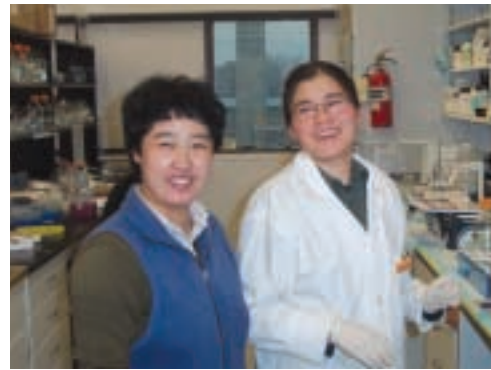


Biology Annual Report • 2004



Department of Biology







Department of Biology
McMaster University

Annual Report 2004

Annual Report Committee

Bhagwati P. Gupta, Ph.D.

Kimberley Dej, Ph.D.

Wendy Burston

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The cover artwork by Maria Abou Chakra represents some of the model organisms studied in the Department of Biology. The photograph on page 19 is also courtesy of Maria, a graduate student in Dr. Jonathon Stone's lab.

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Message from the Chair

The origin of life remains a mystery, even more so the origin of consciousness. The last decade has been momentous in the history of the life sciences. The genomic revolution has put in our hands the power to study genes, all genes, individually as well as units of interacting genetic systems, developmental pathways and evolutionary systems. It would not be an overstatement to say that the science of genomics has put in our hand the power to find the needle, every needle, in the haystack!

The science of life is the subject matter of the Department of Biology and for our size we are probably the most diverse Department of Biology in the country. We have faculty members working in highly varied areas including cell and developmental biology, genetics and molecular biology, microbiology, population and evolutionary genetics, ecology and evolution, bioinformatics and functional genomics, plant biology and environmental physiology.

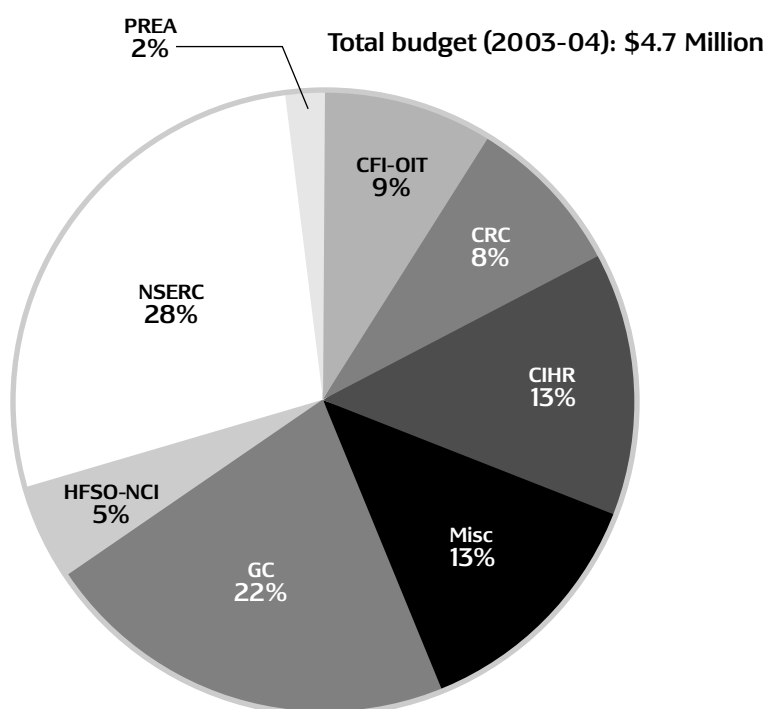
The Department has come a long way. Starting with no more than a couple of faculty members teaching basic biology, the University established a unit in Biophysics, Biochemistry and Molecular Biology and moved to a full fledged Department of Biology in 1972. The Department has grown to include almost all areas of Life Sciences from cell and molecular to ecosystem biology. Our diversity and quality has allowed the Department to retain its top faculty as well as attract young and internationally known new ones.

The discovery of the structure of DNA and the genetic code in the last century pushed life sciences to the forefront of the scientific revolution. A great deal of progress has been made from unleashing the green revolution to molecular medicine and the war on cancer. Much remains to be done and there is great excitement in the Life Sciences. All signs tell us that the twenty first century will belong to the Life Sciences. A great future awaits our students in biology.

This report is a brief reflection of what we do in biology. We would appreciate your help in its dissemination and welcome your comments.

Dr. Rama S. Singh
Acting Chair, Department of Biology

Highlights



* Canadian Centre for Inland Waters, Cominco Limited, ENSR Corporation, Environment Canada, Environment Hamilton Incorp., Falconbridge Ltd., Department of Indian and Northern Affairs Canada, International Copper Association Ltd., International Lead Zinc Research Organization, Kodak Canada Inc., Nickel Producers Environmental Research Association, Noranda Inc., Ontario Ministry of Natural Resources, ORDCF – SHARCNET, Perkin Elmer Life Sciences, U.S. Army Medical Research Acquisition Activity, U.S. Department of Defense Breast Research Program, U-I ORDCF, University of Waterloo, VWR International

CFI: Canadian Foundation for Innovation
 OIT: Ontario Innovation Trust
 CRC: Canada Research Chairs Program
 CIHR: Canadian Institutes of Health Research
 GC: Genome Canada
 HSFO: Heart and Stroke Foundation of Ontario
 NCI: National Cancer Institute of Canada
 NSERC: Natural Science and Engineering Research Council
 PREA: Premier's Research Excellence Award
 Misc: Miscellaneous Sources*

Number of Publications

134 Research papers/articles in peer reviewed International journals
 7 Book chapters

Teaching

In 2004, the Biology Department taught 6984 students (about 1600 of whom were in 1st year Biology) in 49 courses.

Achievements and Awards

FACULTY

Journal Editors

Dr. R. Singh – Associate editor, Genome

Dr. B. Golding – Associate editor, Molecular Biology and Evolution

Research Grant Panels

Dr. A. Campos (NSERC, Molecular and Developmental Genetics)

Dr. J. Daniel (US Army DOD, Pathobiology Grant Panel)

Dr. J. Daniel (Cancer Research Society, Cell Signaling Panel)

Dr. S. Igldoura (CIHR, Genetics panel)

Dr. C. Baron (NSERC, Cell Biology)

Dr. H. Schellhorn (Health Canada Panel)

Dr. C. Wood (NSERC, Integrative Animal Biology)

Canada Research Chairs

Dr. C. Wood (Tier I, Environment and Health)

Dr. G. B. Golding (Tier I, Environmental Genomics)

Dr. B. Gupta (Tier II, Developmental Biology)

Dr. M. Elliot (Tier II, Microbiology)

University Committees and Appointments

Dr. C. Baron (Member), University Senate

Dr. A. Campos (Member), Faculty of Science Tenure and Promotions Committee

Dr. R. Singh (Chair), Mahatma Gandhi lectures on Nonviolence

Dr. R. Singh (Member), Redman lecture committee

Dr. R. Singh (Member of the governing council), Centre for Peace Studies

Dr. J. Stone (Associate Director), Origins Institute

Members/Committees (Miscellaneous)

Dr. Grant McClelland (Selection Panel Member),
Ontario Graduate Scholarship Program

Headline Stories

The Discover Magazine selected Dr. James Quinn's work on air pollution and germline mutations (Somers et al., Science, 2004) among the top 100 science stories of 2004. (www.discover.com/issues/jan-05/features/top-100-stories/)

Research Areas and Faculty

New Appointments

Dr. Christian Baron

Dr. Baron joined the Department of Biology in August 2002. His research focuses on pathogenic bacteria that cause diseases. Dr. Baron's laboratory applies biochemical, genetic and cell biological methods to understand bacterial virulence and to develop novel anti-bacterial treatments. He received his Ph.D. in Microbiology from the Ludwig-Maximilians Universität München (Germany). Before joining McMaster, he was a post-doctoral fellow in Patricia C. Zambryski's laboratory at the University of California at Berkeley and Assistant Professor in the Microbiology Department of the Ludwig-Maximilians Universität.

Dr. André Bédard

Dr. Bédard joined the Department of Biology in September 2002. His research program is centered on the study of gene expression in normal and cancer cells. In particular, he is studying the regulation of genes by the viral Src tyrosine kinase. More recently, Dr. Bédard has been focusing on two additional projects that involve Menin tumor suppressor (in vertebrates and in fruit fly *Drosophila melanogaster*) and "growth arrest specific" genes (that are activated when cells exit the cell cycle and enter quiescence). Before joining McMaster, Dr. Bédard worked at York University and at the University of Montréal. Dr. Bédard received his Ph. D. from McGill University and was a post-doctoral fellow in the laboratory of Dr. Ray Erikson at Harvard University.

Dr. Robin Cameron

Dr. Robin Cameron arrived in the Department of Biology in October 2003. Her main research goal is to elucidate and understand the signal transduction pathways that lead to, and the processes responsible for, induced resistance responses in plants (*Arabidopsis*) to pathogens, including Systemic Acquired Resistance (SAR) and Age-related Resistance (ARR). Dr. Cameron received her Ph.D. in Bacterial Molecular Genetics from McGill University after which she did post-doctoral studies at the Salk Institute in San Diego and The Noble Foundation in Oklahoma and spent 7 years in the Department of Botany at the University of Toronto as an Assistant Professor.

Dr. Kimberley Dej

Dr. Dej joined the Department of Biology in August 2004. Using *Drosophila melanogaster* as a model system, her research interests have focused on examining the regulatory mechanisms that control the separation of replicated sister chromatids at anaphase of the mitotic cell cycle. Her recent work has looked at the role of the condensin complex in chromosome dynamics during mitosis and meiosis. Dr. Dej received her Ph.D. from Johns Hopkins University and was a post-doctoral fellow with Dr. Terry Orr-Weaver at the Whitehead Institute at the Massachusetts Institute of Technology.

Dr. Ben Evans

Dr. Evans joined the Department of Biology in March 2004. His research aims to (1) better understand molecular evolution of genes after duplication and (2) examine patterns and processes of biological diversification. His research involves fieldwork in Asia and Africa and employs a variety of study organisms including macaque monkeys and clawed frogs. Dr. Evans received his Ph.D. in Biological Sciences from Columbia University. Before joining McMaster, he did post-doctoral research at the University of Texas at Austin.

Dr. Bhagwati Gupta

Dr. Gupta joined the Department of Biology in March 2004. His primary research focuses on understanding the mechanism of cell fate specification and evolution of gene networks in two nematode species, *Caenorhabditis elegans* and *C. briggsae*. Dr. Gupta received his Ph.D. in Molecular Biology from the Tata Institute of Fundamental Research. Before joining McMaster, he was a post-doctoral fellow in Paul Sternberg's laboratory at the California Institute of Technology working on vulval development in *C. elegans* and *C. briggsae*. Dr. Gupta holds the Canada Research Chair position in Developmental Biology.

Dr. Grant McClelland

Dr. McClelland joined the Department of Biology in July 2003. His research interests are in the environmental physiology of muscle metabolism and comparative exercise physiology / biochemistry. His research stretches from cell culture models to fish and rodents to studying the molecular mechanisms up to the whole organism aspects of adaptation. Dr. McClelland received his Ph.D. from the University of British Columbia in Comparative Biochemistry. He continued his research with post-doctoral appointments at University of California at Berkeley and Queen's University.

Dr. Jonathon Stone

Dr. Stone joined the Department of Biology in January 2003 as a SHARCNet Chair in Computational Biology. He earned his M.Sc. and Ph.D. in Evolutionary Biology at the University of Toronto. Prior to arriving to McMaster University, he tenured a NSERC Post-doctoral Research Fellowship in Developmental Genetics at the State University of New York at Stony Brook; a Swedish Natural Science Research Council Post-doctoral Project Grant in Population Genetics at Uppsala University; and a CIHR Post-doctoral Research Fellowship in Developmental Biology at Dalhousie University. Professor Stone combines data analysis, mathematical or numerical modeling, and graphical or rule-based simulation to research living systems. He also holds the Associate Director position at the Origins Institute.

Dr. Xu-Dong Zhu

Dr. Zhu joined the Department of Biology in September 2003. Dr. Zhu received her Ph.D. in Molecular and Medical Genetics from the University of Toronto in 1998. Her primary research focuses on understanding the molecular mechanism of how human telomere length is regulated. Telomeres play an important role in tumorigenesis and cellular aging. Before joining McMaster, Dr. Zhu was a post-doctoral fellow in Dr. Titia de Lange's laboratory at the Rockefeller University.

Recent Retirements

Dr. Frank Graham

Dr. Frank Graham's research focused on the regulation of gene expression emphasizing mechanisms of action of transforming genes, and development and use of human adenovirus vectors for gene transfer into mammalian cells. In 1973 he codeveloped one of the most useful DNA transfection methods, called the "calcium phosphate coprecipitation" technique that, a quarter century later, is still being used routinely throughout the world. As one of the world's most accomplished researchers in molecular virology, particularly in adenovirus biology, Dr. Graham developed and patented novel gene-delivery systems that set the standard for developments in this area. In 1999, he was selected as a fellow of the Royal Society of Canada, a national academy whose object is the promotion of learning and research in the arts and sciences. Election to a Fellowship in the Royal Society of Canada is the highest academic accolade available to scientists and scholars in Canada. His other achievements include National Cancer Institute of Canada's Eli Lilly Award for his contributions that led to significant advances in Cancer biology. Dr. Graham retired in 2002.

Dr. John Lott

Dr. John Lott's research was focused in the area of plant structure, function and composition. He combined structural/ultrastructural methods (light microscopy, scanning and transmission electron microscopies, cryogenic preparations, histochemical methods, immunocytochemical probes) with a variety of chemical and physiological methods (energy dispersive x-ray analysis, atomic absorption spectroscopy, chromatography, light and UV spectrophotometric methods, and others) to try and understand the links of structure with function and composition. Most studies were on developing seeds, mature seeds and growing seedlings. Seeds/grains are of enormous importance economically but also are a great experimental system. Over the last four decades, Dr. Lott's laboratory made significant research contributions. These include complexity of the mineral nutrient storage system in sequestering trace elements and the discovery and characterization of iron rich particles in plastids of seeds of conifers and other gymnosperms. His laboratory was the first one to develop global estimate of P, phytic acid and phytate in all the world's crop seeds/grains/fruits and demonstrated that the amount of P, K and Mg being removed with seed crops is large in relation to the tonnage of mineral fertilizers being applied to crop lands.

Dr. Lott has taught many courses both at undergraduate and graduate levels. These include plant biodiversity and a cell ultrastructure project course. In 1976 he published a book of scanning electron micrographs for use in teaching. Dr. Lott has served on a wide variety of committees at McMaster and on outside agencies. As Faculty Supervisor of the Life Sciences Electron Microscopy Unit, he was instrumental in obtaining three new electron microscopes, the most recent being a very special environmental scanning electron microscope system. He also served on the Joint Committee as one of three Faculty Association representatives and President of the McMaster University Faculty Association. Outside McMaster, Dr. Lott has served as an Associate Editor of the Canadian Journal of Botany for many years and organized numerous scientific meetings.

Dr. George Sorger

Dr. George Sorger joined McMaster in the summer of 1966, to what was then the Research Unit of Biochemistry, Biophysics and Molecular Biology. After the Research Unit was dissolved and the members distributed between the Departments of Biochemistry, Biology and Chemistry, he became a member of the Biology department.

Dr. Sorger started his research career at McMaster in the area of genetics of nitrogen fixation. His lab was the second lab in the world to publish the isolation and characterization of mutants deficient in nitrogen fixation. Later on, after moving into the research area of nitrate reduction in *Neurospora*, his lab was the first one to isolate nitrate reductase constitutive mutants and to characterize the regulatory gene. Currently, Dr. Sorger's research involves the bioactive principles of medicinal plants that are used in Central and South America, primarily, to counter worm infestations in people.

Dr. Sorger's teaching contributions include cell and molecular biology courses at the graduate and undergraduate levels. He also designed a course entitled The Right to Food, which spanned the areas of Biology, History, Economics and Politics. In recent years he has been involved in teaching undergraduate introductory courses in Genetics and Microbial Genetics. Dr. Sorger won the Lifetime Teaching Award in 2003.

Areas of Research Activities*

Bioinformatics and Functional Genomics

Deriving functional information from the data of large scale genome sequencing projects of bacteria and of eucaryotes is one of the biggest challenges of modern biology. The faculty members with interest in this area use state-of-the-art computational, genomics, transcriptomics (DNA chip), metabolomics and systems biology approaches to understand the function(s) of biological systems and of their evolution. Models analyzed in the Biology Department are the agriculturally important bacterium *Sinorhizobium meliloti*, the environmental stress-tolerant plant *Thellungiella salsuginea*, the human pathogen *Brucella suis* and the model bacterium *Escherichia coli*. Student participation in the inter-disciplinary research at the interface of informatics and biology will contribute to applications such as new treatments for bacterial infectious diseases and improved agricultural practice.

Developmental Biology

The combination of molecular genetic technologies with other contemporary tools of biology, such as electrophysiology, electron microscopy, immunochemistry and DNA chip analysis has fueled dramatic advances in both cell and developmental biology. Our laboratories use recombinant genetics, mutagenesis, biochemistry, confocal and electron microscopy, tissue culture, and transgenic organisms to work on models such as the nematode *Caenorhabditis elegans*, the fruit fly *Drosophila melanogaster* and mammalian cells. Currently studied research questions encompass gene regulation, cancer biology, neurosystem and reproductive system development and function. Students at all levels are welcome to get involved in this research, which will influence applications in medical therapy, diagnostics and applied biotechnology.

Cell and Molecular Biology

Researchers in the Biology Department carry out basic and applied research in this area using state-of-the-art methods such as tissue culture, RNAi technology, transgenic animals, DNA chip, laser dissection and immunofluorescence technology. The different laboratories study a wide variety of models such as the tissue cell culture, the domestic mouse *Mus musculus*, the nematode *Caenorhabditis elegans*, the plant *Arabidopsis thaliana* and the fruit fly *Drosophila melanogaster*. The research is of immediate relevance to human health in different areas, such as breast cancer, genetic diseases and disease resistance, DNA repair, neurosystem development and function. Work in the Biology Department gives students at all levels the opportunity to contribute to scientific progress, which may lead to improved treatment of diseases.

Microbiology and Plant Biology

The natural biodiversity of microorganisms surpasses that of all other organisms. Their metabolic capabilities, adaptability and interactions with plants and animals shape our planet. Researchers in the Biology Department study a variety of metabolic processes, such as the stress response of *Escherichia coli* and of plants and their seeds, *Arabidopsis thaliana* plant disease resistance, the agriculturally important legume plant symbiotic interaction with *Sinorhizobium meliloti*, human diseases caused by *Brucella suis*, population genetics of human pathogenic fungi and gene transfer from *Agrobacterium tumefaciens* to plants and between antibiotic-resistant bacteria. Students at all levels are involved in this research, which is highly applicable to industrial and agricultural biotechnology and health research.

Environmental Physiology

Studies on the adaptation of animals to environmental changes, pollutants and stress conditions have high relevance for human health. Researchers in the Biology Department use a variety of modern techniques such as microinjection, patch-clamp analysis, tissue culture, confocal immunofluorescence analysis, transcriptome and proteome analysis to study models such as mice, fish and human cells. The research covers diverse areas such as environmental physiology and aquatic toxicology of aquatic animals, heavy metal metabolism, the effect of hypoxia on ion channel function in the neurosystem, growth hormone action and exercise physiology. Students at all levels can contribute to this research, which is relevant for the protection of human health and of the environment.

Ecology and Evolution

The analysis of natural biodiversity and of the impact of modern society on ecosystems plays a major role for the conservation of our environment. Research in this area is supported by collaborations with regulatory agencies, the Royal Botanical Garden and conservation authorities in other parts of the country, which facilitate field studies. Faculty research interests cover theoretical and evolutionary ecology. Research done by members of the Biology Department on the impact of environmental pollution on health has raised a lot of attention showing the impact of research, which is being conducted by students at all levels.

Population and Evolutionary Genomics

Population genetics is the theoretical powerhouse of evolutionary biology. The discipline of population genetics in combination with technical breakthroughs in molecular biology has opened the floodgate of large-scale genomic comparisons between distantly related species that were not possible before. Biology Department members are carrying out population and evolutionary genomic research on a variety of organisms including bacteria, *Drosophila*, fungi, plants, fishes and humans. These studies are meant to shed light on mechanisms of adaptation, host-pathogen interactions and co-evolution, sexual reproduction, sexual selection and speciation. A new area of research in germ cell genomics, using model organisms such as mouse, *Drosophila*, nematode and trout, promises to revolutionize the science of gamete biology and fertilization systems.

*These research areas are not necessarily the same as those recognized by OCGS.

Research Faculty

PROFESSOR

Patricia Chow-Fraser

Assessment of anthropogenic impacts on the functional ecology of freshwater ecosystems, in particular, lakes and wetlands of the Great Lakes basin

Turlough M. Finan

Molecular genetic analysis of the N₂-fixing bacterium *Sinorhizobium meliloti*

G. Brian Golding

Molecular evolution, genomics, bioinformatics, computational biology

J. Roger Jacobs

Developmental genetics, cancer genetics

Jurek Kolasa

Ecology of aquatic communities: Organization and function in context of heterogeneity, habitat hierarchy, and scale; responses to environmental gradients using tropical microcosms

John N.A. Lott

Composition and structure of storage protein bodies in seeds; Analytical electron microscopy; Mineral nutrients in seeds

Colin A. Nurse

Cellular and molecular mechanisms of O₂, and CO₂/pH sensing in vertebrates

Michael J. O'Donnell

Ionoregulation and excretion in invertebrates and fish: Cellular mechanisms and control of epithelial transport

Andrew J. Rainbow

Molecular mechanisms for DNA repair in mammalian cells and their role in human disease using viruses as probes

C. David Rollo

Exploration of the regulatory integration of mammalian form and function utilizing transgenic mice as probes

Herbert E. Schellhorn

The regulation of stress genes in *Escherichia coli*

Rama S. Singh

Population and evolutionary genetics, molecular evolution and speciation

Elizabeth A. Weretilnyk

Plant abiotic stress tolerance; Metabolomics; Environmental genomics; Chemical biology

Christopher M. Wood

Environmental physiology and aquatic toxicology of aquatic animals

ASSOCIATE PROFESSOR**Christian Baron**

Pathogenic bacteria, antimicrobial drugs, chemical biology

André Bédard

Characterization of cell proliferation and transformation

Robin Cameron

Elucidation of the signal transduction pathways that lead to, and the processes responsible for, induced resistance responses, including Systemic Acquired Resistance (SAR) and Age-related Resistance (ARR)

Ana R. Campos

Genetic and molecular analysis of visual system development in *Drosophila melanogaster*

Juliet Daniel

Roles of Catenins and Transcription Factors in Normal Cell Growth and Development

Susan A. Dudley

Evolutionary ecology of carbon acquisition traits in plants; natural selection, quantitative genetics, and phenotypic plasticity of adaptations to drought stress and competition

Suleiman Igdoura

Molecular genetics of Tay-Sachs disease and Sialidosis

James S. Quinn

Genetic relatedness, parentage and behavioural ecology of colonial and cooperative-breeding birds and anthropogenic induction of germline mutations in gulls and mice

ASSISTANT PROFESSOR**Ben Evans**

Molecular evolutionary analysis of biodiversity and gene duplication

Bhagwati P. Gupta

Vulval development in *C. elegans*; Regulation, function, and evolution of gene networks

Grant McClelland

Integrative physiology of muscle and animal performance, environmental stress

Jonathan Stone

Computational Biology conducted at multiple hierarchical levels

Jianping Xu

Molecular Ecology and Evolutionary Genetics

Xu-Dong Zhu

Functional analysis of DNA repair complexes at human telomeres

CLA/Teaching Faculty

ASSISTANT PROFESSOR

Kimberley Dej

Regulation of chromosome segregation in *Drosophila melanogaster*; Dynamics of chromosome condensation and sister-chromatid cohesion in mitosis and meiosis

Lovaye Kajiura

Organismal ecology, resource allocation and life history, impact of biotechnology on physiology, endocrinology, nutrition, and behaviour, analysis of the transgenic rat growth hormone mouse model

Peter Summers

Genomics; large-scale screens for gene function by observing changes to metabolic and phenotypic profiles in response to altered gene expression



Research Activities



Christian Baron
Associate Professor

Pathogenic Bacteria, Antimicrobial Drugs, Chemical Biology

Laboratory Personnel

Post-doctoral Fellows: Dr. Athanasios Paschos; *Ph.D. Students:* Khaled Ahmed Aly, Qing Yuan, Durga Sivanesan; *M.Sc. Students:* Chan (Daphne) Gao; *Undergraduate Students:* Mike Chmatil, John Morala; *Lab Assistant:* Greg Rekas

Funding

Canadian Institutes of Health Research (2003 – 2006)
Natural Sciences and Engineering Research Council (2003 – 2007)
Genome Canada (2003 – 2007)
Canadian Foundation for Innovation (2003)
Ontario Innovation Trust (2003)

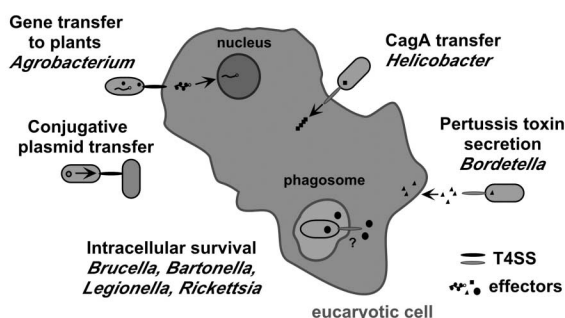
The basic aim of my scientific work is to understand the adaptation of pathogenic bacteria to their host environment and to derive new anti-bacterial treatments from this knowledge. Our current focus is on **Type IV Secretion Systems (T4SS)**, which mediate the translocation of virulence factors from bacteria to eucaryotic cells and thereby modulate their host's defense response (Baron *et. al.*, 2002). This strategy is used by many important pathogens such as *Bordetella pertussis* (whooping cough), *Brucella suis* (Brucellosis), *Helicobacter pylori* (gastritis and stomach cancer) and *Legionella pneumophila* (Legionnaire's disease). T4SS also mediate the spread of broad-host-range plasmids, which carry antibiotic resistance genes, and this has wide implications for microbe ecology and resistance gene spread in hospitals. A T4SS is also responsible for gene transfer from *Agrobacterium tumefaciens* to plant cells - a process that is widely being applied in plant research and agricultural biotechnology.

The *Agrobacterium tumefaciens* model T4SS

Khaled Ali, Chan (Daphne) Gao, John Morala and Qing Yuan

Gene transfer from *A. tumefaciens* to plant cells is mediated by a T4SS. Infection with wild type *Agrobacteria* followed by the transfer of oncogenic DNA leads to the development of plant tumors. The *A. tumefaciens* T4SS has become the paradigmatic model system for analyses of the type IV secretion process. The T4SS forms a membrane-spanning channel and catalyzes the assembly of surface-exposed structures, such as T-pili, and the translocation of effector molecules into recipient cells. Four groups of proteins are required for T4SS function(s): The translocated **effectors**, the **transporters** (VirB4, VirB11 and VirD4), the components of the **T4SS core complex** (VirB6, VirB7, VirB8, VirB9 and VirB10), and **surface structures** (VirB2 and VirB5), which may contact host cells. We have identified VirB5 as a minor T-pilus component. The crystal structure of the VirB5 ortholog TraC was solved, revealing a triple-helix bundle attached

T4SS-mediated translocation of macromolecules from Gram-negative pathogens serves different functions



to a flexible globular domain (Yeo *et. al.*, 2003). We have pursued detailed structure-function studies of this protein, which identified its globular domain as interaction site with other VirB proteins. Based on genetic and biochemical studies, we have postulated a mechanism for T-pilus assembly (Krall *et. al.*, 2002), which is currently being refined by analysis of specific *virB* gene deletion mutants and of VirB5 protein variants. Long-term objectives of our research on the *Agrobacterium* system are to understand the mechanism of T-pilus assembly and the molecular events, which determine cell-cell contact formation between *Agrobacterium* and plant cells.

Virulence of the mammalian pathogen *Brucella suis*

Durga Sivanesan and Dr. Athanasios Paschos

B. suis was the first bacterium weaponized as a biowarfare agent in the last century and *Brucella* species are regarded as bioterrorist threats. One aim of our research is to exploit the knowledge of the T4SS towards the development of antimicrobial drugs for the protection against such threats. This organism is interesting from a basic research point of view, because it thrives in the inhospitable environment of macrophages. Vesicles with phagocytosed bacteria fuse with lysosomes followed by degradation. The secretion of virulence factors by the T4SS alters the intracellular pathway of *Brucella*, and the bacteria survive and replicate in autophagosome-like vacuoles. We have used biochemical and cell biological methods to study the *B. suis* T4SS, which contains orthologs of all the eleven VirB proteins of *A. tumefaciens* and one additional protein (VirB12) (Rouot *et. al.*, 2003). Several VirB proteins (VirB1, VirB4, VirB5, VirB8, VirB9, VirB10, VirB11 and VirB12) were overexpressed, purified by affinity chromatography followed by analysis of their interactions. We have identified several pair-wise interactions, which yielded insights into their spatial organization in the cell envelope. In addition, we have devised an assay to determine the functionality of the *B. suis* T4SS in the heterologous host *A. tumefaciens*. For the first time, we have shown the heterologous complementation between VirB proteins from different T4SS in the case of *B. suis* and pKM101-encoded VirB1 orthologs (Höppner *et. al.*, 2004). These proteins are believed to act as lytic transglycosylases, which facilitate the assembly of the T4SS in the cell envelope.

