Quantitative Life Sciences Ph.D. Program Proposal

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Prepared By:

Peter Grutter Chair of QLS Committee, Physics
Mathieu Blanchette Computer Science
Guillaume Bourque Human Genetics
Erik Cook Physiology
Celia M T Greenwood Oncology/Epidemiology and Biostatistics
Frédéric Guichard Biology
Sabine Dhir Graduate and Postdoctoral Studies
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EXECUTIVE SUMMARY

We propose a novel inter-department and inter-faculty Ph.D. training program in Quantitative Life Sciences to produce the next generation of leaders in the rapidly changing world of biology, medicine and biotechnology. This program has been designed from the ground-up with close consultation with all stakeholders to produce graduates with the quantitative and interdisciplinary skills that Quebec and Canada need to maintain their positions as world-leaders in bio- and life-science research. It builds on, integrates and expands many currently loosely connected initiatives at McGill and will enable a stimulating, sustained and exciting interdisciplinary training environment.

The Quantitative Life Sciences Program (Figure 1) fits centrally into a rapidly expanding interdisciplinary field that includes ecology, physiology, genetics, systems biology, computational biology, bioinformatics, mathematical biology, evolutionary biology and biophysics among others. Overall, the goal of these research fields is to understand the biological whole: how the complex interactions among the individual components (e.g., molecules, genes, cells) underlie entire living systems (e.g., cells, organisms, environments). To achieve this goal, active research lies at the interface between biological processes and advanced mathematics, physics, statistics and computer science. Here we are proposing an interdisciplinary doctoral level program to support this endeavor.

Figure 1. The Quantitative Life Science Program will train the next generation of multidisciplinary researchers needed to bridge the life and quantitative sciences. In addition, this new graduate program will facilitate collaborative life science research that cuts across departments and faculties at McGill University.

At the core of this proposal is a large multidisciplinary group of McGill researchers focused on quantitative approaches to understanding genetic, molecular & physiological systems, global ecosystems and disease interactions. McGill University has been very successful in hiring and bringing together interdisciplinary researchers to tackle the most important life science questions. The University has also taken first steps toward facilitating interdisciplinary training (e.g. through department specific graduate options and several research Centres or NSERC/CIHR funded training programs), but it still lacks a cohesive, cross-department and cross-faculty graduate program to train our students in this essential multidisciplinary field. We thus propose an interdisciplinary Ph.D. training program engaged in applied mathematical, statistical, physical and computational research that connects to all aspects of the life sciences, and capitalizes on the commonalities in quantitative methods in disparate fields.
Key elements of the proposed program have been designed to broaden the contextual knowledge of students, to encourage interactions between traditional fields of research and to create a sense of community. For example, a core course including a series of in-depth case studies will demonstrate links between quantitative methods and life sciences research in many different contexts. The depth of the proposed Ph.D. program is built around three different areas of research, or streams, defined by the type of biological questions being addressed and the quantitative approach being used (additional streams may be added later depending on the evolution of the field and demonstrated sufficient interest). Co-supervision of graduate students between life and quantitative researchers will be strongly encouraged. The program’s streams are:

- **Computational and statistical molecular biology**: Quantitative methods in genetics/genomics and molecular biology
- **Biophysics**: Application of physical principles, development of tools and modeling approaches to quantitatively study biological systems, including biomolecules.
- **Ecosystems**: Mathematical and computational approaches in ecology and evolution.

The interest and the demand for interdisciplinary research in quantitative life sciences has led to the formation of new international graduate programs in the US and Europe, which emphasize quantitative research skills applied to the life sciences. Worldwide, governments and industry have begun to invest in quantitative life science and many top research universities worldwide have launched similar themed programs. This proposal is timely, and already in demand by McGill University students and researchers.
1. **PROGRAM IDENTIFICATION**

Program title: Quantitative Life Sciences  
Degree title: Ph.D.  
Unit responsible: Interfaculty Studies (IFS); Participating units: Medicine and Science.

2. **RATIONALE FOR THE PROPOSED PROGRAM**

2.1 **ACADEMIC AND CULTURAL**

2.1.1 **Evolution of the Quantitative Life Science Discipline**

Quantitative Life Sciences is the broad application of mathematical, computational and other quantitative methods to study biological systems at all scales - from single molecules to the environment\(^1\)\(^-\)\(^4\). It is part of a rapidly expanding field that includes such specializations as systems biology, bioinformatics, biophysics, medical informatics, computational biology, computational pharmacology, computational neuroscience and mathematical biology. The motivation for establishing a training program in Quantitative Life Sciences is the recognition that the most important and challenging problems in biology, medicine and the environment, will not be solved without a highly interdisciplinary approach that brings together students and researchers across all scientific disciplines and university faculties. This new Ph.D. program will train the future generation of researchers in the quantitative methods (mathematics, statistics, measurement, computer simulation and data analysis) needed to advance the rapidly changing landscape of the life sciences.

