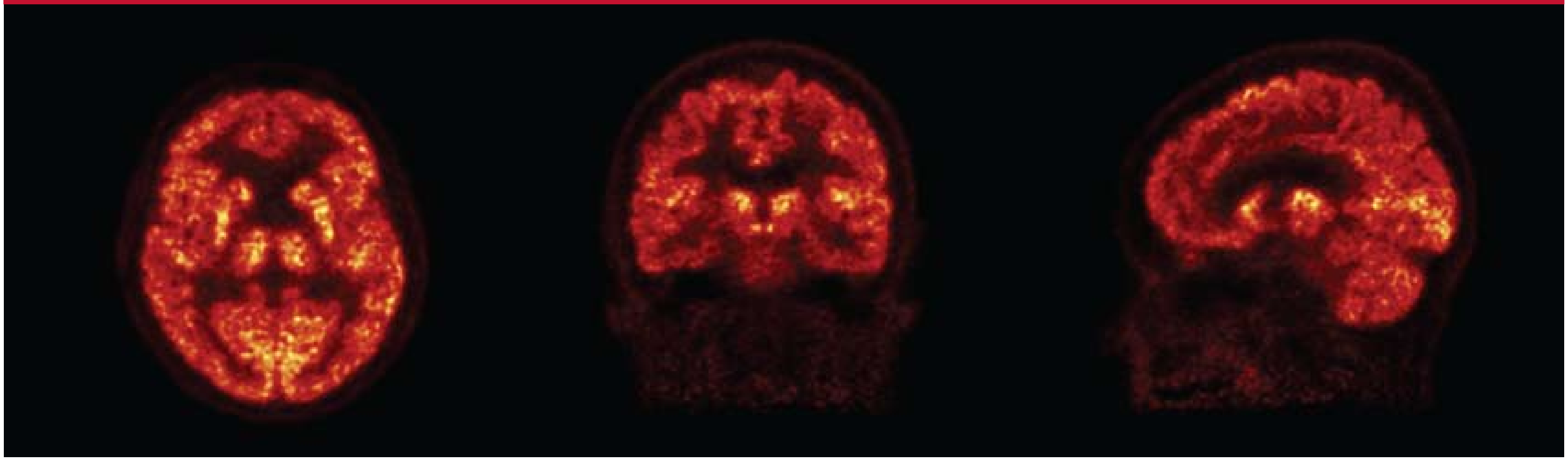
THE UNIVERSITY OF BRITISH COLUMBIA

SYNERGY » JOURNAL OF UBC SCIENCE

ISSUE 1|2008



Words from the Dean

Photo: Martin Dee

Scholars have been coming together to learn since the time of Socrates, Plato and Aristotle in ancient Greece. Globally, close to 40 modern universities trace their roots back over 500 years. By comparison, UBC is a youngster. We are celebrating 100 years of higher education in British Columbia—in 1908, the University Act was proclaimed to establish our university.

In March, we celebrated the reopening of the Chemistry Heritage Centre Block (see photo). Work on this building began before World War I. But it was not completed until after the Great Trek of 1922, when UBC students demanded the university be built in Point Grey. Hundreds of students displayed banners on the partially constructed Science Building. None of these people are alive today, but their vision is all around us.

Amazing advances have occurred in chemistry since UBC's first Science Building completed construction: from Michael Smith's Nobel Prize winning work on site-directed mutagenesis—a technique that allows the DNA sequence of any gene to be altered in a designated manner—to Neil Bartlett's demonstration that so-called inert gases can react. Bartlett's discovery changed our understanding of chemical bonding, and inert gases have been called "noble gases" ever since.

The Faculty of Science has been foundational in the evolution of UBC. The first president of the university, Frank R. Wesbrook, was a scientific pioneer and trained bacteriologist, and the first full-time bacteriologist in Canada, Hirbert W. Hill, established our Department of Microbiology & Immunology (see p. 13).

And today, our Faculty continues to enrich the university environment through fundamental research and transformational science education as highlighted in this issue.

Great universities are founded on great people and great facilities. In just 100 years, UBC has become one of the world's leading universities—one that attracts the brightest minds from across our province, Canada and the world.

Simon M. Peacock
Dean, UBC Faculty of Science

UBC Science (in the) News

UBC Gains $46.4 Million in Science and Engineering Funding – May 2007
UBC investigators funded by the Natural Sciences and Engineering Research Council include Science members Ivar Ekeland of the Pacific Institute for the Mathematical Sciences, Earth & Ocean Sciences professor Roger Beckie and Botany professor Fred Sack, and nine recipients of Discovery Accelerator Supplements (see p. 12).

UBC Confronts Gender-related Differences in Faculty of Science
University Affairs – Oct 2007
Canada's magazine on higher education discusses the results of the Assessment of the Working Climate for Science Faculty at UBC, which was published by UBC Science in May 2007. The study "shows female Science faculty members are not promoted as quickly as their male counterparts. The Faculty of Science has already taken a first step in addressing the issue, naming Anne Condon to the new position of Associate Dean, Faculty Affairs and Strategic Initiatives."

Curious George Showcases UBC Advances in Robotic Vision – Oct 2007
Jim Little, Director of UBC's Laboratory of Computational Intelligence (LCI), specializes in the integration of robotics and vision systems. Showing prowess in these areas is Curious George, LCI's robot, which won the first prize at an international competition held during the Association for the Advancement of Artificial Intelligence conference in 2007.

UBC Astronomer Learns Why Moon's Orbit Is Wonky
The Vancouver Sun – Oct 2007
Using a computer model, UBC astronomer Matija Cuk found evidence that our distant neighbours in the solar system once exerted forces on the moon that gently tugged it out of a more circular orbit around Earth.

Unlocking Tree Genetics Gives New Hope for Pine Beetle Defence – Jan 2008
Michael Smith Laboratories member Joerg Bohlmann and his team have discovered some of the genetic secrets that enable pine and spruce trees to maintain a battery of chemical defences against insects—including British Columbia's notorious pine beetles.

Two New Canada Research Chairs, Eight Renewed in 2007 – Dec 2007
UBC Science builds on and expands its research excellence with the appointment of Ken Harder, CRC in Host-Pathogen Immunogenetics, and Christian Schoof, CRC in Global Process Modelling, and with the renewal of eight previously appointed Chairs.

UBC Researcher Produces First Detailed Map of Dark Matter – Jan 2008
Using NASA's Hubble Space Telescope, Catherine Heymans, a Marie Curie International Outgoing Fellow in the Department of Physics & Astronomy, has produced the highest resolution map of dark matter ever captured.

Photo: Martin Dee

Oldest UBC Building Gets Extreme Makeover – Mar 2008
The oldest building on UBC's Vancouver campus reopened with new state-of-the-art research and learning facilities and its historic charms intact. The Chemistry Heritage Building features BC granite on its façade in the Collegiate Gothic style, complete with copper scuppers and gargoyles, and traditional oak trimmed interiors, all of which have been preserved in this UBC Renew project.

Stick Insects and Natural Selection – Apr 2008
Studying walking-stick insects in southern California, post-doctoral fellow in Zoology Patrick Nosil has conducted the first in-nature experiments that show environmental adaptation accelerates the development of new species—one of Charles Darwin's cornerstone ideas.

Source: UBC Media Releases 2007/08 or as indicated

From Coast to Coast—A Blue Whale's Journey across Canada

The skeleton of a blue whale that washed ashore on Prince Edward Island (PEI) two decades ago will soon find a permanent home at the University of British Columbia's new Beaty Biodiversity Museum. Scheduled to open in fall 2009, the museum will be the first attraction in Canada to exhibit the skeleton of the largest animal on earth—even larger than any known dinosaur.

In 1987, a rare event took place: an approximately 25-metre-long dead blue whale was discovered on the PEI coast near the town of Tignish. Foreseeing the scientific and educational value of exhibiting the whale's skeleton, the Canadian Museum of Nature (Ottawa) arranged for burying the remains on crown land nearby. The Museum of Nature and the Government of PEI are supporting UBC's efforts to exhume and display the national treasure.