Functional Genomics of α -proteobacteria

Greg Rekas, Yanixia (Sally) Li and Mike Chmatil

The genomic sequences of many α -proteobacteria became available in recent years and most of them were found to contain multiple chromosomes and megaplasmids. This group of organisms comprises several human pathogens and plant symbionts, which live inside their host cells. The long-term goal of this work is to understand the intracellular life style of these bacteria inside eucaryotic cells. To this end, we study 85 conserved proteins of unknown function (PUFs), which restricted to the α -proteobacteria and occur in the genera *Brucella* (intracellular pathogens of mammals) and *Sinorhizobium* (intracellular symbionts of plants). The PUF-encoding genes have been cloned and the effects of the overexpression on the metabolome, on the transcriptome, on the growth characteristics and on the host interactions will be analyzed by our group and by other members of the Genome Canada-funded *S. meliloti* project. In addition, we will apply TAP-tagging technology to identify PUF-associated proteins as a means to identify their role in the physiology of *S. meliloti*.



André Bédard
Associate Professor

Control of Cell proliferation and Transformation

Laboratory Personnel

Post-doctoral Fellows: Nishi Singh; *MSc. Students:* Jenny Wang; *Research technician:* Ying Wu

Research Collaborators

Dr. Ana Regina Campos (McMaster University)

Funding

Natural Sciences and Engineering Research Council (2000-2005)

Canadian Institutes of Health Research (2002-2005)

National Cancer Institute of Canada (with Dr. A. Campos) (2004-2007)

Transformation by the v-Src Oncoprotein:

My laboratory is interested in the study of cell proliferation and transformation by the v-Src tyrosine kinase. Through the characterization of genes activated aberrantly in transformed cells, we have identified several transcription factors and signaling pathways targeted by the v-Src oncoprotein. Particular attention is devoted to the study of JunD/AP-1 and NF- κ B, two transcription factors providing a survival advantage to v-Src transformed cells. Using a variety of approaches of cellular and molecular biology, we are characterizing the role of v-Src regulated genes, activated by these transcription factors, in cell transformation (funded by the Canadian Institutes of Health Research).

Characterization of the Menin Tumour Suppressor:

Our studies on AP-1 led to the finding that v-Src transformed chicken embryo fibroblasts (CEF) express reduced levels of the Menin tumour suppressor. Menin, the product of the multiple endocrine neoplasia type I gene (*Men1*) has been implicated in several biological processes including the control of gene expression, apoptosis and MAPK signaling pathways. However, the mechanism(s) by which Menin exerts its function of tumour suppressor is unknown. Therefore, we have initiated the study of Menin in the model system *Drosophila melanogaster*, a project done in collaboration with Dr. Ana Campos in the Department of Biology at McMaster University. Using tools unique to *Drosophila*, we have uncovered a role for Menin in the control of the stress response and, in particular, in the expression of heat shock proteins. This work led to the conclusion that Menin is required for the response of *Drosophila* to several stresses including heat shock, hypoxia, hyper-osmolarity and oxidative stress. The relationship between the action of Menin in the stress response and its function of tumour suppressor is the subject of current investigations in the *Drosophila* model system (funded by the National Cancer Institute of Canada).

Characterization of Growth-Arrest Specific (GAS) Gene Expression:

Cells exiting the cell cycle induce the expression of a class of genes known collectively as growth-arrest specific or GAS genes. By and large, the function of this class of genes remains unknown. The objective of our research program on GAS genes is to elucidate the function of the products of these genes and to characterize the regulatory mechanism of their induction in quiescent cells. While several factors can induce cell quiescence, we are particularly interested in the control of GAS genes by contact inhibition. Using the p20K lipocalin gene as a model, we identified C/EBP β as the central activator of this gene in contact inhibited CEF. We have demonstrated a role for C/EBP β in the inhibition of CEF proliferation and in the induction of several other GAS genes. Other transcriptional activators of GAS genes, working cooperatively with C/EBP β , are presently under investigation (funded by the Natural Sciences and Engineering Research Council of Canada).

Mechanisms of cell transformation by v-Src

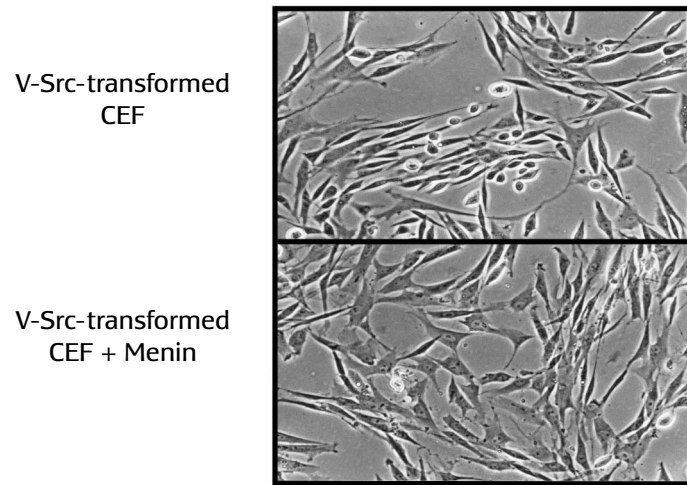


FIGURE: The Menin tumor suppressor is down-regulated in v-Src-transformed chicken embryo fibroblasts (CEF), which exhibits the elongated and refractile morphology of transformed cells (upper panel). The re-expression of Menin results in the flattening of the cells and a more normal morphology (lower panel).



Robin K. Cameron

Associate Professor

Elucidation of the signal transduction pathways that lead to, and the processes responsible for, induced resistance responses, including Systemic Acquired Resistance (SAR) and Age-related Resistance (ARR)

Laboratory Personnel

Post-doctoral Fellows: Asif Mohammed, Heather Shearer; *Ph.D. Students:* Fadi Al-daoud; *Undergraduate Students:* Jessie Carviel, Erum Khan; *Research technician:* Karen Haines

Research Collaborators

Pierre Fobert (Plant Biotech Inst., Saskatoon), Nancy Dengler (University of Toronto), Daphne Goring (University of Toronto), Keiko Yoshioka (University of Toronto), Chris Lamb (John Innes Centre, UK)

Funding

Premier Research Excellence Award (2001-2006)
Natural Sciences and Engineering Research Council (2003-2007)

Our long-term goal is to elucidate and understand the signal transduction pathways that lead to, and the processes responsible for, induced resistance responses in plants to disease, including Systemic Acquired Resistance (SAR) and Age-related Resistance (ARR), using molecular genetics, plant pathology, physiology, biochemistry, genomics and cell biology.

SAR is induced by an initial “immunizing” infection in one part of the plant resulting in broad non-specific resistance throughout the plant to normally virulent pathogens. The outcome of the SAR response is similar to vaccination in mammals except that it protects the plant against many different unrelated pathogens (bacteria, viruses, fungi, nematodes). The accumulation of a set of pathogenesis-related (PR) proteins (anti-microbial) and salicylic acid (SA) has been correlated with SAR in tobacco, cucumber and in *Arabidopsis thaliana*. A long distance signal moves, perhaps via the phloem, from the “immunized” leaf to the rest of the plant where it is perceived and the plant becomes primed or “immune” as indicated by SA accumulation and subsequent PR-1 expression. Upon challenge with a virulent pathogen, the plant responds in a resistant manner, which includes production of a number of anti-microbial PR proteins and compounds. It is thought that different subsets of these are effective against different pathogens, resulting in the broad spectrum of resistance observed during SAR. Little is known about the nature of the long distance SAR signal or how it translocates from the induced leaf via the vasculature to distant leaf cells to produce a primed or “immune” plant. Our studies will contribute to elucidation of long distance signaling during SAR and will form the basis to genetically modify crops to respond to many diseases in a resistant manner.

Over the years we have observed that in some experiments, older *Arabidopsis* displayed resistance to normally virulent *Pseudomonas syringae* pv *tomato* (*Pst*). This Age-Related Resistance (ARR) has been described in the literature in a number of plant species and in a few cases the resistance observed is correlated with anti-microbial phytoalexin production. Studies in our lab using plant lines which do not accumulate SA (*NahG*, *sid1*, *sid2*) demonstrate that ARR is a distinct defense response from SAR, but is similar to SAR in that SA accumulation is required (5). Intercellular washing fluids (IWFs) from plants expressing ARR exhibit anti-bacterial activity to *Pst* (1). These data suggest that SA may accumulate in intercellular spaces and act as an anti-microbial agent during ARR, rather than as an intracellular signaling molecule as it does in SAR. Our studies (measuring SA levels in IWFs, adding SA destroying enzymes or SA to the intercellular space) suggest that SA must be present in the intercellular space for a functional ARR response, providing support for an anti-microbial/non-signaling role for SA during ARR (1). Very little is known about the genes required for the ARR response. Therefore, we have also taken a molecular

genetic approach to identify genes involved in ARR, using classical forward and reverse genetics (ARR microarray/T-DNA knock-out lines).

ARR

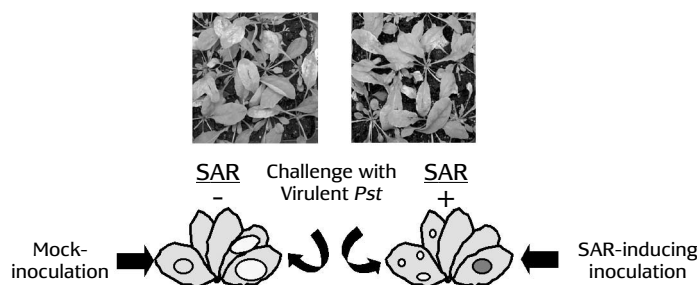
A number of interesting genes are up-regulated during ARR and to determine which of these genes are actually required for the response, T-DNA knock-out lines from the SALK collection have been obtained and characterized at the molecular level (reverse genetics). Seven T-DNA mutant lines exhibited a reduced

ARR response indicating that these genes are required for ARR (discussing potential for genetic manipulation with Performance Plants Inc, Kingston ON). Moreover, mapping and ultimately cloning of the ARR mutant identified by classical genetics is ongoing and should provide key insights into ARR signaling as the loss of function semi-dominant phenotype of this mutant suggests that the wild type gene may encode a positive regulator of the ARR response.

SAR

Studies in our lab using *dir1-1*, a SAR-defective mutant, indicate that *dir1-1* can perceive the SAR signal present in petiole exudates (enriched for phloem sap) from wild type SAR-induced plants, but *dir1-1* exudates do not contain this signal indicating that DIR1 is required for long distance signaling during SAR (4). Protein gel blot analysis demonstrated that DIR1 protein is present in petiole exudates of SAR-induced wild type, but not *dir1-1* or mock-inoculated plants. These results suggest that DIR1, which encodes a putative lipid transfer protein (LTP), may be involved in the production of the SAR mobile signal or in transporting a lipid signal to distant tissues (perhaps via the phloem) to establish SAR. We have constructed a number of transgenic Arabidopsis lines (DIR1 promoter/reporter gene [GUS], DIR1 promoter/DIR1 coding sequence fused to the GUS/GFP reporters) to localize DIR1/LTP in healthy plants and track its movement during SAR. Homozygous lines have been obtained and characterized and preliminary microscopic studies are very promising as DIR1/LTP is expressed in the vasculature (xylem parenchyma and phloem cells) and therefore DIR1/LTP has access to both transportation systems of the plant, for movement to distant tissues upon SAR induction. Continued studies of the transgenic lines will allow us to determine if DIR1/LTP is part of the SAR long distance signaling complex and will also provide novel insights into long distance signaling in plants.

SAR in Arabidopsis to *Pseudomonas syringae* pv *tomato*





Patricia Chow-Fraser

Professor

Assessment of anthropogenic impacts on the functional ecology of freshwater ecosystems, in particular, lakes and wetlands of the Great Lakes basin

Lab personnel

Ph.D. Students: Sheila McNair, Titus Seilheimer, Anhua Wei; *M.Sc. Students:* Kristina Kostuk; *Undergraduate Students:* Ben Speers, Teegan Docherty, Lesley Malloy, Nathalie Arki, Kathryn Harrison, Heather Pankhurst, Bob Farmer, Kristina Kostuk, Claire Robinson, Lindzie O'Reilly

Research collaborators

Lake Huron Management Unit, Owen Sound (Ontario Ministry of Natural Resources), Georgian Bay Association (Georgian Bay Foundation) Dr. Nick Eyles (University of Toronto)

Funding

Natural Sciences and Engineering Research Council (2003-2007)
Ontario Ministry of Natural Resources, Canada-Ontario Agreement (2004-2005)
Environment Canada (2004-2005)

Coastal wetlands are among the most productive ecosystems in the world, comparable to tropical rain forests and coral reefs. Despite their great ecological value, many of the large wetland complexes in settled areas of the Great Lakes basin have been either lost due to draining, dredging or filling, or have been severely degraded because of their sensitivity to altered land uses (agricultural and urban development) and to invasion by exotic species. My research program on wetlands began in 1991 when I became involved in the restoration of Cootes Paradise Marsh. Using a 60-year data record, I showed that reduction in cover of emergent vegetation (from 85% in 1934 to 15% in 1993) was significantly related to increased water levels (Chow-Fraser et al. 1998; Chow-Fraser 2004), and that the disappearance of a diverse community of submergent macrophytes was linked to increased eutrophication and water turbidity (Chow-Fraser et al. 1996; Loughheed et al. 1998; Loughheed and Chow-Fraser 1998; Wei and Chow-Fraser 2005). The disappearance of submergent vegetation affected the zooplankton, benthic invertebrate and ultimately the fish communities (Chow-Fraser et al. 1998).

I examined the sources of turbidity in the marsh over a 4-year period and determined that sediment resuspension by wind and wave action, disturbance by a large population of common carp, and excessive growth of algae, as well as sediment input from the watershed were all major contributors (Chow-Fraser 1999). The conceptual ecological models, based on effects-hypothesis diagrams, were used to evaluate the appropriateness of various management and restoration options, including carp exclusion (Chow-Fraser 1998; Loughheed et al. 1998). In 1995-6, we conducted *in situ* experiments to determine how different size and biomass of carp affected water turbidity, nutrient levels and the plankton community, and these results were used to predict the impact of carp exclusion (Loughheed et al. 1998). We also conducted experiments in 1999 and 2000 to determine other confounding factors that may slow down restoration efforts, such as internal loading from the historically enriched sediments (Kelton and Chow-Fraser 2004; Kelton and Chow-Fraser, 2005). Through my research, I also initiated a pilot planting program using community volunteers that has become a model for other restoration projects (Chow-Fraser and Lukasik, 1995; Chow-Fraser 1999b). Research results stemming from our work in Cootes Paradise Marsh have provided guidance to wetland managers elsewhere regarding the general feasibility of biomanipulation as a restoration strategy to restore wetlands (Angeler et al. 2003).

The research I conducted to guide the restoration of Cootes Paradise Marsh indicated clearly that polluted runoff associated with altered land in the watershed played a major role in marsh degradation. In 1996, I began a parallel research program that specifically addressed the impact of land use alteration on water and sediment quality in wetlands (Crosbie and Chow-Fraser 1999). In Chow-Fraser and Albert (1999), I highlighted the need to develop ecosystem-level indicators of wetland quality to track changes in habitat quality. In 2000, the Great Lakes Fishery Commission funded a 4-year, binational program to develop ecological indicators to assess fish habitat in coastal wetlands of all five Great Lakes, because coastal wetlands provide critical spawning and nursery habitat to the Great Lakes fish community. Products of this research program include the development of indicators of wetland quality based on data collected from over 150 wetlands throughout Canada and the U.S. shoreline of all five Great Lakes. Indicators include macrophyte species richness (Lougheed et al. 2001), zooplankton species (Lougheed and Chow-Fraser 2002), periphyton biomass (McNair and Chow-Fraser 2003), water quality (Chow-Fraser 2005), and fish species (Seilheimer and Chow-Fraser, in submission). We are now applying these indices to assess the ecological status of coastal wetlands of Georgian Bay and the North Channel, which are two areas of the Canadian shoreline that are being threatened by recreational development.

We are also creating a Great Lakes GIS database that contains the current and historical distribution of fish, plant and macro-invertebrates, and some associated land-cover information. This database will eventually house all information derived from our sampling program, and we are making it available to managers and other researchers through our WIRE Net website (Wetland Inventory for Research and Education Network; <http://www.wirenet.info>). It is also being used to investigate the spatial relationship between fauna/flora and coastal wetlands at the scale of all five Great Lakes. Using historical fish surveys and wetland maps, we have already demonstrated that more than two-thirds of all Great Lakes fishes are spatially associated with coastal wetlands in Lake Ontario (Wei et al. 2004). My long-term research goal is to be able to measure changes in both the quantity and quality of fish habitat in coastal wetlands of the Great Lakes, to relate these changes to natural and human-induced stressors, and to help environmental managers and regulators predict impacts of proposed land uses or restoration efforts on these fish habitats.



Juliet M. Daniel
Associate Professor

Role of Catenins and Transcription Factors in Normal Cell Growth and Development

Laboratory Personnel

Post-doctoral Fellows: Hong Wang; *Ph.D. Student:* Kevin F. Kelly; *M.Sc Students:* Abena A. Otchere, Nickett S. Donaldson; *Undergraduate Students:* Andrew Petrosniak, Andrew Shaw; *Research Technician:* Monica Graham

Research Collaborators

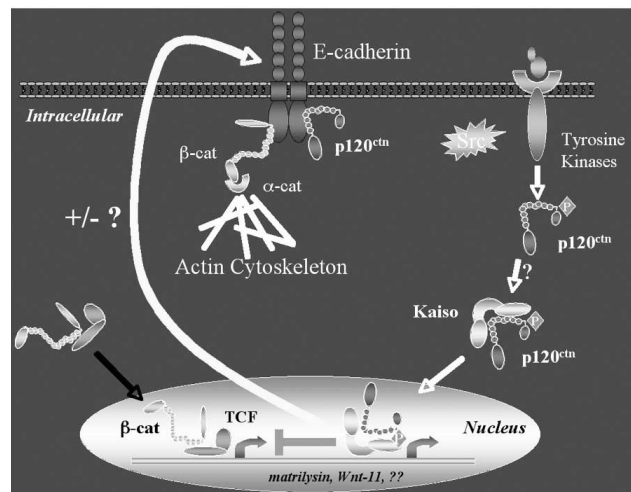
Dr. Howard C. Crawford (SUNY, New York), Dr. Pierre McCrea (University of Texas, MD Anderson Cancer Center), Dr. Pierre deFossez (Institut Curie), Dr. Bob Eisenman (Fred Hutchinson Cancer Research Center)

Funding

Canadian Institutes of Health Research (2004-2007)
US Army Department of Defense (2002-2005)
Premier Research Excellence Award (2001-2006)

Our research program aims to understand the cellular and molecular basis of cadherin-mediated adhesion in normal cell growth, development and tumorigenesis. Currently, we are most interested in the primary epithelial cell-cell adhesion system involving E-cadherin and its cytosolic cofactors, the catenins α -, β -, γ - and p120^{cas}. This adhesion system is perturbed in ~50% of human metastatic tumours, and its malfunction correlates with the metastatic, invasive phenotype. Hence a thorough understanding of the factors that regulate and control cell adhesion and motility would significantly facilitate the development of improved cancer therapies. Recently, in addition to their established roles in cell-cell adhesion, the catenins were found to also play a role in signal transduction via their transcriptional regulation of target genes involved in tumorigenesis. One of the least characterized components of the cadherin-catenin complex is the catenin p120^{cas} that was first identified as a Src kinase substrate. However our discovery of the BTB/POZ transcription factor Kaiso as a specific binding partner for p120^{cas} has further strengthened the idea of dual roles for the catenins in cell adhesion and signaling, and has opened new areas of research in the cadherin-catenin field.

Kaiso is a member of the POZ-ZF family of transcription factors with roles in cancer and development. It is the first POZ-ZF transcription factor with dual-specificity DNA-binding and transcriptional repression ability; Kaiso binds and recognizes either a sequence-specific Kaiso binding site, TCCTGCNA or methylated CpG-dinucleotides. Thus far we have identified *matrilysin* and *cyclinD1* as potential Kaiso target genes and more importantly, we found that β -catenin-induced activation of the *matrilysin* promoter was repressed by Kaiso overexpression. Our findings thus implicate Kaiso as an inhibitor of the Wnt signaling pathway and a regulator of genes involved in tumorigenesis (e.g. *matrilysin*).



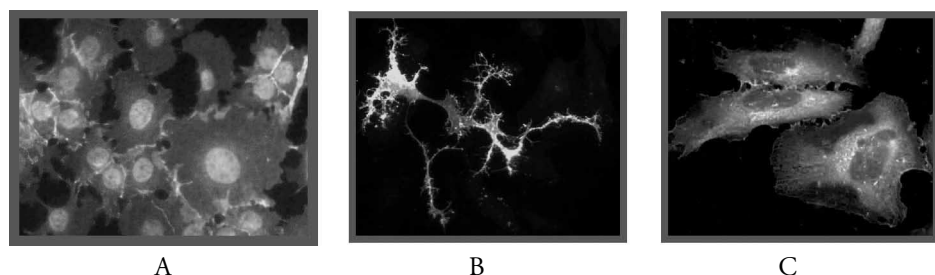
Another ongoing project is to determine what event or signaling molecule triggers the nuclear translocation of p120^{cas} and its interaction with Kaiso. Since p120^{cas} is implicated in cadherin-initiated signaling through the Rho GTPases, it is possible that p120^{cas} mediates the long-suspected adhesion signal. While this trigger remains unknown, we have discovered that nuclear p120^{cas} inhibits Kaiso DNA-binding and Kaiso-mediated transcriptional repression. In addition, we recently mapped the Kaiso and p120^{cas} nuclear localization signals and determined that nuclear localization of p120^{cas} was required for its inhibitory effect on Kaiso-mediated transcriptional activity.

The third major project in my laboratory involves a yeast two-hybrid screen to identify additional Kaiso-binding partners. Using the Kaiso POZ domain as bait, the proteins identified so far include the cytoskeletal protein Nexilin, and the DNA-binding proteins ZNF131 (a new, minimally characterized POZ-ZF protein) and CTCF (a vertebrate insulator protein and tumour suppressor). We are currently characterizing the interactions between Kaiso and ZNF131, and we are collaborating with Dr. Pierre Defossez (Institut Curie, France) to determine the significance of the Kaiso-CTCF interaction in mammalian chromatin insulation.

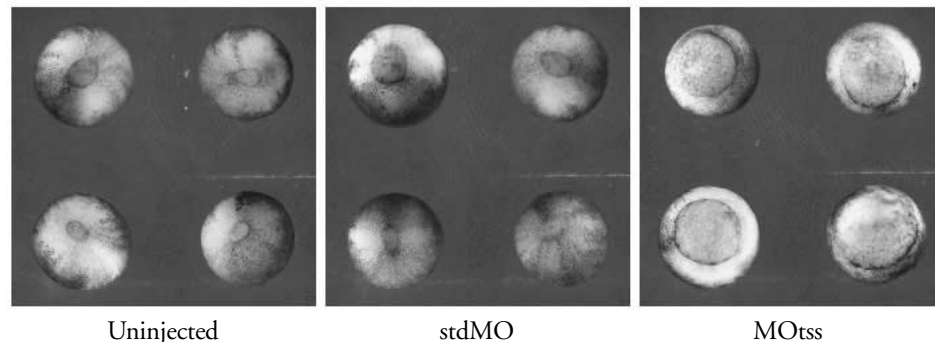
In addition to the above studies that were conducted entirely in my laboratory, I have several ongoing productive collaborations. First, Dr. Pierre McCreary (MD Anderson Cancer Center, Houston, TX) and I are seeking to elucidate the role of *Xenopus* Kaiso in signaling and development. So far we have found that Kaiso misexpression causes ectodermal cell shedding and gastrulation defects in developing *Xenopus* embryos. Second, Dr. Bob Eisenman (Fred Hutchinson Cancer Center, Seattle, WA) and I are investigating the role of the histone deacetylase/mSin3A corepressor complexes in Kaiso-mediated transcriptional repression. We have found that like other BTB/POZ transcription repressors, Kaiso immunocomplexes contain histone deacetylase activity and that Kaiso coprecipitates with the corepressor Sin3A.

Collectively our data allude to p120^{cas} and Kaiso as key modulators of cell adhesion and motility in development and cancer. We are now strategically poised to unravel the putative adhesion-signaling pathway and elucidate the role of the p120^{cas}-Kaiso interaction in development and tumorigenesis. Our current experiments are now aimed at (1) elucidating and understanding the molecular mechanism(s) of Kaiso-mediated transcriptional repression, (2) identification and characterization of *bona fide* Kaiso target genes using unbiased ChIP cloning and ChIP-CpG microarray strategies, (3) elucidating the role of Kaiso in canonical and non-canonical Wnt signaling and (4) determining the molecular basis of Kaiso function during normal cell growth, development and disease states. Our data offer exciting promise for the development of therapeutic strategies and animal models for the treatment of malignant tumours.

FIGURE: (A) p120^{cas} and Kaiso colocalization. (B) p120^{cas} overexpressing cells. (C) p120^{cas} NLS mutant localization.



Vegetal views of control (stdMO) and Kaiso-depleted (MOtss) *Xenopus* embryos showing defective blastopore closure.





Ben J. Evans
Assistant Professor

Molecular evolutionary analysis of biodiversity and gene duplication

Lab personnel

M.Sc. Student: Frederic Chain

Research collaborators

Darcy Kelley (Columbia University), David Cannatella (University of Texas Austin), Don Melnick (Columbia University), Jim McGuire (University of California Berkeley), Rafe Brown (University of Kansas), Richard Tinsley (University of Bristol), Jatna Supriatna (University of Indonesia), Noviar Andayani (University of Indonesia)

Funding

Natural Sciences and Engineering Research Council (2004-2007)

In 2004, we completed two studies of molecular evolution of polyploid clawed frogs using mitochondrial DNA and the nuclear gene RAG-1. These studies are published in *Molecular Phylogenetics and Evolution*, and in press in *Molecular Biology and Evolution*. They (1) detail evolutionary relationships among all known species of clawed frogs, (2) identify new undescribed species, and (3) detail a non-random pattern of gene silencing of paralogous copies of the RAG-1 locus in these polyploids. Our results indicate that evolutionary relationships among these species are complex and reticulate (merging) due to the process of allopolyploidization – a process by which a polyploid species is generated via the synthesis of two smaller, divergent ancestral genomes (see Figure). Results also suggest that in allopolyploid species gene ancestry may influence gene fate. In other words, after gene duplication via allopolyploidization, the nexus of gene expression and genetic interactions may be influenced by the evolutionary history of each gene copy.

We also published a paper on patterns of evolution in multiple, distantly related species (monkeys and toads) on the Indonesian island of Sulawesi in the journal *Evolution*. This paper describes congruent patterns of diversification among species with very different ecological adaptations, and suggests that past abiotic processes, such as marine inundation, may have structured patterns of genetic diversity in similar ways among many species that live on Sulawesi. This finding has important implications for understanding the distribution of genetic variation and the conservation management of biological resources on this biodiverse tropical island.

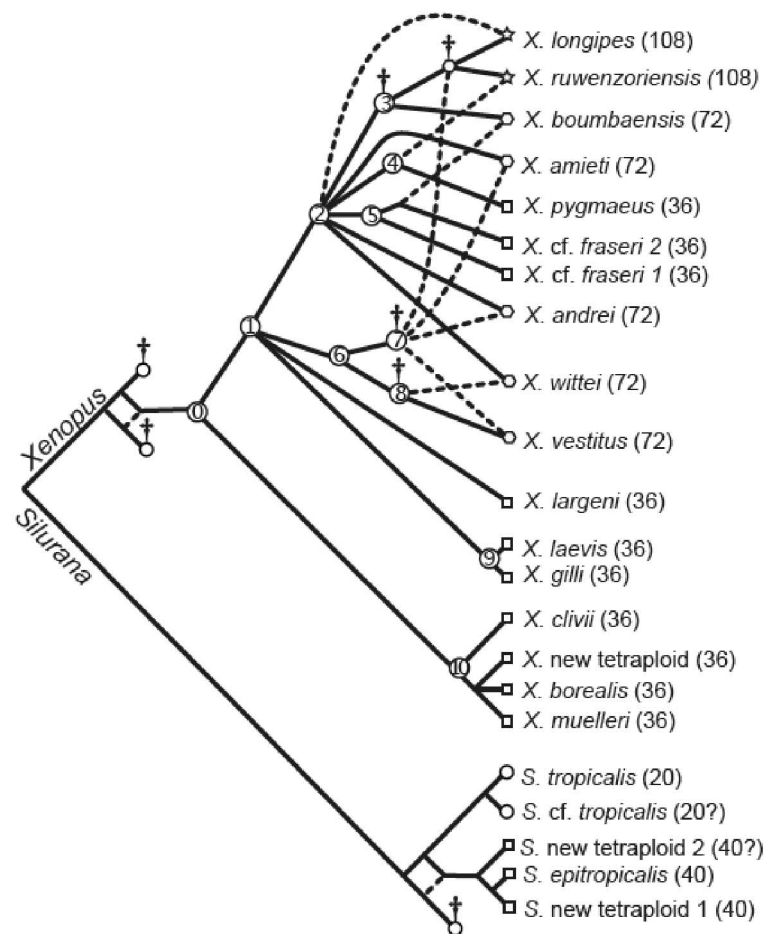


FIGURE: Evolutionary relationships among clawed frogs, estimated from duplicated copies of the RAG-1 gene. Number of chromosomes is in parentheses and diploids, tetraploids, octoploids, and dodecaploids are indicated by circles, squares, octagons, and stars, respectively. Daggers indicate inferred species that are probably extinct; dashed lines indicate paternal ancestry and solid lines indicate maternal or biparental ancestry.



