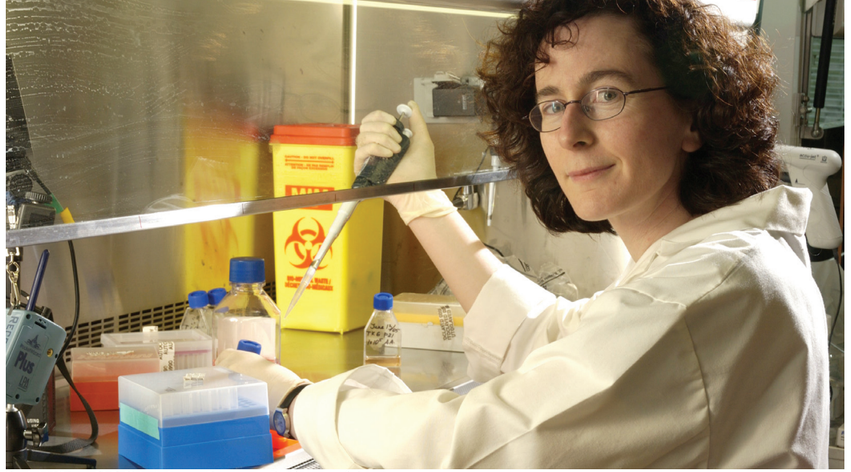
As well, real-life analysts don't pump out results in the matter of half an hour, she says.

George Carmody, Professor Emeritus of Biology and Lama's honours thesis advisor, echoed these sentiments at "CSI: Halifax," a recent FOCUS Tour presentation he gave to Carleton alumni in Nova Scotia's capital.

"Even it if it was an assault on the prime minister and you had good blood evidence, it would take you three days to get the results," says the renowned DNA expert. "(The way it's depicted on television) is not the way it actually works."

However, there is an upside to such popular TV shows as CSI: They spark a lot of interest among aspiring forensic scientists, Carmody says

Adds Lama: "The job is a lot less glamorous than people think. But I find it truly fascinating."



Ruth Wilkins, PhD/96, Adjunct Research Professor of Physics

Getting to the root of radiation

Part of Ruth Wilkins', PhD/96, job is to prepare for the unthinkable.

As a radiobiology research scientist at one of Health Canada's Ottawa facilities, she must be ready to respond to tragic events involving potentially harmful levels of radiation. Such unthinkable scenarios include terrorist attacks or the accidental meltdown of nuclear reactors.

Depending on the event's size, Wilkins and her team would work with an extensive emergency network of scientists from across the country. Each team is equipped to speedily assess the exposure levels of thousands of radiation victims by analyzing their blood samples.

So far, her radiobiology lab has only encountered individual cases. "And that's the way I like it," says Wilkins, who is also the secretary of the Carleton-founded Ottawa Medical Physics Institute.

But despite the absence of large-scale events on Canadian soil, the federal government appears to be taking no chances. Following the September 11, 2001, terrorist attacks on New York and Washington, Wilkins' lab saw an increase in funding and profile. The lab fell under a new national program called the Chemical, Biological, Radiological, Nuclear Research, and Technology Initiative. Part of the lab's new mandate was to develop new ways to analyze the blood samples of potential radiation victims more quickly.

The trick is to locate tell-tale signs of radiation damage: chromosomes in white blood cells that have split apart and subsequently bonded with other mismatched chromosomal pieces. These so-called "misrepairs" are directly correlated to the amount of radiation the victim has received, explains Wilkins.

Looking for misrepairs is especially useful for victims who have had lower doses of radiation and display no other obvious symptoms, such as vomiting or reddening of the skin. The numbers of malformed chromosomes help doctors decide which type of treatment is most suitable for the patient.

Speeding up the blood-sample process, however, doesn't come without its challenges, says Wilkins. Assuming the standard 1,000 blood cells are evaluated, each sample can take about a week to accurately analyze. But the Ottawa researchers have now verified they can get a general idea of exposure levels by looking at only 50 cells, which reduces sample times to a few days.

Wilkins did her PhD in Carleton's Department of Physics and became interested in combining the medical and biological worlds with that of physics when she realized there was a great opportunity to affect people's lives.

Fueling the future

If Edward Chouchani and Cory Centen have their way with a certain bacterial protein, their work could revolutionize the entire energy sector.