There are several major forces driving the need for quantitative methods in the life sciences. First, the high cost and slow timeline of translational bioscience research has become a serious concern for all stakeholders. For example, a conservative estimate for bringing a new drug to market is over one billion USD\(^5\), and major funding agencies, including CIHR, NIH and UK’s MRC, have targeted computer-based predictive models in drug development as a “critical path” for the future\(^6\)\(^-\)\(^8\). Second, we lack the quantitative tools needed to translate the vast amounts of data now generated by high-throughput bioanalysis systems into useful outcomes\(^9\). A promising solution to reduce cost, accelerate development and illuminate existing data is to apply powerful mathematical and computational tools to life science research. For example, entire ecosystems can be modeled, expression products of gene networks can be predicted, and drug interactions can be explored more cost effectively and quickly using mathematics and computer science\(^10\). Finally, new technologies and quantitative tools are rapidly changing the way traditional bioscience research is performed. For example, new imaging technologies have provided unprecedented views of living cells\(^11\) while computational methods have revolutionized genomics\(^12\). Hence, developing and applying novel methods in physics, computer science, mathematics, and chemistry to solve the most pressing biological and medical challenges is a societal priority for future generations. As a demonstration of societal interest, a Pan-Canadian thematic program on Models and Methods in Ecology, Epidemiology and Public Health, was recently held as part of the international Mathematics of Planet Earth 2013 project\(^13\).
2.1.2 Originality of the proposal

Given the need to combine different theoretical orientations, methodologies and methods, creating an Interdisciplinary Program in Quantitative Life Sciences requires a highly original approach that spans departments and faculties across the University. There are only a few graduate programs in Canada that emphasize interdisciplinary life science research (for further clarification, see section 2.4.2.), and these programs are mostly limited to degree options within a single faculty or department.

Although there is a clearly recognized need for the life and health sciences at McGill to become more interdisciplinary, many of McGill University’s current graduate programs do not attract undergraduate students outside of the traditional life science fields. For example, of the 35 graduate students newly recruited in 2014 to McGill’s basic science biomedical departments (Anatomy & Cell Biology, Biochemistry, Microbiology & Immunology, Pharmacology & Therapeutics, and Physiology), only one student had undergraduate training in the quantitative or physical sciences. As described below (section 2.4.2), there are now many new interdisciplinary graduate programs in the Quantitative Life Sciences in the US and Europe. These new programs offer competing opportunities for the best McGill, Quebec and Canadian undergraduate students with quantitative science backgrounds to pursue graduate training in the quantitative life sciences abroad. With our new interdisciplinary graduate program, we hope to retain many of these excellent students at McGill.

As documented below (section 2.1.6), during the last decade McGill University has successfully developed several department specific graduate options, research centres, and NSERC/CIHR funded training programs that facilitate interdisciplinary training in the life and quantitative sciences. Unfortunately, these existing programs lack the ability to train students outside of existing departments and faculties. In addition, many of these NSERC/CIHR externally funded programs will be ending in the next few years. Our proposed Ph.D. program expands upon these successful McGill initiatives to create a permanent cross-department and cross-faculty graduate program to train our students in this multidisciplinary field.

2.1.3 Definition of body knowledge

In the proposed Quantitative Life Sciences Ph.D. Program, students will learn the broad application of mathematical, computational and other quantitative methods to study life science systems at all scales - from molecules to ecosystems. Specifically, students will gain skills and knowledge in the following key areas:

- Foundations of life science, with a focus on how quantitative approaches can best contribute to scientific advancement.
- Application and understanding of advanced technologies and tools used to measure living systems.
- Experimental techniques in relation to analysis methods, including how to analyze large life science data sets.
- Quantitative models and computer simulations of life science systems.
- Identification of similar mathematical, computational and statistical techniques that can be applied across life science levels.
- Effective communication and collaboration between traditional and quantitative life scientist.
This Quantitative Life Sciences Ph.D. program will span departments and faculties, and provide breadth of understanding as well as depth of knowledge to core aspects of bioscience research.

2.1.4 Links to the traditional life and medical science discipline

The Quantitative Life Sciences Ph.D. Program will address several critical limitations in McGill University’s current training and research environment.

2.1.4.1 Links to the traditional life and medical science disciplines

McGill University’s traditional department-centered graduate programs in the Faculties of Science and Medicine do not provide the needed breadth of training to optimally prepare the next generation of students for this interdisciplinary field. We anticipate that the proposed regular interactions between researchers across faculties and departments will lead to synthesis of similar concepts used in different fields, and hence to novel insights and new fruitful collaborations. Furthermore, gathering these cross-disciplinary areas of research under one program will increase visibility, ensure high standards and quality control of the training at the interface between two fields, and attract and retain superb graduate students and researchers at McGill University. By creating a bridge between disciplines (Figure 1 above) we expect our new Ph.D. program to enhance and extend the viability of existing life and quantitative science disciplines at McGill University.