Turlough Finan
Professor

Genomic analyses of the soil bacterium *Sinorhizobium meliloti*

Laboratory personnel

Ph.D Students: Allyson MacLean, Shawn MacLellan, Branislava Poduska, Yuan Zechun; *M.Sc. Students:* Laura Smallbone, Andrea Sartor; *Research Associates:* JiuJun Cheng, Alison Cowie, Rahat Zaheer; *Research Assistants:* Jane Fowler, Chris Sibley; *Post-doctoral associate:* Bridget Kelly

Research collaborators

Dr. B. Golding (McMaster University), Dr. C. Baron (McMaster University), Dr. D. Morton (McMaster University), Dr. E. Weretilnyk (McMaster University), Dr. J. P. Xu (McMaster University), Dr. B. McCarry (McMaster University), Dr. Didier Hérouart (Université de Nice), Dr. Siv Andersson (University of Uppsala), Dr. Barry P. Rosen (Wayne State University)

Funding

Natural Sciences and Engineering Research Council (2000-2005)
Genome Canada (2003-2007)
ORDCF (2003-2008)

The soil bacterium *Sinorhizobium meliloti* is best known for its ability to form N_2 -fixing root nodules on alfalfa. The genome of this bacterium is large and is composed of three replicons – a chromosome and two large plasmids, called megaplasmids pSymA and pSymB. In 1991, we constructed a genetic map for the 1700 kilobase pSymB megaplasmid and ten years later, we were part of the international consortium that determined the DNA sequence of the genome of this organism – all 6,691,694 base pairs. Analysis of this sequence revealed that it contained 6,204 protein coding genes and interestingly the functions of about 2,500 of these genes are unknown. Many of these proteins of unknown function have homologs or similar genes in other organisms. Our major, current, focus is directed to determining the biological roles for these genes of unknown function. In that work, primarily, we are employing a gene fusion - expression approach and have constructed a library of six thousand gene fusions that is presently being analyzed.

A second major project is directed to understanding how replication of the pSymA and pSymB megaplasmids is controlled. In that work we recently discovered a small antisense RNA that appears to play a central role in controlling replication of these plasmids.

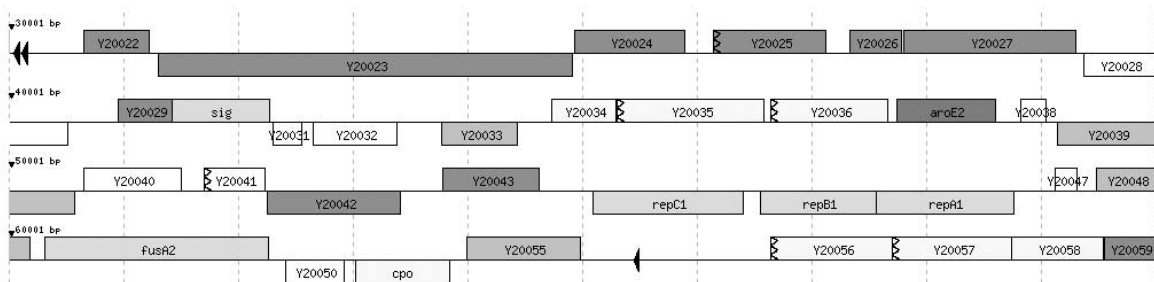
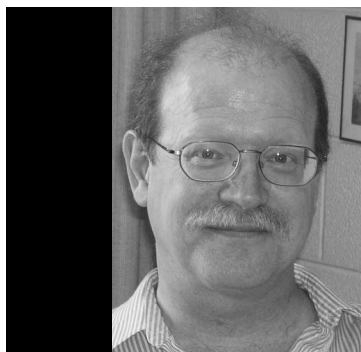


FIGURE 1: Schematic of a gene region from the *Sinorhizobium meliloti* pSymB megaplasmid including the *repA1*, *repB1* and *repC1* genes together with several genes of unknown function prefaced by a Y.



G. Brian Golding

Professor

Canada Research Chair in Environmental Genomics

Molecular Evolution, Genomics, Bioinformatics, Computational Biology

Laboratory Personnel

Post-doctoral Fellows: P. Nuin, P. Reddy; *Graduate Students:* W. Hao, M. Huntley, F. Raftis, B. Whitty;

Research Technician: Y. Fong

Funding

Natural Sciences and Engineering Research Council (2000-2005)

Genome Canada (2003-2007)

Canadian Foundation for Innovation (2002)

Ontario Innovation Trust (2002)

Canada Research Chairs (2002-2009)

Our research interests are in the area of bioinformatics, molecular evolution and DNA sequence analysis. Our research attempts to understand how the processes of evolution act to cause the changes actually observed between molecules, between genes and between genomes. The recent advances in molecular genetics are providing a storm of new data on DNA sequences, on gene structure and higher order genomic structure. However, the implications of these new data are not always clear. This area of scientific inquiry is called bioinformatics and is a relatively new inter-disciplinary field between biology, computer science and mathematics.

We make use of computer based analysis, statistical analysis and mathematical models to answer broad questions about the biology of all organisms. We are presently investigating the following,

- I. The frequency and properties of genes that have been horizontally transferred between bacterial species. We are developing methods to detect these unusual events and to measure their extent of transfer.
- II. We are uncovering the determinants of the rates of amino acid replacements as they relate to the three-dimensional structure of proteins. This has involved the development of new statistical methods to measure evolutionary signal across a potentially large phylogenetic history.
- III. We are determining the properties and determinants of simple repeats within individual proteins. This has included demonstrating that these repeats can form a significant proportion of the genomic protein sequence.
- IV. We are involved in the creation of genomic databases. For example, we are participating in a large scale, multi-university project to determine and archive protist expressed sequence tags. In collaboration with Dr. T. Finan we performed the bioinformatics for a project to sequence the *Sinorhizobium meliloti* 1.7Mbp pExo replicon.

Individual projects change over time but they are united by a consistent, broad interest in the fields of genomics, bioinformatics and molecular evolution.



Bhagwati P. Gupta
 Assistant Professor
 Canada Research Chair in Developmental Biology

Vulval development in *C. elegans*; Regulation, function, and evolution of gene networks

Lab personnel

Undergraduate Students: Md. Samad Zubairi, Zobia Jawed, Zoanna Miller; *Research Technician:* Shushmita Gupta

Research collaborators

Dr. Paul Sternberg (California Institute of Technology), Dr. David Baillie (Simon Fraser University),
 Dr. Raymond Miller (Washington University School of Medicine)

Funding

Natural Sciences and Engineering Research Council, Discovery (2004-2009)
 Natural Science and Engineering Research Council, Research tools (2004)
 Canadian Foundation for Innovation (2004)
 Ontario Innovation Trust (2004)
 Canada Research Chairs (2004-2009)

Our laboratory uses the soil-nematode, *Caenorhabditis elegans*, to understand how genes function to control cell identity and organ formation in multicellular species. Our system of choice is the hermaphrodite vulva, a tubular organ necessary for mating and laying fertilized eggs. We take classical genetic, molecular, and genome-wide approaches to identify genes and study their function and regulatory networks during vulval tubule morphogenesis. We use Computational Biology tools to compare the genomes of closely related nematodes (of the *Caenorhabditis* genus) to study how functions of vulval pathway genes have evolved and complement such findings with specific experiments.

To understand the mechanism of tissue morphogenesis, we are focusing on the regulation and function of a LIM homeobox (LHX) family of transcription factor *lin-11*. LHX genes control diverse morphogenetic events in eukaryotes. Targeted deletion and RNA interference (RNAi) of some of the family members in vertebrates (mouse, chicken and Xenopus) have been shown to cause severe growth and viability defects. In *C. elegans*, mutations in *lin-11* give rise to an egg-laying defective phenotype because of morphogenetic defects in hermaphrodite vulval tubule and its connection to the uterus. We have recently shown that *lin-11* plays a crucial role in controlling the adhesion, polarity, and invagination of vulval cells. Our future experiments focus on identifying *lin-11* target genes that mediate each of these processes and study their regulatory network.

Our comparative studies aim to understand evolutionary changes in vulval gene networks in three *Caenorhabditis* nematodes – *C. briggsae*, *C. remanei*, and CB5161 – that are closely related to *C. elegans*. Over the past two years, we have carried out multiple genetic screens in *C. briggsae* to isolate vulval mutants. Our preliminary analysis has revealed that some of the mutants display unique phenotypes not previously reported for the known *C. elegans* vulval mutants. Thus, experimental findings in *C. briggsae* promise to reveal differences in gene function and role in vulval development and morphogenesis.

To facilitate the genetic analysis of vulval mutants in *C. briggsae*, we are working with other laboratories to develop resources and tools for comparative studies. In collaboration with Paul Sternberg (California Institute of

Technology) and David Baillie (Simon Fraser University), we have isolated more than 200 mutants to construct a genetic linkage map of *C. briggsae*. So far, we have mapped more than 50 mutants leading to the definition of six linkage groups (five autosomes and one x-linked). To help anchor the linkage groups, we have identified some of the orthologs of *C. elegans* genes. A high-resolution linkage map will not only benefit our own research but will also be a valuable resource for the entire *C. briggsae* research community.

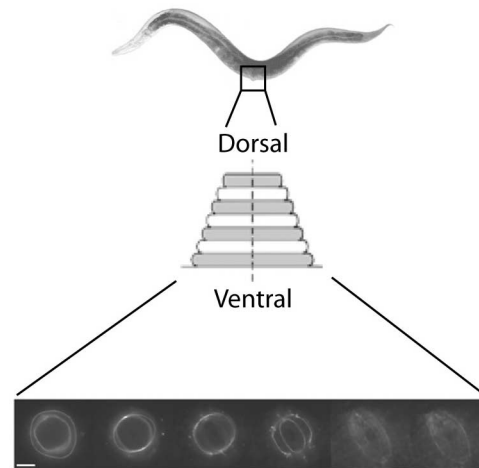


FIGURE 1: Vulval tubule in an adult *C. elegans* hermaphrodite. The vulva (box region) is composed of seven concentric toroids that are stacked upon one another. The toroidal rings (observed in different focal planes) can be visualized by the expression of *ajm-1*.



J. Roger Jacobs
Professor

Developmental Genetics, Cancer Genetics

Personnel:

Post-doctoral Fellow: Firoz Mian; *Ph.D. students:* Allison MacMullin, Leena Patel, Katie Moyer, *M.Sc. Students:* Noor Hossain, Kelly Teal; *Undergraduate students:* Christine Elder; *Research Technician:* Mihaela Georgescu

Funding:

Natural Sciences and Engineering Research Council, Discovery (2002-2005)
Canadian Institutes of Health Research (2002-2005)
National Cancer Institute of Canada (2003-2006)

Our research program explores the molecular and genetic basis of cell to cell signaling events in developing and mature tissues. We employ *Drosophila* as a model organism, because the rapidity with which we can isolate new mutations, or otherwise modify gene expression. *Drosophila* is a relatively complex organism, wherein the functions of most genes are reflected by conserved (similar in structure) mechanisms in humans. All of our three research streams examine cell to cell signaling that is conserved at the molecular level, but less well understood in humans. Through applying an unbiased genetic approach in *Drosophila*, we can discover new dimensions of signaling events that are impossible or difficult to uncover in mammals.

Function of Veli in polarised signaling

Veli, or vertebrate Lin-7 is a small protein that acts as a scaffolding protein at the apical cell surface. Veli acts to organise into larger complexes, signaling molecules that function as a unit. Typically these molecules include ones that protrude from the cell surface, and are engaged in cell to cell communication. Veli is expressed at the sending and receiving sides of the major cell to cell signaling system in the nervous system, the synapse. We have isolated and characterised the *Drosophila* form of this protein, and used genetic tools to alter its function. We have discovered that it is required to efficient presynaptic signal release, and that altered function reduces output. The synapse attempts to compensate for reduced Veli protein levels by expansion of cell to cell contacts in the synapse (see Figure 1) but nevertheless, impaired veli function results in sluggish behaviour.

Molecular and genetic analysis of the morphogenetic functions of Slit

The formation of complex tissues in the embryo requires the directed movement of cells (migration) or directed growth of cell processes, like the axons of the nervous system. We co-discovered the primary repellent guidance signal for migration in the nervous system, called Slit, in 1999. Today we are examining its function in the assembly of a simpler tissue, to better understand the molecular basis of its activity. We focus on the *Drosophila* heart, whose development mirrors the vertebrate heart up to the point of looping morphogenesis. We have discovered that Slit can act as an attractant in heart cell migration events, and that this function is strongly affected by other cell adhesion signals, in particular from the integrin family (see Figure 2). Currently we are using gene misexpression tools, and timelapse studies of cell movements in living tissue, to see how cells react to the intersecting signals of attraction, repulsion and adhesion.

Genetic dissection of mammalian ErbB2 signaling in *Drosophila*

Nearly a third of human breast cancers involve a change in the regulation or expression of a major cell to cell signaling system, involving ErbB2, a member of the Epidermal Growth Factor Receptor family. ErbB2 signals growth and differentiation signals, and in cancer, unregulated cell growth, by recruiting and activating many intracellular messenger proteins, called second messengers. Clinicians and scientists would like to determine what specific outcomes result from the activation of each second messenger, so that we may identify more specific targets for therapeutic intervention. Scientists looking at the mammalian model have designed altered forms of ErbB2 that can only activate a small set of second messengers at a time. Technically, it is very slow and expensive to determine the effects in living mammalian models of cancer.

Drosophila shares a signaling pathway that is strongly conserved with vertebrate ErbB2. We have discovered that expression of mammalian ErbB2, including the altered forms, can signal through *Drosophila* second messengers. Moreover, we can apply genetic approaches in *Drosophila* to identify which second messengers, or discover new second messengers that are required for specific signaling pathways that radiate from ErbB2. Currently we are focused upon discovering the signal pathways employed by ErbB2 to down-regulate its own outputs.

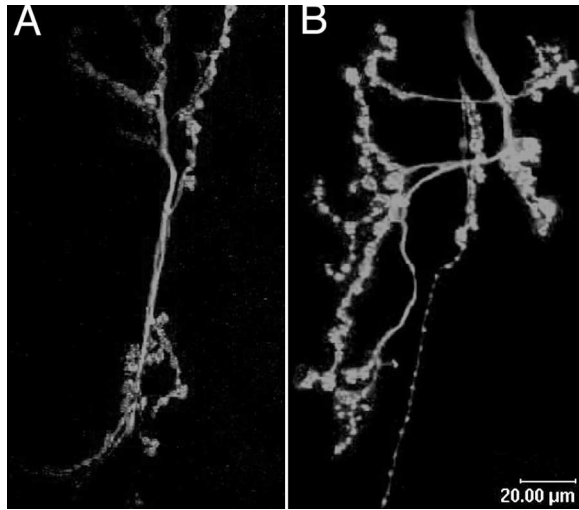


FIGURE 1:
Panel A shows the size and location of synaptic boutons on the muscle of a normal fly. Panel B shows the increased size and number of boutons when Veli levels are reduced.

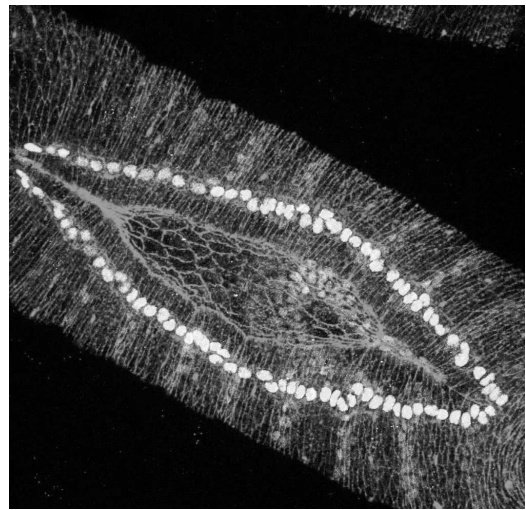
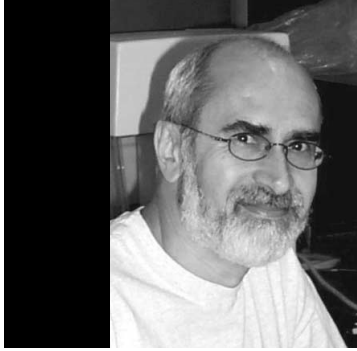


FIGURE 2:
This is a dorsal view of the *Drosophila* embryo, as the heart cells (nuclei marked in green) move from both sides towards the midline, to form a tube. The red label outlines the actin filaments underlying each cell membrane.



Jurek Kolassa
Professor

Integration of Multi-Species Assemblages and its Effects on Biodiversity

Laboratory personnel

Ph.D. Students: April Hayward. *Students:* Marla Bojarski, Brooke Vanhartingsvelt.

Research collaborations

Dr. Steward T. Pickett (Institute of Ecosystem Studies), Dr. Nigel Waltho (York University), Dr. Tamara N. Romanuk and Dr. Beatrix Beisner (Université du Québec à Montréal)

Funding

Natural Sciences and Engineering Research Council (2000-2005)

Our work concentrates on structure and variability of complex, multi-species assemblages. We are interested to find out how complexity and community interactions affect species extinctions and levels of biodiversity at various scales of time and space. The communities we investigate are invertebrates inhabiting natural, subtropical rock pools. These rock pools serve as model systems. The considerable number of discrete and yet interacting communities (over 200 in one location) allows us to control for, or factor out, unwanted influences while focusing on testing specific hypotheses.



The most recent project led us to uncover a number of relationships with significant implications for understanding ecological communities. For example, we found that species richness can have a stabilizing effect on variation of individual species (diversity-stability hypothesis) but this effect is only exposed when variability of specialists is factored out. We have also found that species richness appears to stabilize density of species at broader scales – that of metacommunity. Theoretical studies permitted us to demonstrate that more integrated communities provide a functionally more stable arrangement of species in the absence of major disturbances, but require greater modularity of interactions (greater degree of specialization) in order to take advantage of species diversity. A project in progress analyzes the effect of habitat heterogeneity on patterns of species accumulation with increasing sample size – a regularity of great interest to biodiversity conservation efforts.



Grant McClelland
Assistant Professor

Integrative physiology of muscle and animal performance, environmental stress

Laboratory personnel

Post-doctoral fellows: Dr. Makiko Kajumura; *M.Sc. Students:* Marie-Pierre Schippers; *Undergraduate Students:* Shawn Dipardo, Ayaz Hyder; *Lab Volunteers:* Déanne Malenfant, Yazan Hammany, Kalindi Dhekney

Research collaborations

Dr. Reuven Dukas (McMaster University), Dr. Jon Stone (McMaster University), Dr. Chris Wood (McMaster University)

Funding source and duration

Canadian Foundation for Innovation (2004)
Natural Sciences and Engineering Research Council, Discovery (2004-2008)
Natural Sciences and Engineering Research Council, Research Tools (2004)
NSERC CRD Grant & industrial partners (with C. Wood) (2005-2008)

Our lab is focused on gaining a better understanding of the cellular, molecular, genetic, environmental and evolutionary determinants of fuel selection with an emphasis on lipid metabolism. In the last year we focused on four major research themes:

Vertebrate muscle remodeling

Shawn Dipardo and Ayaz Hyder

This recent research focuses on muscle plasticity to environmental stress and how this impacts on whole-animal performance. Using adult zebrafish as a model system we have been investigating an apparent paradox concerning the qualitative changes in mitochondrial biogenesis with chronic increases or decreases in muscle metabolism. We have found some significant differences in the mechanisms of mitochondrial biogenesis in response to contraction and temperature-induced triggers.

Lifetime performance and muscle physiology

Marie-Pierre Schippers

We have also been investigating the relationship between lifetime learning and foraging performance changes in relation to muscle physiology in honeybees. (With R. Dukas)

Regulation of lipid metabolism with environmental stress

Déanne Malenfant and Dr. Makiko Kajumura

We are examining the regulation of muscle lipid oxidation with environmental stress. Specifically we are looking at the enzymatic steps controlling fat entry into mitochondria via carnitine palmitoyltransferase I (CPTI). Using ectothermic vertebrates we are studying how both genomic and nongenomic factors affect mitochondrial oxidation rates through enzyme abundance and changes in cellular milieu in the form of membrane phospholipids composition.

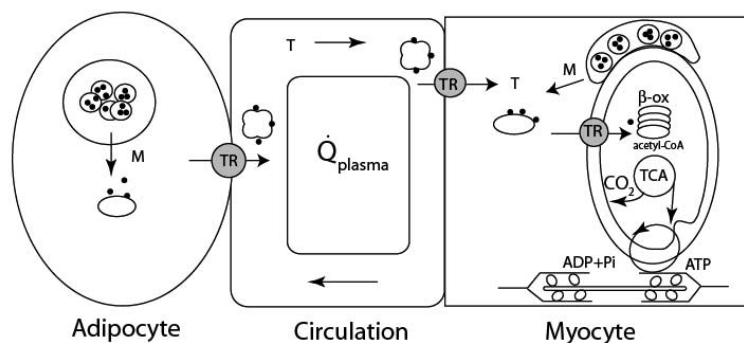
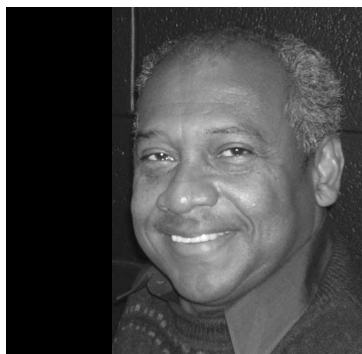


FIGURE: Transport steps in fat delivery from storage sites to working muscle mitochondria

Interactions between oxygen delivery and fuel metabolism

We are embarking on two lines of study to examine the relationships between oxygen delivery and fuel metabolism. Lines of rats selectively bred for high and low aerobic capacity are being used to study the relationship between exercise intensity and fuel kinetics. Chronic hypoxia is used to examine changes in muscle and heart metabolic properties.



Colin Nurse
Professor

Cellular and molecular mechanisms of O₂, and CO₂/pH sensing in vertebrates

Lab personnel

Ph.D. Students: S. Brown, M. Lowe, V. Campanucci, M. Jonz; *M.Sc. Students:* J. Buttigieg, J. Liu; *Undergraduate Students:* H. Saltys, S. Ali; *Senior Technician:* Cathy Vollmer; *Research Associate:* Dr. Min Zhang

Research collaborators

Ernest Cutz (Hospital For Sick Children), Ian Fearon (University of Manchester), Ana Campos (McMaster University)

Funding

Canadian Institutes of Health Research (2004-2009 and 2002-2005)
Natural Sciences and Engineering Research Council, Discovery (2003-2007)
Heart and Stroke Foundation (2001-2006)

My laboratory is interested in the cellular and molecular mechanisms by which cells sense O₂, CO₂, and pH and make appropriate physiological responses to changes in these variables. For example, we study specialized receptor cells and neurons that respond to low O₂ (hypoxia) by activating a signaling cascade leading to regulation of plasma membrane K⁺ channels, and release of neurochemicals. We combine cell culture, patch clamp electrophysiology, confocal immunofluorescence, RT-PCR, and western blotting techniques, with the use of cell lines to characterize key components in the signaling pathway. A major focus has been on characterization of O₂, CO₂, and pH sensing in specialized chemoreceptors of the mammalian carotid body and in chromaffin cells of the neonatal adrenal medulla. Additionally, the use of a transgenic knockout model has led to the identification of a plasma membrane, neutrophil-like NADPH oxidase complex as the O₂ sensor in pulmonary neuroepithelial bodies (collaboration with Dr. E. Cutz, Hospital For Sick Children). We have also characterized an immortalized O₂-sensitive cell line from the rat adrenal medulla (MAH cells) to aid studies on the role of the mitochondrial electron transport chain in acute oxygen sensing, and on the regulation of gene expression by chronic hypoxia. More recently, we have begun to explore O₂ sensing mechanisms from a comparative and evolutionary perspective, while taking advantage of powerful genetic tools available in zebrafish and *Drosophila* (collaboration with Dr. Ana Campos).

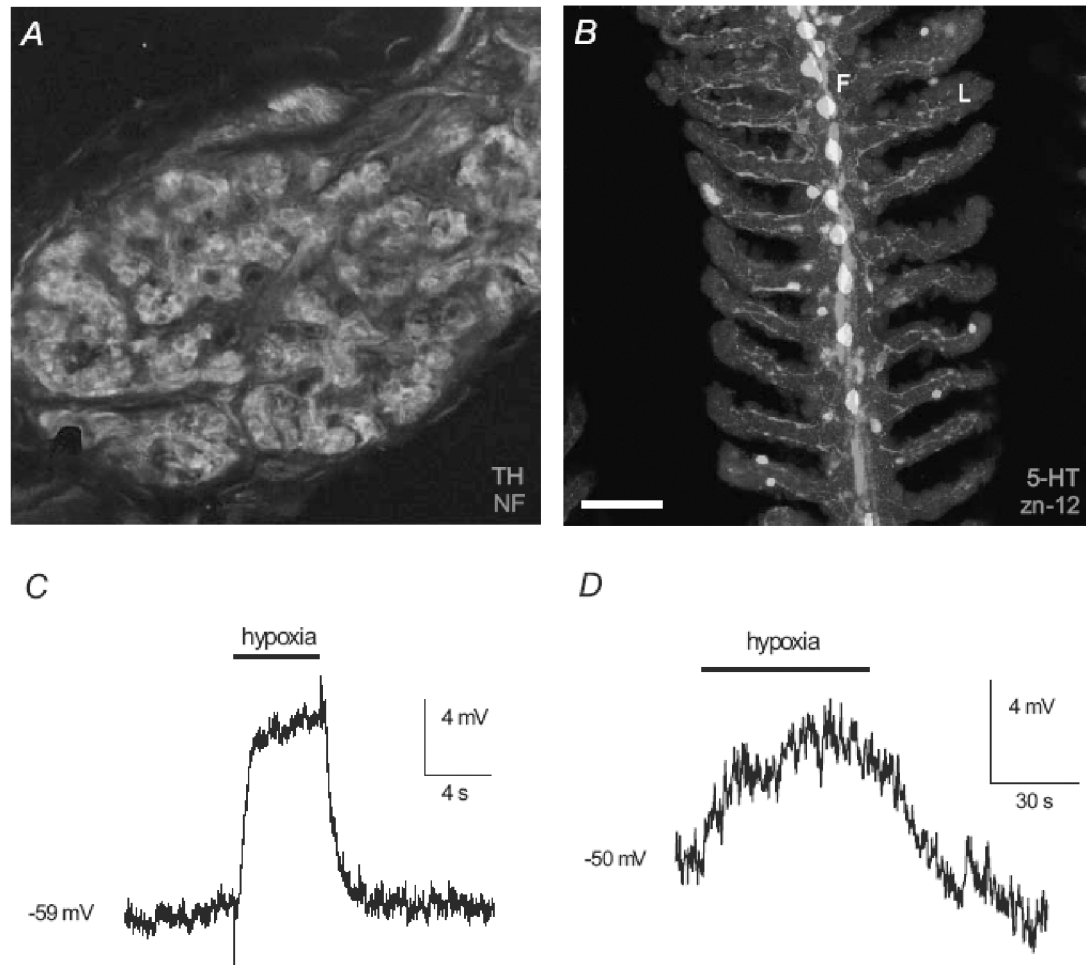
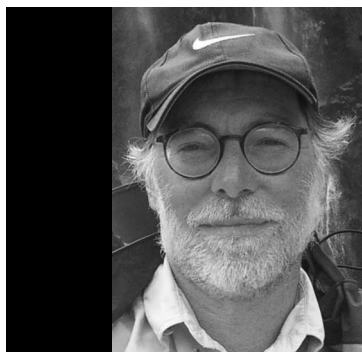


FIGURE: Fluorescence images of O_2 receptors, their innervation, and their physiological response to hypoxia in rat carotid body (A,C) and zebrafish gill (B,D). (For the colour photo and details see Jonz and Nurse, 2005)



Michael J. O'Donnell

Professor

Ionoregulation and excretion in invertebrates and fish: Cellular mechanisms and control of epithelial transport

Laboratory Personnel

Post-doctoral fellows: Dr. Andrew Donini, *Ph.D. Students:* Juan Ianowski, Mark Rheault, Esau Ruiz-Sanchez, *M.Sc. Students:* George Bijelic, *Undergraduate Students:* Jenn Plaumann, Bob Christensen, Nancy Kim

Funding

Natural Sciences and Engineering Research Council, Discovery (2001-2005)
Natural Science and Engineering Research Council, Research tools (2004)

The primary goal of my research program is to elucidate the cellular and molecular mechanisms of excretion and ion transport by insect epithelia. A related objective is to explain how such processes are controlled by hormones and intracellular second messengers. My research makes extensive use of electrophysiological methods, including intracellular recording, ion-selective microelectrodes and patch clamping. My students and I must also develop or adapt specialized micro-techniques for measuring pH or ion concentrations inside or adjacent to epithelial cells, or in nanolitre samples of biological fluids. Our studies of physiological mechanisms of ionoregulation and excretion provide insights that we hope will aid development of novel, environmentally-benign insecticides for pest species.

