

ANNUAL REPORT 2015

BIOLOGY DEPARTMENT

MCGILL UNIVERSITY

McGill University
Biology Department Annual Report
2015

The Department of Biology takes responsibility for undergraduate teaching, graduate teaching and research in the life sciences.

The Biology Department offers a popular Major program and operates or contributes to several other Major and Minor programs. It also offers large-enrolment courses to students in other Faculties, especially those intending to enter medical fields. The central principle of the undergraduate program is the design and delivery of courses by professors. Almost all the courses in our programs are given by full-time or affiliated tenure-track academic staff of the Department; we do not use course lecturers or sessional teachers, except in exceptional circumstances. Moreover, all the faculty members participate in undergraduate teaching. The undergraduate program is at the heart of the Biology Department.

Graduate training in the Biology Department is firmly based on the apprentice model: both MSc and PhD programs emphasize bench research in close collaboration with a faculty member who acts as supervisor. Although coursework makes only a minor contribution to the degree, we have developed a wide range of advanced and specialized courses for graduate students. The graduate program is attractive and highly selective. Financial support for graduate students from Faculty allocations, teaching assistantships and research funds is offered for the duration of the program. Retention rates are high and graduation is timely. Most of our doctoral students succeed in obtaining academic employment.

Almost all faculty members are actively engaged in research supported by operating grants from the Tricouncil agencies. Our research programs fall into three clusters of related fields: the Conservation, Ecology, Evolution and Behaviour (CEEB) group, the Cellular, Molecular and Development (CMD) group, and the Neurobiology (Neuro) group. They are supported by a range of facilities, research centres and field stations. Publication rates are high and rising, and faculty members publish many highly-cited papers in high-impact journals. As an indicator of superior research performance, peer-reviewed NSERC and CIHR awards are consistently above the national average. Our members have received many national honours, and the Department includes four FRSC, ten CRC holders and two recent Steacie Fellows.

Department members play a full part in the mission and governance of the University. They teach students from many other Faculties, and are closely involved in Field Semester programs. Two members are Associate Deans, and others serve on some of the most important university committees. Several faculty members have made prominent contributions to local, national and international organizations devoted to outreach and policy development.

Teaching and learning.

The Biology Department is responsible for core teaching in biology in science and biomedical departments. It delivers large introductory laboratory and lecture courses as well as a full suite of advanced courses. It also has a large graduate program. The statistics underline the extent of undergraduate and graduate teaching undertaken by the Department.

Graduate and undergraduate teaching. 92 students graduated with a Biology BSc degree, and 32 with a BASc, maintaining the level of previous years. In all, 420 students were enrolled in Biology programs, and the overall enrolment in Biology courses, from all sources, stood at 5971 students. Total enrolment shows a decrease from recent years (6447 in 2014), probably reflecting increased enrolment in the Neurobiology program.

The number of MSc students was steady at 62, about the five-year average, while the number of PhD students continued to climb, reaching a new high of 121. This represents an increase of 36% in the number of PhD students over the last five years, and confirms the trend towards an increasing proportion of graduate students in the PhD program.

The Department consciously strives to improve the quality of teaching at all levels. This was underscored last year by the success of **Andrew Hendry** in winning the Principal's Prize for Excellence in Teaching. He follows **Gary Brouhard** and **Laura Nilson** as a winner of this prestigious award, confirming the very high quality of undergraduate teaching offered by the Department. Prof Hendry is also Director of the NSERC CREATE program *Biodiversity, Ecosystem Services and Sustainability*. He stepped down as Director of the joint McGill-Smithsonian Neotropical Environment Option and was replaced by **Brian Leung**.

Tamara Western was appointed Associate Dean (Academic) and joins **Laura Nilson**, Associate Dean of Graduate and Postdoctoral Studies, in the suite of the Dean of Science in Dawson Hall.

The McGill Biology Students Union (MBSU) and the **Biology Graduate Students Association (BGSA)** both proposed important initiatives in 2014 for renovating space in the building so as to better serve undergraduate and graduate students. We have begun to install study spaces for undergraduates in the public areas of the Stewart building, and hope to expand this program in 2016 despite uncertainty about the future of the building. BGSA moved into its first permanent office space on the second floor, near the main courtyard entrance of the Stewart Building.