Under construction. *The glass atrium of the Beaty Biodiversity Museum, future home of the blue whale skeleton. (Rendering: Patkau Architects and Derek Tan)*

Last December, a preliminary dig (see images below) was conducted by marine mammal specialist and UBC Biodiversity Research Centre member Andrew Trites, master skeleton articulator Michael deRoos and volunteers from the Atlantic Veterinary College (University of PEI). Despite the 20-year burial, decomposition of the remains has been very slow due to the low organic content of the soil. However, the team determined that the excavation would be possible once the soil has thawed.

Preliminary dig. *(A) Michael deRoos in the pit watches excavator peeling back some whale tissue; (B) Vertebrae uncovered; (C) The whale's scapula, or shoulder blade. (Photos: Andrew Trites)*

Starting May 13, Trites and deRoos will lead a team of more than twenty UBC staff and UPEI volunteers to unearth the bones. An exhumation using heavy equipment will be followed by manual digging over a couple of days to uncover the approximately 80 tonnes of gigantic dead whale. The next steps will include cutting the remaining flesh off the bones, loading them into a huge refrigerated container and transporting them across Canada—from PEI to BC—where the skeleton will be prepared for display.

Once the parts of the skeleton have arrived back in BC in early June, deRoos and his crew will begin to clean off the oil that is saturating the bones. Utilizing a relatively new technique for this degreasing process, the bones will be soaked in a heated solution of bioenzymes that will digest the oil. About six months later, deRoos hopes to begin the skeleton articulation. Its final stage, the installation in the museum, will be another major endeavour, considering that the skull and jaws alone weigh up to 2000 kilograms.

The blue whale skeleton will be showcased in the Beaty Biodiversity Museum—in a glass atrium at the heart of the university (see image above). The exhibit will be the centrepiece of an educational outreach program and a collection of more than two million specimens of preserved mammals, shells, fossils, insects, birds and plants. The museum will be the first public institution in Canada to focus exclusively on biodiversity research and education.

"Visitors will be awed by the blue whale's size," says museum director Wayne Maddison, who is also a professor in the Departments of Botany and Zoology. "More importantly, the whale will help us tell the story of biodiversity to the public—how the earth's species are interconnected ecologically and genetically."

www.beatymuseum.ubc.ca

Mining Community Invests in New Earth Systems Science Building

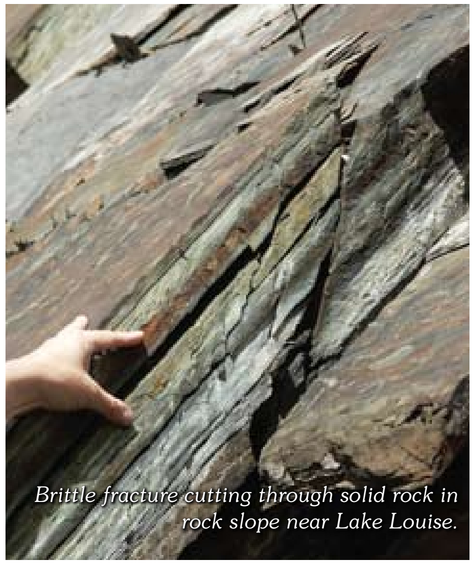
The Vancouver Sun – Jan 2008

Major minerals companies announced that they will collectively invest more than $20 million in the new UBC Earth Systems Science Building. This $75 million facility will house UBC's Earth & Ocean Sciences department known for its global leadership in sustainability research and education and its longstanding ties and remarkable contributions to Canada's minerals industry.

Source: UBC Media Releases 2008 or as indicated

Solid as a Rock?
Predicting Geological Catastrophes

UBC geological engineer Erik Eberhardt is working to understand and mitigate the complex processes and problems of rock failure. Whether in natural disasters such as landslides, or in the challenge of building tunnels and mines, his research investigates the slippery slopes of rock mechanics and engineering.



Brittle fracture cutting through solid rock in rock slope near Lake Louise.

Installation of borehole instrumentation at the Randa In Situ Rockslide Laboratory.

The image of a mountain conjures permanence, solidity and strength. But even the most solid rock is prone to erosion, fracture and failure over time. Erik Eberhardt, associate professor in the Department of Earth & Ocean Sciences, uses a combination of geotechnical monitoring tools, geological mapping data and numerical modelling to understand how rock responds to engineering or natural activity. His research helps to better predict rock slope hazards and mining and tunnel disasters, as well as provide insight into the effects of human interaction with the environment and changing global climate patterns.

Eberhardt started his geological career with Atomic Energy of Canada, as a doctoral student at the University of Saskatchewan researching potential rock fracture and damage in excavations for storing nuclear waste. If fractures were generated during the excavation process, they could potentially create new pathways for the stored waste to escape. One of Eberhardt's first major contributions to the field was his research on a phenomenon called brittle fracture.

"The rock itself has natural defects. Brittle fracturing occurs along these defects and through the bridges of intact rock in between," explains Eberhardt. "As these fractures progressively link up, the high-strength bridges degrade over time, causing the rock to destabilize along the extended fracture, eventually resulting in a through-going rupture surface and catastrophic failure." He has applied his research and methodology to help solve geological engineering problems around the world—in South America, Europe, the US, South Africa and Canada, including the Kicking Horse Pass and Sea-to-Sky Highway in British Columbia.

Bringing the Laboratory to the Mountain

On average, a massive rock slide—greater than 10 to 20 million cubic metres—occurs somewhere in the world every 20 to 30 years. Key questions puzzled Eberhardt. If a slope has remained standing since the glaciers retreated several thousand years ago, why would it come down now? If it was merely triggered by a heavy rainfall or earthquake, why didn't it fail earlier during any one of a number of previous heavy rainfall or earthquake events?

Eberhardt took his theories of brittle fracture and strength degradation to Zurich to study a massive rock slide that had occurred in the southern Swiss Alps in 1991. With funding from the Swiss National Science Foundation and colleagues at the Swiss Federal Institute of Technology (ETH Zurich), he set up the Randa In Situ Rockslide Laboratory on a shifting mass of mountain—rock above the 1991 slide that hadn't failed yet but was moving. It was the first installation of its kind to integrate a variety of multidisciplinary investigation techniques together with qualitative and quantitative analyses in the study of rock and landslide hazards (see photo above).

"These mass movements of earth and rock involve a large number of geological, hydrological and geomechanical processes that occur as the result of a continuous, causal series of events," says Eberhardt. His research on strength degradation has shown that, contrary to popular belief, the strength of the rock itself is not constant, but gradually weakens over time. Heavy rainfall or tremors can act to destabilize a slope, but not through a single large event. Instead, each rainfall or tremor acts to disturb the balance of forces in the slope, enabling brittle fractures to develop, which in turn progressively weaken the rock.

Multifaceted Observation

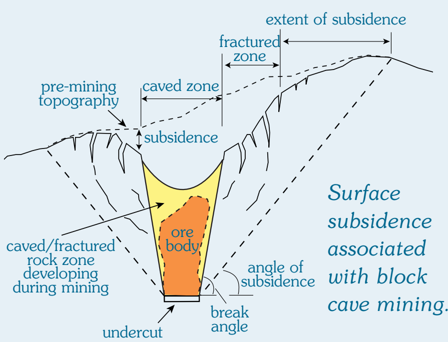
One of the problems that geological engineers have faced over the years is that their approach to problem solving has been largely observation based and phenomenological. But measuring events at the surface of a rock slope does not provide information on what is happening at the subsurface where the failure is developing.

When dealing with deep fractures, visual observation is not enough. To accurately measure and model the interconnected events that lead to brittle fracture and strength degradation

Digging Deeper Mines

With mineral prices soaring, and many surface mines reaching a depleted state, mining companies need to dig deeper to unearth more difficult deposits. One of the methods currently used in copper and diamond mining is block caving, where tunnels are drilled underneath the ore body. Since the rock is already weak and fractured, little blasting is required to mine the ore (see graphic below). Instead, it collapses under its own weight, and then shovelled and taken to the surface to be processed.

"Essentially, they let the rock mine itself," says Eberhardt. "The problem, as you let it collapse, is that anything from subsidence to a big hole opening up on the surface can happen." He notes that for earlier mines located in remote regions, this was not a critical issue. Now, with mines being built under working surface mines or near to communities, there is more at stake.



Surface subsidence associated with block cave mining.

Eberhardt and colleagues at UBC, Simon Fraser University, and international partners Rio Tinto and Diavik Diamond Mines are studying the causal effect of geological faults and fractures on mining-induced subsidence patterns, and their effect on sensitive surface structures.