Transport of organic cations and organic anions by insect epithelia

Excretion and ionic and osmotic regulation in insects are accomplished by the Malpighian tubule/hindgut system. The functional kidneys of insects are the Malpighian tubules that transport a wide variety of organic anions and organic cations including metabolites and both natural pesticides (e.g. nicotine) and anthropogenic compounds. Recent studies by other groups suggest that organic ion transporters play a role in insecticide resistance. Current models propose that type I organic cations (<400 Da, monovalent) enter renal cells through an electrodiffusive pathway driven by the inside negative membrane potential, whereas the larger (>500 Da) more hydrophobic OCs of type II may diffuse across the cell membrane. Transport of type I organic cations across the apical membrane may involve OC/H⁺ exchange, whereas type II organic cations are substrates of the multi-drug resistant (MDR) gene product p-glycoprotein (P-gp), an ATP-dependent pump. Organic anions enter the cells through several pathways which may involve cotransport with protons or exchange for cellular dicarboxylic acids. Organic anions may cross the apical membrane into the lumen through a voltage-dependent transporter, through exchange for other anions in the lumen, or through a multidrug resistance associated protein (MRP).

Development of novel electrophysiological methods for analysis of organic ion transport

We recently developed two novel electrophysiological techniques to study transport of the prototypical organic cation (OC) tetraethylammonium (TEA). The first technique involves a TEA-selective self-referencing (TEA-SeR) microelectrode which exploits the 107-fold higher selectivity of a common ion exchanger for TEA relative to K⁺. This non-invasive technique provides excellent spatial and temporal resolution of TEA transport by the Malpighian tubules, ureters and gut of insects, even those as small as the fruit fly *Drosophila*. We also developed TEA-selective microelectrodes to measure TEA concentration in nanoliter droplets of fluid collected from isolated Malpighian tubules set up under paraffin oil in the Ramsay assay. TEA flux (pmol min⁻¹) by individual Malpighian tubules can be calculated as the product of secreted fluid TEA concentration (mmol l⁻¹) and secretion rate (nl min⁻¹). TEA-selective microelectrodes can also measure changes in haemolymph [TEA] after injection of TEA or after insects

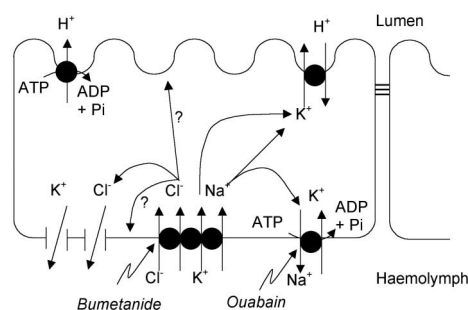
are fed TEA-enriched diets. We extended strategies developed for TEA measurement to measurement of the organic anion (OA) salicylate, using ion exchanger microelectrodes based on tridodecylmethylammonium. TEA-selective or salicylate-selective microelectrodes provide rapid, safe, and low cost methods for analysis of Malpighian tubule transport of OCs and OAs. Detection limits are actually lower than those achievable using liquid scintillation counting.

Mechanisms of organic cation and organic anion transport in insects

Basolateral uptake of the prototypical organic cation TEA by MTs of *Drosophila* is a saturable process and is dependent on basolateral membrane potential, indicating electrogenic transport. The posterior midgut and the lower region of the MT and ureter also transport TEA, and multiple transporters appear to be involved. Moreover, diuretic factors which stimulate active transport of Na^+ , K^+ and Cl^- osmotically obliged water flow also stimulate TEA transport. MTs of insects from 8 species in 6 orders also transport TEA and the p-glycoprotein (P-gp) substrate nicotine at high rates. In conjunction with collaborator C. Donly we initiated the isolation of lepidopteran P-gp cDNAs using degenerate primers based on *Drosophila* P-gp sequences. We used RT-PCR and unique primer sets to determine expression of 4 related MDR genes in Malpighian tubules and other tissues of caterpillars. We have also used confocal microscopy to show that organic anions are transported across the cytoplasm of principal cells both by diffusion and in vesicles, indicating multiple transport mechanisms.

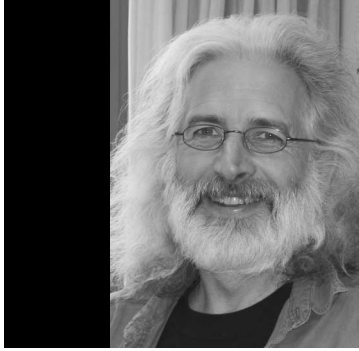
Mechanisms of Na^+ , K^+ and Cl^- transport by insect Malpighian tubules

A striking aspect of insect Malpighian tubules is their capacity for varying the $\text{Na}^+:\text{K}^+$ ratio in secreted fluid to compensate for variations in dietary Na^+ and K^+ intake. Our model for secretion of K^+ -rich fluid by *Drosophila* MTs proposes that K^+ and Cl^- cross the basolateral membrane through a Na^+ -driven $\text{Na}^+:\text{K}^+:2\text{Cl}^-$ cotransporter; most of the Na^+ that enters cells is returned through the Na^+/K^+ -ATPase (5). Thus, although the main driver for transport is the apical H^+ -ATPase, the Na^+/K^+ -ATPase plays an important role in fine tuning the secreted fluid cation composition.



Ion transport by anal papillae and Malpighian tubules of larval mosquitoes

Classic work done on fresh water species used whole larvae and radioisotopes to assess kinetic parameters of ion uptake in dilute waters. Little is known of the cellular mechanisms involved and virtually nothing is known of the role of hormones in controlling ion uptake or excretion by the Malpighian tubules, hindgut and anal papillae in the larvae. We used self-referencing ion-selective microelectrodes positioned near the surface of papillae in intact larvae to directly measure fluxes of Na^+ , H^+ , Cl^- , K^+ , Ca^{2+} and NH_4^+ .



James S. Quinn
Associate Professor

Genetic relatedness, parentage and behavioural ecology of colonial and cooperative-breeding birds and anthropogenic induction of germline mutations in gulls and mice

Laboratory personnel

Ph.D. Student: Gregory Schmaltz, *M.Sc. Student:* Cindy Lentz, *Undergraduate Students:* Heather Eaton, Pinky Gaidhu, Sameer Kassim and Bill Mous

Research collaborators

Dr. Mark Hauber (University of Auckland)

Funding

Natural Sciences and Engineering Research Council, Discovery (2001-2005)
Natural Sciences and Engineering Research Council, Research Tools (2004)
Premier Research Excellence Award (2001-2006)
Earthwatch (2004)

Our research has focused in two directions. First, we have been trying to understand the complex social system of a communal plural breeding joint-nesting bird, the smooth-billed ani (*Crotophaga ani*). Progress on that front follows:

We have developed microsatellite markers for smooth-billed anis and a species of future research interest – pukeko (*Porphyrio porphyrio*). In the field we have made significant improvements in techniques and equipment for capturing and video taping anis in Puerto Rico. Recent local studies of colonial nesting waterbirds have allowed the development of techniques for non-destructive sampling and isolation of maternal DNA from the external surface of eggs. This latter method, which appears effective for ani maternal genotyping, will represent an important advance in field studies as it limits the need to sample the mother directly and it increases the statistical power of identifying the father by allowing a focus on specifically paternal alleles.

We have extracted DNA samples from 305 ani adults and 385 chicks from 40 territories over the past 6 years. Many of these have been genotyped with 5 microsatellite loci using 33P labelled primers. Preliminary analyses have revealed that a) both sexes have extra-pair fertilizations and b) young from most groups disperse to join other groups. Most groups (N = 13) examined were unrelated adults (10% of within-group dyads are related) while two groups had many more related dyads (about 30 to 66.7% of within-group dyads related), suggesting that offspring in these two groups had not dispersed.

We developed three general methods for capturing anis (netting nocturnal roosts, trapping adults on territory using lure birds, and radio-controlled nest traps) and field tested a video recording system. We have found that smooth-billed anis while socially monogamous, engage in extra-pair fertilizations and live in groups of mostly unrelated adults. We know that egg tossing and burial represent deliberate behaviours and that nocturnal incubation involves actively repelling potential predators such as rats (both from video evidence).

Novel field methods for pukeko studies have already been worked out. We have established three microsatellite markers that will facilitate rapid genotyping of eggs and adults in some pukeko groups. I have established an

important collaborative relationship with Dr. Mark Hauber at University of Auckland that will facilitate field studies of pukeko north of Auckland, New Zealand.

In another area of research we followed up on our previous findings that germ-line tandem repeat DNA mutations are induced by human produced pollution. We recently demonstrated that air pollution can induce mutations and that the particulate component is responsible (see Figure below). This work was accomplished through experimental exposure of lab mice to air pollution in “mouse hotels” located downwind of Hamilton’s industrial core compared with those housed 35 km north on a non-polluted reference site. This work has led to prominent and important publications in *PNAS* and *Science* showing that germ-line tandem repeat DNA mutations in gulls and mice are related to particulate air pollution associated with heavy industry and diesel exhaust. I hope that demonstrations such as these will lead to reductions in pollution-inducing urban sprawl and a tightening of restrictions on the release by industry and traffic of particulate air pollution that has already been implicated in deadly cardiac and respiratory disorders.

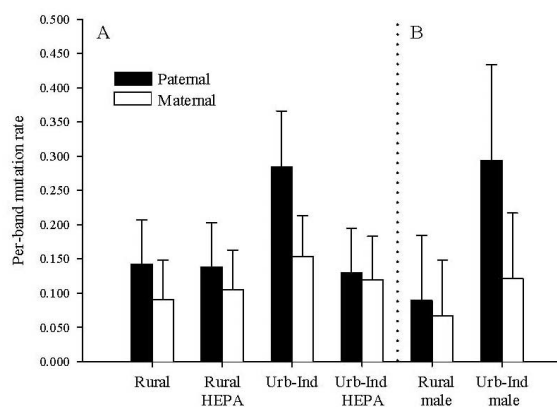
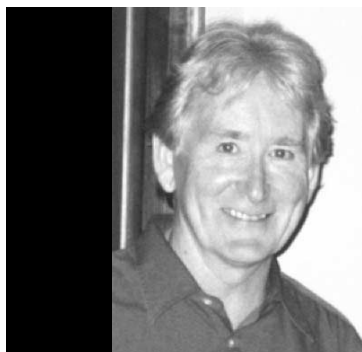


FIGURE: (A) The paternal and maternal per-band mutation rates (+ 95% CI) measured in the offspring of sentinel mice exposed in situ to ambient or HEPA-filtered ambient air at the urban-industrial (Urb-Ind) and rural field sites. Mutation rates are for ESTR single loci Ms6-hm and Hm-2 pooled, and are based on analysis of 94 to 114 offspring (177 to 220 bands) in 17 to 20 pedigrees from each treatment group. (B) Mutation rates resulting from mating males exposed to ambient air at the rural and Urb-Ind sites to unexposed females. Mutation rates are for Ms6-hm and Hm-2 pooled from 8 pedigrees (45 to 48 offspring, 79 to 91 bands).



Andrew J. Rainbow

Professor

Molecular mechanisms
for DNA repair in mammalian cells and their role in
human disease using viruses as probes

Laboratory personnel

M.Sc. Students: Natalie Zacal, Adrian Rybak, Robert Cowan, Shaqil Kassam, Diana Dregoes, Alicia O'Neill.

Research Collaborators

Dr. Gurmit Singh (McMaster University), Dr. Regen Drouin (University of Sherbrooke)

Funding

National Cancer Institute of Canada (1999-2006)

Ontario Cancer Research Network (2005-2008)

Our research objective is to understand the role of DNA damage and DNA repair in the induction of human cancer as well as to improve protocols for radiation therapy and chemotherapy of cancer. Knowledge concerning DNA repair comes from comparative studies of cell strains from normal individuals as well as from patients suffering from a number of human genetic diseases including xeroderma pigmentosum (XP), Cockayne syndrome, Bloom's syndrome, Fanconi's Anemia and ataxia telangiectasia. Cells from most patients with these diseases are hypersensitive to certain cytotoxic agents, show some deficiency in DNA repair and have a predisposition to cancer. For example, the majority of XP patients are deficient in the first step of nucleotide excision repair (NER) of DNA and the incidence of sunlight-induced skin cancer in these patients' approaches 100%. Efficient DNA repair thus plays a major protective role from cancers resulting from exposure to the sun.

Our research uses cell culture, recombinant DNA techniques and viruses as probes and expression vectors to examine DNA damage induced by ionizing radiation, ultraviolet light, cisplatin and other cytotoxic agents and the repair of this damage in several different mammalian cell types. DNA damage and DNA repair play an important role in the response of tumour cells to radiation therapy and chemotherapy. In our research we are also examining the response to DNA damaging and other cytotoxic agents of tumor cell lines with an altered response to radiation, chemotherapeutic agents and/or photodynamic therapy (PDT) treatment. The information we gain from these studies is expected to lead to new approaches which reduce the detrimental effects of DNA damaging agents in the environment and help in the management of individuals at high risk for carcinogen induced malignancy. Such knowledge will also be used to improve protocols for radiation therapy, chemotherapy and photo chemotherapy of cancer.

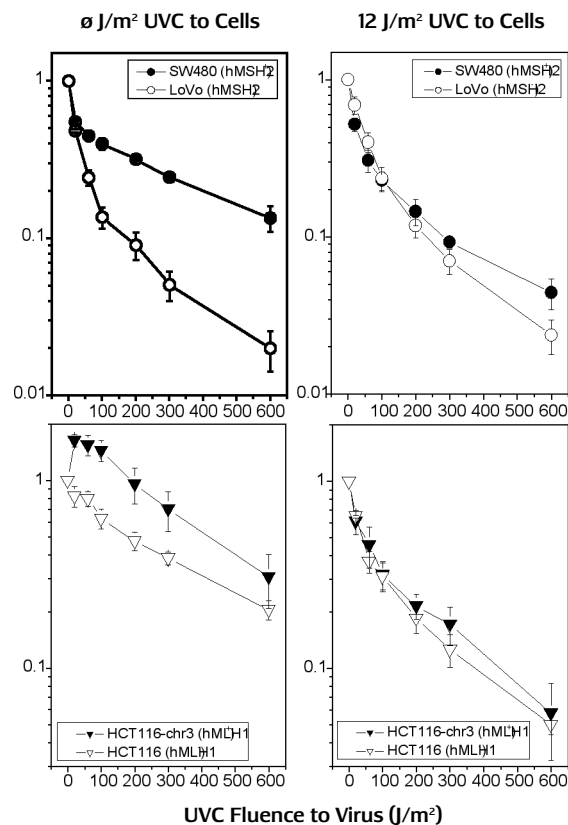
One of our approaches to examining the mechanisms of PDT is by inducing and selecting PDT-resistant variants and determining alterations in gene expression that lead to resistance. We have generated several photosensitizer specific PDT resistant cell variants of HT29 human colon adenocarcinoma cells and recently reported several alterations in mitochondrial and apoptosis regulating gene expression in these cells (Shen et al. 2005, *Photochem. Photobiol.* In press).

We have reported that the removal of UVC-induced DNA damage by NER can be induced in normal human cells and that this induction requires the normal functioning of the p53 gene, a well known "tumor suppressor" gene (Rainbow et al. 2005, *Comprehensive Series in Photosciences*. In press). UVA alone, as well as several photosensitizing

agents plus visible light, can produce oxidative DNA damage which results in damage to single DNA bases which are repaired by base excision repair (BER). We are currently extending our studies to examine the genes required for BER and to determine if BER, like NER, can be induced in cells.

In other recent work we have examined the role of two mismatch repair (MMR) genes in the repair of UV-induced DNA damage by NER. MMR recognizes and repairs bases incorrectly incorporated during DNA replication and involves two principle repair genes hMLH1 and hMSH2. Individuals heterozygous for a mutated MMR gene are predisposed to developing non-polyposis colorectal carcinoma (HNPCC) and tumors from patients with HNPCC have a mutator phenotype. In addition, the MMR proteins have been reported to bind to UV-induced DNA damage and protect mammals against UVB-induced skin cancer and there is evidence that MSH2 protein levels are altered in human non-melanoma skin cancers. These latter reports suggest a link between alterations in MMR gene expression and increased levels of unrepaired sunlight-induced photolesions in skin cells. Using a recombinant adenovirus expressing the β -galactosidase gene as a probe for DNA repair, we demonstrated that human cells mutated in the MMR genes hMLH1 and hMSH2 are deficient in NER and that the ability to detect this deficiency is dependent on UVC fluence to cells (see Figure below).

FIGURE: Host cell reactivation of ψ -galactosidase activity for UVC-irradiated AdHCMVlacZ virus in non-pretreated cells or cells pre-irradiated with UVC (12 J/m² UVC to cells). Results are shown for hMSH2+ SW480, hMSH2- LoVo, hMLH1+ HCT116-chr3, and hMLH1- HCT116. Each point is the average \pm SE of three independent experiments, each performed in triplicate. From Lee et al. *Cancer Research*, 64, 3865-3870, 2004.





Herb E. Schellhorn

Professor

The regulation of stress genes in *Escherichia coli*

Laboratory Personnel

Post-doctoral fellow: Cheryl M. Patten; *Ph.D Student:* Galen Chen; *M.Sc. Students:* Sun Yuan, Tao Dong, Michael Schertzberg, Saima Tariq, Jeevaka (Primo) Weerasinghe; *Undergraduate Students:* Andrew Hughes, Daniel Li, Roxanne Longman, Dagmara Sieron, Matt Trudeau.

Research Collaborators

William J. Muller (McGill University), Suleiman Igdoura (McMaster University), Richard A. Morton (McMaster University), Frank L. Graham (Rome, Italy)

Funding

Canadian Institutes of Health Research (2000-2003, 2003/4)
Natural Sciences and Engineering Research Council (2001-2005)

My laboratory examines how bacteria adapt to suboptimal growth conditions by turning on expression of specific sets of genes. Recent advances in genome sequence information, bacterial chromosome modification and gene expression detection technology permit new approaches in our ongoing studies. Using microarray and gene fusion technology, we have demonstrated that many (~250) genes are controlled by RpoS, a primary regulator of adaptive genes in *Escherichia coli*, a bacterium that has long served as a model for regulation and metabolism. Because RpoS is a conserved regulator (found in many bacteria) and has been implicated in human, animal and plant disease processes, understanding the signals that activate this regulator will further our understanding of bacterium/host interaction. A second project in my laboratory, as described below, examines the role of vitamin C metabolism in mammals.

RpoS-regulated genes and RpoS regulation in *Escherichia coli*

Cheryl Patten, Sun Yuan, Michael Schertzberg, Saima Tariq, Galen Chen

We have recently reported the culmination of an extended project in my lab to identify members of the *RpoS* regulon by a genetic screen that is based upon the differential levels of expression of β -galactosidase expression in wild type and *RpoS* mutant strains. In the course of this work, we identified, by phage isolation DNA sequencing, over 100 operon fusions that depend on the RpoS sigma factor for expression. Because many of the independent genes identified are members of operons, about 120 genes were found in total and further, since the mutant library we used was estimated to have hits to about half the genes in *E. coli*, the size of the *RpoS* regulon is likely ~200 genes, the number that is in fairly close agreement with the 200+ genes that we have found by microarray analysis (Patten et al. 2004).

Manipulation of RpoS levels itself may contribute to our understanding of which genes depend on RpoS directly for expression (as opposed to being indirectly controlled through an intermediate regulator). To directly alter cellular levels of RpoS, we have generated constructs that either over express (Chen and Schellhorn, 2003) or attenuate cellular levels of RpoS (Chen et al, 2003). Interestingly, mutations in the *RpoS* gene can be selected (and reverted) under specific conditions which has led us to propose that such mutations may function as a molecular switch to modulate expression of the large *RpoS* regulon.

Physiological Role(s) of RpoS regulated genes

Andrew Hughes, Daniel Li, Roxanne Longman, Tao Dong, Michael Schertzberg, Jeevaka Weerasinghe

As RpoS controls many seemingly-unrelated metabolic functions, understanding the individual physiological function of each gene is necessary to understand the adaptive process. Catalase regulation (Long, Li), phosphate utilization (Dong) GABA utilization (Schertzberg) and regulation of genes of unknown function (Hughes) are being actively examined using common technologies (gene knockout, gene complementation, enzyme assays and gene expression detection). We are also using mass spectrometry (chemical biology) to identify subtle changes in metabolite pools in bacterial strains carrying defined mutations.

Vitamin C metabolism

Dagmara Sieron

Humans (and other primates) are unusual mammals because we lack a key enzyme required for the synthesis of vitamin C. The endogenous human gulonolactone oxidase gene is defective – having been inactivated by mutation about 40 million years ago. Since vitamin C is essential for life, why did we lose this function? To examine this, we cloned murine gulonolactone oxidase gene from a mouse liver cDNA library and used this to construct an adenovirus vector that can express the gulonolactone oxidase activity in human cells (Ha et al, 2004). This adenovirus vector should be useful in pre-clinical gene therapy to examine the role of endogenous vitamin C synthesis in antioxidant physiology of mammals that lack the enzyme (i.e. humans and guinea pigs). Vitamin C is of topical interest, not just because of its importance as an antioxidant, but because of recent findings that it may stimulate embryonic stem cell differentiation and that high affinity transport of this vitamin is essential for post-natal development (mouse models lacking the high affinity transporter die at birth).



Rama S. Singh
Professor

Population and evolutionary genetics, molecular evolution and speciation

Laboratory personnel

Post-doctoral Fellow: Dr. Wilfried Haerty, *Ph.D. Students:* Sanjay Hiremath, Santosh Jagadeeshan, *M.Sc. Students:* Abha Ahuja, *Undergraduate Students:* Carla Gibson, Manhal Younes, *Lab Assistant:* Aaron Thomson

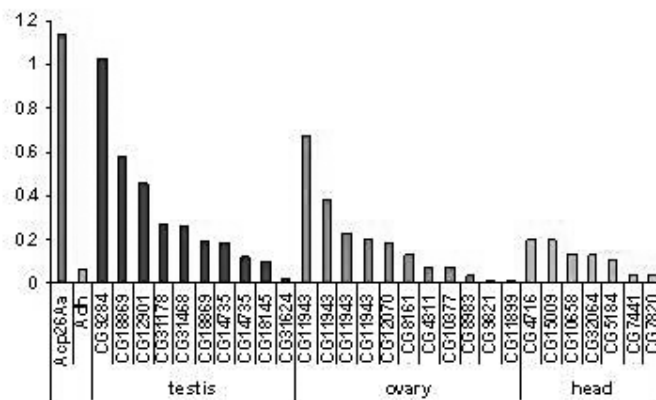
Funding

Natural Sciences and Engineering Research Council (2000-2005)
Natural Sciences and Engineering Research Council Genomics Grant (2002-2005)

The main focus of research in our lab is on the molecular evolution of Sex and Reproduction Related (SRR) genes. We have made use of both the *Drosophila* and the mouse model systems. Using several closely related species of *Drosophila*, we have shown (1) that sex genes evolve faster than non-sex genes, (2) that sex-related genes specific to males evolve faster than other sex- or non-sex genes, and (3) that sex-genes on the X chromosome evolve faster than those on autosomes. Using tissues from head, testis and ovary we have shown that ovary genes evolve faster than head but slower than testis (testis>ovary>head). Using data from mouse and human we have shown (1) that sperm genes evolve faster than all other genes, (2) that sperm genes on the X chromosome evolve faster than those on autosomes and (3) that the sperm genes are evolving under the influence of sexual selection. A study with somatic and testis-specific proteosomes of *Drosophila* showed gene duplication and functional specialization to be a mechanism of rapid change. This finding was bolstered by similar findings from comparing genes affecting fertility in mice. We showed that genes affecting sterility in males or females, but not both, evolve much faster than genes affecting both sexes; the latter genes were similar in their rates of evolution to lethal (essential) genes.

In addition to trying to find out the molecular dynamics of SRR genes, we are also interested in finding out (1) if the evolution of SRR genes is linked to speciation, (2) if SRR genes in males and females, particularly those involved in fertilization, evolve through co-evolution, and (3) if SRR genes are more susceptible to environmental perturbation.

Fig: Divergence of candidate Rapidly Evolving Genes in testis, ovary and head between *D. melanogaster* and *D. simulans*.



Ka/Ks indicates the proportion of silent substitutions relative to amino acid changing substitutions. These estimates are between two Sibling species of *Drosophila* that have diverged from each other only ~ 2.5 MYA.



Jonathon R. Stone
 Assistant Professor
 SHARCNet Chair in Computational Biology

Computational Biology conducted at multiple heirarchical levels

Laboratory personnel

M.Sc. Students: Maria Abou Chakra, Marc Colangelo, *Undergraduate Students:* Lori Beres, Ayaz Hyder (collaboration supervisor G. McClelland), Zobia Jawed (collaboration with B. Gupta), Shaimaa Ahmed, David Cantelmi, Wendy Mok, Aisha Siddiqui, Marlena Zdelar, *Research Associates:* Carlijn Moester

Research collaborators

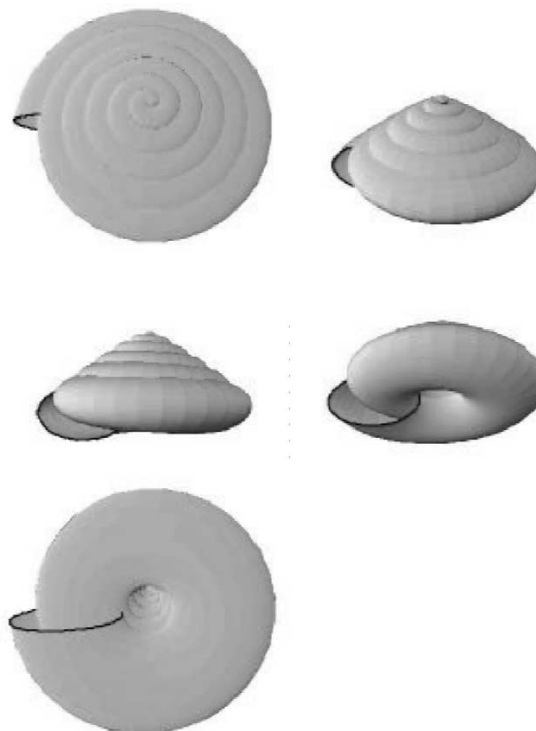
Mats Björklund (Uppsala University), Brian Hall (Dalhousie University), Greg Wray (Duke University)

Funding

Natural Sciences and Engineering Research Council, Discovery (2003-2005)
 Canadian Foundation for Innovation (2004)
 Ontario Innovation Trust (2004)

Computational biological projects concerning gene regulatory evolution, Severe Acute Respiratory Syndrome coronavirus evolution, viral chemotherapeutic applications in cancer growth and tumour metastasis, and theoretical morphology for echinoid skeletons were advanced.

FIGURE: Computer-simulated sundial snail shell observed from different orientations





Elizabeth A. Weretilnyk
Professor

Plant abiotic stress tolerance; Metabolomics; Environmental Genomics; Chemical Biology

Laboratory personnel

Ph.D. Students: David Guevara, Michael BeGora; *Undergraduate Students:* Katie Tchourliaeva, Jeff Dedrick;
Technical Assistants: Karen Haines, Chris Wang; *Undergraduate Lab Assistant:* Michelle Melone

Research collaborators

Christian Baron (McMaster University), Turlough Finan (McMaster University), G. Brian Golding (McMaster University), Peter Summers (McMaster University), J-P Xu (McMaster University), Brian McCarry (McMaster University), Trevor Charles (University of Waterloo), Marilyn Griffith (University of Waterloo), Barbara Moffatt (University of Waterloo)

Funding

Ontario Genomics Institute (2004)
Performance Plants (2003-2006)
NSERC/AAFC Industrial Partner Support Program (2001-2005)
Canola Council (2001-2003)
NSERC Discovery Grant (2001-2004)
Genomic analysis of soil microorganisms (2003-2006)
Genome Canada (2003-2007)
ORDCF (2003-2008)

The molecular basis underlying environmental stress tolerance traits in plants is complex and so our current understanding of how plants survive (and even thrive) in adverse environments is very incomplete. My program is directed towards identifying environmental stress tolerance traits in plants using physiological, biochemical, metabolomic and genomic approaches. We are also using metabolomics approaches to help identify functions of uncharacterized gene products in plants and bacteria.

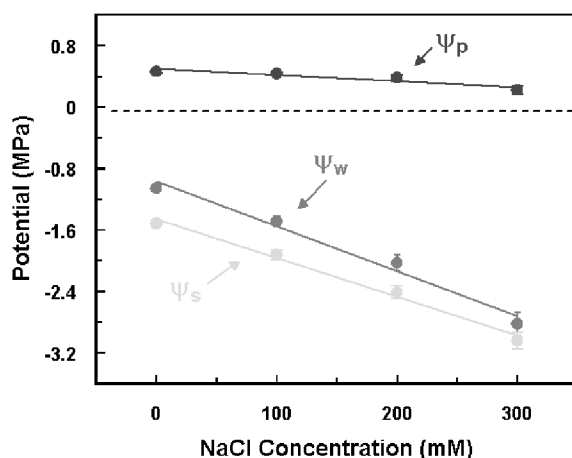
We have focused on two research objectives: 1) to examine the synthesis and accumulation of the compatible solute glycine betaine by plants subjected to osmotic stress. Our biochemical model has been spinach, a glycine-betaine accumulating plant. 2) In collaboration with G.B. Golding and B. McCarry (Chemistry, McMaster) and M. Griffith and B.A. Moffatt (both in Biology at Waterloo), we are studying a highly stress tolerant native plant, *Thellungiella salsuginea*. This plant is a member of the Cruciferae family and is closely related to *Arabidopsis thaliana*, the genetic model plant whose genome has been completely sequenced, and canola (*Brassica napus* and *B. rapa*) which is Canada's most important oilseed crop. A limitation to using *Arabidopsis* to identify traits associated with environmental stress is that this plant has very little capacity to withstand cold, drought or saline conditions. By contrast, *Thellungiella* endures freezing temperatures, semiarid conditions and grows on saline and alkaline soils of the Yukon. We have been able to use and benefit greatly from the abundant genetic resources developed for research on *Arabidopsis* for our studies of stress tolerance in its extremophile relative.