Research and publications.

Faculty in the Biology Department continued to push back the boundaries of knowledge in 2015. A list of all publications can be found at: <http://biology.mcgill.ca/biopubs2015.html>. Department members published 151 papers in 2015, a rate of nearly three a week, continuing the steady increase in research output that has doubled the publication rate in the last decade. Many of these papers were published in the top flight of academic journals – *Nature* (plus *Nature Communications*, *Nature Microbiology* and *Nature Cell Biology*), *Science*, *Cell*, *Proceedings of the National Academy of the USA*, *Proceedings of the Royal Society*, and others - and have a very high impact on their field. Here are three examples of fundamental contributions to biology published in leading journals.

- The research group headed by **Graham Bell and Andrew Gonzalez** extended the scope of ‘evolutionary rescue’ to whole communities (<http://www.pnas.org/content/112/46/14307.short>) . Community rescue occurs when populations within a community evolve in response to an environmental stress that was initially lethal to all the constituent organisms. They studied how communities of soil microbes can extend the area they occupy to include conditions that were initially lethal, and how these communities can persist despite the degradation of environmental conditions. Their results suggest that entire communities have the potential to adapt to severe environmental stress. Community rescue is promoted by the initial diversity in the community, is more frequent among communities that have previously experienced intermediate sublethal levels of stress, and is facilitated by the dispersal of organisms across the landscape.
- **Siegfried Hekimi’s** research group continued their work on ageing with a review published in *Science* of the role of mitochondria, the energy-producing component of the cell, in the characteristic process of ageing (<http://science.sciencemag.org/content/350/6265/1204>). It has often been argued that mitochondrial failure, or damage to mitochondria, is a major cause of senescent decline. Wang and Hekimi argue that, on the contrary, signalling from mitochondria can be manipulated to slow down the rate of ageing.
- **Ehab Abouheif’s** group continued their investigations of complex quantitative traits, like size and behaviour, in ants (<http://www.nature.com/ncomms/2015/150311/ncomms7513/full/ncomms7513.html>) . Quantitative trait variation is the product of both genetic and environmental factors, yet little is known about the mechanisms through which their interaction generates this variation. Epigenetic processes, such as DNA methylation, can mediate gene-by-environment interactions during development to generate discrete phenotypic variation. Abouheif’s group showed that DNA methylation in the carpenter ant indirectly regulates quantitative methylation of a conserved cell-signalling gene and thereby generates continuous variation in the size of workers. This

mechanism, alongside genetic variation, may determine the phenotypic possibilities of loci for generating adaptive variation in natural populations.

The Department has a prominent international presence and the results of research by faculty are diffused throughout the world. Besides numerous speaking engagements in Canada and the USA, Department members gave invited seminars in Australia, Belgium, China, France, Germany, Italy, Japan, the Netherlands, Panama, Spain, Switzerland, Taiwan, Turkey and the UK.

Impact. The discoveries made by faculty members go beyond fundamental research. For example, **Catherine Potvin** spearheaded a large pan-Canadian scholarly initiative that currently counts 64 researchers from across Canada and across disciplinary fields from philosophy to engineering. The [Sustainable Canada Dialogues](#) aims to propose a range of science-based and viable policy options that could motivate change to help Canada in the necessary transition to more sustainable development. Through the mobilization of scientific expertise, the initiative is founded in identifying positive solutions to overcome obstacles to sustainability. This group of scholars developed a draft Climate Action Plan for Canada that was made public on 18 March 2015. Following the release of our first report Prof Potvin engaged, very actively with both traditional and non-traditional communication media to share the finding of our research.

Andrew Gonzalez was being instrumental in launching the Montreal hub of Future Earth in February 2015, at an event attended by the Premier of Quebec, Philippe Couillard, the Mayor of Montreal, Denis Coderre, and the Chief Scientist of Quebec, Remi Quirion: (see interviews at <http://montrealgazette.com/news/local-news/montreal-lands-future-earth-bureau>). The main opening event, attended by about 300 people, was held at the Société des Arts Technologiques on 9 April 2015: <http://www.futureearth.org/news/forum-future-earth-montreal>.