"Again, understanding the influence of geology and fractures, and their potential impact on a design, is critical for helping engineers develop safe, economical and efficient solutions," says Eberhardt.

Aerial view of the villages of Campo Vallemaggia and Cimalmotto, located on top of the Campo Vallemaggia landslide.

requires a multifaceted approach. For example, Eberhardt uses microseismic monitoring—similar to that performed for large-scale earthquakes—to listen to the snap, crackle and pop of movement and fractures deep underground.

"The problem is so complex that we try to throw everything at it," he says. "In order to understand the network of fractures in the ground, we monitor displacements, water pressures and microseismicity over time to determine how the kinematics of the failure in the slope is developing. We then use numerical models to try to reproduce some of these effects and gain a deeper understanding of the mechanisms and processes."

Eberhardt credits BC-based consulting companies Golder Associates, BGC Engineering, Piteau Associates Engineering, and mining company Rio Tinto for providing case histories that allow him and his students to further develop their ideas.

Villages on a Slippery Slope

Imagine an entire community slowly sliding down a mountain, closer and closer to tumbling into the abyss. The villages of Campo Vallemaggia and Cimalmotto in the southern Swiss Alps are situated on top of a deep-seated, creeping landslide of approximately 800 million cubic metres of crystalline rock (see photo above). Its movement has been reported for over 200 years. The presence of artesian springs deep below the surface have also been documented, dating back to famed alpine geologist Albert Heim's observations in 1897. Historical belief was that erosion at the toe of the landslide was the primary cause of the instability. However, measures to stop the landslide through erosion control have failed, and the villagers have been on continuous alert for emergency evacuation.

"Our understanding of how water destabilizes a slope didn't come about until the 1920s," notes Eberhardt. Complicating the matter, the rock type wasn't one considered as being permeable. He and former PhD student Luca Bonzanigo used numerical modelling techniques to demonstrate that high water flow pressures within fractures cutting through the rock were responsible for driving the unstable slope movements.

"Many thought that draining the slope wouldn't work, because so little water was coming out of this huge mass of rock. We used numerical models to show that high water pressures don't necessarily mean large volumes of water." Although the crystalline rock the villages are perched upon has very low permeability, the fractures in the rock are permeable, and have the ability to drive up high water pressures at depth. These in turn counteract the frictional forces working to prevent slip, enabling movement along the sliding surface.

Eberhardt's work not only confirmed that deep drainage using a large number of boreholes was the correct method to stabilize the slope, it also helped to show villagers that annual inspection of boreholes was required to maintain drainage. ■

Chemistry at the Surface

Manipulating Molecules with Electric Fields

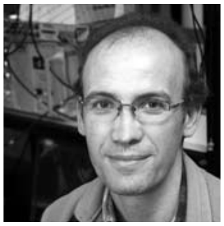


Photo: Elaine Simons

UBC associate professor Dan Bizzotto probes molecules with electrodes to study basic questions about how organic substances like lipids and proteins behave and interact, or how metals such as zinc and platinum can be used as catalysts.

Anyone who has watched the thin film of a soap bubble form brilliant swirls of colour that darken and fade until the bubble bursts has observed surface chemistry. Detergents behave like lipids, or fat molecules, in that they form a thin film surface on water. Lipids are hydrophobic (non water soluble), and as they spread over the surface of water they create a very thin layer—only one molecule thick (the length of a typical lipid molecule is around 12 angstroms or 1.2 nanometres).

While fat is generally given a bad rap, the importance of lipids in the body and their interaction with proteins has become a new scientific sub-discipline called lipidomics. All cell membranes are composed of a bilayer of lipid molecules that play a crucial role in cell, tissue and organ physiology. Membrane lipids control protein traffic and facilitate communication within and between cells. Genetic studies have shown that many human diseases, such as cancer, diabetes and neurodegenerative and infectious diseases, involve the disruption of lipid metabolic enzymes and pathways.

UBC electrochemist Dan Bizzotto is investigating how electric charge, or potential, changes the behaviour of lipid molecules on an electrode surface to better understand lipid biochemistry and to characterize the interaction between lipids and proteins in an electric field.

"What is becoming recognized now is that the way lipids are organized around cell membrane proteins and how they interact with the proteins can definitely change the way a protein functions," Bizzotto explains.

Probing Thin Films with Electrodes

The first step in Bizzotto's research is developing new methods to test what happens to lipids when they are subjected to a change in potential. To date, there are not many ways of doing this in a controlled fashion. He describes the process as similar to a capacitor that stores energy in the form of an electrostatic field. In its simplest form, a capacitor consists of two metal plates separated by an insulating material. One plate is positively charged, and the other negatively charged. The separation of charge, or difference in potential, produces an electric field.

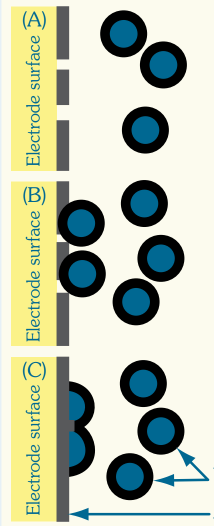
In Bizzotto's lab experiments, a metal electrode carries the negative charge and the water accumulates a positive charge with the lipid molecules located between these two "plates" of charge. The lipid molecules react to the change of potential and are adsorbed onto the metal surface.

"What we do is touch the electrode surface onto the floating lipid layer and transfer the layer onto the electrode surface," explains Bizzotto. "We then use various spectroscopic techniques to quantify the influences of the electric field on the adsorbed lipid film." His lab has found that potential can cause these lipid molecules to change the way they are organized. However, he notes that the electric fields needed to manipulate the lipid molecules in the lab are three to five times greater than those in a biological system.

Preparing the Surface for Future Discovery

While Bizzotto investigates questions in basic research, the results could have enormous implications for questions in health and medicine, such as: Why are some people fat and some thin? What is the role of fatty acids in human brain development? What is the role of lipids in wellness and disease?

The next step in Bizzotto's research is developing a system to incorporate cell membrane proteins onto charged electrodes in such a way that the protein assumes its



Adsorption, incorporation and fusion of vesicles onto an electrode surface.
(A) Potential is set to poke little holes in the adsorbed lipid layer.
(B) Vesicles are adsorbed onto the pores.
(C) Change of potential destabilizes and closes the holes in the lipid layer, and the liposomes get adsorbed into the lipid layer.

normal or natural configuration. "This is a major challenge, because unlike lipids, you can't put a membrane protein directly onto a piece of metal or it will unfold into a big mess," says Bizzoto. "What we have to do is create a happy medium between an electrode and a biomembrane."

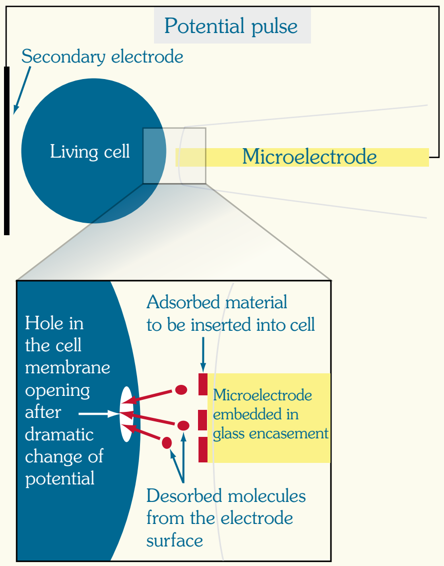
Using a similar process as with lipids, his lab has developed a biomembrane model that adsorbs liposomes onto a surface of an electrode. Liposomes are spherical membrane-enclosed sacs, or vesicles, that store and transport cellular material. "If we can put them on gold or mercury and get them to sit down on these solid surfaces, then the membrane protein can exist as part of this hemi-liposome," he says. "Encased in this lipid bilayer, the proteins should behave normally. Then we can use fluorescence spectroscopy to try to answer specific questions about protein–lipid behaviour and interaction."

Serendipity and "Potential" Discovery

It is one thing to put molecules onto an electrode, but quite another to take them off. The process, called desorption, requires even higher electric charges than adsorption. In the process of the liposome research, Bizzotto made a serendipitous discovery—a new method to implant cells with other molecules and thereby modify cell chemistry and activity.