Choline serves as a precursor for glycine betaine in all multicellular plants studied to date. Despite the ubiquitous nature of choline, not all of the genes encoding enzymes responsible for its synthesis have been identified from plants (or non-plants). We are using functional complementation of a choline-requiring yeast mutant to clone

genes involved in choline metabolism. By transforming the mutant with plasmids from an *Arabidopsis* cDNA library constructed in a yeast expression vector, we can identify cDNAs that “rescue” the yeast mutant by conferring the capacity for it to grow in the absence of added choline. At least two enzymes are S-adenosylmethionine-dependent methyltransferases and kinetic analyses of one such enzyme is underway. Comparisons of the biochemical properties of these enzymes can identify how their activities contribute to plant growth under non-stress conditions and whether changes in their properties are required to accommodate glycine betaine accumulation under stress. (Michael BeGora, Katie Tchourliaeva and Michelle Melone)

We have analyzed the physiological response of *Thellungiella* to increasing salinity, to drought imposed by withholding water and during recovery of the plant when watering is resumed following drought. As it is impossible to replicate field conditions in growth cabinets, we have supplemented our comparisons with physiological measurements taken from plants growing in field sites in the Yukon. In all cases, plant tissues were harvested and RNA extracted to generate cDNA libraries (under the direction of our collaborators at Waterloo) and an EST database has been created by Brett Whitty (M.Sc. student, GB Golding, supervisor). In our lab, metabolome profiles of well-watered and stressed plants have been obtained by gas chromatography/mass spectrometry and are being analyzed to identify metabolic phenotypes associated with stress tolerance. Information from these profiles will complement and add value to the information arising from our ongoing physiological and genomics studies with this plant. By all criteria, the physiological data indicates that *Thellungiella* is extremely drought and salt tolerant and we believe that this plant is as an excellent physiological and genetic model for future studies in plant tolerance to environmental stress. (Dave Guevara, Jeff Dedrick and Karen Haines)

Together with Peter Summers (McMaster), we are applying metabolomics approaches to identify the biological roles of genes encoding products of unknown function. The model organism under study is *Sinorhizobium meliloti*. We have extracted polar metabolites from bacteria cells and generated comprehensive metabolite profiles by gas chromatography/mass spectrometry. This has required the development of the necessary bioinformatics tools to process and interpret the large volumes of data generated. We have helped design and test the software program “GASP” developed by Paolo Nuin (PDE, G.B. Golding, supervisor). GASP aligns comparable peaks from successive chromatography runs and allows the user to statistically analyze and display experimental results. The bioinformatics skills and data made available by this project will be readily applicable to metabolomic studies of virtually any organism from bacteria to man. (K. Haines, Dave Guevara, Katie Tchourliaeva and C. Wang)



Water potential, Ψ_w solute potential, Ψ_s and turgor potential, Ψ_p for *Thellungiella* salinized gradually by increasing the NaCl content of the irrigating medium by 50 mM every three days to final concentrations of 100, 200 or 300 mM NaCl. Values are means \pm SE; $n=6$. The positive turgor despite decreasing Ψ_w is evidence of osmotic adjustment.



Well-watered Controls and *T. salsuginea* exposed to 300mM NaCl are similar in size and leaf number and undergo flowering as shown in panel B. By comparison, *Arabidopsis thaliana* cannot survive exposure to salt levels in excess of 75 to 100 mM.



Christopher M. Wood

Professor

Canada Research Chair in Environment and Health

The Physiology of Transport Processes
and Metabolism, and the Aquatic Toxicology
of Metals in Fish and Crustaceans

Laboratory Personnel

Post-doctoral Fellows: Dr. Patty Gillis, Dr. Natasha Franklin, Dr. Richard Smith, Dr. Fernando Galvez, Dr. Makiko Kajimura (joint with Dr. Grant McClelland); *Ph.D. Student:* Eric Pane; *M.Sc. Students:* Carol Bucking, Lara Alves, Adeola Ojo, Sunita Nadella; *Technicians:* Linda Diao, Monika Patel

Research Collaborators

Dr. Grant McClelland (McMaster University), Dr. Pat Chow-Fraser (McMaster University), Dr. Pierre Laurent (McMaster University), Dr. George Heigenhauser (McMaster University), Dr. Russell Bell (McMaster University), Dr. Jim Kramer (McMaster University), Dr. Martin Grosell (University of Miami), Dr. Pat Walsh (University of Miami), Dr. Yuxiang Wang (Queens University), Dr. Colin Brauner (University of British Columbia), Dr. Kath Sloman (Plymouth University, UK), Dr. Bernardo Baldisserotto (Brazil), Dr. Adalto Bianchini (Brazil), Dr. Adalberto LuisVal (Brazil), Dr. Sue Clearwater (NIWA, New Zealand), Dr. Jim McGeer (Natural Resources Canada), Dr. Greg Pyle (Nipissing University), Dr. Ora Johannsson (DFO, Burlington)

Funding

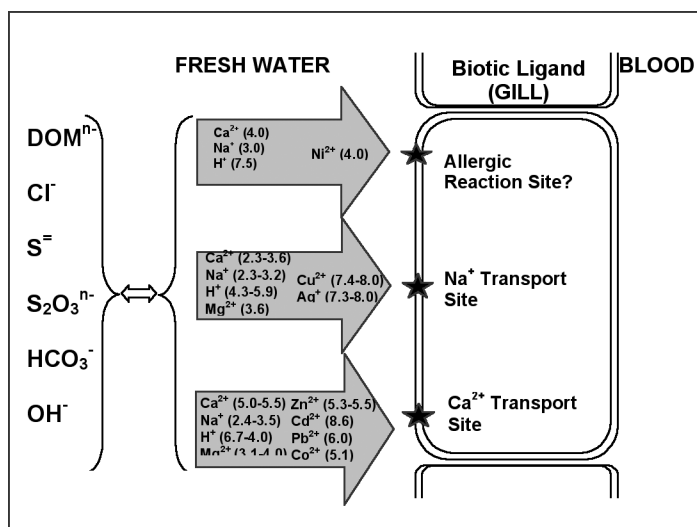
Natural Sciences and Engineering Research Council Discovery Grant (2002-2007)
Natural Sciences and Engineering Research Council, Collaborative Research and Development Grant (2005-2009)
International Copper Association (2005-2009)
Copper Development Association (2005-2009)
Nickel Producers Environmental Research Association (2005-2009)
International Lead-Zinc Research Organization (2005-2009)
Noranda-Falconbridge (2005-2009)
Teck Cominco (2005-2009)
Inco (2005-2009)
International Copper Association Human Health Program Grant (2004-2005)
Natural Sciences and Engineering Research Council Metals in the Human
Environment Research Network Grant (2005-2009)
Canada Research Chair Program (2001-2008)

Our lab studies the basic mechanisms by which ions, nutrients, respiratory gases, metabolic wastes, and acid-base equivalents are transported across environmental and internal surfaces in fish and crustaceans, and how these processes are impacted by environmental stressors. In our applied research program, the stressors of interest are waterborne and dietary metals, and our goal is to use data on physiological responses to develop models that can be used to generate more protective and cost-effective environmental regulations for metals. While our starting point is always basic mechanistic physiology, we use tools of molecular biology, proteomics, cell biology, organismic physiology, behavioral analysis, field studies, geochemistry, and modeling to address these questions.

A selection of ongoing projects in the laboratory is listed below:

- (i) The role of the gastrointestinal system in ion and acid-base regulation in freshwater and marine fish
- (ii) The mechanisms by which dietary metals (Cu, Zn, Ni, Cd, Pb, & Ag) are transported by the gastrointestinal tracts of freshwater fish, and the protective actions of naturally occurring cations (Ca, Na)
- (iii) Urea transport, aquaporin function, cocoon function and protein metabolism in aestivating lungfish
- (iv) Ion and metal transport by reconstructed gill epithelia in primary culture in vivo
- (v) The impact of feeding on urea metabolism in ureo-osmotic elasmobranchs
- (vi) The impact of chronic waterborne and dietary metal exposure on behavioral responses to intraspecific chemical signals in fish
- (vii) The impact of environmental hypoxia on ion transport processes in the freshwater fish gill
- (viii) Metal uptake and depuration in daphnia and chironomids
- (ix) Proteomic and molecular analysis of ionoregulatory proteins in the fish gill
- (x) Analysis of the mechanism(s) by which natural organic matter (“NOM, DOC”) alters the electrical and ion transporting properties of fish and daphnia gills, and its relationship to NOM composition.
- (xi) Development of “Biotic Ligand Models” to predict water quality criteria that are protective against acute and chronic metal toxicity to a range of different fish and invertebrate species. Fig. 1 below illustrates one such model.

FIGURE: A Biotic Ligand Model showing the binding strengths (log K values) of various metals to the physiological sites of toxicity in the gills of freshwater rainbow trout (*Oncorhynchus mykiss*). Log K values for competitive, protective binding by certain naturally occurring cations are also shown.





J. P. Xu
Assistant Professor

Molecular Ecology and Evolutionary Genetics of Microorganisms

Laboratory personnel

Ph.D. Students: Zhun Yan, Sheng Sun, *M.Sc. Students:* Roven Tey, Xiaoyu (Susan) Han;
Undergraduate Students: Megan Szak, Lisa Lan, David Sanford; *Research Associate:* Hong Guo

Research Collaborators

Dr. T. M. Finan (McMaster University), Dr. G. B. Golding (McMaster University), Dr. Elizabeth Weretilnyk (McMaster University), Dr. B. McCarry (McMaster University), Dr. V. Chaturvedi (New York State Department of Health), Dr. J. Kronstad (University of British Columbia)

Funding

Natural Sciences and Engineering Research Council, Discovery (2001-2005)
Genome Canada (2003-2006)
Premier Research Excellence Award (2002-2007)

The focus of our research is to understand the origins and maintenance of genetic variation in microorganisms, with a special emphasis on fungi. To achieve these goals, we examine microbial populations from the environment, clinics, and laboratory to address a variety of questions, including the rate and effect of spontaneous mutations on medically important traits; the spread of microbes in natural environments and human populations; and the origins of novel strains and species. Our research uses both molecular as well as microscopy and quantitative genetic tools.

The most notable discovery from our lab this year was the identification of a gene that controls mitochondrial inheritance. This was the first report of any gene controlling mitochondrial inheritance in any organism. This study was published in the journal *Current Biology*.

Our second most notable discovery was that spontaneous mutations show significant genotype-environment interactions and that the patterns of interactions could be used to analyze life history traits of microorganisms in nature - a previously considered intractable problem. This study was published in the journal *Genetics*.

We are close to completing the collaborative project with Dr. Jim Kronstad at UBC examining the origin and spread of a fungal pathogen causing recent outbreaks on Vancouver Island. Our analysis suggests multiple, recent global migrations.



Xu-Dong Zhu
Assistant Professor

Functional Analysis of DNA Repair Complexes at Human Telomeres

Laboratory personnel

Post-Doctoral Fellow: Yili Wu; *Ph.D. Student:* Yang Chen; *M.Sc. Student:* Shujie Xiao

Funding

Natural Sciences and Engineering Research Council, Discovery (2004-2009)

Natural Sciences and Engineering Research Council, Research tools (2004)

Canadian Institutes of Health Research (2004-2007)

Unlike circular chromosomes in bacteria, chromosomes in eukaryotes are linear and contain specialized protein-DNA complexes at their ends, called telomeres. The integrity of telomeres is a critical determinant for cell growth and viability. Mammalian telomeric DNA is composed of tandem TTAGGG repeats to which two small dimeric proteins TRF1 and TRF2 bind. While TRF1 is implicated in regulating telomere length, TRF2 functions primarily to protect telomeres from being recognized and processed as DNA double-strand breaks. The ability of TRF2 to protect telomeres is likely dependent on its interacting partners. A number of proteins have been shown to interact with TRF2, including the Mre11/Rad50/Nbs1 (MRN) complex and the ERCC1/XPF complex. The MRN complex is involved in double-strand break repair pathway and plays a central role in maintaining genome stability as mutations in MRE11 and NBS1 genes give rise to ataxia-telangiectasia-like disease (ATLD) and Nijmegen breakage syndrome (NBS), respectively. Both ATLD and NBS are cancer-prone diseases. On the other hand, the ERCC1/XPF complex plays an important role in nucleotide excision repair as patients carrying mutations in the XPF gene are sensitive to UV light and have late onset of skin cancer. Both MRN and ERCC/XPF complexes are associated with human telomeres and play a role in telomere maintenance. However, how these complexes contribute to telomere maintenance remains unknown. Elucidating the molecular mechanism underlying the functions of these two distinct DNA repair complexes in telomere biology is the research focus in my laboratory.



Kimberley Dej
Assistant Professor

Regulation of chromosome dynamics during mitosis and meiosis

Research collaborators

Ana Campos (McMaster University), André Bédard (McMaster University), Rama Singh (McMaster University), Terry Orr-Weaver (Whitehead Institute)

Cells reproduce by a highly coordinated process of cell division. The integrity of the genome is contingent upon the faithful replication of the DNA and the accurate segregation of the duplicated copies of the genome into the two daughter cells. I am studying the pathways that ensure that sister chromatids separate precisely at anaphase of mitosis. Separation too early or too late can lead to aneuploidy and chromosome breakage. Research has correlated the occurrence of aneuploidy with tumorigenesis.

During mitosis, the large genomic DNA molecules must be compacted so that they can be easily transported on the mitotic spindle. This requires the process of chromosome condensation. Condensation factors form an integral part of the mitotic chromosome, yet the mechanisms of condensation remain elusive. One important component appears to be the pentameric complex called the condensin complex. In all species studied, condensin proteins are associated with condensing chromosomes during mitosis and are involved in proper chromosome dynamics including the segregation of sister chromatids. My post-doctoral studies focussed on a genetic analysis of one subunit of the condensin complex in *Drosophila* called dCAP-G. These studies revealed dramatic defects in the resolution of sister chromatids and the segregation of chromatids at anaphase. Surprisingly, chromosome compaction was not altered dramatically, however, we found that chromosome condensation is disrupted when DNA replication is absent prior to mitosis.

Genetic analyses of the condensin complex have revealed in yeast and in *C. elegans* that the condensin complex has numerous varied functions during interphase. Our studies in *Drosophila* showed that dCAP-G and perhaps the entire complex is involved in the regulation of gene expression in heterochromatic regions of the genome. Currently, studies of dCAP-G are focused on its role in chromosome condensation and chromosome segregation in the meiotic cell divisions of the germ line cells in *Drosophila*. In addition, we have identified several other genes that are required for the separation of sister chromatids in both mitosis and meiosis, at least one of which interacts genetically with dCAP-G.



Peter Summers
Assistant Professor

Metabolism in Plants and Bacteria

Thanks to many genome sequencing projects, we know the exact number and the exact sequence of every open-reading-frame in many organisms. With a variable degree of confidence these sequences have been annotated with a biological function based on similarities to other sequences. However, to identify the exact function of the proteins coded by DNA, further genetical and biochemical-supporting evidence is often required. I work on the metabolism of carbohydrates, amino acids and secondary compounds. Jointly with other researchers at McMaster we are using biochemical techniques to understand the specific biological role of proteins in plants and bacteria whose functions are currently not fully known. Techniques used range from simple enzymatic assays up to gas chromatography/mass spectrometric analysis of whole extracts of metabolites from an organism. When the biochemical evidence is analyzed in conjunction with genetical and microarray data, we hope that we can add improved identities to the thousands of genes currently labelled as “unknown”, “hypothetical” or “putative”.

Retired Faculty Lecturers

Douglas Davidson

BIOL 1A03 Cellular & Molecular Biology

Dr. Davidson is a Professor Emeritus from the Department of Biology and continues to teach part of one of our largest courses, Biology 1A03.

Richard Morton

BIOL 3FF3 Evolution

Dr. Morton is a Professor Emeritus and continues to participate in teaching and research in the Department of Biology.

George Sorger

BIOL 3O03 Microbial Genetics

Dr. Sorger has recently joined the ranks of our Professors Emeritus. For information on Dr. Sorger's career at McMaster University, please see his article which is featured earlier in this report.

Sessional Lecturers

Linda Ellis

BIOL 1K03 Biology for the Humanities & Social Sciences, 3K03 Animal Histology

Dr. Ellis has been teaching for the Department of Biology since 2003/2004 and is on a contractually limited appointment (CLA).

David Galbraith

BIOL 4AA3 Conservation Biology

Dr. Galbraith is an Adjunct faculty member in the Department of Biology. For more information on his research interests and professional activities, please look under the Adjunct Faculty section of this report.

Jeff Hummel

BIOL 3I03 Eukaryotic Genetics

Dr. Hummel is a Post-Doctoral Fellow in the Department of Pathology and Molecular Medicine and occasionally teaches for the Department of Biology.

Nigel Waltho

BIOL 3TT3 Community Ecology

Dr. Waltho regularly teaches the Community Ecology course for the department on a contractually limited basis.

Adjunct Faculty

Gary Chiang

Professor

Department of Biology, Redeemer University College, Ancaster, ON, Canada

My research areas include (1) Endocrinology of growth and development in insects. Determining the effects of the topical application of juvenile hormone (JH) on metamorphosis and reproduction in the blood-feeding insect, *Rhodnius prolixus*. Documenting the spontaneous electrical activity of neurosecretory cells (NSCs) terminating in the aorta of *Rhodnius* to elucidate how these cells are involved in the endocrine regulation of growth and reproduction. (2) Integrating science and Christianity. Clarifying the role of religious presuppositions in the development of scientific theories. (3) Construction of a library resource that documents public opinion on scientific theories as found in original commentaries and newspaper articles that appeared during Darwinian England, a society that was heavily influenced by Christian ideology.

David A. Galbraith

Assistant Professor

Department of Research and Natural Lands, Royal Botanical Gardens, Hamilton, ON , Canada

I am interested in evolutionary and ecological consequences of the activities of our own species, and interactions among animal and plant species and communities and human populations. To date most of my research has been on the ecology, conservation biology and population biology of reptiles and plants. These groups have some important practical and theoretical constraints. Both plants and reptiles are relatively sedentary compared to mammals, birds, and even many insects, and both groups contain some members which are very long-lived. Both reptiles and plants have been systematically under represented in public perception of conservation priorities. Plants are often viewed either as a source of raw materials or as habitats for more interesting animals. Reptiles have suffered at best from benign ignorance and at worst from terror and fear. Both reptiles and plants offer opportunities to study the structuring of population genetic information at varying scales, especially as it relates to conservation issues. At present I am collaborating with Prof. Brad White at Trent University on the population genetics of endangered wood poppies (*Stylophorum diphyllum*), and am serving on the Amphibians and Reptiles specialist group of COSEWIC, the Committee on the Status of Endangered Wildlife in Canada.

Pierre Laurent

Professor

Department de Morphologie Fonctionnelle et ultrastructurale des Adaptations,
Center d'Ecologie et de Physiologie Energetique, CNRS, Strasbourg, France

As a cell biologist I have long been interested in the structure to function relationship in the fish gill in relation to environmental variables, particularly in euryhaline species. In the current project Chris Wood and I combined our complementary expertise and focussed on some cellular responses of ionic regulation during the rapid transfer of the estuarine killifish, *Fundulus heteroclitus*, from sea to fresh water. We are investigating the links between the populations of the different cell types present in the gill and functional changes in branchial ion transport machinery. Experiments combine a range of classical and modern morphological techniques, as well as cell turnover, apoptosis, molecular expression, and ion transport studies.

Gary Leppard

Professor

National Water Research Institute of Environment Canada, Aquatic Ecosystem Management Research Branch,
Burlington, ON Canada

Research Focus: Gary G. Leppard is an environmental biochemist and microbiologist who studies the roles of natural and engineered aquatic aggregates (flocs, biofilms) in the transport and fate of contaminants. In concert with these activities, he develops electron-optical means to analyze the colloidal structure of natural dispersing agents and the structure-activity relations of microbial consortia and their extracellular polymers, in both biofilms and flocs. Research interests extend into genomics, biogeochemistry, water treatment and materials science. Currently Dr. Leppard is focused on quantitative chemical and molecular architectural analyses of natural biofilms using synchrotron-based scanning transmission X-ray microscopy. He intends to expand his structure-activity examinations using technology transfer from genomics and novel technology from McMaster's new National Ultrahigh Resolution Electron Microscopy Facility.

Jim McGeer

Assistant Professor

Mining and Mineral Sciences laboratories, Natural Resources Canada, Ottawa, ON, Canada

Charles K. Minns

Associate Professor

Great Lakes Laboratory for Fisheries and Aquatic Sciences, Canada Center for Inland Waters,
Burlington, ON, Canada

James Pringle

Associate Professor

Royal Botanical Gardens, Hamilton, ON, Canada

My work focuses on systematics of the flowering plants, including naming and description of new species, revised classifications, improved identification guides, nomenclature, geographic distribution, and spread of invasive species. My research involves Gentianaceae of the Americas, *Syringa*, and the history and biography of natural history and field biology. I am also interested in nature interpretation, and teach the course in systematics of flowering plants in the Ontario Universities Program in Field Biology.

Harvey Shear

Assistant Professor

Regional Science Advisor, Environment Canada - Ontario region, Toronto, ON, Canada

My work involves eutrophication and hydrology of small lakes in Latin America; development and utilization of ecosystem health indicators.

Professors Emeriti/Retired Faculty

Stanley T. Bayley, Professor Emeritus

Douglas Davidson, Professor Emeritus/Adjunct (LSB-337)

Douglas M. Davies, Professor Emeritus

Allan D. Dingle, Associate Professor/Adjunct

Frank L. Graham, Professor Emeritus

Doris E.N. Jensen, Associate Professor/Retired

Kenneth A. Kershaw, Professor Emeritus

John Lott, Professor Emeritus (LSB-338)

Stanley Mak, Professor Emeritus

Richard A. Morton, Professor Emeritus/Adjunct (LSB-539)

B. Ann Oaks, Professor Emeritus

Ludvik A. Prevec, Professor Emeritus/Adjunct (ABB-124)

George J. Sorger, Professor Emeritus (LSB-336)

François Takahashi, Professor Emeritus

Stephen F.H. Threlkeld, Professor Emeritus

Jean E.M. Westermann, Professor Emeritus

Bradley N. White, Professor Emeritus

Publications

This section includes publications (peer-reviewed original articles, reviews, and book chapters) that have been published or are currently in press. Papers have been listed alphabetically based upon the first author. The names of lab PIs have been bolded.

- Baldisserotto, B., C. Kamunde, A. Matsuo, and **C.M. Wood**. (2004) Acute waterborne cadmium uptake in rainbow trout is reduced by dietary calcium carbonate. *Comp. Biochem. Physiol. C*. 137: 363-372.
- Baldisserotto, B., J.M. Chowdhury, and **C.M. Wood**. Effects of dietary calcium and cadmium on cadmium accumulation, calcium and cadmium uptake from the water, and their interactions in juvenile rainbow trout. *Aquatic Toxicology* (In press).
- Baldisserotto, B., C. Kamunde, A. Matsuo, and **C.M. Wood**. (2004). A protective effect of dietary calcium against acute waterborne cadmium uptake in rainbow trout. *Aquat. Toxicol.* 67: 57-73.
- Balsinger, S., C. Ragaz, **C. Baron**, and F. Narberhaus. (2004). Replicon-specific regulation of small heat shock genes in *Agrobacterium tumefaciens*. *J. Bacteriol.* 186: 6824-6829.
- Beaton, L.L. and **S. A. Dudley**. (2004). Tolerance to salinity and manganese in three common roadside species. *International Journal of Plant Science* 165: 37-51.
- Bianchini, A., R.C. Playle, **C.M. Wood**, and P.J. Walsh. Mechanism of acute silver toxicity in marine invertebrates. *Aquat. Toxicol.* (In press).
- Bijelic, G. and **M. J. O'Donnell**. Diuretic factors and second messengers stimulate secretion of the organic cation TEA by the Malpighian tubules of *Drosophila melanogaster* (In press).
- Broday, L., I. Kolotuev, C. Didier, A. Bhoumik, **B. P. Gupta**, P. W. Sternberg, B. Podbilewicz, and Z. Ronai. (2004). The small ubiquitin-like modifier (SUMO) is required for gonadal and uterine-vulval morphogenesis in *C. elegans*. *Genes Dev.* 18:2380-2391.
- Bucking, C.P. and **C.M. Wood**. Does urea reabsorption occur via the glucose pathway in the kidney of the freshwater rainbow trout? *Fish Physiol. and Biochem.* (In press).
- Bulmer, J.T., N. Zacal, and **A.J. Rainbow**. Persistent cisplatin-induced DNA damage in active genes activates the Jun N-terminal kinase and correlates with cisplatin sensitivity in human cells. *Cancer Chemotherapy and Pharmacology*. (In press).
- Buttigieg, J. and **C. A. Nurse**. (2004). Detection of hypoxia-evoked ATP release from chemoreceptor cells of the rat carotid body. *Biochem. Biophys. Res. Comm.* 322: 82-87.
- Butz, C. E., **G. B. McClelland**, and G. A. Brooks. (2004). MCT1 confirmed in rat striated muscle mitochondria. *J. Appl. Physiol.* 97: 1059-1066.
- Cameron, R. K.** and K. Zaton. Intercellular salicylic acid accumulation is important for Age-Related Resistance in Arabidopsis to Pseudomonas syringae. *Physiological and Molecular Plant Pathology*. (In press).
- Campanucci, V. A. and **C. A. Nurse**. Biophysical characterization of whole-cell currents in O2-sensitive neurons from the rat glossopharyngeal nerve. *Neuroscience*. (In press).
- Caney, C., G. Singh, H. Lukka, and **A.J. Rainbow**. (2004). Combined gamma-irradiation and subsequent cisplatin treatment in human squamous carcinoma cell lines sensitive and resistant to cisplatin. *Int. J. Radiation Biology* 80: 291-299.
- Chen, G. and **H.E. Schellhorn**. (2004). Positive selection for loss of RpoS function in Escherichia coli. *Mutation Research* 554: 193-203.
- Chowdhury, M.J., B. Baldisserotto, and **C.M. Wood**. Tissue-specific cadmium and metallothionein levels in rainbow trout chronically acclimated to waterbourne or dietary cadmium. *Arch. Env. Contam. Toxicol.* (In press).
- Chowdhury, M.J., D.G. McDonald, and **C.M. Wood**. (2004). Gastrointestinal uptake and fate of cadmium in rainbow trout acclimated to sublethal dietary cadmium. *Aquat. Toxicol.* 169: 149-163.
- Chowdhury, M.J., E.F. Pane, and **C.M. Wood**. (2004). Physiological effects of dietary cadmium acclimation and waterborne cadmium challenge in rainbow trout: Respiratory, ionoregulatory and stress parameters. *Comp. Biochem. Physiol. C*: 139:163-173.
- Chow-Fraser, P.** Development of the Wetland Water Quality Index to assess basin-wide land-use alteration in Great Lakes coastal wetlands. In *Coastal Wetlands of the Laurentian Great Lakes: Health, Habitat and Indicators*" Edited by T. P. Simon, P. M. Stewart, M. Munawar, and T. A. Edsall. (In press).
- Chow-Fraser, P.** Ecosystem response to changes in water level of Lake Ontario marshes: lessons from the restoration of Cootes Paradise Marsh. *Hydrobiologia*. (In press).

