



Brock University

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Transitions

Brock University has undergone significant transitions over the last five years. Under the leadership of Dr. Jack Martin Miller, Associate Vice-President Research and Dean of Graduate Studies, the level of sponsored research programs has increased by more than four fold and the number of graduate programs increased from less than 10 to nearly 30. Indeed, the graduation of our first two PhD candidates at the Spring 2004 convocation marks a significant milestone in the maturation of the Brock research profile.

Dr. Miller has toiled to ensure that researchers in all faculties who have sponsored programs of research have the necessary laboratory space to conduct their research and to train their students.

Dr. Miller championed the University's applications to the Canada Foundation for Innovation and use of Federal Indirect Costs to provide essential laboratory equipment and renovate facilities to enable our faculty members and students to engage in leading-edge scientific, social science and humanities research.

Dr. Miller, who retires from the AVP Research position on July 1, 2004, leaves a positive legacy that will be with us for many years. I look forward to building on this legacy as I transition from the Director of Research Services to the Associate Vice-President Research and look forward to working with each faculty member to advance your scholarly, research and fine and performing arts programs.

We also welcome to Brock University two new Canada Research Chairs: Dr. Melanie Pilkington, Tier II CRC in Chemistry, joined us from Switzerland, and Dr. Cheryl McCormick, Tier II CRC in Psychology, returned to Canada after a decade of teaching and research in the United States. Join me in welcoming these new colleagues who will help in the transition of Brock to a more research intensive, comprehensive university that values equally excellence in teaching and outstanding research and scholarship.



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Advancement in Amphibian Limb and Spinal Cord Regeneration

Research into regeneration began over 200 years ago with Italian scientist Lazzaro Spallanzani. The Italian scientist's work confirmed that certain species were able to re-grow tissue, organs and bone in response to trauma, and made a number of important conclusions that still hold true today. Among them, he discovered that while young animals have greater regenerative abilities than mature animals of the same species, Urodele amphibians are the exception.

Urodele amphibians, such as the newt, are the only adult vertebrates that can regenerate many tissues.

For Robert Carlone, Associate Professor of Brock's Biological Sciences Department, the newt, a small amphibian that lives either on land or in the water, offers a unique model system to study the phenomena of limb and spinal cord regeneration. Amputation of the limb or damage to the spinal cord in newts leads to replacement of the missing tissue and functional recovery, unlike mammals.

Researching the regeneration of Urodele amphibians offers an understanding of how mammals such as humans are able or unable to regenerate. Ultimately, the research of scientists like Carlone will lead to

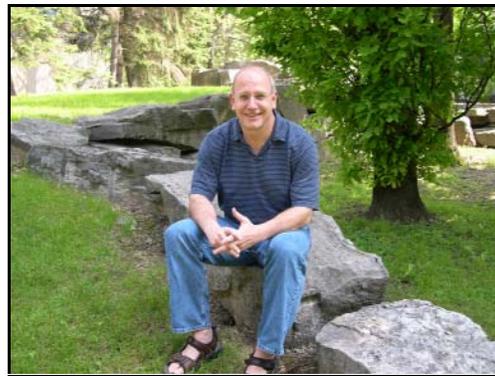
advances in the treatment of severe wounds, burns and spinal cord injuries.

One aspect of Carlone's work is determining the chemical basis for the reciprocal interactions between spinal cord nerves and the regeneration blastema at the tip of the amputated limb. A limb

blastema is a mass of embryonic-like cells from which tissue regrows. Nerves are required for growth of the blastema and in turn, the blastema exerts an influence on regrowth of spinal cord nerves and

reinnervation of the limb.

Along with colleague Gaynor Spencer and students Jennifer Dmetrichuk and David Prince, Carlone has demonstrated that spinal cord nerve outgrowth is promoted by retinoic acid, or vitamin A, which is produced by the blastema cells. With another colleague in the department, Professor Adonis Skandalis and students Brandon Bourque and Chris Carter, Carlone's lab has recently isolated a receptor protein from adult newt spinal cord and brain tissue, which may mediate the nerve growth promoting activities of vitamin A. Most interestingly, this receptor protein has been found in



Robert Carlone

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the spinal cords of embryonic mice, which can regenerate, but is not present in the cords of adult mice, which have lost that ability.