While cell implantation has already been done, many molecules are difficult to introduce into a cell. For example, hydrophobic drug compounds must be dissolved in detergent or solubilizing agents in order to pass through the cell membrane. This process can mask the effect of the pure drug or even cause cell death.

Bizzotto's lab is working to develop a novel alternative for cell implantation. The method involves adsorbing individual molecules onto the end of an electrode, positioning them close to the cell, and changing the potential very quickly to high negative or positive values. The change in potential pokes a hole in the cell membrane and directs the molecule into the cell. "There is evidence that they follow the electric field into the cell. If we do it right, the hole will close back up again and the cell won't die," he says.



***Molecule implantation into a living cell** using electrochemical desorption and electroporation.*

Bizzotto acknowledges Kishor Wasan, professor of pharmaceutics and biopharmaceutics at UBC, and chemistry professor Tom Fyles at the University of Victoria, who are collaborating with him on cell implantation research.

"This work relies very heavily on the mechanical, electrical and glassblowing shops in Chemistry at UBC. They really are critical partners in these discoveries."

He also credits the NSERC Discovery Grant program and the Western Economic Development Organization for funding his basic research. "You can't program discovery. It happens when you are lucky, prepared and have the resources to pursue your work. Innovation is not use-motivated; it is about the interesting science you can discover." ■

Fuel Cell Research a Catalyst to Discovery

Fuel cells are electrochemical devices that combine hydrogen and oxygen to produce electricity, with water and heat as by-products. Because the conversion of fuel to energy doesn't require combustion, the process is clean and two to three times more efficient than burning fuel. Fuel cells are also silent, and the by-products can provide heat or hot water for a home or office. As promising as they sound, however, fuel cells are still an expensive, relatively inefficient way to produce power.

In the normal process of discovery, research moves from basic to applied. Dan Bizzotto's work in fuel cell optimization has taken the opposite turn. His group has been studying the use of platinum in hydrogen fuel cells, which can improve the efficiency of the oxygen reduction reaction (ORR)—and thus the power the fuel cell generates. Alloys of platinum with metals such as cobalt, iron and chromium have been studied. Iridium, gold, rhodium, and palladium coated with a platinum monolayer have also been shown to improve overall efficiency of the ORR.

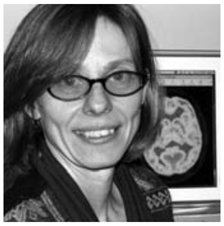
"One issue is cost, but a larger issue in platinum alloy catalysts is stability," notes Bizzotto. "It must be stable enough for 5,000 hours of operation, which is the benchmark for the fuel cell industry." Bizzotto and his lab were just starting a Ballard project to investigate non-precious metals in fuel cell catalysis.

At the same time, in an unrelated project, he and former graduate student Ed Guerra were studying the electrodeposition of zinc in collaboration with UBC materials engineer Dave Dreisinger. They decided to deposit zinc on platinum for this applied project and, to their surprise, zinc and platinum formed an alloy so stable that they couldn't remove it from the electrode.

In preparation for the Ballard project, Bizzotto and chemical engineering professor Elod Gyenge test ran the platinum/zinc alloy for ORR and found an improvement in reaction kinetics. It was unexpected because this combination should result in reaction rates similar to gold or copper, which are usually very poor. All the metal elements that are typically alloyed with platinum in order to improve oxygen reduction are on the left-hand side of platinum in the periodic table. Bizzotto found that the way platinum and zinc (to the right of platinum on the periodic table) form an alloy is similar to platinum and chromium in how the electrons are distributed in various orbitals. "We don't get much more of an improvement than with the platinum/chromium alloy, but the platinum/zinc alloy should be more stable. And, more importantly, it changes the way we think about forming alloys for electrocatalysis," he says.

In this research, serendipity has triggered fundamental questions, such as: How do metals from the "wrong" side of the periodic table bond together to form effective electrocatalysts? Why does this work and why is the alloy so stable? These are questions that scientists like Bizzotto love, because they often lead to groundbreaking discovery.

Imaging Neuronal Degeneration
PET Studies in Parkinson's Disease



Medical physicist Vesna Sossi is a member of the Pacific Parkinson's Research Centre and the Positron Emission Tomography group at UBC-TRIUMF. She is part of a multidisciplinary team working to understand disease progression and brain function in Parkinson's disease at the biomolecular level.

Watching someone slowly succumb to Parkinson's disease (PD) is like watching a fire slowly dwindle in mist. Motor coordination becomes impaired, muscles and joints become rigid and communication through speech and handwriting deteriorates. As the disease progresses, depression, mood swings and other cognitive disorders are manifested. In Canada, approximately one out of every 100 adults suffers from PD, and 20 percent of those are under the age of 50. Yet there is no cure, and researchers are still struggling to discover the cause.

Vesna Sossi, UBC associate professor in the Department of Physics & Astronomy, works with neurologists, chemical physicists, engineers, psychiatrists, computer programmers, and a host of technicians and students trying to reveal the complex workings of the brain. Sossi's area of expertise is in high-resolution 3-D imaging using positron emission tomography (PET), which allows researchers to study the interaction of molecules in the brain.

The Physics of PET Imaging

PET involves injecting radioactive tracers into a patient to study specific biochemical processes. Some tracers are similar to a compound normally found in the body, except they have one of the atoms replaced by a very similar radioactive atom, or radioisotope. Other tracers are specifically designed to be sensitive to selected biochemical processes.

When a radioisotope decays in the body, the tracer emits a positron which then collides with an electron, annihilating both particles. Each event produces two photons (with a specific energy of 511-kiloelectron-volts gamma rays), which fly off in opposite directions almost exactly 180 degrees from each other. Researchers can localize the source of these "coincidence events" along the straight line of response. The flying photons are detected by a large crystal cylinder. When a sufficient number of events have been detected, data can be reconstructed into images of tracer distribution. These images show tissues in which the radioisotope has become concentrated. The tracer uptake rates in living subjects vary, depending on the type and function of tissue involved.

Several key steps must be completed in the imaging process before Sossi can even start to reconstruct the image. The first is the design of site-selective radio tracers by TRIUMF scientists. Second, all the other physical interactions between the tissue and the radiation must be measured and corrected for. Finally, once the photons are detected, the images are reconstructed using complex algorithms and modelling techniques.

Sossi's current focus is on developing models to study the kinetics of tracers in the body. She credits the Canadian Institutes of Health Research (CIHR), the Natural Sciences and Engineering Research Council of Canada, the Michael Smith Foundation and TRIUMF's Life Sciences program for funding her basic research. Sossi and Arman Rahmim, her former graduate student and now assistant professor at Johns Hopkins University, developed an algorithm to reconstruct PET data in list mode as the data streams are being acquired, which doesn't require changing the format of the data before reconstruction. She and graduate student Kevin Cheng are currently trying to optimize reconstruction time by switching from list mode to histogram mode (the traditional way of reconstructing PET data).

Former Physics & Astronomy MSc student and now skilled technologist Katie Dinelle implements part of patient motion correction work that she and other students in the group have developed.

Positron Emission Tomography (PET). *After tracer administration, the patient is scanned with a PET camera. Above: the inside of a high-resolution research tomography scanner.*

Dopamine Regulation and the Role in PD

Sossi has been studying the mechanisms that regulate the neurotransmitter dopamine. "For proper function, your brain must have just the right amount of dopamine," she explains. "Lack of dopamine in the synapses leads to imbalances that can result in movement disorders such as Parkinson's disease."