- Chow-Fraser, P.**, K. Kostuk, T. Seilheimer, M. Weimer, T. MacDougall, and T. Theysmeyer. Effect of wetland quality on sampling bias associated with two fish survey methods for coastal wetlands of the lower Great Lakes. In *Coastal Wetlands of the Laurentian Great Lakes: Health, Habitat and Indicators*. Edited by T. P. Simon, P. M. Stewart, M. Munawar, and T. A. Edsall. (In press).
- Civetta, A., and **R.S. Singh**. (2004). Rapid evolution of sex-related genes: Sexual conflict or sex-specific adaptations? In: *Selective Sweep*. Nurminsky, D. (ed.) pp. 13-21, Landes Bioscience, Georgetown, Texas.
- Dej, K. J.**, C. Ahn, and T. L. Orr-Weaver. (2004). Mutations in the Drosophila condensin subunit dCAP-G: defining the role of condensin for chromosome condensation in mitosis and gene expression in interphase. *Genetics* 168(2):895-906.
- Dudley, S. A.** (2004). Plasticity and the Functional Ecology of Plants. In *Phenotypic Plasticity: Functional and Conceptual Approaches*. Edited by T.J. DeWitt and S.M. Scheiner. Oxford University Press.
- Evans B. J.**, D. B. Kelley, D. J. Melnick, and D. C. Cannatella. Evolution of RAG-1 allopolyploid clawed frogs. *Molecular Biology and Evolution* (In press).
- Evans B. J.**, D. B. Kelley, R. C. Tinsley, D. J. Melnick, and D. C. Cannatella. (2004). Mitochondrial DNA phylogeny of clawed frogs: phylogeography and implications for polyploidy evolution. *Molecular Phylogenetics and Evolution* 33:197-213.
- Evans, B. J.**, D. C. Cannatella, and D. J. Melnick. (2004). Understanding the origins of areas of endemism in phylogeographic analyses: a reply to Bridle et al. *Evolution* 58:1397-1400.
- Fu, X. W., **C. A. Nurse**, and E. Cutz. (2004). Expression of functional purinergic receptors in pulmonary neuroepithelial bodies and their role in *hypoxia chemotransmission*. *Biol. Chem.* 385: 275-284.
- Fuller, M. M., T. N. Romanuk, and **J. Kolasa**. (2004). Community structure and metacommunity dynamics of aquatic invertebrates: a test of the neutral theory. E-print Archive (<http://arxiv.org/>)
- Gillis, P.L., P. Chow-Fraser, J.F. Ranville, P.E. Ross, and **C.M. Wood**. Daphnia need to be gut cleared too: The effect of exposure to and ingestion of metal-contaminated sediment on the gut clearance patterns of *D. magna*. *Aquat. Toxicol.* (In press).
- Glover, C., E.F. Pane, and **C.M. Wood**. Humic substances influence sodium metabolism in the freshwater crustacean *Daphnia magna*. *Physiol. Biochem. Zool.* (In press).
- Glover, C.N. and **C.M. Wood**. Physiological characterization of a pH- and calcium dependent sodium uptake mechanism in the freshwater crustacean, *Daphnia magna*. *J. Exp. Biol.* (In press).
- Glover, C.N. and **C.M. Wood**. Physiological interactions of silver and humic substances in *Daphnia magna*: effects on reproduction and silver accumulation following an acute silver challenge. *Comp. Biochem. Physiol. C.* (In press).
- Golding, G. B.** (2004). Population biology and bioinformatics. In *The Evolution of Population Biology*. Edited by R. S. Singh and M. K. Uyenoyama. Cambridge Univ. Press, New York.
- Gonzalez, R.J., R.W. Wilson, and **C.M. Wood** (2004). Ionoregulation in tropical fish from ion-poor, acidic blackwaters. In *The Physiology of Tropical Fish, Fish Physiology*, Vol. 22. Edited by A. L. Val, V. M. Almeida-Val, and D. J. Randall. Academic Press, San Diego, CA, U.S.A.
- Grosell, M., **C.M. Wood**, R.W. Wilson, N.R. Bury, C. Hogstrand, C. Rankin, F.B. Jensen. Active bicarbonate secretion plays a role in chloride and water absorption of the European flounder intestine. *American Journal of Physiol.* (In press).
- Grosell, M., M.D. McDonald, P.J. Walsh, and **C.M. Wood**. (2004). Effects of prolonged copper exposure on the marine gulf toadfish (*Opsanus beta*). I. Hydromineral balance and plasma nitrogenous waste products. *Aquat. Toxicol.* 68: 233-247.
- Grosell, M., M.D. McDonald, P.J. Walsh, and **C.M. Wood**. (2004). Effects of prolonged copper exposure on the marine gulf toadfish (*Opsanus beta*). II. Copper accumulation, drinking rate, and Na⁺/K⁺-ATPase activity. *Aquat. Toxicol.* 68: 249-262.
- Ha, H., F.L. Graham, C.K. D'Souza, W.J. Muller, S.A. Igdoura, and **H.E. Schellhorn**. 2004. Functional rescue of vitamin C synthesis deficiency in human cells using adenoviral-based expression of murine gulonogamma-lactone oxidase. *Genomics* 83: 482-92.

- Hao, W. and G. B. Golding. (2004). Patterns of bacterial gene movement. *Mol. Biol. Evol.* 21:1294-1307.
- Hassan J., B. Iyengar, N. Scantlebury, V. R. Rodriguez-Moncalvo, and A. R. Campos. (2004). The photic input pathways that mediate the *Drosophila* larval response to light and circadian rhythmicity are developmentally related but functionally distinct. *J. Comp Neurol.* 481: 266-275.
- Höppner, C., Z. Liu, N. Dom, A. N. Binns, and C. Baron. (2004). VirB1 orthologs from *Brucella suis* and pKM101 complement defects of the lytic transglycosylase required for efficient type IV secretion from *Agrobacterium tumefaciens*. *J. Bacteriol.* 186:1415-1422.
- Huntley, M. and G. B. Golding. (2004). Neurological Proteins are not enriched for repetitive sequences. *Genetics* 166: 1141-1154.
- Huntley, M., S. Mahmood, and G. B. Golding. (2004). Simple sequence in proteins. *Genome*. (In press).
- Ianowski, J. P. and M. J. O'Donnell. (2004). Na⁺ competes with K⁺ in bumetanide-sensitive transport by Malpighian tubules of *Rhodnius prolixus*. *J. Exp. Biol.* 207: 3707-3716.
- Ianowski, J.P. and M. J. O'Donnell. (2004). Basolateral ion transport mechanisms during fluid secretion by *Drosophila* Malpighian tubules: Na⁺ recycling, Na⁺:K⁺:2Cl⁻ cotransport and Cl⁻ conductance. *J. Exp. Biol.* 207, 2599-2609.
- Jessica C. L., I. Ockenden, M. Truax, and J. N. A. Lott. (2004). Phytic acid – phosphorus and other nutritionally important mineral nutrient elements in grains of wild-type and low phytic acid (lpa1-1) rice. *Seed Science Research* 14: 109-116.
- Jonz, M. and C. A. Nurse. Fishing for O₂-chemoreceptors in vertebrates. *Physiological News*, J. Physiol. Soc. (invited contribution; In press).
- Jonz, M. G., I. M. Fearon, and C. A. Nurse. (2004). Neuroepithelial oxygen chemoreceptors of the zebrafish gill. *J. Physiol. Lond.* 560: 737-752.
- Kajimura, M., S.J. Croke, C.N. Glover, and C.M. Wood. (2004). The effect of feeding and fasting on the excretion of ammonia, urea, and other nitrogenous waste products in rainbow trout. *J. Exp. Biol.* 207: 1993-2002.
- Kamunde, C., and C.M. Wood. (2004). Environmental chemistry, physiological homeostasis, toxicology, and environmental regulation of copper, an essential element in freshwater fish. *Austr. J. Ecotoxicol.* 10: 1-20.
- Kamunde, K., S. Niyogi, and C.M. Wood. Interaction of dietary sodium chloride and waterborne copper in rainbow trout: sodium and chloride homeostasis, copper homeostasis, and chronic copper toxicity. *Can J. Fish. Aquat. Sci.* (In press).
- Kelly K. F., A. A. Otchere, M. Graham, and J. M. Daniel. (2004). Nuclear Import of the BTB/POZ Transcriptional Regulator Kaiso. *J. Cell Sci.* 117: 6143-6152.
- Kelly K. F., C. M. Spring, A. A. Otchere, and J. M. Daniel. (2004). NLS-dependent nuclear localization of p120^{cas} is necessary to relieve Kaiso-mediated transcriptional repression. *J. Cell Sci.* 117: 2675-2686.
- Kelton, N. and P. Chow-Fraser. A simplified assessment of factors controlling phosphorus loading from oxygenated sediments in a very shallow eutrophic lake. *Lakes and Reservoir Management*. (In press).
- Kelton, N., P. Chow-Fraser, and I. Jordan. (2004). Relationship between sediment phosphorus release rates and characteristics of the benthic microbial community in a hypereutrophic marsh. *J. Aquat. Ecosyst. Health and Management*. 7: 31-41.
- Kim S. W., J. I. Park, C. M. Spring, A. K. Sater, H. Ji, A. A. Otchere, J. M. Daniel, and P. D. McCrea. (2004). Non-Canonical Wnt signals are modulated by the Kaiso transcriptional repressor and p120-catenin. *Nat. Cell Biol.* 6: 1212-20.
- Kjoss, V.A., C.N. Kamunde, S. Niyogi, M. Grosell, and C.M. Wood. Dietary Na does not reduce dietary Cu uptake by juvenile rainbow trout. *J. Fish Biol.* (In press).
- Kolasa J. and S. Pickett. (2005). *Changing academic perspectives of ecology – a view from within*. In *Environmental Education or Advocacy: Perspectives of Ecology & Education in Environmental Education*. Edited by M. Mappin and E. Johnson. Cambridge University Press.
- Kolasa, J. and T.N. Romanuk. *Assembly of unequals in the unequal world of a rock pool metacommunity*. In *Metacommunities: spatial dynamics and ecological communities*. Edited by M. Holyoak, M. A. Leibold and R. D. Holt. University of Chicago Press. (In press).

- Kolasa, J. Complexity, system integration, and susceptibility to change: biodiversity connection. *Ecological Complexity*. (In press).
- Kulathinal, R.J. and R.S. Singh. (2004). The nature of genetic variation in sex and reproduction-related genes among sibling species of the *Drosophila melanogaster* complex. *Genetica* 120: 245-252.
- Lee, D., R. Drouin, P. Pitsikas, and A.J. Rainbow. (2004). Detection of an involvement of the human mismatch repair proteins hMLH1 and hMSH2 in nucleotide excision repair is dependent on UVC fluence to cells. *Cancer Research*, 64: 3865-3870.
- Lee, J. Y., K. J. Dej, J. M. Lopez, and T. L. Orr-Weaver. (2004). Control of centromere localization of the MEI-S332 cohesion protection protein. *Curr. Biol.* 14(14):1277-83.
- Lemon J.A., D. R. Boreham, and C. D. Rollo. 2003. A dietary supplement abolishes age-related cognitive decline in transgenic mice expressing elevated free radical processes. *Expt. Biol.Med.* 228(7): 800-810.
- Lemon J.A., D. R. Boreham, and C. D. Rollo. A complex dietary supplement extends longevity of mice. *J. Gerontology*. (In press).
- Lin, L., I. Ockenden, and J. N. A. Lott. (2004). The concentrations and distribution of phytic acid-phosphorus and other mineral nutrients in wild-type and low phytic acid1-1 (*lpa1-1*) corn (*Zea mays* L.) grains and grain parts. *Canadian Journal of Botany*.
- Liu, L. and A.J. Rainbow. (2005). Pre-UV-treatment of cells results in enhanced host cell reactivation of a UV damaged reporter gene in CHO-AA8 Chinese hamster ovary cells but not in transcription-coupled repair deficient CHO-UV61 cells. *Somatic Cell and Molecular Genetics*. (In press).
- Lougheed, V.L., T. Theysmeijer, T. Smith, and P. Chow-Fraser. (2004). Carp exclusion, food-web interactions, and the restoration of Cootes Paradise Marsh. *J. Great Lakes Res.* 30 (1): 44-57.
- Ludwig, F., D. M. Rosenthal, J. A. Johnston, N. Kane, B. L. Gross, C. Lexer, S. A. Dudley, L. H. Rieseberg, and L. A. Donovan. (2004). Selection on leaf ecophysiological traits in a desert hybrid *Helianthus* species and early generation hybrids. *Evolution* 58: 2682-2692.
- MacLellan S., L. Smallbone, C. Sibley, and T. M. Finan. (2004). The expression of a novel antisense gene mediates incompatibility within the large repABC-family of α -proteobacterial plasmids. *Molecular Microbiology* 55:611-623.
- MacLellan, S., C. D. Sibley, and T. M. Finan. (2004). Second Chromosomes and Megaplastids in Bacteria. In *Plasmid Biology*, Edited by B. E. Funnell, and G.J. Phillips, ASM Press, Washington, D.C.
- Mann, R., M. Grosell, A. Bianchini, and C.M. Wood. (2004). Biologically incorporated dietary silver has no ionoregulatory effects in American red crayfish (*Procambarus clarkii*). *Env. Toxicol. Chem.* 23: 388-395.
- Mann, R.M., M.J. Ernste, R.A. Bell, J.R. Kramer, and C.M. Wood. (2004). Evaluation of the protective effect of reactive sulfide on the acute toxicity of silver to rainbow trout (*Oncorhynchus mykiss*). *Environ. Toxicol. Chem.* 23:1204-1210.
- Matsuo, A.Y.O., R.C. Playle, A.L. Val, and C.M. Wood. (2004). Physiological action of dissolved organic matter in rainbow trout in the presence and absence of copper: sodium uptake kinetics and unidirectional flux rates in hard and soft water. *Aquat. Toxicol.* 70: 63-81.
- McClelland, G. B. (2004). Fat to the fire: the regulation of lipid oxidation with exercise and environmental stress. *Comp. Biochem. Physiol.* 139(3):443-460.
- McClelland, G. B., A. Dalziel, N. Fragoso, and C. D. Moyes. Effects of oxidative and temperature stress on mitochondrial gene expression in fish muscle. *J. Exp. Biol.* (In press).
- McClelland, G. B., D. Michaud, C. Kraft, J. C. Russell, C. R. Mueller, and C. D. Moyes. (2004). Leptin and the control of respiratory gene expression in muscle. *Biochem. Biophys. Acta.* 1688:86-93.
- McDonald, M.D., and C.M. Wood. (2004). Evidence for facilitated diffusion of urea across gill basolateral membranes of the rainbow trout (*Oncorhynchus mykiss*). *BBA-Biomembranes* 1663: 89-96.
- McDonald, M.D., and C.M. Wood. (2004). The effect of chronic elevations in cortisol on urea metabolism and excretion in the rainbow trout (*Oncorhynchus mykiss*). *J. Comp. Physiol. B.* 174: 71-81.
- McDonald, M.D., C.M. Wood, M. Grosell, P.J. Walsh. (2004). Glucocorticoid receptors are involved in the regulation of pulsatile urea excretion in toadfish. *J. Comp. Physiol. B.* 174:649-658.
- Morgan, T.P., and C.M. Wood. (2004). A relationship between gill silver accumulation and acute silver toxicity in the freshwater rainbow trout: support for the acute silver Biotic Ligand Model. *Environ. Toxicol. Chem.* 23: 1261-1267.

- Morgan, T.P., C.M. Guadagnolo, M. Grosell, and C.M. Wood. Effects of water hardness on toxicological responses to chronic waterborne silver exposure in early life stages of rainbow trout (*Oncorhynchus mykiss*). *Environ. Toxicol. Chem.* (In press).
- Morgan, T.P., M. Grosell, K.M. Gilmour, R.C. Playle, and C.M. Wood. (2004). Time course analysis of the mechanism by which silver inhibits active Na⁺ and Cl⁻ uptake in the gills of rainbow trout. *Am. J. Physiol.* 287: R234-R242.
- Morgan, T.P., M.G. Grosell, R.C. Playle, and C.M. Wood. (2004). The time course of silver accumulation in rainbow trout during static exposure to silver nitrate: physiological regulation or an artifact of the exposure conditions? *Aquatic Toxicol.* 66: 55-72.
- Morton, R.A., M. Chouldhary, M.-L.Cariou, and R.S. Singh. (2004). A reanalysis of allozyme variation in *Drosophila melanogaster*, *D. simulans*, *D. mauritiana* and *D. sechellia*: Effects of population size and selection. *Genetica* 120: 101-114.
- Nakhmchik, A., Z. Zhao, N. J. Provart, S.-H. Shiu, S. K. Keatley, R. K. Cameron, and D. R. Goring. A Comprehensive Expression Analysis of the Arabidopsis Proline-rich Extensin-like Receptor Kinase Gene Family using Bioinformatic and Experimental Approaches. *Plant and Cell Physiology*. (In press).
- Niyogi, S. and C.M. Wood. (2004). The Biotic Ligand Model, a flexible tool for developing site-specific water quality guidelines for metals. *Environ. Sci. Technol.* 38:6177-6192.
- Niyogi, S., and C.M. Wood. (2004). Kinetic analyses of waterborne calcium and cadmium transport and their interactions in the gills of rainbow trout (*Oncorhynchus mykiss*) and yellow perch (*Perca flavescens*), two fish species differing greatly in acute cadmium sensitivity. *J. Comp. Physiol. B.* 174: 243-253.
- Niyogi, S., P. Couture, G. Pyle, D.G. McDonald, and C.M. Wood. (2004). An evaluation of cadmium and calcium gill-binding characteristics in laboratory reared and metal-impacted wild yellow perch (*Perca flavescens*) in comparison to rainbow trout (*Oncorhynchus mykiss*): implications for the Biotic Ligand Model (BLM). *Can. J. Fish. Aqu. Sci.* 61:942-953.
- O'Donnell, M. J. and M. R. Rheault. (2004). Ion-selective microelectrode analysis of salicylate transport by the Malpighian tubules and gut of *Drosophila melanogaster*. *J. Exp. Biol.* 208, 93-104.
- Ockenden, I., J. A. Dorsch, M. M. Reid, L. Lin, L. K. Grant, V. Raboy, and J. N. A. Lott. (2004). Characterization of the storage of phosphorus, inositol phosphate and cations in grain tissues of four barley (*Hordeum vulgare* L.) low phytic acid genotypes. *Plant Science* 167: 1131-1142.
- Pane, E.F., A. Haque, and C.M. Wood. (2004). Mechanistic analysis of acute, Ni-induced respiratory toxicity in the rainbow trout (*Oncorhynchus mykiss*): an exclusively branchial phenomenon. *Aquat. Toxicol.* Vol. 69 Issue 1 Pg 11-24s.
- Pane, E.F., A. Haque, G.G. Goss, and C.M. Wood. (2004). The physiological consequences of exposure to chronic, sublethal waterborne nickel rainbow trout (*Oncorhynchus mykiss*): exercise versus resting physiology. *J. Exp. Biol.* 207: 1249-1261.
- Pane, E.F., C. Bucking, M. Patel, and C.M. Wood. Renal function in the freshwater rainbow trout (*Oncorhynchus mykiss*) following acute and prolonged exposure to waterborne nickel. *Aquat. Toxicol.* (In press).
- Pane, E.F., J.C. McGeer, and C.M. Wood. (2004). The effects of chronic waterborne nickel exposure on two successive generations of *Daphnia magna*. *Environ. Toxicol. Chem.* 23: 1051-1056.
- Patten, C.L., M.G. Kirchhof, R.A. Morton, and H.E. Schellhorn. Microarray analysis of RpoS-mediated gene expression in *Escherichia coli* K-12. *Molecular Genomics and Genetics*. (In press).
- Perreault, M.L., C.D. Rollo. 2004. Gender-specific impacts of photoperiod and growth hormone transgenesis in mice. *Canadian J. Zoology* 82: 950-965.
- Quinn, J. S. and C. M. Somers. (2004). Particulate air pollution and inheritable mutations in mice: possible health effects? *Discovery Medicine* 4: 139-143.
- Rainbow, A.J. P. Pitsikas, C. Caney, I. Boszko, B. C. McKay, and M. A. Francis. Reactivation of UV-damaged viruses and reporter genes in mammalian cells. In *DNA photolesions to mutations, skin cancer and cell death*. Regen Drouin, Evelene Sage and Mahmoud Roubhia (Volume Eds.) Donat-P. Hader, Giulio Jori (Series Eds.). Comprehensive Series in Photosciences. Amsterdam: Elsevier Science. (In press).

- Rheault, M. R. and **M. J. O'Donnell**. (2004). Organic cation transport by Malpighian tubules of *Drosophila*: Application of two novel electrophysiological methods. *J. Exp. Biol.* 207, 2173-2184.
- Richards, J.G., A. Bonen, G.F. Heigenhauser, and **C.M. Wood**. (2004). Palmitate movement across red and white muscle membranes of rainbow trout. *Am. J. Physiol. R.* 286: R46-R53.
- Rintamäki, P. T., **J. Stone**, and A. Lundberg. (2003). Seasonal and diurnal body mass fluctuations for two nonhoarding species of *Parus* modeled using path analysis. *Auk* 120:658-668.
- Rodova M., K. F. Kelly, M. VanSaun, **J. M. Daniel**, and M. J. Werle. (2004). Regulation of the Rapsyn promoter by Kaiso and β -catenin. *Mol. Cell. Biol.* 24: 7188-7196.
- Rogers, J.T., and **C.M. Wood**. (2004). Characterization of branchial lead-calcium interactions in the freshwater rainbow trout. *J. Exp. Biol.* 207: 813-825.
- Rollo, C. D.**, M. Lai, K. Whitehead, M. L. Perreault, J. A. Lemon, and A. Chaudhry. (2004). Thermoregulation of transgenic growth hormone mice. *Canadian J. Zoology* 82: 934-949.
- Rollo, C.D.** Review of "Phenotypic integration: Studying the ecology and evolution of complex phenotypes." by M. Pigliucci and K. Preston (eds.). *Oxford University Press. Quart. Rev. Biol.* (In press).
- Romanuk, T. N. and **J. Kolasa**. Resource limitation, biodiversity, and competitive effects interact to determine the invasibility of rock pool microcosms. *Biological Invasions*. (In press).
- Scott, G.R., J.T. Rogers, J.G. Richards, **C.M. Wood**, and P.M. Schulte. (2004). Intraspecific divergence of ionoregulatory physiology in the euryhaline teleost *Fundulus heteroclitus*: possible mechanisms of freshwater adaptation. *J. Exp. Biol.* 207: 3399-3410.
- Shen, X-Y., N. J. Zacal, G. Singh, and **A.J. Rainbow**. Alterations in mitochondrial and apoptosis regulating gene expression in photodynamic therapy resistant variants of HT29 colon carcinoma cells. *Photochem. Photobiol.* (In press).
- Singh, R.S.** and M. Uyenoyama (Ed). 2004. The Evolution of Population Biology: Beyond The Modern Synthesis. Cambridge University Press, New York.
- Singh, R.S.** and R. Morton. (2004). Beyond Beanbag Genetics: Wright's Adaptive Landscape, Gene Interaction Networks and the Evolution of New Genetic Systems. In *The Evolution of Population Biology: Beyond The Modern Synthesis. Edited by R.S. Singh and M. Uyenoyama*. Cambridge University Press, New York.
- Singh, R.S.** and R.J. Kulathinal. Male sex-drive and masculinization of the genome. *BioEssays*. (In press).
- Slooman, K.A., G.R. Scott, D.G. McDonald, and **C.M. Wood**. (2004). Diminished social status affects ionoregulation at the gills and kidney in the rainbow trout, *Oncorhynchus mykiss*. *Can. J. Fish. Aquat. Sci.* 61: 618-626.
- Slooman, K.A., O. Lepage, J.T. Rogers, **C.M. Wood**, and S. Winberg. Socially-mediated differences in brain monoamines in rainbow trout: effect of trace metal contaminants. *Aquat. Toxicol.* (In press).
- Somers, C. M., B. E. McCarry, F. Malek, and **J. S. Quinn**. (2004). Reduction of particulate air pollution lowers the risk of heritable mutations in mice. *Science* 304: 1008-1010.
- Spring C. M., K. F. Kelly, I. O'Kelly, M. Graham, H. C. Crawford, and **J. M. Daniel**. The catenin p120ctn inhibits Kaiso-mediated Transcriptional Repression of the β -catenin/TCF target gene matrixin. *Exp. Cell Res.* (In press).
- Srivastava, D. and **J. Kolasa**. (2004). Are natural microcosms useful model systems for ecology? Trends in *Ecology and Evolution* 19(7):379-384.
- Stone J. R.** and B. K. Hall. 2003. Software development: computer simulated neural crest cell migration. *Integrative and Comparative Biology* 42:1319.
- Stone, J. R.** (2003). Mapping cladograms into morphospaces. *Acta Zoologica* 83:64-68.
- Stone, J. R.** (2003). Probabilities for completely pectinate and symmetric cladograms. *Cladistics* 19:565-566.
- Stone, J. R.** (2004). Nonoptimal shell forms as overlapping points in theoretical and functional morphospaces. *American Malacological Bulletin* 18:123-128.
- Stone, J. R.** and Brian K. Hall. (2004). Latent homologues for the neural crest as an evolutionary novelty. *Evolution & Development* 6:123-129.
- Suzuki, H., Y. Xia, **R. K. Cameron**, G. Chadle, J. Blount, C. Lamb, and R. Dixon. (2004). Signals for local and systemic responses of plants to pathogen attack. *J. Experimental Botany* 55 (395): 169-179.

- Torgerson, D.G., and **R.S. Singh**. (2004). Rapid evolution through gene duplication and subfunctionalization of the testes-specific proteasome subunits in *Drosophila*. *Genetics* 168: 1421-1432.
- Vehrencamp, S. L., and **J. S. Quinn**. (2004). *Joint laying systems*. In *Ecology and Evolution of Cooperative Breeding in Birds*. Edited by W.D. Koenig and J.L. Dickinson. Cambridge University Press.
- Vijayakumar, S.R., C.L. Patten, M.G. Kirchhof, and **H.E. Schellhorn**. (2004). Identification of RpoS regulated genes in *Escherichia coli*. *Journal of Bacteriology*. 186(24): 8499-507.
- Walsh, P.J., Z. Wei, **C.M. Wood**, A.M. Loong, K.C. Hiong, S.M.L. Lee, W.P. Wong, S.F. Chew, and Y.K. Ip. (2004). Nitrogen metabolism and excretion in the *Allenbatrachus grunniens* (L): effects of variable salinity, confinement, high pH and ammonia loading. *J. Fish Biol.* 65: 1392-1411.
- Wei, A. and **P. Chow-Fraser**. Untangling the confounding effects of urbanization and high water level on the cover of emergent vegetation in Cootes Paradise Marsh, a degraded coastal wetland of Lake Ontario. *Hydrobiologia*. (In press).
- Wei, A., **P. Chow-Fraser**, and D. Albert. (2004). Influence of shoreline features on fish distribution in the Laurentian Great Lakes. *Can. J. Fish. Aquat. Sci.* 61: 1113-1123.
- Wilson, P.J., **C.M. Wood**, P.J. Walsh, A.L. Bergman, H.L. Bergman, P. Laurent, and B.N. White. (2004). Discordance between genetic structure and morphological, ecological, and physiological adaptation in Lake Magadi tilapia. *Physiol. Biochem. Zool.* 77: 537-555.
- Wood, C.M.** (2004). Is exogenous ammonia a growth stimulant in fish? *J. Exp. Biol.* 207: 2043-2054.
- Wood, C.M.**, M.D. McDonald, P. Walker, M. Grosell, J.F. Barimo, R.C. Playle, P.J. Walsh. (2004). Bioavailability of silver and its relationship to ionoregulation and silver speciation across a range of salinities in the gulf toadfish (*Opsanus beta*). *Aquatic Toxicology* 70:137-157.
- Wood, C.M.**, P.J. Walsh, S.F. Chew, and Y.K. Ip. Ammonia tolerance in the slender lungfish (*Protopterus dolloi*); the importance of environmental acidification. *Can. J. Zool.* (In press).
- Xu, J.** (2004). Genotype-environment interactions of spontaneous mutations affecting vegetative fitness in the human pathogenic fungus *Cryptococcus neoformans*. *Genetics* 168:1177-1188.
- Xu, J.** (2004). The prevalence and evolution of sex in microorganisms. *Genome* 47:775-780.
- Yan, Z., C. M. Hull, J. Heitman, S. Sun, and **J. Xu**. (2004). SXI1a controls uniparental mitochondrial inheritance in *Cryptococcus neoformans*. *Current Biology* 14:R743-R744.
- Zhang, M. and **C. A. Nurse**. (2004). CO₂/pH signaling in co-cultures of rat carotid body receptors and petrosal neurons: role of ATP and ACh. *J. Neurophysiol.* 92: 3433-3445.
- Zhou, B., J. Nichols, R.C. Playle, and **C.M. Wood**. (2004). An in vitro biotic ligand model (BLM) for silver binding to cultured gill epithelia of freshwater rainbow trout (*Oncorhynchus mykiss*). *Toxicol. Appl. Pharmacol.* 202: 25-37.
- Zhou, B., S.P. Kelly, and **C.M. Wood**. (2004). Response of developing cultured freshwater gill epithelia to gradual apical media dilution and hormone supplementation. *J. Exp. Zool.* 301A:867-881.