Funding. The research infrastructure of the Department continues to grow. The total research support to Biology faculty through operating and equipment grants, principally from the major science funding agencies (NSERC, CIHR, CFI and FQRNT), amounted to \$20.7M, an average of over \$500,000 per professor. This included a major contribution from the CFI proposal ‘An Integrated Quantitative Biology Initiative’, spearheaded by **Jackie Vogel**, which was awarded in March 2015 and will be crucial in advancing the quality of our research infrastructure. Excluding this large infrastructure grants, research support remains very strong at nearly \$8M, and has almost doubled in the last five years. The main shift in funding that underlies this remarkable success is the increased participation of Department members in CIHR programs, where they have been very successful in obtaining funding.

Involvement in the community.

Biology faculty participate fully in local, regional and federal programs. The main public interface of the Department is at the Gault Nature Reserve, where **Gregor Fussmann** serves as Director. Besides hosting a number of active research programs, the Reserve has a Nature Centre that welcomes about 200,000 visitors each year.

Department members participate in a broad range of provincial and national agencies. **Rudiger Krahe** serves as Section Chair of Animal Stream of Evaluation Group 1502 (Biological Systems and Functions) of NSERC. **Dan Schoen** chairs the Working Group on Plant Reproductive Biology in the NSERC-Canadian Pollination Initiative. **Louis Lefebvre** serves as a member of the Comité des Programmes Universitaires (Ministère de l'Éducation), a crucial group that advises the Minister on the acceptance of all new university programs. **Paul Lasko** is the Scientific Director of the CIHR Institute of Genetics and chairs the executive committee of the International Rare Diseases Research Consortium. **Graham Bell** ended his term as President of the Royal Society of Canada.

Martin Lechowicz holds the Liber Ero Chair in Conservation Biology and has promoted conservation research and outreach through the project on “Sustaining a Green Identity at the Western Perimeter of Greater Montréal”. This includes a formal entente with the town of St-Lazare to gather data and create tools for urban planning that weigh competing priorities such as development and ecosystem services. This initiative has produced a range of working papers and reports to shape discussions of green and blue corridor networks in the western sector of the Montreal Urban Community.

Department members also make important contributions to science education and science policy inside and outside Canada. **Ehab Abouheif** is a founder and co-Director of the McGill Centre of Islam and Science. **Lauren Chapman** serves as an honorary lecturer in the Department of Zoology at Makerere University, the national university of Uganda, and assists in their graduate program. **Catherine Potvin** acts as Special Scientific Advisor to the National Authority for the Environment of Panama and plays an important role in developing policy in areas such as deforestation.

Partnerships. The Department is the focus of several major partnerships. **Andrew Gonzalez** is Director of the Quebec Centre for Biodiversity Science, an FQRNT-funded network that links 70 researchers from universities across Quebec, along with hundreds of graduate students and postdocs. The Centre won renewal in 2012 at a considerably increased level of funding – a remarkable achievement in the contemporary fiscal climate – and continues to expand its activities. **Frédéric Guichard** is co-Director of the Centre for Applied Mathematics in Bioscience and Medicine, which likewise links a large group of researchers in Montreal and

elsewhere. **Nam-Sung Moon, Laura Nilson** and **Dan Schoen** organized *CanFly*, the major national meeting for researchers using the fruitfly *Drosophila* as a model organism for research in genetics. **Jackie Vogel** has continued to develop the Quantitative Biology initiative, which involves faculty from five departments at McGill and two at Université de Montréal.

Honours and Awards.

Principal's Prize for Excellence in Teaching. This prize was instituted recently to celebrate exceptional individuals who embody the best in teaching, supervising, advising and mentoring. It was awarded this year to **Andrew Hendry**, who has developed what he calls “inspiration-based teaching” as his model in the classroom. Lectures must be dynamic, engaging and inspiring. “My lectures – even in the largest classes – aspire to be a tour-de-force immersive experience that includes video, social media, hands-on demonstrations and performances,” says the man who employs everything from live snakes, full gorilla skeletons and interpretive dance as classroom aids. Prof Hendry is the originator, administrator, and primary contributor to the *Eco-Evo Evo-Eco* blog. The blog has more than 347,000 page views since its inception, including approximately 156,000 page views in 2015. In the last year, it was twice featured in commentaries in *Nature*, once online (doi:10.1038/522009f) and once in the journal itself (523:491-493).