There are two mechanisms for removing dopamine from the synapse: degrading (metabolizing) or storing it in a different place. The latter involves the dopamine transporter

PD and the Dopamine Dilemma

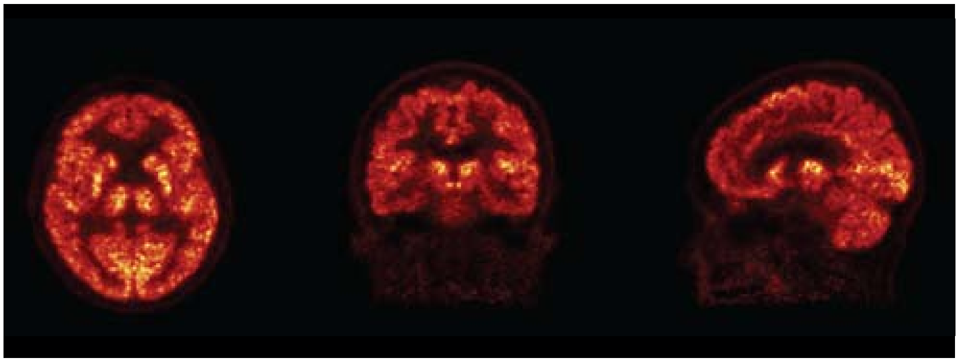
Parkinson's disease affects the levels of dopamine, a neurotransmitter in the brain involved in aspects of behaviour and cognition, motor activity, motivation and reward, regulation of milk production, sleep, mood, attention, and learning. As the disease progresses, dopamine deficiency increases. The clinical manifestations of tremor, rigidity and slow movement generally occur when 50 percent of the dopaminergic neurons (i.e., neurons whose primary neurotransmitter is dopamine) have died. As with other diseases such as Alzheimer's and many forms of cancer, PD has a long latency period, where neurochemical changes are taking place long before the patient experiences clinical symptoms. PET is extremely valuable because it is capable of detecting changes in neurochemistry level prior to the onset of clinical symptoms.

DAT, which clears dopamine out of the synapse and carries it back into the vesicles of the presynaptic neuron. “That is the only safe place for dopamine,” says Sossi. “In the presynaptic vesicle, dopamine is stored and not exposed to any degrading mechanism. It can be used again, so this is also a kind of recycling process in the human body.”

To better understand the role of DAT in Parkinson’s disease, the Pacific Parkinson’s Research Centre (PPRC) investigators have conducted PET scans in PD patients and relatives who were not symptomatic but genetically predisposed to the disease. They found that pre-symptomatic subjects already had a significant reduction in DAT density. Their studies confirm that the down regulation of DAT in the early and pre-symptomatic stages of the disease may represent a compensatory mechanism that keeps synaptic dopamine levels high enough to maintain relatively normal motor function.

Most importantly, their work has shown that this compensatory mechanism is also likely to influence disease progression by being associated with an increase in dopamine turnover, or the ratio of dopamine metabolized to dopamine produced. They found that a decrease in DAT expression because of a reduced ability to take dopamine back up into the presynaptic terminals, leaves the dopamine exposed to enzymatic degradation. Consequently, dopamine is metabolized and cleared more quickly from the brain. “Dopamine is produced from levodopa, which is one of the drugs used to treat PD,” says Sossi. “In the more advanced stages of the disease, dopamine is being released more quickly, because the storage mechanism isn’t working. As a result, the post-synaptic neuron receives a wide fluctuation in the amount of dopamine it receives—from a lot, to not enough.”

This fluctuation in dopamine levels has been shown in animal studies to cause motor complications. “It is also well known clinically that people who develop PD when they are younger tend to have a higher incidence of motor complications,” notes Sossi. She has also shown that the increase in dopamine turnover is higher for these people than those who develop the disease at an older age.



A PET image *(transaxial, coronal and sagittal views) using the HRRT scanner. The radiotracer distribution provides information on glucose metabolism in the brain.*

Gambling Addiction: A Side Effect of PD Treatment?

Sossi and colleagues in the PPRC and Departments of Psychiatry and Psychology just received a grant from the CIHR to investigate the controversial relationship between gambling addiction and levodopa treatment in PD patients.

“Motor complications are only one aspect of the disease,” says Sossi. “There are also psychiatric complications such as mood disorders, including pathological gambling. A higher percentage of people with PD also develop depression compared with people in a comparable disease state.”

Treatment-related compulsive behaviours and impulse control disorders, or TRCB-ICD, is a side effect in 4 to 8 percent of PD patients who are taking levodopa. Since dopamine mediates the brain’s reward and expectation mechanism, a lack of dopamine could have some influence on how people perceive pleasure. Sossi will be using imaging techniques to gain insight into the neurochemical mechanisms underlying TRCB-ICD in Parkinson’s patients.

“We think that compulsive disorder in PD could be a combination of dysfunction in the ventral striatum area of the brain, which is associated with perceiving reward or expectation, together with some cognitive impairment, where people might not be able to assess the implications or consequences of their actions,” Sossi explains. “With more understanding of the mechanisms of PD, we hope our research will lead to better treatment and, ultimately, a cure.”■

PET Imaging at UBC-TRIUMF

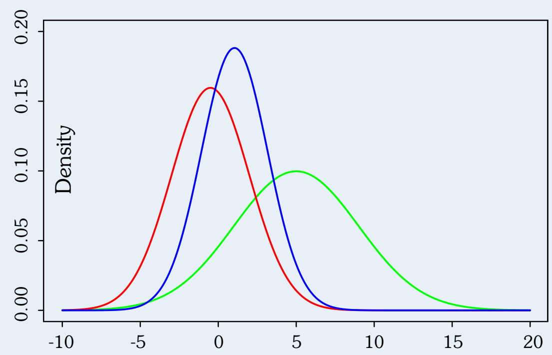
The Positron Emission Tomography (PET) group at UBC and TRIUMF, Canada’s national laboratory for particle and nuclear physics, is world renowned for its imaging research and technical expertise. The centre is home to three PET scanners, a brain scanner, a small animal PET scanner, and a high-resolution research tomography (HRRT) scanner—one of only 17 such scanners in the world. The new HRRT 120,000-crystal scanner can detect up to 6 percent of all positron emission, while older scanners with typically around 10,000 crystals detect only 2 percent. However, correcting for patient movement is much more of a challenge. “The resolution of this scanner is about 2.5 millimetres in all three directions, whereas with the other scanners it is about 7 millimetres,” says Sossi. “Some of our scans require patients to stay in the scanner for up to four hours, and if a patient moves by 1 or 2 millimetres—which is very hard not to do—the image becomes blurred.” In collaboration with an international team of researchers, Sossi is working on next-generation algorithms for reconstructing images from the super-sensitive HRRT.

Improving Outcomes

Using Statistics to Enhance Medical Analysis

Photo: Elaine Simons

Statistical analysis is a key tool of all scientific disciplines, but not all statisticians agree on enhancing quantitative data with qualitative assumptions. Statistician Paul Gustafson is honing medical and statistical analysis by incorporating unknowns and assumptions into the equation.



Bayesian Inference. *Prior Distribution (green) represents pre-study knowledge; Likelihood (red) represents the information content of the data; Posterior Distribution (blue) represents the conditional distribution of all unobservables given all observables.*

Questions of uncertainty, randomness and probability have haunted and inspired scientists in all disciplines. The issue of uncertainty is central to the discipline of statistics. While many fields of mathematics require absolute proof of a theorem, statisticians look for the best methods to analyze data in order to make reasonable assumptions or predictions.

It is interesting to ponder the fact that Thomas Bayes introduced one of the most important theorems dealing with uncertainty nearly 300 years ago, before the American and French revolutions. Since then, Bayes' theorem has revolutionized the field of statistics, and has caused much controversy in the process. An important aspect of Bayes' theorem is that it provides a rule of how to strengthen or revise evidence-based suppositions by incorporating conditional probabilities. Bayesian statistics uses a mechanism called the prior distribution, which takes into account prior subjective assertions about the relationships between the variables being studied.

"A prior distribution is chosen to represent what the investigator thinks about key quantities," explains UBC statistics professor Paul Gustafson. "It's an attempt to summarize a hypothesis about the situation before the data are taken into account and then to take that qualitative assumption and make it quantitative."

Bayesian analysis is an iterative approach that uses earlier probabilities to provide better solutions to subsequent problems. It also allows researchers to question how variables are measured and to incorporate that uncertainty into the analysis. "It provides a realistic alternative to traditional approaches, which tend to be too optimistic in many studies that involve unknown or badly measured variables," Gustafson says.

The Problem of Non-randomization

Gustafson's interest in badly measured variables (see sidebar) led him into the burgeoning area of medical statistics, where Bayesian techniques are used in the analysis of observational data. It is difficult to draw statistical inferences from medical studies, because they are often not randomized due to cost or ethics. This lack of randomization makes the data extremely difficult to analyze. "If we are comparing two drugs, we don't get to control who gets which one, we can only observe who is taking which drug, with a lot of speculation about why the physicians involved recommended those drugs to their patients," says Gustafson.