Visitors, Post-doctoral Fellows and Research Associates

Post-doctoral Fellows

Donini, Andrew (Working with M.J. O'Donnell)
Ph.D., University of Toronto
Mechanisms of Ion Regulation in Aquatic Insects
October 20, 2003–October 19, 2005

Franklin, Natasha (Working with C.M. Wood)
Ph.D., University of Technology, Sydney
Dietary/waterborne metal interactions in fish
April 14, 2003 – April 29, 2005

Galvez, Fernando (Working with C.M. Wood)
August 1, 2003 – July 31, 2005

Gillis, Patricia (Working with P. Chow-Fraser November 2002–April 2004,
Chris Wood May 2004–May 2005)
Ph.D., University of Waterloo
Assessing Metal Bioavailability and Routes of Exposure in Aquatic Invertebrates
November 1, 2002 – April 30, 2005

Haerty, Wilfried (Working with R. Singh)
Ph.D., University of Pierre et Marie Curie, Paris VI
*Analysis of genes involved in hybrid male sterility in the *Drosophila simulans* clade*
September 1, 2004 – August 31, 2005

Kajimura, Makiko (Working with G. McClelland)
Regulation of fat oxidation with environmental stress
May 1, 2002 – April 30, 2005

Kelly, Bridget (Working with T.M. Finan)
Ph.D., University College Dublin, Ireland
*Determination of activities of the proteins of unknown function (PUF) in *S. meliloti**
September 6, 2004 – September 9, 2005

Marri, Pradeep Reddy (Working with G.B. Golding)
Ph.D., University of Hyderabad, India.
Comparative Genomics and Lateral Gene Transfer in Bacteria
June 1, 2004 – May 31, 2006

Mian, Firoz (Working with J. R. Jacobs)

Ph.D., UPM University

Molecular Genetic Dissection of PDZ-protein LIN-7 (dLIN-7) in Drosophila

November 1, 2003 - October 31, 2005

Mohammad, Asif (Working with R. Cameron)

Ph.D. from the University of Western Sydney, Australia

Elucidation of the defense signaling pathways, Systemic Acquired Resistance (SAR) and Age-Related Resistance (ARR) that lead to induced resistance in Arabidopsis to virulent Pseudomonas syringae pv tomato (Pst)

November 15, 2003 - November 14, 2005

Niyogi, Soumya (Working with C.M. Wood)

February 1, 2001 – March 31, 2004

Nuin Suano, Paolo (Working with G.B. Golding)

February 1, 2003 – January 31, 2005

Paschos, Athanasiios (Working with C. Baron)

Ph.D. from the Ludwig-Maximilians-University, Munich-Germany

Analysis of interactions between VirB proteins of the Brucella suis type IV secretion system

November 1, 2003 - October 31, 2005

Pitsikas, Photini (Working with A.J. Rainbow)

Ph.D. from Concordia University

DNA repair mechanisms in response to UV and treatment by photosensitizers in mammalian cells

April 1, 2002 - March 31, 2004

Shearer, Heather (Working with R. Cameron)

Ph.D. from the University of Guelph

Systemic acquired resistance and age-related resistance: Elucidation of two distinct signaling pathways involved in resistance to Pseudomonas syringae infection in Arabidopsis

October 18, 2004 - October 19, 2005

Singh, Nishi (Working with A. Bedard)

March 1, 2003 – February 28, 2005

Smith, Richard (Working with C.M. Wood)

Branchial proteomics in freshwater fish and Sodium channel expression and copper uptake mechanisms in Xenopus oocytes

May 1, 2002 – April 30, 2005

Wang, Hong (Working with J. Daniel)

Ph.D., The University of Iowa

Identification of gene targets for novel transcriptional factor-Kaiso

May 1, 2004 - April 30, 2005

Wu, Yili (Working with: X-D Zhu)

May 1, 2004 – April 30, 2005

Research Associates

Cheng, JiuJun (Working with T. M. Finan/ G. B. Golding)
Ph.D., University of Wales Swansea
Research project: Analysis of bacterial genes of unknown functions

Cowie, Alison (Working with T.M. Finan)
M.Sc., McMaster University
*Research project: To assign function to unknown genes of *Sinorhizobium meliloti* by construction and analysis of an expression library*

Patten, Cheryl (Worked with H.E. Schellhorn)
*Research project: Regulation of *RpoS* function in *Escherichia coli**

Zaheer, Rahat (Working with T.M. Finan)
Ph.D., Punjab University, Lahore, Pakistan
*Research project: Characterization of *PhoB* regulated genes in *Sinorhizobium meliloti**

Zhang, Min (Working with C.A. Nurse)
M.D., Shandong University in China,
Research project: Chemosensory mechanisms in carotid body and sensory neurons



Graduate Studies

Graduate Program Structure

GRADUATE STUDIES IN BIOLOGY

Programs

The Biology Department offers graduate programs leading to M.Sc. and Ph.D. degrees. The programs offer graduate students the opportunity to participate in one of the over thirty faculty research labs. Areas of research cover a broad range and include: biochemistry, bioinformatics, cancer biology, cell biology, developmental biology, population ecology, environmental physiology, evolution, genetics, immunology, microbiology, molecular biology, and others. Often, a research project of any one laboratory involves more than one of these categories.

Students in the Biology graduate program will enter directly into their chosen research lab in their first year of study. Therefore, students are encouraged to consider their research interests and acquaint themselves with the research programs of professors in the applicable fields. They then arrange to meet with the professors and discuss the possibility of pursuing a graduate degree in the lab.

The graduate programs are designed to teach students the research and communication skills required for a successful career as an independent scientist. Many graduates go on to careers in universities, research institutions, or the biotechnology industry, and a growing number choose areas such as consulting, science writing, technology transfer, and patent law.

The average program length is 2 to 3 years for a M.Sc. and 4 to 5 years for a Ph.D. Currently there are 35 students in the M.Sc. program and 42 Ph.D. candidates.

M.Sc. degree

The M.Sc. program requires the submission of a research thesis and is recommended for anyone planning to proceed later to a Ph.D. or to otherwise continue in research.

A candidate for the M.Sc. in Biology must spend at least one calendar year in full-time graduate study at McMaster University and must complete satisfactorily one full graduate course (or two half courses) in biology or related fields. Upon completion of their research, the candidate must present a thesis embodying original results, and have an oral defense before a departmental examining committee.

This is a brief overview of the M.Sc. program. For details on program requirements, please see the *Guide to Graduate Studies in Biology at McMaster University* or contact Pat Hayward.

Ph.D. degree

Candidates may enter the program with an Honours B.Sc. or an M.Sc. It is customary for graduate students holding a bachelor degree to enter a M.Sc., rather than a Ph.D. program. If the student wishes to proceed to a Ph.D., at the end of an appropriate period of study, they will be asked to submit a critical report on their research to date. The candidate will be examined on this report for evidence of research potential to determine whether they will be granted permission to transfer to the Ph.D. program.

The requirements to complete a Ph.D. in Biology are:

- Satisfactory completion of at least two and one half full graduate courses beyond the baccalaureate degree in biology or related fields.
- Successful completion of a comprehensive examination designed to test the Ph.D. candidate's breadth of knowledge and competence in biology. The examination will be comprised of two parts: the preparation of a formal research proposal and the presentation of a public seminar, followed by a meeting with the examination committee.
- While not a requirement, most students hold teaching assistantships during their graduate career. The financial remuneration forms a significant part of the graduate stipend and affords the opportunity to acquire teaching skills and experience.

- Successful defense of a thesis of original research. Upon completion of their research, a Ph.D. candidate is required to present and defend a thesis embodying the results of their original research.

This is a brief overview of the Ph.D. program. For details on program requirements, please see the *Guide to Graduate Studies in Biology at McMaster University* or contact Pat Hayward.

Departmental Participation

The Biology Faculty welcome input from graduate students in matters governing the Department. Graduate students in Biology elect two of their members to attend the regular Departmental faculty meetings, one member to serve on the Graduate Studies Committee, and one member is elected to the Department Curriculum Committee. The Biology Graduate Studies Committee is responsible for maintaining the integrity and academic excellence of the graduate program.

Biology Graduate Students' Society

The Biology Graduate Students' Society (BGSS) is comprised of elected graduate students from within the Department of Biology. BGSS members act as representatives for biology graduate students to the department of biology on issues ranging from undergraduate and graduate academics to health and safety. In addition, the BGSS hosts 3 annual social events: the summer picnic, the Welcome Week BBQ and the winter holiday formal called the Holly Frolic. Other smaller events and socials held in the past include karaoke nights, movie/potluck nights, an Oktoberfest trip, a trip to Wonderland, wine tours, free coffee breaks, and pumpkin carving contests.

Graduate Students Association (GSA)

The mandate of the Graduate Students Association of McMaster University (GSA) is to promote the welfare and interests of McMaster graduate students, to represent the members before the duly elected and appointed authorities of McMaster University, and to promote communication and participation in all matters of common interest between the members of the Association and the members of other student organizations.

The GSA owns and operates the Phoenix restaurant and bar, providing an opportunity for graduate students and other members of the McMaster community to interact in a casual restaurant/pub setting.

The GSA periodically hosts seminars and colloquia, including the annual Graduate Students Day. The GSA also provides financial and media support for departmental and faculty seminar days, colloquia, etc. The GSA also publishes a monthly newsletter, *The GSA Today*, that provides news and information relating to graduate issues and events throughout McMaster University.



Graduate Distinguished Honours

Governor General's Academic Gold Medal:

Christopher Somers

Fellowships

NSERC:	Kevin Kelly John Fitzpatrick Allyson MacLean Zhun Yan	April Hayward Melanie Huntley Michael BeGora
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OGS:	Dara Torgerson Eric Pane Clinton Robbins	Shaqil Kassam Jennifer Kinder
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US Army Breast Cancer Research Award:

Abena Otchere

Biology Travel Award:

George Bijelic	Maria Papaconstantinou
Josef Buttigieg	Mark Rheault
David Guevara	Adrian Rybak
Susan Han	Nadia Scantlebury
Weilong Hao	Gregory Schmaltz
Melanie Huntley	Rovena Tey
Kevin Kelly	Dara Torgerson
David Lee	Qing Yuan
Veronica Rodriguez-Moncalvo	

The James F. Harvey and Helen S. Harvey Travel Scholarship:

April Hayward

OGSST:

Marg and Edward Lyons:

Gregory Schmaltz

Heart and Stroke:

Allison MacMullin

Lorne F. Lambier Q.C. Scholarship:

Maria Papaconstantinou

Yates Fund Travel Scholarship:

Bijan Kumar Dey

2004 ICA Chris Lee Award for Metals Research:

Eric Pane

McMaster Biology Poster Day: Graduate Division Winners, 2004

1st Place	Melanie Huntley (with Brian Golding) - Simple Sequence Repeats In Neurological Proteins
2nd Place	David Guevara (with Elizabeth Weretilnyk) - Physiological and biochemical responses of <i>Thellungiella salsuginea</i> to salt stress
3rd Place	David Lee (with Andrew Rainbow) - The Role of Mismatch Repair Genes hMLH1 and hMSH2 in Transcription-Coupled Nucleotide Excision Repair

Degrees conferred, 2004:

Laura Louise Beaton, Ph.D.

Thesis: Evolutionary Change in Three Species of Common Roadside Plants

Veronica Andrea Campanucci, Ph.D.

Thesis: Electrophysiological Properties, PO₂- and ATP-Sensitivity of Paraganglion Neurons of the Rat Glossopharyngeal Nerve

Richard Chan, Ph.D.

Thesis: In Vivo Structure-Function Studies of the ERBB2 Receptor Tyrosine Kinase

Susan Elizabeth Doka, Ph.D.

Thesis: Spatially Explicit Habitat Characterization, Suitability Analysis, Verification, and Modelling of the Yellow Perch, *Perca flavescens* (Mitchell 1814) Population in Long Point Bay, Lake Erie

John Norman Grant Hutchison, Ph.D.

Thesis: The Role of the Akt-1 Serine/Threonine Kinase in Mammary Gland Development and Tumorigenesis

Juan Pablo Ianowski, Ph.D.

Thesis: Mechanisms of Transport of Na⁺, K⁺ and Cl⁻ in Malpighian Tubules of *Rhodnius prolixus* and *Drosophila melanogaster*

Christopher Michael Somers, Ph.D.

Thesis: Germline Mutations at Expanded Simple Tandem Repeat DNA Loci in Sentinel Mice

Kelly Anne Best, M.Sc.

Thesis: Ascorbate Transport in Coronary Artery

George Bijelic, M.Sc.

Thesis: Toxicology of Organic Cations and Regulation of Organic Cation Transport in *Drosophila melanogaster*

Alanna Mary Chaudry, M.Sc.

Thesis: Characterization of a Novel Circling Mouse (Cr) Generated in a Transgenic Growth Hormone Breeding Colony

Rupinder K. Gill, M.Sc.

Thesis: Characterization of Hypotonic Shock Induced Ascorbate Release from Pig Coronary Artery Endothelial Cells

Sean Gregory, M.Sc.

Thesis: A Comparison of Microsatellite Isolation Techniques Using Avian Genomes

Xiaoyu Han, M.Sc.

Thesis: Developing a Genetic Linkage Map from an Intervarietal Cross of Serotypes A and D and the Analysis of the Costs and Benefits of Hybridization in *Cryptococcus Neoformans*

Ying-Hsu Huang, M.Sc.

Thesis: Mutagenesis and Functional Analysis of *dveli*, the *Drosophila* orthologue of *C. elegans Lin-7*

Nicole Langlois, M.Sc.

Thesis: Examining the Role of p53 in Radiation-Induced Mutations of *Estr* loci

David Lee, M.Sc.

Thesis: The Role of Mismatch Repair in the Repair of DNA Damage Induced by Ultraviolet Radiation and Hydrogen Peroxide

Lan Lin, M.Sc.

Thesis: The Concentration and Distribution of Mineral Nutrients and Phytic Acid-Phosphorus in Wild-type and Low Phytic 1-1 (LPA1-1) Corn (*Zea mays* L) Grains and Parts

Mark David Mitchell, M.Sc.**Diana Morarescu, M.Sc.**

Thesis: Bicistronic Vectors for Animal Models of Breast and Prostate Cancer

Curtis Nordgaard, M.Sc.

Thesis: Binding Partners for the Novel BTB/POZ Transcriptional Repressor Kaiso

Lesley Reid, M.Sc.

Thesis: A Multiscale Study of the Role of Environmental Variability on the Diversity and Abundance of Rock Pool Communities

Christopher Sibley, M.Sc.

Thesis: Identification and Characterization of the *Sinorhizobium meliloti* Chromosomal Origin of Replication and the Replication Initiator DnaA

Saima Tariq, M.Sc.

Thesis: Modulation of RpoS Expression by an Inducible RpoS Sense and Antisense on a High-Copy Plasmid and as a Single Copy in the *Escherichia coli* Chromosome

Rovena Tey, M.Sc.

Thesis: Various Aspects of the Profiling of Metabolome in Human Pathogenic Yeasts using Gas Chromatography-Mass Spectrometry

Full-time Students

Ph.D. Students

- Aly, Khaled Ahmed** (C. Baron)
Structure-function analysis of the minor T-pilus component VirB5 from Agrobacterium tumefaciens
- Begora, Michael** (E. Weretilnyk)
Phosphobase N-methyltransferases involved in phosphocholine synthesis
- Brown, Stephen** (C. A. Nurse)
The Function of Hypoxia Induced Factors (HIFs) in Acute and Chronic Hypoxia in Rat Adrenomedullary Chromaffin Cells.
- Champigny, Marc** (S. Igdoura)
- Dey, Bijan Kumar** (A. R. Campos)
Dissecting the function of the Drosophila disconnected (disco) gene using molecular and genetic approaches
- Frasier, Tim** (B.N. White)
Integrating Genetic and Photo-Identification Data to Assess Reproductive Success in the North Atlantic Right Whale (Eubalaena glacialis).
- Guevara, David** (E. Weretilnyk)
Physiological and metabolic responses of Thellungiella salsuginea toward abiotic stress
- Hao, Weilong** (G. B. Golding)
Lateral Gene Transfer
- Hayward, April** (J. Kolasa)
Allometric Scaling at Multiple Scales of Biological Organisation in Aquatic Rock Pool Microcosms
- Hiremath, Sanjay** (R.S. Singh)
- Hossain, Noor** (J. R. Jacobs)
- Huntley, Melanie** (G. B. Golding)
The evolution and origins of protein repeats
- Jagadeeshan, Santosh** (R. S. Singh)
Comparative and functional genomics of Rapidly evolving genes in Drosophila
- Kelly, Kevin** (J. Daniel)
Nucleocytoplasmic trafficking and gene regulation of the POZ-ZF transcriptional regulator Kaiso and the catenin p120
- Lowe, Michael** (C. A. Nurse)
- MacLean, Allyson** (T. M. Finan)
Aromatic acid metabolism in Sinorhizobium meliloti
- MacLellan, Shawn** (T.M. Finan)
The control of megaplasmid replication in alpha-proteobacteria
- MacMullin, Allison** (J.R. Jacobs)
- Masoudi, Raheleh** (M. Fahnestock)
- McNair, Sheila** (P. Chow-Fraser)
- Moyer, Katie** (J.R. Jacobs)
- Pane, Eric** (C. M. Wood)
Mechanistic Analysis of the Effects of NI on Daphnia Magna and Rainbow Trout
- Pande, Jyoti** (A. K. Grover)
- Papaconstantinou, Maria** (A. Campos)
- Patel, Leena** (J.R. Jacobs)
- Pattison, Susan** (S. Igdoura)
- Peters, Jason** (J.A. Hassell)
Identifying PEA3 target genes
- Poduska, Branislava** (T. M. Finan)
FRT directed deletions in Sinorhizobium meliloti genome
- Rheault, Mark** (M.J. O'Donnell)
- Robbins, Clinton** (C. Richards)
- Rodriguez, Moncalvo, Veronica** (A. R. Campos)
- Ruiz-Sanchez, Esau** (M. J. O'Donnell)
- Schmaltz, Gregory** (J. S. Quinn)
Reproductive skew and competition in the smooth-billed ani (Crotophaga ani)
- Seilheimer, Titus** (P. Chow-Fraser)
Dimensions of fish habitat in Great Lakes coastal wetlands: water quality, plant diversity, and fish species interactions
- Shaw, Carla** (B.N. White)
- Sivanesan, Durga** (C. Baron)
Protein-Protein interactions between Brucella suis type IV secretion system components.
- Torgerson, Dara** (R. S. Singh)
The Molecular Evolution of Genes Expressed in the Sperm
- Wei, Anhua** (P. Chow-Fraser)
- Yan, Zhun** (J. P. Xu)
Mating type and Mitochondrial Inheritance in the Human Pathogenic Fungus Cryptococcus neoformans
- Yuan, Qing** (C. Baron)
Comparative functional analysis of different type IV secretion systems
- Yuan, Zechun** (T. M. Finan)
Study of phosphate transport and regulation in the nitrogen fixing soil bacterium Sinorhizobium meliloti

Full-time Students

M.Sc. Students

- Abha, Ahuja** (R. S. Singh)
Genetics of variation in Sex Comb morphology of males of Drosophila
- Abou Chakra, Maria** (J. Stone)
Computational Model of Echinoid Skeleton Morphogenesis
- Alves, Lara** (C. M. Wood)
The Chronic Effects of Dietary Lead on Juvenile Rainbow Trout from a Toxicological and Physiological Perspective
- Bucking, Carol** (C. M. Wood)
The Physiology of Digestion in Rainbow Trout
- Buttigieg, Josef** (C. A. Nurse)
Genetics of variation in Sex Comb morphology of males of Drosophila
- Chain, Frederic** (B. Evans)
Molecular evolution of duplicate genes in allopolyploid clawed frogs (Xenopus and Silurana)
- Chong, Taryne** (S. Igdoura)
The impact of sialidase on inflammation mediated cell surface proteins in neurodegeneration
- Cowan, Robert** (A. J. Rainbow)
The role of nucleotide excision repair genes in the repair of oxidative DNA damage in Chinese hamster ovary cells
- Donaldson, Nickett** (J. Daniel)
The novel POZ-ZF protein ZNf131 enhances Kaiso-Mediated Transcriptional Repression via heterodimerization of their POZ domain
- Dong, Tao** (H. E. Schellhorn)
Dregoes, Diana (A. J. Rainbow)
The role of p53 in the transcription-coupled and global genomic sub-pathways of nucleotide excision repair
- Fitzpatrick, John** (S. Balshine)
Fowler, Jane (T. M. Finan)
Gao, Chan (C. Baron)
Irazuza, Sebastian (S. Dudley)
Floral display height effects pollinator visitation frequency in garlic mustard (Alliaria petiolata): possible consequences to plant fitness
- Kassam, Shaqil** (A. J. Rainbow)
The role of Nucleotide Excision Repair genes in the repair of oxidative DNA damage in human cells
- Kinder, Jennifer** (A. Campos)
King, John Paul (S. Igdoura)
Kostuk, Kristina (P. Chow-Fraser)
Fish-benthos interactions in coastal wetlands: influence of fish sampling methods and plant diversity
- Lentz, Cindy** (J. S. Quinn)
Liu, Jingjing (C. A. Nurse)
Nadella, Sunita (C. M. Wood)
Dietary uptake of copper in rainbow trout (Onchorhynchus mykiss): a study of mechanisms
- Ojo, Adeola** (C. M. Wood)
Bioavailability and interactions of metals via the intestinal tract of Rainbow trout
- Otchere, Abena** (J. Daniel)
The Role of the POZ-ZF Transcription Factor Kaiso in Breast Tumourigenesis
- Raftis, Frances** (G. B. Golding)
Rybak, Adrian (A. J. Rainbow)
Cytotoxicity of UVA-irradiated saline and conditioned media from UVA-treated human cells
- Sartor, Andrea** (T. M. Finan)
Schippers, Marie Pierre (G. McClelland)
Exercise physiology and lifetime performance in honeybees
- Smallbone, Laura** (T. M. Finan)
Malic Enzymes: Interacting Proteins and Metabolomics
- Sun, Sheng** (J.P. Xu)
Population Biology of the Nitrogen-fixing Bacterium Sinorhizobium meliloti
- Szewczyk, Magdalena** (A. K. Grover)
Teal, Kelly (J. R. Jacobs)
Wang, Lizhen (A. Bedard)
Whitty, Brett (G. B. Golding)
Yang, Abraham (S. Igdoura)
Yang, Tao (A. R. Campos)
RNA Interference with Drosophila Menin in S2 Cells and the Effect on Heat Shock Protein 70

Undergraduate Studies

Undergraduate Program Structure

Staff and faculty in the department of Biology teach, support and administer some of the largest courses and degree programs in the Faculty of Science. We constantly strive to meet the changing academic and social needs of students by offering the most current and innovative means of support available.

Programs

The Biology Department offers the **CORE** option and two specializations, **Genetics** and **Biodiversity**, the interdisciplinary programs **Biology & Psychology**, **Biology & Mathematics**, **Molecular Biology** and the Co-op options of **Biology & Pharmacology** and **Biology & Genetics**.

The current undergraduate program structure within the department was initiated in the 2002/2003 academic year and 2004 saw the first cohort of graduates complete their programs of study.

Core

The Honours Biology (Core) program includes a set of fundamental courses that are shared with other Biology Honours streams. It also permits the greatest flexibility in selection of additional courses. Students will be able to choose biology courses following their own interests, or to develop an interdisciplinary approach to biology that may include obtaining a minor. It provides an excellent background for graduate studies if the student completes a Biology Thesis or Project and chooses Level III and IV courses from Science. Students selecting this program should be aware that many 3rd and 4th year courses have specific course pre-requisite requirements. Students can switch into the more specialized streams after year 2 if they wish but must satisfy the course requirements of the desired program.

Genetics Specialization

Increasingly, biology tools are being applied to the solution of fundamental problems in food production and in the identification and treatment of human disease. Students in the Genetics stream will take a laboratory-centered program that culminates in an undergraduate thesis in an active research laboratory. Students follow a program of study that emphasizes practical applications of genetics in the study of human and animal disease, molecular models of development, molecular microbiology, evolutionary processes, gene expression, and the growing field of bioinformatics. Students will obtain practical training in molecular biology laboratory skills, communication skills and will thus be well prepared for a postgraduate career in academia, the health field or in the rapidly developing biotechnology industry, among many more.

Biodiversity Specialization

Biodiversity is the diversity of life itself, at all levels of organization from the gene to the ecosystem. Without question, the preservation of biodiversity will be the single greatest challenge for the human race in the 21st century. The goal of the Biodiversity Specialization at McMaster is to train students with the interdisciplinary skills they will need to deal with Biodiversity issues; Students who will have a strong background in basic ecology, evolution, population genetics, and conservation biology. Students will be comfortable dealing with plants, animals, and microorganisms, and will be trained in thinking about the big picture, and about all levels of ecosystem interactions, including the role of humans. To facilitate this process, students will be exposed to two inquiry courses in years II and III. The first course will expose the students to a broad range of ideas and expertise from both inside and outside McMaster, through presentations and discussions with representatives of government, industry, and international conservation and development organizations. The second course will expose students to the range of Biodiversity-related research ongoing at McMaster, and will prepare students for their own research projects in year IV. Graduates of this program will have the appropriate background to pursue careers in government, academia, and international agencies, among many more.

Origins Specialization (new in 2005)

The Origins Institute is an intellectual enterprise that promotes, maintains and strengthens interdisciplinary collaboration among researchers who are interested in solving scientific problems concerning 6 origins themes:

- The origin of our universe
- The origin of elements
- The origin of structure of our universe (eg. Solar systems, planets)
- The origin of life
- The origin of species
- The origin of humans

The Specialization in Origins Research curriculum is designed to re-introduce to students through these themes to the 19th century ideal “Natural Science” (ie. well-rounded comprehension about the world) but from a modern perspective. Students graduating from the specialization will possess a comprehensive, liberal education in the natural sciences.

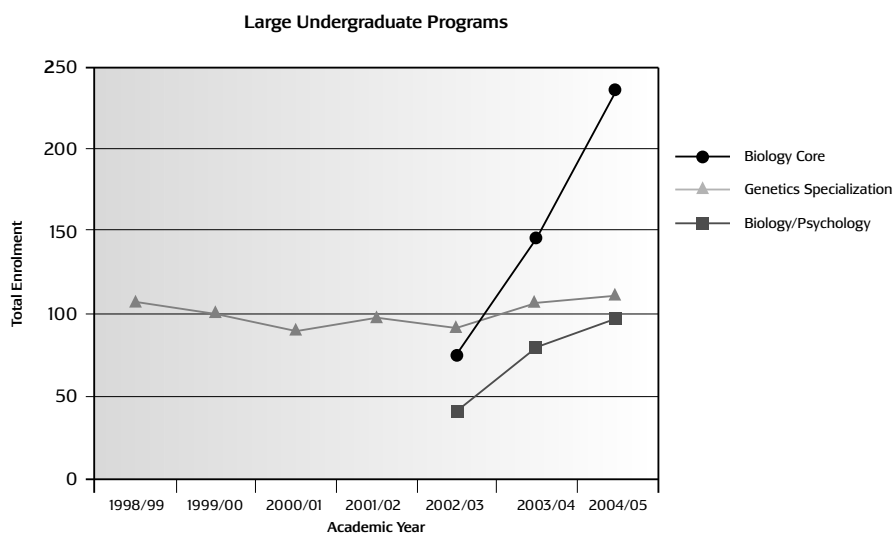
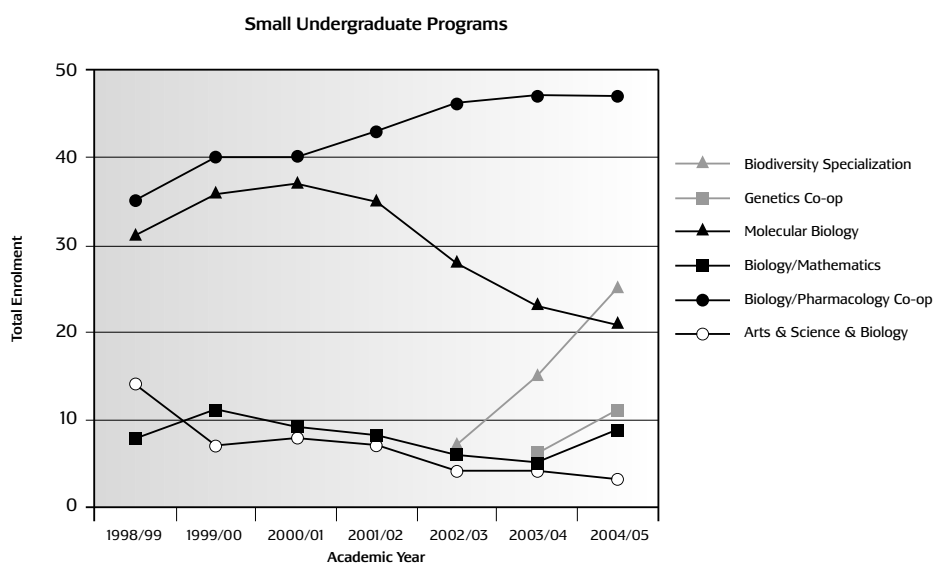
Students who are interested in this specialization will enroll in a Core program in Biochemistry, Biology, Chemistry, Computing and Software, Earth and Environmental Sciences, Mathematics and Statistics, Physics and Astronomy or Psychology and then take the courses required for the Origins Specialization as electives.

ENROLMENT

Program	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04*	2004/05*
Biology Core	0	0	0	0	76	147	236
Genetics Specialization	0	0	0	0	41	80	97
Biology/Psychology	108	101	91	98	92	107	112
Biodiversity Specialization	0	0	0	0	7	15	25
Genetics Co-op	0	0	0	0	0	6	11
Molecular Biology	31	36	37	35	28	23	21
Biology/Mathematics	8	11	9	8	6	5	9
Biology/Pharmacology Co-op	35	40	40	43	46	47	47
Arts & Science & Biology	14	7	8	7	4	4	3
TOTALS	196	195	185	191	300	434	561

*The statistics of 2003/04 and 2004/05 are yet to be approved by the Office of the Registrar.

Class of 2004: 109 degrees were conferred upon Biology Undergraduates. *58.7% of our student body graduated on the Dean's Honours List.*



Teaching

During the 2003/2004 academic year, Professors, Instructional Assistants and support staff in the Biology Department facilitated 49 courses with a total enrolment of 6984 (including about 1600 in 1st year Biology). These courses we've provided to students enrolled in every faculty of the University.

Some of the teaching styles, tools and resources that the Biology Department offers are:

- Inquiry Projects
- Problem-Based Learning (PBL)
- 1st Year Biology Skills Labs
- Peer Mentoring program
- Laboratory-Based Courses (Experimental)
- Senior Project and Thesis courses (62 students participated in 2004)
- Formal, traditional lectures
- Small group tutorials
- Ontario Universities Program in Field Biology (OUPFB)
- Computer-mediated instruction
- Ontario Biology Day
- McMaster Biology Poster Day (*NEW in 2005* – McMaster Biology Poster Day will be replaced by the Biology Undergraduate Symposium (BUS) wherein thesis and project students will present their final year project findings to faculty, students, friends and family, followed by a gala reception.)

Distinguished Honours and Awards

Our students in the undergraduate Biology programs are some of the best McMaster University has to offer. In 2004, many of our students were recipients of University Scholarships and Awards for their academic excellence and contributions to the community.