Chouchani, a third-year biochemistry student, and Centen, a long-time friend and colleague from McMaster University, hope to generate electricity from bacteriorhodopsin.

Third-year Biochemistry student, Edward Chouchani

This purple- and yellow-coloured protein powerhouse is capable of converting light into metabolic energy. The daunting challenge for these student researchers is to harness the protein's energy and extract enough electrical current to power anything, no matter the size.

"However, if they can come up with molecules that produce more electricity, or ones that are specifically engineered to pump out a lot of current, … then this will have a lot of potential in the future," says Bill Willmore, a professor in the Institute of Biochemistry who joined Chouchani in a television interview with CBC's *Canada Now* last spring.

The process for making the bacteria is certainly promising. Machinery used to isolate, purify, and grow the bacteria is a one-time cost, while the price of each bacteria batch would be about $20, says Chouchani.

"This is probably one of the biggest selling points. It costs next to nothing when compared to the production of conventional energy. And this protein is versatile: you can make it any size, from nanoscale up to huge sheets of the stuff. You can have it power city generators to cellphones. That's what we believe this is capable of."

The pair started working on the idea in their first year at university, phoning around to various academic and government labs to see if anyone was willing to provide enough of the bacteria to get them started.

After contacting several groups, a researcher at the University of California at Berkeley answered their call by sending them some samples. Then Perry Fleming, a technical officer from the National Research Council of Canada, provided them with some much-needed lab space for a few weeks that summer. Throughout the last academic year, Biology professor Jim Cheetham also gave the pair some professional advice and lab space so they could continue their work.

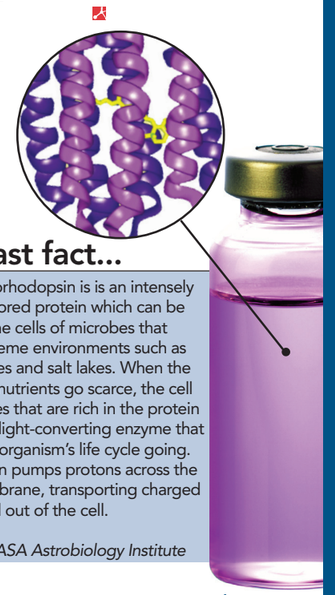
Critical to the pair's success thus far has been Luc Lalande, director of Carleton's Innovation Transfer Office. With Lalande's help, Chouchani and Centen secured a $5,000 grant from Carleton's Foundry Program, which focuses on building and nurturing on-campus innovation.

Currently, the pair is focused upon securing more funding, and a group of commerce students have been assigned to help refine their business plan.

"That's the good thing about the Foundry Program: It puts you in touch with a lot of business people, and forces you to look at the business side of things as well as the research," says Chouchani.

In the near future, Chouchani and Centen hope to have a cell to show potential granting agencies such as the Ottawa Centre for Research and Innovation or the federal government's Industrial Research Assistance Program.

Centen adds the end goal is to be a producer of the protein and sell isolated and purified cells to companies that can integrate them into their own energy applications.



! Fast fact...

Bacteriorhodopsin is is an intensely purple-colored protein which can be found in the cells of microbes that live in extreme environments such as salt marshes and salt lakes. When the microbe's nutrients go scarce, the cell membranes that are rich in the protein serve as a light-converting enzyme that keeps the organism's life cycle going. The protein pumps protons across the cell's membrane, transporting charged ions in and out of the cell.

Source: NASA Astrobiology Institute

ALIEN invasion

The aliens have landed, and they're taking North America by storm.

Alien plants brought in from other continents are infiltrating North American landscapes at an alarming rate. Once their growth patterns spiral out of control, these resilient invaders threaten the survival of local species and create a huge expense for wildlife authorities, says Naomi Cappuccino, a professor of Biology who is conducting cutting-edge research on ways to identify and eradicate some of the worst culprits.

Often there are no natural pathogens or herbivores to keep the growth of alien populations in check. Of particular concern in the last few years is the swallow-wort or dog-strangling vine, which came to North America from Ukraine and Russia, says Cappuccino. The plant now has a stranglehold on many Toronto-area landscapes as well as upstate New York.

So the Carleton biologist began studying this pest of a plant. And the more she and her colleagues studied it, the more they realized it was toxic to everything. At the heart of its toxicity is an active compound that actually deters herbivores from eating the plant. Biology professor Myron Smith and Thor Arnason, a phytochemist from the University of Ottawa, also discovered the plant has some really strong anti-fungal properties.