He and colleagues Lawrence McCandless (Imperial College, London, UK) and Adrian Levy (Centre for Health Evaluation and Outcome Sciences, Vancouver, and Department of Health Care & Epidemiology, UBC) reviewed an observational study of nearly 7,000 heart failure patients, using health care administrative data to estimate the effectiveness of beta-blocker therapy. The data included information on age, sex, other complicating health conditions, length of hospitalization, and type of medication dispensed.

However, the study provided only limited information on clinical variables that influence the prescribing of drugs, and no information on the degree of heart failure in each patient. The study also indicated that patients who received beta-blocker therapy were more likely to be female, younger and have other aggravating medical conditions.

In reviewing the data and applying Bayesian techniques, Gustafson and colleagues wanted to determine if unmeasured indications of disease severity might be associated with the treatment decision, which could bias the estimated effectiveness of beta-blocker therapy.

"We simply didn't think that we had great information on the severity of each person's disease," says Gustafson. "The problem with administrative data is that it isn't designed for research purposes." It can also lead to selection bias where—despite best efforts—certain populations are under-represented or over-represented.

How Confounding Variables Elucidate Data

Selection bias is only one mechanism that muddies the waters in observational studies. Others include exposure classification (see sidebar) and confounding variables. In the language of statistics, confounding variables are those that are both associated with the outcome being studied and the potential cause.

"One example would be if you wanted to study the potential link between alcohol consumption and a certain form of cancer," explains Gustafson. "Smoking could confound that relationship because often smoking and alcohol consumption are associated. Smoking could also be the biggest causative agent for the cancer in question." When

Example of Poorly Measured Variables

One type of bias mechanism in medical statistics is exposure classification, where often the potential cause or exposure being studied is difficult to measure accurately. For example, Paul Gustafson describes a data set where smoking was the primary exposure he and his colleagues were interested in.

However, the question posed did not have a simple yes/no answer, in terms of the respondent being a smoker or non-smoker. Rather, Gustafson was interested in lifetime exposure, where the unit of the variable is in packs/day × years (where someone smokes one pack of cigarettes a day for a year, added up over a lifetime). "All we could do is ask that question on a questionnaire. Even the best intentioned respondent won't remember accurately," Gustafson says. "So there is considerable error in that kind of variable, and that is just the random error."

In addition, there are systematic errors, such as those involving psychology, where patients might under-report or over-report their smoking. "What happens if you ignore these variables and simply do a standard statistical analysis, with cancer as the outcome and a self-reported smoking variable as the potential cause, is that those results can be quite misleading. They tend to underestimate the relationship between the exposure and the disease."

Gustafson notes that problems with poorly measured variables can be approached in a non-Bayesian manner. However, it tends to demand that the researcher know exactly how bad the measurements are. "The difficulty is that you don't know that either. You have a range, but you don't know it," he says. "Bayesian methods can deal with that uncertainty."

Bayesian Statistical Analysis. *In a test of this methodology, uncertainty about the benefit of beta-blocker therapy derived from linking unobserved and observed confounders (column A) was seen to be much reduced compared to the unlinked situation (column B), but not falsely precise as when unobserved confounders are ignored (column C). Horizontal lines represent uncertainty in regards to unobserved confounders.*

considering causal relationships between treatment and outcome in the beta-blocker study, there were 21 potential confounders in the observed data, such as demographics, comorbidities, characteristics of hospitalization, and medications prescribed.

If a variable is not part of the observed data, then it is described as an "unmeasured or unobserved confounder." These unobserved variables "compound" the "confounding" and are very difficult to quantify. The unknown variables in the beta-blocker study were the severity of heart disease in each patient, and the clinical variables that determined why certain drugs were prescribed.

But how do you give a value to unmeasured confounders? How do you measure the relationship between unobserved variables and patient exposure (in this case to beta-blockers), and health outcomes?

"There is no basic science to tell us what all the confounding variables are, so we include what we think are confounders as well as ones that are available in the data, but there is never a guarantee that you have them all."

Gustafson's novel contribution to Bayesian analysis is in making the link—or assuming a relationship—between measured and unmeasured confounding. "If the confounding effect of an unmeasured variable is known to be similar to that of measured confounders, we can use prior distributions to model the strength of those associations and quantify uncertainty from unmeasured confounding."

He notes that there is no magic bullet to working with poorly measured or unobserved variables. Health researchers must make judgments on the strength of largely unverifiable assumptions, which is very difficult. However, academic statisticians can provide tools to make better inferences, which can lead to improved recommendations for patient care and treatment—such as who should be prescribed beta-blocker therapy after a heart attack.

"The challenge is dealing with the complexity of interactions between all of these observed and unobserved confounders," admits Gustafson. "We really are just beginning to tackle this. It's the next step in this line of research."■

Faculty of Science: Kudos

Tom Beatty, Prof., Microbiology & Immunology
- Killam Research Fellow, Canada Council for the Arts

Allan Bertram, Assoc. Prof., Chemistry
- Accelerator Supplement Award, NSERC

Jim Bryan, Prof., Mathematics
- Visiting Research Professorship, University of California, Berkeley

David Brydges, Prof., Mathematics
- Fellow, Royal Society of Canada

David D.Y. Chen, Prof., Chemistry
- W.A.E. McBryde Medal, Canadian Society for Chemistry

David Dolphin, Prof., Chemistry
- BC Biotechnology Award for Lifetime Achievement 2007, LifeSciences BC

Tony Glass, Prof. Emeritus, Botany
- Gold Medal Award, Canadian Society of Plant Physiologists

Paul Gustafson, Prof., Statistics
- Accelerator Supplement Award, NSERC

Patrick Keeling, Assoc. Prof., Botany
- Fellow, Canadian Institute for Advanced Research Fellowship

Leah Keshet, Prof., Mathematics
- Accelerator Supplement Award, NSERC

Isabella Laba, Prof., Mathematics
- Accelerator Supplement Award, NSERC

Brian Leander, Asst. Prof., Botany and Zoology
- Scholar, Canadian Institute for Advanced Research Fellowship

Spotlight—Sally Otto

Sarah (Sally) Otto, professor in the Department of Zoology, has been awarded the 2007 Steacie Prize in the natural sciences—Canada's top honour for young scientists and engineers. Otto has won international acclaim for her work in applying mathematical models to understanding how species evolve. She analyzes how factors such as mating system, genome composition, population size, and ecology are able to channel evolutionary transitions in certain directions but not others.

Each year, the award recognizes exceptional contributions from a scientist or engineer of 40 years of age or less. Winners are selected by a panel appointed by the E.W.R. Steacie Memorial Fund, a private foundation dedicated to the advancement of science and engineering in Canada.

Evolutionary biologist Otto has also been named director of UBC's Biodiversity Research Centre (www.biodiversity.ubc.ca). She succeeds Zoology colleague and Canada Research Chair Dolph Schluter who stepped down end of December 2007 after five years at the helm of the Centre.

"The excellence and innovation of young investigators like Prof. Otto contribute greatly to UBC's reputation as a global leader in research," says John Hepburn, Vice-President, Research. "Their vigour and new ideas strengthen UBC's research, and enable us to attract similar stellar talent and the best students from around the world."

Otto has donated the Steacie Prize money of $15,000 to UBC's new Beaty Biodiversity Museum (www.beatymuseum.ubc.ca). Her gift will help fund educational programming and public outreach efforts at the museum. "The Beaty Biodiversity Museum will be a place where young children can learn about the tremendous diversity of life on our planet, where the public can see, perhaps for the first time, plants and animals from throughout BC and the world. I'm very pleased to support such an important addition to our community."