Accenture Inc. Scholarship:

Mandeep (Pinky) Gaidhu

Abe Black Memorial Prize:

Jennifer Heisz

Edwin Marwin Dalley Memorial Scholarships:

Aneesh Paul Chhabra	Sachin Sarin
Daryl Mason	Marko Skrtic
Maria-Alexandra Petre	Gayathri Vaidyanathan

D. M. Davies Prize:

Hamood Malik

J. L. W. Gill Prizes:

Tamer Abdelshaheed	Katayun Treasurywala	Ravi Roshan Bajaj
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Dr. Harry Lyman Hooker Scholarships:

Tamer Abdelshaheed	Yi Daniel Li	Stefanie Scaini
Salman Chaudhry	Michelle Melone	Melissa Sergi
Teegan Docherty	Ketan Mistry	Priya Sharma
Elise Hall	Lindzie O'Reilly	Katayun Treasurywala
Lyndsay Harrison	Andrew Petrosniak	Johanna Withers
Charlie Joyce	Nicholas Romatowski	Samantha Wong

Damian Miguel Headley Award:

Christine Kerr	Yi Daniel Li	Melissa Sergi
Tamer Abdel Shaheed	Courtney MacMillan	Priya Sharma
Salman Rafat Chaudhry	Michelle Melone	Katayun Treasurywala
Teegan Docherty	Ketan Mistry	Faiza Upal
Nadia Haddad	Lindzie O'Reilly	Johanna Withers
Elise Hall	Andrew Petrosniak	Samantha Wong
Lyndsay Harrison	Nicholas Romatowski	Iris Suzanne Wood-Rooke
Charlie Joyce	Stefanie Scaini	

Dr. Ronald V. Joyce "Amazing" Grace Awards:

Christine Kerr

Ernest Robert MacKenzie Kay Scholarships:

Paul Cassar	Laura Golding
Heather Eaton	Erin Holtz
Christine Elder	Heather Pankhurst

George P. and Leatha M. Keys Scholarships:

Erin Holtz

J. J. Miller Prize:

Johanna Withers

Moulton College Scholarships:

Dana Onica

Psychology Society Prizes:

Ketan Mistry

Margaret A. Service Book Prize:

Maria-Alexandra Petre

Shenstone Prize:

Maria-Alexandra Petre

University Prizes for Special Achievement:

Heather Eaton
Megan Szak
Julie Witmer

University (Senate) Scholarships:

Ravi Bajaj	Mina Girgis	Nikol Piskuric
Ashita Bhatt	Rebecca Haque	Katelyn Reynolds
Emily Charlesworth	Mark Hindle	Parastoo Salehi
Derek Chaves	Sara Hostland	Amin Sandhu
Michael Chmatil	Alexandra Inman	Stephanie Scott
Michael Cho-Young	Liisa Johnston	Stevie Struiksma
Kalindi Dhekney	Tracy Kok	Amman Takhar
Shawn DiPardo	Erica Leung	Yumi Tanaka
Michelle Ford	Terence Lim	Kathryne Taylor
Nicole Garzia	Laura Mendelsohn	Sari Van Delft
Carla Gibson	Laura Pierce	Jordan Wronzberg

Wilson Foundation Leadership Awards:

Joanna Jarecki

Rotary Club of Hamilton Community Contribution Award:

Katherine MacDuff

Science Class of '97 Legacy Award:

Mandeep (Pinky) Gaidhu

Stephen F. H. Threlkeld Award:

William Mous

Biology Academic Achievement Award:

The Department of Biology bestows this new award upon the top academic achievers in first year Biology 1A03 – Cellular & Molecular Biology. In 2004 12 of these awards were bestowed on the following 1st year Biology students.

Jamunarany Balachandran
Simon Grafe
Rebecca Haque
Alexandra Inman

Terence Lim
Lindsay Matthews
Maria-Alexandra Petre
Laura Pierce

Josephine Scaglione
Elizabeth Stoesser
Gayathri Vaidyanathan
Mohammad Zubairi

Undergraduate Committees and Activities

Biology Society 2004

(President: Heather Pankhurst)

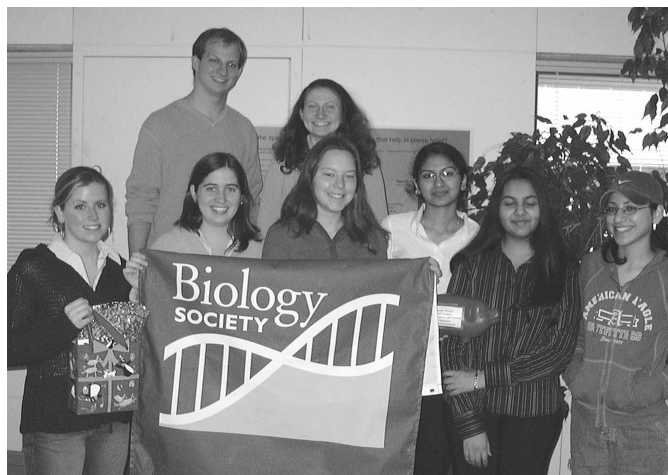
The Biology Society organized a number of successful events as well as introduced new services and fundraising initiatives this year.

In January, the Society in cooperation with Science Career Services, organized a Biology Career Night in which speakers talked about their Biology related careers and provided students with information about various career options and the steps they took to get there. The sale of “MAC Biology” hoodies was also introduced and this was quite successful with the departmental staff and students. In September, a ‘Meet the Profs’ barbeque was held at the Phoenix pub on campus, where professors and students mingled in a very informal atmosphere.

The Biology Society also developed a number of fundraising initiatives in 2004. In November, through the proceeds from a number of bake sales as well as a jelly bean guess jar, over \$300 was raised for the McMaster Children’s Hospital. In addition, through running a toy and book drive, generous donations were received for shelters in the Hamilton area.

The society also introduced, with the help of Science Career Services, a Biology Resume Writing workshop in which students can learn about writing style and technique for resumes.

From the left: Heather Bryce, Jordan Wronzberg (back), Heather Pankhurst, Lina Ostrovsky (back), Kathryn Harrison, Aisha Shamas-Din, Nipa Pandya & Anna Balasingham.



BUGS Committee

The Biology Undergraduate Studies Committee, or BUGS, is a group of faculty, staff and students who meet regularly to discuss and resolve issues involving Undergraduate Studies in the Department of Biology. There are two student representatives on the committee who act as advocates for their fellow students and help address their concerns to the department.

Ontario Biology Day 2004

Ontario Biology Day has become a tradition for senior Biology undergraduate students at McMaster University. The weekend conference is open to students of all Ontario Universities who undertake a senior thesis or project. It is an opportunity for them to reveal their findings and to meet representatives of other schools.

27 students, 6 faculty and 2 staff members participated in the 17th Annual Ontario Biology Day at Nipissing University in North Bay over the weekend of March 13th, 2004. Everyone boarded a coach for the icy, 4-hour trek to North Bay where students either presented talks or participated in poster sessions based on their Senior Projects and Theses.

McMaster Biology's contingent made up the largest proportion of the 105 university students from across Ontario and represented the following faculty members' labs:

Department of Biology:

Dr. Christian Baron	Dr. Turlough Finan	Dr. Herb Schellhorn
Dr. Ana Campos	Dr. Jurek Kolasa	Dr. Jian-Ping Xu
Dr. Patricia Chow-Fraser	Dr. Colin Nurse	

Department of Biochemistry and Biomedical Sciences:

Dr. Richard Epan	Dr. Radhey Gupta
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Department of Psychiatry and Behavioural Neurosciences:

Dr. Margaret Fahnestock	Dr. Lennard Niles
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Department of Pathology and Molecular Medicine:

Dr. James Mahony	Dr. Carl Richards
Dr. Karen Mossman	Dr. Judith West-Mays
Dr. Astrid Petrich	

Department of Medicine:

Dr. Suzette Salama

The participants agreed that this was a great opportunity to network with students and faculty from other universities with similar or complementary research interests.

McMaster's Biology department hosted Ontario Biology Day in 1999 and is scheduled to host again in 2007.

McMaster Biology Poster Day

During the week following Ontario Biology Day, undergraduate and graduate students participated in McMaster Biology's poster day. Submissions covered areas of research as diverse as our department. Of the more than 20 undergraduate submissions, there were three that rose to the top and were awarded prizes.

Undergraduate Division Winners, 2004

1st Place	Giuseppe Pino: Matrix Metalloproteinase inhibitor GM6001 (Ilomostat) prevents TGFb-induced subcapsular cataract formation in the cultured rat lens
2nd Place	Esther Malik: Signature sequences as molecular markers for Cynobacteria
3rd Place	Victor Chiu: Relative Levels of Brain-Derived Neurotrophic Factor and Serotonin Receptor 5-HT2A mRNA in Autistic Human Brain Tissues Using RT-PCR

Beginning in 2005, the McMaster Biology Poster Day will be replaced by the Biology Undergraduate Symposium (BUS), the first of which is scheduled for April 7th, 2005.

Undergraduate Promotions

The Department of Biology initiated a new position called Undergraduate Promotions in 2003. The purpose of this position is to better address the needs of students in such a large Department as Biology.

Due to the large number of students in the Biology programs and the size of some of the classes, many students feel that they do not have a chance to connect with others in their programs. The purpose of the Undergraduate Promotions position is to create opportunities for students to meet with each other and to create a sense of community among them.

Some of the activities this position has been involved in are:

- Creating and promoting program feed-back mechanisms
- Organizing and promoting program-specific get togethers
- Upper Year Student Volunteer Leadership Initiative (*BioLinks*)
- Organizing and promoting the Class of 2004 Semi-Formal
- Mail-outs to all Ontario high schools, Science Teachers' Association of Ontario conference attendance
- Helping students organize and promote Biology & Society Discussion Forums
- Helping students organize and promote the Biology Career Planning & Employment Workshop (SCS & CPEC)
- Helping to organize and promote other regularly occurring events such as May@Mac, Upper Level Info Night, 1st Year Info Night and Meet the Profs.

Biology Staff

OFFICE PERSONNEL

Name	Position
Marg Biggs	Administrative Secretary
Wendy Burston	Administrative Secretary - Undergraduate Promotions
Marge Geroux	Biology Administrator
Kathy Greaves	Administrative Secretary to the Chair & Administrator
Pat Hayward	Administrative Assistant - Graduate
Jeannette Jackson	Administrative Secretary
Kathy McIntosh	Administrative Assistant - Undergraduate
Barb Reuter	Administrative Secretary
Anne Symons	Administrative Secretary

DEPARTMENTAL PERSONNEL

Name	Position
Debbie Bernardo	Glassware Technician / Biomedical Waste
A. Seong Cheong	Undergraduate Laboratory Assistant
Ian Giles	Undergraduate Laboratory Assistant
Rob Gillies	Electronics Specialist
Marvin Gunderman	Technical Coordinator / Instructor of Entomology
Paul Hoffman	Undergraduate Laboratory Assistant
Arif Rawji	Computing Services Coordinator
Klaus Schultes	Electron Microscopy Specialist
Sharon Stray	Undergraduate Laboratory Assistant
Arthur Yeas	Greenhouse Technician

INSTRUCTIONAL ASSISTANTS

The Instructional Assistants (IA) act a bridge between the students and faculty. An Instructional Assistant often runs the lab component of the course, keeps track of all student marks, reschedules students in lab sections and deals with student conflicts. An Instructional Assistant may develop new labs or modify existing ones and are very familiar with the course content.

Name	Course
Lori Ann Goff	Biology 1A03/1AA3, Cellular and Molecular Biology & Biodiversity, Evolution & Ecology
Thelma Leech	Biology 2D03, Plant Biodiversity
Beryl Piccinin	Biology 1A03/1AA3, Cellular and Molecular Biology & Biodiversity, Evolution & Ecology
Ray Procwat	Biology 2C03, Genetics

Facilities

OVERVIEW

The Department of Biology has a wide range of core facilities that are available to its research labs. These include the insect rooms, the fish facilities and the plant facilities (greenhouse and plant growth chambers). We also have a wide range of imaging equipment available in the Microscope facilities.

The Institute for Molecular Biology and Biotechnology manages the MOBIX lab, a centre that provides a wide range of molecular biology services to McMaster University.

MICROSCOPE FACILITIES

These facilities provide scientists with the equipment and training necessary to generate and interpret microscopic images. Faculty and staff with expertise in electron microscopy can help design, conduct and interpret your analyses.

Resources:

Surface Imaging

Samples that are dry, wet or oily can be observed without the aid of any metal coating in our new Environmental SEM (Electroscan 2020 ESEM). Dynamic changes can be studied as samples are subjected to changes in temperature (1500° C), applied tension or compression (up to 1000 pounds and 1000° C) or changes in hydration. Wet or oily samples can viewed on a low-temperature control stage (-5° to + 60° C) or at ambient temperature.

Low-Temperature Preparation

Cryogenic techniques are available for studying samples either on our Transmission Electron Microscope (TEM) or on our Environmental Scanning Electron Microscope (ESEM).

Image Analysis

Areas, dimensions, volumes and many other features of images can be quantified.

Element Composition

Energy dispersive x-ray (EDX) analysis provides information about elements present in very small areas of the sample. Elemental distributions can sometimes be mapped. Standardless semi-quantitative or fully quantitative results can be obtained.

Interior Imaging

Thin sections (>40 nm) of epoxy resin embedded samples can be viewed for ultrastructure and/or element composition. Wet samples can be frozen, fractured to reveal interior details, etched and observed uncoated while still frozen using a cryostage fitted to our ESEM. Wet samples can be frozen, cryosectioned, and the frozen sections observed using a cryostage on our TEM.

Particles and Flocs

Dry particulate samples can be studied for structure and composition. Colloids and flocs can be observed.

Electron Microscope Facility

The Electron Microscope Facility is located on the first floor of the Life Sciences Building. The facility is directed by John Lott and managed by microscopist Klaus Schultes. It is equipped with the following:

Confocal microscope

- BIO RAD Microradiance Confocal Microscope
- The system is attached to a Nikon E800 conventional epi-fluorescence microscope
- Lasers include an Argon Ion (488, 514) and Helium Neon (543)
- Z-drive with a focus resolution of 0.05 microns
- Transmission detector installed
- Dual Photomultipliers
- LaserPix 2D software for analysis and enhancing of your images

Environmental scanning electron microscope

- ESEM 2020
- Full environmental capabilities with LaB6 filament
- Peltier cold stage for viewing wet samples
- Fullam tensile/ 1000 ° C heating stage for compression or tension studies (1000lb, 50lb, & 250 gr load cells and linear transducer) coupled to Mtest windows live readout system.
- Electroscan 1500 ° C heating stage
- Micromanipulator with ability to add liquid or gases to samples in situ
- PGT microanalysis system with PRISM light element detector, semi or full quantitative analysis software/ image analysis software
- VCR recording available with miroVIDEO video digitizing and editing system

Scanning Transmission electron microscope

- JEOL 1200EX11 STEM
- 120 Kv LaB6 Scanning Transmission Electron Microscope
- Gatan cryo transfer system installed
- Single tilt and double tilt goniometers
- PGT IMIX microanalysis system with beryllium detector, semi and full quantitative software package/ image analysis software

MOLECULAR BIOLOGY FACILITIES

MOBIX

The Institute for Molecular Biology and Biotechnology

The vision of MOBIX, the McMaster Institute for Molecular Biology and Biotechnology, is to develop a world-class centre for life science and translational research. MOBIX makes use of the most recent advances in basic and applied molecular biology and develops these findings into diagnostic and therapeutic interventions in human health. MOBIX consists of a series of centres, set up within the institute, each with its own experimental and development goals and all sharing a common vision. The Institute also houses the MOBIX Lab, a central facility that provides molecular biology expertise and services to the research community, both inside and outside McMaster.

(See web page, <http://www.science.mcmaster.ca/mobix/>)

MOBIX LAB

MOBIX Lab is committed to providing diligent service and support in Oligo synthesis, DNA sequencing and fragment analysis with exceptional quality, accuracy and value. We believe in integrity and teamwork in everything we do. We will continue to progress with the purchase and sharing of state-of-the-art equipment and introduction of new services. Mobix Lab is located in the Life Sciences Building, Room B123.

Resources:

Oligo Synthesis

Oligos are synthesized on either an ABI 394 DNA/RNA Synthesizer or an ABI 3900 High Throughput DNA Synthesizer.

Sequencing

DNA cycle sequencing in our lab is performed using ABI BigDye terminator chemistry and ABIPRISM® 3100 Genetic Analyzer. The ABI PRISM® 3100 Genetic Analyzer is a multi-color fluorescence-based DNA analysis system fully automated from sample loading to data analysis.

Fragment Analysis

Microsatellite analysis and SNP

Equipment Available

Alpha Imager 2200, Kodak Image Station 440, and Phosphoimagers

Phone: 905-525-9140 Ext. 27048

FAX: 905-526-1427

Email: mobixlab@mcmaster.ca

Facility Manager: Galina Kataeva, Ph.D.

Technician: Liliana DeSousa, BSc

Technician: Richard Lamb, BSc

OTHER RESEARCH RESOURCES

Neutron activation analysis (nuclear reactor), Mass spectrometry, High resolution resonance spectrometer.

COMPUTER SERVICES

The Department of Biology has a PC computing lab located in Room 215. During the academic year, student consultants are available for assistance.

Hours during the academic year:

Monday - Thursday: 9:15am-8:00pm

Friday: 9:15am-4:00pm

Hours during May - August and during exams

Monday - Friday: 9:15am-4:00pm

Computer Services Coordinator: Arif Rawji

ANIMAL FACILITIES

Insect rooms

The Life Sciences Building has a small insectary used for housing live insects for physiology experiments. The insects include the American cockroach, *Periplaneta americana*, and the true bug *Rhodnius* sp. The former is used in undergraduate physiology labs and the latter in research labs by Dr. Mike O'Donnell.

Marvin Gunderman is our instructor of entomology and curator of biology's insect collection. The collection has pinned specimens from the 1930s right up to 2004 and is thus a valuable resource for presence/absence and range data for insects from mostly southern Ontario. Student collections from Marvin's courses are integrated into the departmental collection ensuring growth. There is a small liquid collection of mostly larvae and pupae. The collection has been used by several researchers for range data, especially the Lepidoptera (butterflies only) and Coleoptera (Coccinellidae and Cicindelidae).

Contact: Marvin Gunderman

Fish facilities

The aquatic laboratories are a multi-user facility housed in four separate rooms (B101, 575 sq. ft; B102, 185 sq. ft; B109, 200 sq. ft; B112, 895 sq. ft) in the basement of Life Sciences Building. It has the capacity for maintaining fish of various sizes in tanks ranging from 10 - 500 L, as well as conducting experimental procedures and analytical work. The facility currently maintains a variety of fish species including the freshwater rainbow trout (*Oncorhynchus mykiss*) and yellow perch (*Perca flavescens*), the tropical zebrafish (*Danio rerio*), the euryhaline killifish (*Fundulus heteroclitus*), and the aestivating African lungfish (*Protopterus dolloi*). In addition to fish, invertebrate cultures are held in B112 including the midge larva, *Chironomus riparius* and the cladoceran, *Daphnia magna*. The facility is used in part to study the effects of environmental stressors on homeostatic mechanisms in fish. In particular, the laboratories of Drs. Wood and McClelland are currently performing industrially-supported research to gain a better understanding of impact of metals to aquatic biota. The research is expected to yield valuable information that will be used in the derivation of a new generation of environmental regulations for metals. A large basic research component is focused on understanding basic physiological questions relating to acid-base and ion regulation, and nitrogenous waste excretion. The facility is equipped with a unique swim tunnel, to allow for research on exercise physiology, as well as X-ray equipment, and a Passive Integrated Tagging (PIT) system to enable fish identification and tracking. In the past five years more the 15 undergraduate students, 14 graduate students, 16 post-doctoral fellows and a number of visiting professors have used the facilities to conduct experiments.

Contact: Dr. Chris Wood

PLANT FACILITIES

Greenhouses

The biology greenhouse, which is located to the west of The James Stewart Centre (formerly Hamilton Hall), is used extensively, for teaching and research purposes. Each year hundreds of students either use the greenhouse in their laboratories or use plants provided by the greenhouse. A number of research projects use green facilities, especially those of Susan Dudley.

The greenhouse is open to visitors most weekdays from 9:00am until 3:00pm.

Contacts: Mr. Art Yeas at yeasart@mcmaster.ca Dr. John Lott at lott@mcmaster.ca

BARC (Bay Area Restoration Council)

Bay Area Restoration Council (BARC) is at the centre of efforts to restore and protect the ecosystem health of Hamilton Harbour and its watershed. Located in the Life Sciences Building, Room B130F, BARC's Great Lakes and Hamilton Harbour Resource Centre contains 1000s of documents on Great Lakes Clean-up projects, with a particular emphasis on the Hamilton Harbour Remedial Action Plan (RAP), Cootes Paradise marsh and the McMaster Ecowise program. The resource centre is open to visitors most weekdays from 10 am to 3 pm. Students may borrow items for one week. Volunteer activities and public meetings are listed on the web site: learnlink.mcmaster.ca/barc.

You can also email BARC at barc@mcmaster.ca or call ext: 27405.

Seminars and Visitors

INVITED SPEAKERS

Biology Seminar Series

Dr. Guy Sauvageau (Institute of Research in Immunology and Cancer, Montreal)
September 30, 2004

Polycomb group genes regulate stem cell proliferation

Dr. Richard Palmer (University of Alberta)
October 14, 2004

Evolution of Development: Insights from Biological Asymmetries

Dr. Ben Neel (Harvard Institute of Medicine)
October 21, 2004

Tyrosine Phosphatases in Health and Disease

Dr. Naweed I. Syed (University of Calgary)
October 28, 2004

Novel Insights into the Mechanisms of Short-Term Synaptic Plasticity Underlying working Memory

Dr. Priti Krishna (University of Western Ontario)
November 11, 2004

Plant hsp90: Some Conservation and some Novelty

Dr. Chantal Autexier (Bloomfield Center for Research In Aging, McGill University)
November 25, 2004

Telomerase Structure, Function and Regulation: Implications for Cancer and Aging

Dr. Aled Edwards (Toronto General Research Institute)
December 9, 2004

Genome Scale Structural Biochemistry

Dr. Ralph Greenspan (Neuroscience Institute San Diego)
December 10, 2004

Arousal, Attention and the Rudiments of Consciousness in Drosophila

EEE (evolution, ecology, ethology) Seminar Series

Chad Johnson (University of Toronto)
October 6, 2004

The ecology and evolution of sexual cannibalism: exploring the multi-variate behavioral phenotype

Kate Jackson (University of Toronto)
October 20, 2004

How snakes eat snakes (and why)

James Umbanhowar (University of Guelph)
October 27, 2004

Integrating mutualisms into community theory: a case study with the mycorrhizal symbiosis

David Galbraith (Royal Botanical Gardens)
November 3, 2004

Exploring new options for research at Royal Botanical Gardens

Marie-Josée Fortin (University of Toronto)

November 10, 2004

From structural to functional landscape connectivity

Ben Evans (McMaster University)

November 17, 2004

Duplicate gene evolution in clawed frogs

Hélène Cyr (University of Toronto)

November 24, 2004

Benthic biofilms in Canadian Shield lakes

James Fullard (University of Toronto)

December 1, 2004

Auditory degeneration in bat-released moths: hear today, gone tomorrow

Grant Hurlburt

December 8, 2004

Relative Brain Size In Alligators and Dinosaurs: Implications for the Evolution of Endothermy

Andrew Mason (University of Toronto)

December 15, 2004

Multimodal courtship signals in jumping spiders

Origins Institute Seminar Series

Dr. Sir Martin Rees, University of Cambridge, United Kingdom

20 October 2003

Life in Our Universe and Others

Dr. Stuart Kauffman, Santa Fe Institute

13 November 2003

Molecular Autonomous Agents - a Possible Physical Definition of Life

Dr. James Ferris, Rensselaer Polytechnic Institute, New York

1 December 2003

From the Big Bang to the Origins of Life - an Approach to the Formation of the RNA World

Dr. Alan Boss, Carnegie Institute, Washington

22 January 2004

Looking for Earths: The Race to Find New Solar Systems

Dr. Norman R. Pace, University of Colorado at Boulder

18 March 2004

A Molecular View of the Origin and Large-Scale Evolution of Life

Dr. Donald Clayton, Clemson University

4 November 2004

The Origin of the Atoms of our World

Symposium on Environmental Genomics

“Environmental Genomics: Current applications and potential”

McMaster University, May 7, 2004

Dr. Ed DeLong (Monterey Bay Aquarium Research Institute)

Exploring the marine microbial world: from genomes to biomes

Dr. Terry McIntyre (Division for Environment Canada)

Putting a Green Thumb on Genetics - New Vistas for Environmental Genomics in Canada

Dr. Brian McCarry (McMaster University)

Aromatic Hydrocarbons in Urban Air: From Chemical Analysis and Source Apportionment to DNA Microarrays

Dr. Jim Quinn (McMaster University)

Pollution-induced germ-line mutations in tandemly repetitive DNA

Dr. Barbara Moffatt (University of Waterloo)

*Transcriptional and metabolic responses to abiotic stress of *Thellungiella salsuginea**

Dr. Turlough Finan (McMaster University)

*The *Sinorhizobium meliloti* genome project*

EXTERNAL SEMINARS

(Seminars given at outside institutions by members of the Biology Department)

Cameron, R. 15th International Plant Protection Congress, Beijing China.

*Induced Resistance in *Arabidopsis*.*

Cameron, R. 15th International Arabidopsis Conference, Berlin Germany.

Involvement of DIR1, a putative lipid transfer protein, in long distance signaling during Systemic Acquired Resistance.

Chow-Fraser, P. 7th Intecol International Wetlands, Utrecht, The Netherlands. “Role of Water-level fluctuations in lakes and wetlands” Special Invited Symposium, July 30, 2004.

Ecosystem response to changes in water level of Great Lakes marshes.

Cowan, R, Kassam, S., Pitsikas, P. and Rainbow, A.J. 31st Annual meeting of the American Society for Photobiology, Seattle, WA. July 2004.

Repair of DNA damage induced by methylene blue plus visible light in human and Chinese hamster cells.

Lee, D. and Rainbow A.J. Annual Meeting of the Association for Radiation Research, Missenden Abbey, Buckinghamshire, UK, May 2004.

Human cells with mutations in the mismatch repair genes hMLH1 or hMSH2 are deficient in the repair of UV-damaged DNA.

Lee, D.F. and Rainbow, A.J. 31st Annual meeting of the American Society for Photobiology, Seattle, WA. July 2004.

The role of the human mismatch repair genes hMSH2 and hMLH1 in the repair of oxidative DNA damage induced by UVA.

Pitsikas, P. and Rainbow, A.J. 16th Lorne Cancer Conference, Lorne, Victoria, Australia, February 2004.

The role of the human mismatch repair genes hMLH1 and hMSH2 in the repair of oxidative DNA damage induced by methylene blue plus visible light.

Campus and City Life

McMaster University

McMaster University, established in 1887, has occupied its present site in the beautiful west end of Hamilton since 1930. Faculties include those of Science, Engineering, Health Sciences, Humanities, Business and Social Sciences. Preliminary reports of full-time registration this year are about 17,033 undergraduate and 2,231 graduate students. Collaboration between the various departments of McMaster and studies in interdisciplinary areas are a valuable feature of the scientific research programs in the University. In the Department of Biology, research may be undertaken entirely within the Department or in conjunction with other Departments such as Anatomy, Biochemistry, Geology & Geography, Pathology, Physics and Psychology.

The University contains a well-equipped Physical Education Complex which houses an Olympic size swimming pool, racquet ball and squash courts and gymnasias for year-round sports activities. Among the sports activities organized in the University, a renowned Climbing and Caving Club deserves special mention. At appropriate seasons, golf, skiing and sailing are available in the area.

Visit these links for more information about the University and its facilities and services.

About McMaster: www.mcmaster.ca/welcome/aboutmac.cfm

Relocating to McMaster: www.mcmaster.ca/welcome/relocate/

Hamilton – The City

Hamilton (a city with population ~300,000) is located between Toronto and Niagara Falls. It is situated at the extreme western tip of Lake Ontario. The Niagara Escarpment (locally known as “the mountain”), which cuts through the city provides an excellent view of the city and its natural harbour. Hamilton is about an hour’s drive from Toronto International Airport. In addition, it is less than two hours away from the Buffalo (N.Y.), the closest border of United States.

The city has two major sports activity centres, the Victor K. Coppers Coliseum and the Ivor Wynne Stadium. The latter is used by the Hamilton CFL Football team the Tiger Cats. In addition, Hamilton Place, one of the finest concert halls in Canada, attracts a variety of plays, musicals, ballets and concerts.

The average winter temperature in Hamilton ranges between 0 and -5°C. The snowfalls are lighter compared to the other Canadian cities. The summer temperatures range between 20 to 35°C.

For details about Hamilton, please visit the website <http://city.hamilton.on.ca>.

Housing & Transportation

Housing in Hamilton is generally easy to find around the University campus. Often houses become available when University employees go on research leave. While rents vary depending upon the location and condition of the building, they range between \$500 to \$2000 per month.

The local newspaper “The Hamilton Spectator” is a good source for accommodation advertisements. In addition, the McMaster student housing office (in Wentworth House) is another helpful resource.

The City and surrounding areas have efficient transportation services. The services are provided by the Hamilton Street Railway (HSR) bus system and GO train and bus systems.

For details please visit the following websites:

www.macocho.com/index.cfm

www.city.hamilton.on.ca/Living-Here/Transit/Current-Schedules/default.asp

www.gotransit.com/publicroot/default.htm

Contacts

McMaster University: 905 525-9140

For phone numbers on campus, only the extension is indicated in the following list.

Name	Office extension	Lab extension	E-mail
Abha, Ahuja		27413	ahujaa2@mcmaster.ca
Abou Chakra, Maria		27676	abouchm@mcmaster.ca
Al-daoud, Fadi		27994	
Alves, Lara		27257	alvesl@mcmaster.ca
Aly, Khaled Ahmed		27410	mohamkaa@mcmaster.ca
Balshine, Sigal		23024	sigal@mcmaster.ca
Baron, Christian	26692	27410	baronc@mcmaster.ca
Baxter, Marilyn		(905) 527-7111	barc@mcmaster.ca
Bayley, Stanley T.			
Bédard, André	23149	23154	abedard@mcmaster.ca
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