Along with Arnason, Cappucino has addressed the question of whether highly invasive plants are so chemically unique that no herbivores can eat them and no native fungi can attack them. In the case of the dog-strangling vine, they proved this to be true. The plant's chemicals are completely foreign to North America.

The next step of the research is to grow natural herbivores such as the American locust and determine its preferences when faced with plants that are either highly invasive or non-invasive.

Helping Cappucino with this stage is Tania Jogesh, a fourth-year honours student and insect enthusiast. The insect experiment comprises the bulk of Jogesh's thesis.

"I love insects," she says from the Nesbitt greenhouses which contain fully-grown grasshoppers that were recently shipped from the U.S.

By determining the plant preference of these insects, the study could offer wildlife authorities new insight into which foreign plants are menacing enough to warrant a bio-control program, adds Jogesh. These decisions are critical since such a tracking and quarantine program can cost roughly $300,000 per species, says Cappuccino.

"Hopefully, our research will help people in their decision-making," she says. "If you can somehow predict which plants are going to cause the worst problem before they spread all across North America, then you can get at these plants while they're still manageable. The chemistry and the herbivore damage might be one clue as to whether or not the plant will become a really bad one."

Biology professor Naomi Cappuccino holds one of several American grasshoppers that will be used in her ongoing research on alien plants

! Fast fact...

Each year, the U.S. Fish and Wildlife Service spends US$10 million dollars on controlling exotic plant species. This doesn't include the billions in annual damages to the agriculture and forestry industries, as well as range lands and roadways. Meanwhile, 42 percent of America's endangered and threatened species have declined as a result of encroaching exotic plants and animals.

Source: National Park Service

Ashkan Golshani, Biology professor

Demystifying alternative medicine: Seeking the truth behind echinacea and scorpion venom

For years, the healing powers of homeopathic medicines have been steeped in mystery.

While there may be an abundance of anecdotal evidence supporting alternative remedies such as echinacea and scorpion venom, there is very little empirical evidence to prove these treatments are directly responsible for someone's recovery.

But if biologists are able to examine some of these natural compounds at the molecular level, they may get the definitive proof they need to turn homeopathic remedies into cutting-edge designer drugs, explains Ashkan Golshani, a Biology professor who is the director of Carleton's Genomics Centre for Disease Control.

"Our theory is that if echinacea, for example, is truly effective, it must have some sort of activity with certain gene products and pathways within the cell," he says.

While echinacea has long been favoured by Canadian Aboriginal Peoples for its anti-fungal properties, Golshani wants to find out how it actually stops the growth of yeast. This means deleting specific genes in thousands of yeast strains and applying echanesia in their absence. In doing so, scientists could theoretically see if the healing affect of echanesia and function of each deleted gene are related.

The same concept could be applied to scorpion venom, which is believed by some groups to have anti-cancer properties. Especially popular in Cuba, this natural compound is now the focus of researchers in Alabama who are trying to determine if it can be used to treat primary brain tumors.

"I think there is some truth to about 25 percent of the myths (concerning homeopathic remedies)," Golshani says. "But I think the most important thing is for scientists to keep their mind open."

Getting to the bottom of those myths, however, can be very time-consuming if it's done manually. Recently, some scientists have begun using a new robot specifically designed to test the various combinations of gene-deletions with the homeopathic compound in question.

"All of a sudden, we have the computer automation power to do this type of work, such as crossing 4,000 strains of yeast with one another," says Golshani. "There are so many questions we can now get answers to."

Golshani intends to seek new research funding so he can add this new technology to his lab in the Nesbitt Building. The lab, which is designed to create new antibiotics, recently received $177,840 in funding from the Canada Foundation for Innovation.

Cyber-crime meets its match

In a bid to gain an advantage over cyber-criminals, Carleton has co-founded a unique Internet security forum.

The Forum for Information Security Innovation in Canada (FISIC) promises to increase public awareness about potential gaps in Internet security and offer new ways to stop cyber-criminals.

Teaming up with Carleton to address these pressing issues include Bell Security Solutions Inc., Bell University Labs, and the federally-funded Mathematics of Information Technology and Complex Systems based at Simon Fraser University, B.C.

Together, they will work on FISIC's debut project: to investigate the technologies and processes used to fight email abuse, such as spamming and spoofing, as well as expensive denial-of-service (DoS) attacks that can deny businesses millions of dollars.