Catherine Potvin was elected as a Fellow of the Royal Society of Canada. She was awarded the Mirosław Romanowski Medal by the Society in 2014.

Milestones.

An Integrated Quantitative Biology Initiative. **Jackie Vogel's** successful bid for major CFI funding will not only provide state-of-the-art molecular biology equipment for the Department but will also advance the Quantitative Biology option in the Biology Major program. This option is designed for students with a deep interest in biology who wish to gain a strong grounding in physical sciences and their application to biological questions. The Quantitative Biology option has two streams: an ecology and evolutionary biology stream, and a physical biology stream. Both streams provide a balance of theory and experimental components. Prof Vogel has been instrumental in developing this innovative contribution to interdisciplinary undergraduate teaching in biology.

Irene Gregory-Eaves was appointed to a Canada Research Chair (Tier 2). The goal of Prof Gregory-Eaves' research is to provide a long-term and large-scale context for understanding how human activities alter aquatic ecosystems. Her recent and ongoing work largely falls into one of three thematic areas: quantifying past changes in fish populations and understanding how these dynamics affect freshwater ecosystems; advancing knowledge on eutrophication and shallow

lake ecology; and studying northern lakes as sentinels of environmental change. Prof Gregory-Eaves has established herself as a leading figure in the fields of limnology and palaeolimnology. She joins other Department members who have recently been appointed to a Canada research Chair: Andrew Gonzalez in 2014, Catherine Potvin, Melania Cristescu and Rodrigo Reyes-Lamothe in 2013, and Lauren Chapman in 2012.

New faculty. We have hired three new professors who will be joining us in the next academic year: **Stephanie Weber** (molecular biology) arrives in August 2016, with **Anna Hargreaves** (conservation biology) and **Tomoko Oyama** (neurobiology) following in January 2017. All come with exciting research programs that will sustain our reputation as an internationally renowned full-service biology department.

The future of the Biology Department

The Biology Department is currently undertaking a fundamental review of its research and teaching programs over the next thirty years. This has been prompted by two developments that will inevitably alter the historical priorities of the Department.

The first is the shift of focus within the general area of biology. Our Department is currently structured around three major axes: molecular biology (including genetics and development), ecology (including evolution and conservation) and neurobiology. In the past, these three areas were clearly delineated and mutually exclusive. Over the last decade, they have tended to move together and even merge, creating hybrid fields such as evolutionary developmental biology, in which methods and approaches from two or more traditional areas are combined. We believe that this trend will continue, in part because new technologies will enable us to pose new questions, or bring more powerful methods to bear on old problems that have resisted solution in the past.

The second development is the strong likelihood of a radical renovation of the Stewart Biology Building, brought about by the need to replace aging infrastructure and remove asbestos. This will provide us with a unique opportunity to refresh the academic mission of the Department and construct the facilities that will enable us to reinforce our position as a major research department in North America and a major teaching unit within the University.

We have gone through two preparatory planning exercises recently to sharpen our vision of the future of the Department. The first was a faculty Retreat in April 2015 to discuss the design of the renovated Stewart Building in relation to the goals of the Department. The second was the Cyclical Review, which entailed a thorough study of all aspects of the Department's activities by an external panel. The report of this panel was released in May 2015 and provides an objective assessment of the current status of the Department and an appraisal of its plans.

These two exercises have convinced us that the organizing principle for the Department should be the integration of themes from areas of biology that are normally considered distinct into a single research program. We aim to configure both the academic profile of the Department and the physical design of the renovated Stewart Building so as to maximize our ability to mount integrated research programs.

The Biology Department continues to make an exceptional contribution to McGill University in every area of academic activity. In particular, **the productivity of Biology faculty in 2015 maintained or surpassed previous levels of research output, grant income, undergraduate teaching and graduate training.** Faculty, staff and students will work together to ensure that we remain at the forefront of modern research and teaching in the study of life.