Carlone's work is contributing to the strides being made in spinal cord research. Currently, when a person sustains injury to the spinal cord, loss of movement is usually permanent. This loss occurs because the body cannot regenerate new central nervous system cells, nor can damaged cells re-establish connections with other cells. Understanding the factors that could permit spinal cord cells to regrow and make functional connections with other nerves in adult newts could potentially lead to advancements in the treatment of spinal cord injuries in humans.

Another aspect of Carlone's work is to determine the factors that contribute to the restoration of the correct pattern in

regenerating tissue. For example, when a hand is developing, certain factors guide the position and identity, such as the thumb to be both the correct size and placement in the regenerating limb. These factors collectively are called 'positional information'. Carlone's lab has recently isolated a gene encoding a protein called Gli3, which is recognized as an important factor in establishing the positional information during development. He has discovered that this gene is re-expressed in the regenerating limb during a period when positional information is thought to be re-established in the blastema. Carlone's work has been sponsored in the past and in part by NSERC, the Natural Sciences and Engineering Research Council of Canada. NSERC is the national instrument for making strategic investments in Canada's capability in science and technology.

~ Kimberley Lee

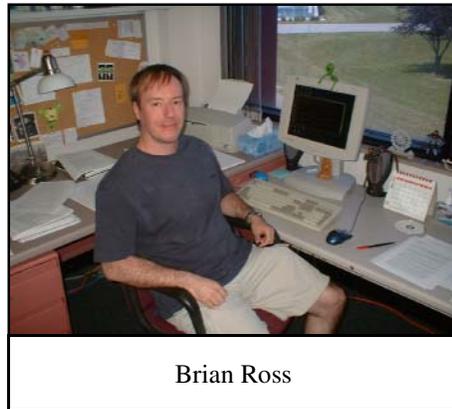
The Evolution of Artificial Intelligence

In order to maximize his time and sales, a travelling salesman wants to figure out how to visit the 3000 cities in his territory with the least amount of travel. However, even if he were able to calculate one billion solutions per second, it would still take him more than 800 years to figure out the most efficient route. Known as "The Travelling Salesman Problem", Professor Brian Ross of the Computer Science Department explains that, "it is a good example of the type of problem that can be analyzed effectively using genetic algorithms."

The Father of genetic algorithms, John Holland, a mathematician, physicist and the first PhD in computer science, conceived genetic algorithms when he discovered that machines could be trained to adapt to changing surroundings, mimicking natural evolution. One of the biggest advantages of genetic algorithms is that they can generate a reasonably good solution to a difficult problem like the Travelling Salesman within minutes or hours, rather than years.

Explains Dr. Ross, "While genetic algorithms are not guaranteed to find the best solutions, they will produce solutions that are much better than what a human being would find on their own without the help of a computer."

One aspect of Dr. Ross' research is formal language inference using genetic programming, which uses computers to automatically learn mathematical systems. This is a branch of artificial intelligence



Brian Ross

research, which is concerned with solving difficult calculations that would normally require advanced intelligence to answer. Ross's approaches are inspired by Darwinian Evolution, in which genetic algorithms are applied to simulate the idea of survival of the fittest.

Among the problems that Dr. Ross is researching are the evolution of computer programs and mathematical formulae that solve problems in mathematics, molecular biology, parallel computation, and of course, finding programs that solve problems like the Travelling Salesman. Complementing this work is his study of "Meta-evolution."

Meta-evolution takes the concept of genetic algorithms a step further. Instead of using a genetic algorithm to solve a problem of interest, meta-evolution looks for a problem-solving strategy that is effective for a particular problem. This means that the problem will determine the best means for solving itself. Instead of

using a hammer for both nails and screws, nails will determine that a hammer is most suitable, and screws will beg the use of a screwdriver. "In a sense, meta-evolution looks at how evolution evolves. My approach is to let evolution find effective strategies for solving given instances of problems," he says. "I am interested in how evolution can be used to construct an effective problem-solving strategy for a given problem."

Among Dr. Ross's other projects are his study of the application of evolutionary algorithms in computer graphics to synthesize graphical textures, and his investigation of computer vision, which has many commercially viable applications. "Evolutionary computation can be helpful in areas such as mineral exploration, to discover potential deposits of valuable mineral resources," he suggests. After supplying a map and example locations of mineral deposits, a genetic program can be evolved that predicts where such minerals might be found on other maps.

Dr. Ross' work is funded in part by the Natural Sciences and Engineering Research Council (NSERC), a key federal agency investing in people, discovery and innovation. The council supports both basic university research through grants, and project research through partnerships among universities, governments and the private sector, as well as the advanced training of highly qualified people.

~ Kimberley Lee