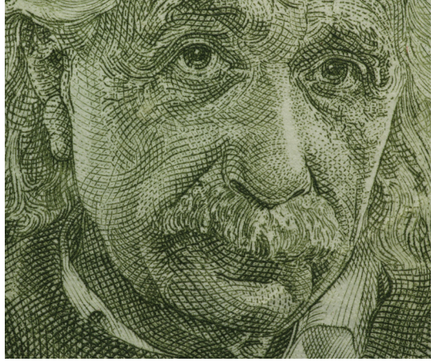
FISIC's debut project is a good fit for Carleton because the university houses one of the largest digital security research groups in Canada, explains Paul Van Oorschot, a professor in Carleton's School of Computer Science and Canada Research Chair in Network and Software Security. Expertise in the School of Computer Science includes intrusion detection, authentication, Internet routing security, software protection, application security, and wireless security.

Van Oorschot expects banks to join FISIC since they have a common interest in protecting online customers. He also anticipates more academic partners to crop up across the country. Thus far, Dalhousie University and the University of Calgary have expressed interest.

"Our intention is to get like-minded companies, universities, and appropriate government departments together," Van Oorschot says, adding the eventual goal is to have interconnected pockets or clusters of expertise across the country that can easily collaborate on digital security issues and work toward common goals.

Other founding partners of FISIC include the Canadian Advanced Technology Alliance and Communications and Information Technology Ontario, an Ontario Centre of Excellence. Visit FISIC at *fisic.ca*.

Paul Van Oorschot, Canada Research Chair in Network and Software Security.



A century later, Einstein is still right

The late Albert Einstein would undoubtedly be pleased.

His revolutionary theories of the early 1900s have stood the test of time. In fact, they continue to guide major research undertakings throughout the world, including those with Carleton connections.

In 1905, the great German scientist described some of his most influential theories — light quanta, Brownian motion and the special theory of relativity — in three separate papers. To mark the 100th anniversary of Einstein's "miraculous year", the International Union of Pure and Applied Physics declared 2005 the World Year of Physics.

The remarkable thing is that Einstein's work continues to be proven true, says Manuella Vincter, professor and Canada Research Chair in Particle Physics.

Physics professor David Sinclair

Every few years, scientific journal articles crop up, claiming he is right … again and again, she says.

Vincter would know. She conducts cutting-edge research at the world's largest sub-atomic research centre, the European Laboratory for Particle Physics (CERN) in Geneva, Switzerland. As part of a large international team of physicists, she works on the A Toroidal LHC Apparatus (ATLAS) project, a 45-metre long particle detector that operates in concert with CERN's enormous particle accelerator.

"The entire physics that governs ATLAS, from the mechanisms that produce particles, to how we record them in our detectors are all consistent with Einstein's special relativity theory," says Vincter.

The ATLAS project is at a pivotal moment in its life: Researchers there are preparing for an experiment that could unlock secrets about the cosmos.

"We're going to recreate for a fraction of a second the conditions of early times," explains Vincter, adding CERN's particle accelerator will attempt to replicate the extreme heat that existed when the universe was created.

According to Einstein, if there is enough energy in a fixed amount of space, then it can be converted into new matter. ATLAS researchers will bank on this theory during the 2007 experiment in which they hope to see the elusive and mysterious Higgs boson.

Dubbed "the God particle" and "the Holy Grail of particle physics," it's believed that the mechanism which produces this key particle gives mass to matter in the universe. The particle's discovery promises to answer some fundamental questions about how other sub-atomic particles acquire their mass.

An ocean away, and about two kilometres underground, fellow Physics Professor David Sinclair strives to answer similar cosmic questions that Einstein first raised in the early 1900s.

The renowned physicist works in shaft No. 9 of the INCO Creighton Nickel Mine near Sudbury, Ontario. There, he is the director of the Sudbury Neutrino Observatory (SNO), where scientists are poised to solve the mysteries behind dark cosmic matter. Despite its elusiveness, dark matter is believed to exist because of the gravitational effect it has on visible matter such as stars and galaxies.

"We know there's this mysterious matter that pervades the universe. Neutrons, protons and electrons only make up a fraction of the universes' mass. So there's something else out there that comprises the rest. Other unknown particles may make up this mass and indeed we're looking for them," says Sinclair, adding SNO is one of the world's best places to study neutrinos as well as candidates for dark matter because the rock filters out cosmic rays that would otherwise cause interference.