Jaymie Matthews, Assoc. Prof., Physics & Astronomy
- Alouette Award 2008, Canadian Aeronautics and Space Institute

Ulrich Mayer, Asst. Prof., Earth & Ocean Sciences
- Accelerator Supplement Award, NSERC

Gail Murphy, Prof., Computer Science
- Diamond Award for Early Career, University of Washington (College of Engineering)

Patrik Nosil, Post-doctoral Fellow, Zoology
- Theodosius Dobzhansky Prize, Society for the Study of Evolution

Scott Oser, Asst. Prof., Physics & Astronomy
- Sloan Research Fellowship, Alfred P. Sloan Foundation

Sarah Otto, Prof., Zoology
- Steacie Prize, National Research Council/ E.W.R. Steacie Memorial Foundation

Dinesh Pai, Prof., Computer Science
- Accelerator Supplement Award, NSERC

Daniel Pauly, Dir., Fisheries Centre; Prof., Zoology
- Honorary Doctorate, Katholieke Universiteit Leuven
- Ted Danson Ocean Hero Award, Oceana

Zinovy Reichstein, Prof., Mathematics
- Accelerator Supplement Award, NSERC

Dale Rolfsen, Prof., Mathematics
- Honorary Doctorate, University of Caen (France)

Kelly Russell, Prof., Earth & Ocean Sciences
- Peacock Medal 2008, Mineralogical Association of Canada

Dolph Schluter, Prof., Zoology
- Sewall Wright Award 2007, American Society of Naturalists

Patricia Schulte, Assoc. Prof., Zoology
- Accelerator Supplement Award, NSERC

Jozsef Solymosi, Asst. Prof., Mathematics
- Andre-Aisenstadt Prize, Centre de Recherches Mathématiques

Curtis Suttle, Prof., Botany, Earth & Ocean Sciences and Microbiology & Immunology
- Fellow, Canadian Institute for Advanced Research Fellowship

Carl Wieman, Dir., CWSEI; Prof., Physics & Astronomy
- Interactive Media Prize, US National Science Foundation

Jeff Young, Prof., Physics & Astronomy
- Accelerator Supplement Award, NSERC

Portrait: The Department of Microbiology & Immunology

The Department of Microbiology & Immunology has a long and distinguished history at UBC. Renowned educator and scientific pioneer Frank F. Wesbrook, the university's first president, was trained in bacteriology, a newly developing area of scientific research. Established in 1926 by the first full-time bacteriologist in Canada and the first epidemiologist in North America, Hirbert W. Hill, the department has had a steady stream of illustrious faculty members. Julia Levy, whose research led to the first effective therapy for macular degeneration, is a prime example (see below).

Today, Microbiology & Immunology is an internationally recognized centre for research into viruses, bacteria and fungi, as well as immunological processes needed to prevent disease. There are more bacterial cells in the human body than there are human cells. And, enormous populations of microscopic organisms play a central role in maintaining the ecological balance of all terrestrial and aquatic environments. Our microbiologists focus on solving environmental problems; for example, using microbes to remediate soil by breaking down contaminants. Our immunologists study diseases associated with immune system dysfunction, including autoimmune diseases (e.g., diabetes and lupus) and various forms of cancer.

The department's vibrant atmosphere reflects the success of individual labs and interdisciplinary teams in developing new areas of research. Recent analysis of DNA sequences has revealed an astounding diversity of bacterial populations. We now realize there are hundreds of thousands of bacterial species and fewer than 1 percent have been studied in the laboratory! Our faculty are interested in the mechanisms used by our innate immune system to eliminate pathogenic (harmful) bacteria and viruses from the body, while retaining symbiotic (useful) bacteria. Our research faculty play leading roles in the Centre for Drug Research and Development, the Centre for Tuberculosis Research and the Centre for Microbial Diseases and Immunity Research, all based at UBC.

Prestigious awards won by faculty include Officer of the Order of Canada (two), the Queen Elizabeth Golden Jubilee Medal, Order of British Columbia, Elected Fellow of the Royal Society, Canada (three), the E.W.R. Steacie Prize, and Elected Fellow of the American Academy of Microbiology (four).

Twenty-seven faculty members teach 85 graduate and over 5,000 undergraduate students in both departmental and Biology-curriculum courses. Our students learn the most up-to-date molecular concepts and techniques and are encouraged to generate their own ideas. Graduate students train in health and environmental sciences research that is primarily supported by highly competitive grants awarded to our faculty. Many undergrads get first-hand research experience in our laboratories.

Our students and research fellows have established several interactive and socially conscious organizations. The Microbiology & Immunology Student Association not only promotes social and academic support for UBC peers, but members have volunteered at AIDS orphanages and hospices in Kenya and Botswana, and have been involved with HIV/AIDS awareness efforts in Vancouver's Downtown Eastside.

Breadth of research opportunities and a distinguished faculty with a passion for science make our department a stimulating place to carry out basic and applied research and prepare our students for leading roles in industry (biotechnology), teaching and medicine. www.microbiology.ubc.ca

Innovator and Entrepreneur—Julia Levy

Julia Levy, UBC alumna and immunology professor (1958 to 1999), was instrumental in building UBC's most successful spinoff company to date and bringing a sight-saving drug to millions of people worldwide.

Curious about lesions her children developed on their legs after playing in a field of cow parsley, Levy learned that cow parsley sap contains a photosensitizer chemical, which, when activated by sunlight, can cause a burning reaction. This sparked Levy's interest in photodynamic therapy (PDT), which she incorporated into her immunology research focusing on cancer. In 1983, she became a director of Quadra Logic Technologies Inc. (now QLT Inc.). Through her foresight, QLT acquired the rights to Photofrin, a first-generation photosensitizer, which was approved in Canada, the US and Japan for treatment of certain cancers in the early '90s.

When her mother developed wet age-related macular degeneration (AMD), Levy learned that wet AMD was the leading cause of blindness in the elderly. As CEO and president of QLT (1995 to 2002), Levy steered research into ophthalmic applications of PTD.

Together with UBC chemistry professor David Dolphin, Levy discovered light-activated porphyrin molecules that could shrink tumours, and they developed

Visudyne, a drug that destroys abnormal, leaky blood vessels.

In January 2008, Levy retired from QLT. But a recent appointment to the board of Cannasat Therapeutics, a developer of cannabis-based pharmaceuticals, indicates she is not retiring from enterprise in science.

Levy's many accolades include Pacific Canada Entrepreneur of the Year (2000), Officer of the Order of Canada (2001), and with Dolphin, the Friesen-Rygiel Prize for medical research and the Prix Galien Canada research award (2002). In 2004, the Julia G. Levy Professorship in Ophthalmology Chair was created at Johns Hopkins Hospital Wilmer Eye Institute, and she received a Lifetime Achievement Award from the BC Biotechnology Association.

Building on Science

Physics Research Enables Worldwide Innovation

Photo: Elaine Simons

Lorne Whitehead measures the extreme luminance levels of the High Dynamic Range display.

As UBC celebrates its 100th anniversary, the Faculty of Science is celebrating the 10th birthday of the high dynamic range (HDR) display. This technology, born out of an interdisciplinary research project in perception and optics, has led to a paradigm shift in modern television viewing.

In 1998, a research program in the Department of Physics & Astronomy tackled an unsolved problem in experimental psychology and illumination engineering: how to provide the best possible illuminated environment with the least possible electrical power. Professor Lorne Whitehead (see image above), who spearheaded the project, soon after invented a new instrument to support this research—the first version of the HDR display: a computer video projector optically registered in order to back-light a small colour liquid-crystal-display (LCD) computer screen. This produced both high brightness and extreme contrast—for the first time spanning the human eye's range of visual intensity perception.

Enter Helge Seetzen, who joined Whitehead's lab in 2000 as an undergraduate student. Seetzen explored the innovation and commercialization potential of this research. With the emerging flat-panel high-definition television industry in mind, Whitehead's subsequent idea of replacing the rear projector with light emitting diodes (LEDs)—developed with collaborative input by Greg Ward, a leading imaging researcher based in Berkeley, California, and investigated by Seetzen—became a reality. The result not only provided high contrast while saving energy, but substantially reduced the thickness of the original HDR set-up.

In 2002, Whitehead created the spin-off company BrightSide Technologies, with Don Graham, a well-known Vancouver business leader, as co-founder and first investor, and freshly graduated Seetzen as the head of technology. Whitehead served as chair, and then advisor. Later, Wolfgang Heidrich, a professor in the Department of Computer Science, joined the company's technical advisory board, and software development related to HDR displays became a key focus in his research (see "Simulating Shadows and Light" in *Synergy* 2 | 2007).

BrightSide Technologies continued to develop demonstration prototypes, attracting strategic partnerships with major companies until, in 2007, the company was bought by Dolby Corporation.