Einstein would be "fascinated" to learn of SNO's potential, Sinclair says, especially since scientists have recently learned that dark matter also contains dark energy.

"This is something we're all flummoxed at," he says. "We just don't have an idea of what the dark energy is. Getting Einstein's view on this would be immensely valuable."

Sinclair reflects for a moment on Einstein's contribution to science.

"Our whole way of thinking has been influenced by him and that seminal period of work — the tentacles of which spread through not only science but our daily lives."

Manuella Vincter, Physics professor and Canada Research Chair in Particle Physics, works on the construction of the Hadronic Endcap Calorimeter for the ATLAS detector in Geneva, Switzerland.

Bob Burk, PhD/90, Chemistry professor

High-tech teacher receives highest honours

When it comes to incorporating technology into the classroom, Bob Burk, PhD/90, is ahead of the curve.

Over the last nine years, the Chemistry professor and director of the College of Natural Sciences has successfully introduced a host of high-tech learning aids to his first-year chemistry course, including online video-streaming, quick-messaging, PowerPoint, and a giant course Web site that ensures archived lectures are only a mouse-click away.

Combined with his practical demonstrations in class, Burk has used the technology to make Chemistry 1000 more accessible and digestible for those who take it. He has also reached more students to ensure they have a firm grasp of the material.

For his efforts, the professor recently received two prestigious teaching awards. Last spring, the Ontario Confederation of University Faculty Associations (OCUFA) awards committee placed him among six of the most outstanding university teachers in the province. That same week, it was announced that he was one of 15 winners of the 2005 Capital Educators' Awards. The Ottawa-area accolades are given to outstanding elementary, secondary and post-secondary teachers. The winners were chosen from 64 finalists and hundreds of nominees.

"It was a good week, let me tell you," says Burk of hearing so much good news all at once.

OCUFA President Michael Doucet says the association's awards committee was impressed with the many accolades Burk had received from colleagues and students for his teaching expertise and for his innovative work in course development.

Burk began his high-tech journey in 1996 when he posted his lecture notes on the Web. That has since grown into a video stream of the actual lectures.

"It's just grown and grown," he says of the course Web site, which is now one of the largest, if not the largest, course sites on campus. "The students can go there, get the course lecture notes, assignments and answers, old exams with answers, online tutorials, and the ones I present on the blackboard. It's huge."

More recently, Burk turned to quick messaging after realizing it was the communication method of choice for his university-age daughter and her friends. The real-time responses of MSN Messenger rival the telephone and prompt students to regard non-instantaneous email as a dinosaur, he says.

"It never occurred to me that I could use MSN, but my daughter said 'Why don't you log on and see who's there?' So I put a note on my Web site saying I'm logged on. The response was immediate and large. I remember the first time I used it, I had 40 simultaneous conversations with students."

The big advantage of quick-messaging is that Burk logs on in the evening and communicates with students when they're studying.

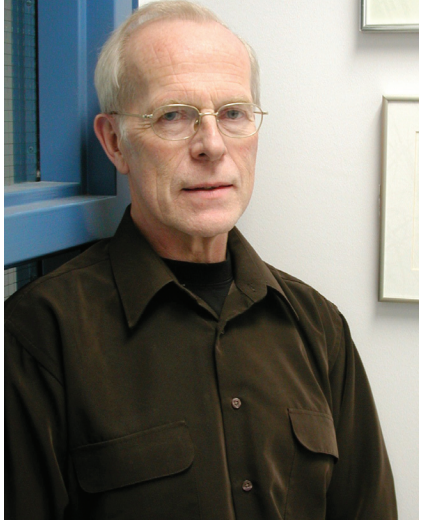
"This is totally different from getting an email the next morning or holding office hours," he says. "This way, when they have a question, they type it in, and, if I'm there, they'll get an answer and they can continue onto the next page."

Student surveys reveal Burk's methods are working. About 80 percent of his first-year class uses one or more of these aids. Roughly all students attend the live lectures and 10 percent will go home and view them a second time on their computers in case they missed something in class. The video-stream feature proves especially useful in the days leading up to exams, says Burk, adding the number of downloads spike during this period.

Burk has literally spent thousands of hours developing his comprehensive site for introductory chemistry students. Visit it at *carleton.ca/~rburk/chem1000.*

! Fast fact...