Whitehead, who has earned more than 100 patents—the single highest number among his colleagues at UBC—played a leading role in every step of this success story. But he hasn't stopped there. Whitehead, who also holds the NSERC-3M Industrial Research Chair in Structured Surface Physics—and, in his post as University Leader of Education Innovation is committed to advancing the learning experience for generations of future UBC students—continues to provide advice on next-generation HDR applications.

The acquisition of HDR technology by Dolby signifies a major technology transfer success. It has not only brought revenue to the university, but has led to the creation of a new and growing high-tech company, Dolby Canada, in Vancouver. The benefits to society are innovative television images that are more life-like and yet use less energy. The technology is now being licensed by Dolby to television manufacturers worldwide.

Photo: Elaine Simons

Running a colour screen test on the HDR display.

Connecting with Science

Remembering Grant Ingram—Supporting Future Oceanographers

The late R. Grant Ingram was a distinguished Arctic oceanographer, UBC professor and administrator. Ingram spent many summers on research icebreakers and in tents on Arctic sea ice. His work advanced the understanding of ocean physics, focusing on the link between the physical environment and marine biological populations in northern and Arctic oceans, as well as studying the effects of climate variability and climate change.

Ingram joined the Department of Earth & Ocean Sciences in 1997 and was the founding principal of UBC's St. John's College from 1997 to 2004. He also served as associate dean of Strategic Planning and Research and dean pro tem in the Faculty of Science, as well as principal of the university's recently created College for Interdisciplinary Studies.

Ingram shared his passion for the study of oceans—as well as his reflections of the world and humanity—with many aspiring students and scientists. "We need to listen to one another and celebrate the value of diversity amongst us," Ingram said once to the community of international scholars gathering at St. John's College for a Festival of Lights. He loved to share food and thoughts around a table full of light, family and friends.

To honour his memory, family and friends have established the R. Grant Ingram Memorial Scholarship in Oceanography to support outstanding students as they continue professor Ingram's legacy—exploring the world's oceans in this challenging time of global change.

To contribute to this scholarship, please call the UBC Development Office at 604-822-5345.

Advancing Science—Community and Friends

Science at UBC is about discovery—whether it's a first-year student taking the newly redesigned Physics 100 class, or a seasoned academic exploring microbial life forms using new technology. UBC's Faculty of Science is a hub of discovery across the disciplines—from the life sciences, to physical and earth sciences, to mathematical and computer sciences. We are preparing our students for lifelong success in their chosen fields, and through the Carl Wieman Science Education Initiative we are discovering how to further enhance undergraduate education.

Creating an outstanding community of learning and discovery requires a clear vision, dedicated faculty members, engaged students and ongoing support from our community. The impact of the contributions we receive from you, our alumni, friends and community partners, is felt throughout our Faculty—in the lives of students, in our capacity for research and in the calibre of our teaching.

Our donors invest in the Faculty's enterprising vision through the creation of new student awards and fellowships and by providing resources to fuel research and build modern teaching facilities. Overall, donor support enriches the academic experience and secures the long-term stability of this place, which many Faculty of Science alumni hold dear. And, it helps ensure that UBC Science is among the best science faculties in the world.

Thank you for your ongoing generosity to UBC Science. Your contributions—as donor, mentor, volunteer or co-op employer—help make the student experience extraordinary and propel research to new frontiers. We thank you.

André Zandstra, Director of Development, Faculty of Science, 604-822-8686, andre.zandstra@ubc.ca

UBC SCIENCE CONNECT
The emagazine of the UBC Faculty of Science

This spring, we launched UBC Science Connect, the e-magazine of the UBC Faculty of Science. Keep in touch and stay up to date with news, kudos, events, classmates, and reunions. You can sign up for UBC Science Connect at science.ubc.ca/connect.

People at UBC Science

Paul Carter Boosts Students onto Technology Trek

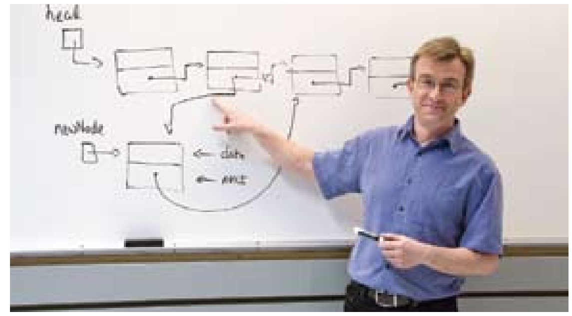


Photo: Elaine Simons

From hand building Lego Robots for high school students, to leading the development of a departmental proposal for the Carl Wieman Science Education Initiative (CWSEI), Computer Science (CS) senior instructor Paul Carter is devoted to attracting diverse students to computer science and ensuring their success. He also sees the CS-CWSEI project as an opportunity to develop more effective approaches to teaching and learning that will allow UBC CS students to emerge as leaders among the next generation of computer scientists.

A Killam Teaching Award recipient and a four-time CS Incredible Instructor Award winner, Carter is very aware of the impact his field has on our society. “Computer science is touching many other areas,” says Carter. “As a result, new fields are emerging. Bioinformatics, for example, lies at the intersection of computer science and biology.” In response to interdisciplinary research like this, the department has created combined programs that allow students to explore the connection between computer science and other science disciplines, commerce and the arts.

Carter directed a second-degree Bachelor of CS program during its inaugural two years and cites this involvement as one of his most rewarding experiences. In this program, students who may have no prior knowledge in computer science combine their existing skills and knowledge—in, for example, biology, psychology, commerce, and education—with a solid foundation in computer science.

He is also a driving force behind CS outreach activities. In the TechTrek program—an opportunity for secondary school students to discover an interest in this discipline, which may not be offered at their school—participants with no prior programming experience use graphical programming environments such as Lego Mindstorms and Scratch to program movement of the Lego Robots and to create 2-D animation and games.

Carter is genuinely interested in the welfare and achievement of his students. Since note-taking is a skill some students struggle with in the transition from high school, he has found that “template notes”—notes available online prior to a class and typically including the statement of a concept followed by some problems to illustrate that concept—are a particularly effective structure. Solutions to the problems are not included in the notes; students develop solutions interactively during class.

In December 2007 Carter stepped down from his two-and-a-half-year run as CS Associate Head for the Undergraduate Program and is looking forward to focusing more on teaching and learning. He had an “aha moment” at a recent CWSEI seminar on Just in Time Teaching (JiTT). He is planning a sabbatical year in 2008/09. Part of his time will be spent exploring JiTT, which uses feedback from pre-class web assignments to adjust classroom lessons so that students receive rapid response to questions and problems they are having.

After all, what is most important to Paul Carter? “Providing students with an opportunity to achieve their full potential.”

CWSEI—Update

Nobel prize laureate and physics professor Carl Wieman leads UBC’s Science Education Initiative since he joined UBC early last year. The initiative supports a variety of projects such as the CS-CWSEI, which aims at improving student learning through (1) determining learning goals, (2) assessing various teaching techniques and their impact on student learning and (3) transforming the CS program in response to these assessments. To date, ten Science Teaching and Learning Fellows have been appointed in five departments to support the implementation of evidence-based education advancements. www.cwsei.ubc.ca

Printed with UV inks (emit no VOCs) on 100% post-consumer recycled paper (no new trees used). Based on the choice of this paper, the following natural resources were saved: **Trees saved.** 34. **Wood saved.** 8,805 kilograms. **Water saved.** 108,047 litres. **Landfill reduced.** 1,373 kilograms. **Greenhouse emissions reduced.** 2,663 kilograms. **Energy reduced.** 40,765 megajoules.

SYNERGY » JOURNAL OF UBC SCIENCE
Published by the Faculty of Science, The University of British Columbia (UBC)
Web. www.science.ubc.ca
Fax. 604-822-5558
E-mail. synergy.science@ubc.ca
Editor in Chief. Carola Hibsch-Jetter
Writers. Mari-Lou Rowley, Pro-Textual Communications (research articles); Charles J. Thompson (department portrait); Carola Hibsch-Jetter
Copy editor. Vicki McCullough
Circulation. 30,000 (two issues per year)
Layout/Artwork. www.mediagroup.ubc.ca
Photos. Provided by UBC Faculty of Science or as indicated.
Printed in Canada on recycled paper.

Return undeliverable Canadian addresses to:
UBC Faculty of Science (*Synergy*)
1505–6270 University Boulevard
Vancouver BC V6T 1Z4 Canada