A recent competition held by the Natural Sciences and Engineering Research Council of Canada resulted in two major equipment grants for the Department of Chemistry. Worth nearly $300,000, the grants helped buy a nuclear magnetic resonance (NMR) spectrometer and a near-field scanning optical microscope. To read more about this new equipment, visit *eureka.carleton.ca.*



Cyril Garner, Professor Emeritus of Mathematics

Four decades of fond memories

The first time it happened to Cyril Garner, he was a bit startled. A few years ago, the Professor Emeritus in the School of Mathematics and Statistics, who specializes in geometry, was told by one of his students that he had taught her father about 25 years earlier.

"At first, you feel really old," jokes Garner, one of Carleton's longest serving faculty members who retired this June. "Now I think it's kind of nice."

Garner was Chair of the Department of Mathematics from 1987 to 1991 and from 1992 to 1994. He also served as Director of the School of Mathematics and Statistics from 2001 to 2004.

As the Professor Emeritus winds down his career, he reflects upon one of the most enjoyable things about being a professor: Watching his students grow over the course of their studies.

"They come in their first year and they're good students. But then you watch them develop and go on to do their graduate work at Princeton, Harvard, MIT, Berkeley as well as reputable universities here in Canada," he says. "That's the best."

Over his 41 years at the University, Garner has also watched a tradition develop among many families: the children are following in their parents' footsteps by studying math at Carleton. He has also encountered siblings, sometimes two, maybe three or four, who have all come to the School and occupied the top echelons of their classes.

"We can honestly say that we're a family."

Garner completed his PhD at the University of Toronto under the supervision of the world's most renowned geometer, Professor H.S.M. Coxeter. Shortly afterward, he joined a small group of mathematics professors at Carleton. He has since watched the School of Mathematics and Statistics' faculty and student body grow immensely.

To read the full version of this story, please visit *eureka.carleton.ca.*

$25 million

in external research funds was awarded to Science faculty members in 2003-04.

@ Read more online!

The Faculty of Science has so many stories to tell, it's hard to put them all in print! Visit *eureka.carleton.ca* to find more exciting news and feature articles.

Calling all Science alumni!

Could you see yourself connecting with old friends from your days at Carleton? If so, we want to hear from you. Carleton's alumni office is always looking for interested Science alumni to launch and coordinate an official Science alumni chapter. Express your interest today by sending an email to *heather_theoret@carleton.ca*

! Upcoming events

The Faculty of Science has an promising line-up of guest speakers for this academic year, including those who will deliver the Discovery Lecture and the Gerhard Herzberg Lecture this winter. As well, the Varian Lecture will be held this spring. Last year, speakers for these events included Gordon Giesbrecht, a professor of thermphysiology at the University of Manitoba who studies human responses to cold climates. The faculty also hosted Philip Currie, an internationally renowned paleontologist and expert on dinosaurs, and Scott Mabury from the University of Toronto's Chemistry Department. Information on this year's lectures will be available soon at carleton.ca/science. Stay tuned!

! Announcements...

The Faculty of Science welcomes the following new tenure-track faculty members who joined the Faculty in 2005.

Dr. David Asner	Department of Physics
Dr. Kevin Cheung	School of Mathematics and Statistics
Dr. Steven Cooke	Institute of Environmental Science & Department of Biology
Dr. Jeffrey Dawson	Department of Biology
Dr. Maria DeRosa	Department of Chemistry
Dr. Michel Dumontier	Department of Biology
Dr. Shelley Hepworth	Department of Biology & Institute of Biochemistry
Dr. Heather Logan	Department of Physics
Dr. Owen Rowland	Department of Biology
Dr. Sanjoy Sinha	School of Mathematics and Statistics
Dr. Nigel Waltho	Department of Biology

The Faculty of Science extends its appreciation and best wishes to the following faculty members who have retired from the University in 2005.

Dr. Robert Carnegie	Department of Physics
Dr. Leslie Copley	Department of Physics
Dr. Cyril Garner	School of Mathematics and Statistics
Dr. Kringen Henein	Department of Biology
Mr. Wiexuan Li	School of Computer Science
Dr. Irwin Pressman	School of Mathematics and Statistics
Dr. Donald Wigfield	Department of Chemistry & Institute of Environmental Science
Ms. Ann Woodside	School of Mathematics and Statistics

Mail To:

PM40063314