2.1.4.2 Links to the bio- and biomedical engineering disciplines

McGill University is currently integrating its existing Biological and Biomedical Engineering training programs between the Faculties of Medicine and Engineering. With their emphasis on the application of methods, paradigms, technologies and devices from engineering to problems in medicine and biology, the Biological and Biomedical Engineering programs complement the proposed training program in Quantitative Life Sciences (QLS). Broadly speaking, Biological and Biomedical Engineering focusses on (i) the design of devices and approaches to measure aspects of biological systems (microscopes, DNA sequencers, microfluidics, etc.), (ii) the design of engineered biological systems (proteins, cells, bacterial communities, etc.) to perform specific functions, and (iii) the design of engineering solutions to medical problems (e.g. artificial tissues). In contrast, QLS is centered on the data analysis aspects of the study of fundamental questions about biological systems. Although these analyses are often based on measurements obtained from devices built by bioengineers, they usually offer their own, distinct set of challenges, both in terms of the approaches used (mathematics, statistics, computer science), and in terms of the biological interpretation of their results. The Biological and Biomedical Engineering and Quantitative Life Science fields are thus highly synergetic: many aspects of QLS would be impossible without devices to measure biological systems, while the impact of these devices would be limited without sophisticated approaches to make use of their measurements.

Most of the newly formed and successful graduate programs in Quantitative Life Sciences in North America exist alongside equally successful Biological or Biomedical Engineering training programs (also see Section 2.4.1). This is because experience has taught us that the broad differences in terms of the nature of the questions addressed, the background required to make a contribution, and the type of education provided, require both educational environments. Thus, Quantitative Life Science and Biological and Biomedical Engineering programs
are highly complementary and together provide a beneficial research and training environment for students and faculty across the university research environment. At McGill, the proposed Program in Quantitative Life Sciences will maintain strong links with Biological and Biomedical Engineering and be open to participation from all researchers in the Faculty of Engineering.

2.1.5 Future developments in Quantitative Life Sciences

In 2006, a group of 111 interdisciplinary researchers from universities across Canada published an important and influential paper that highlighted the need to strengthen the Quantitative Life Sciences\textsuperscript{14}. The main conclusion of their analysis was that the blending of the physical, computational and biological sciences had now become critical to all new advances in biology and medicine, with enormous economic and social impacts. It was also noted that Canada lagged significantly behind in terms of government and academic initiatives needed to promote this new field. Since then many small initiatives have been developed, including several at McGill and in Quebec, that have helped move Canada closer to the forefront of this important trend. In this section, we present evidence that quantitative methods have become an integral part of health and life science research.

Across all life science disciplines, it is commonly accepted that quantitative approaches improve research outcomes by bringing powerful new methods for understanding biological processes that range from biomolecules to the environment. For example, mathematical and computational approaches are needed to support traditional research methods in order to make sense of the thousands of genetic alterations now shown to be associated with cancer\textsuperscript{15}. This type of interdisciplinary research now commonly appears in all major academic journals and there are currently over 650 journals specifically dedicated to multidisciplinary research in chemistry, computer science, engineering, physics and psychology alone according to the scientific citation indexing service Web of Science.

Recently, new scholarly societies have been formed that highlight quantitative life sciences, such as the International Society for Systems Biology, International Society for Computational Biology, Canadian Genetics and Genomics Society, and Canadian Society for Systems Biology. These new societies join existing organizations such as the Society for Mathematical Biology, Institute for Electrical and Electronics and Engineers, and the Biomedical Engineering Society that have traditionally included computational bioscience and bioinformatics as part of their membership domain. In Quebec, the multi-institutional Centre de Recherches Mathématiques regularly supports workshops and meetings that focus on life science applications\textsuperscript{13}. At McGill, the Centre for Nonlinear Dynamics and the newer Centre for Applied Mathematics in Bioscience and Medicine (CAMBAM)\textsuperscript{18} has organized numerous meetings and summer schools in Montreal that focus on the link between quantitative methods and life science research.

2.1.5.1 Importance to future environmental resource management

Computer models have become a critical component for predicting the behaviour of essential environmental resources. The complexity of environmental problems, such as pollution and climate change, and the loss of biodiversity, require quantitative approaches that can cope with the inter-connectivity of our planet\textsuperscript{63, 64}. For example, measuring only temperature or the population of a single species is not enough to capture the
biological whole of the ecosystem. We need better quantitative tools to predict environmental damage from human activity and to develop bioremediation programs. In agriculture, computational models are used to predict crop performance as well as other resources that support human populations\textsuperscript{19,20}. The availability of water supplies is now a critical concern of many parts of the world, including North America. Predicting water resources requires sophisticated models that combine long-term weather forecasting, human usage patterns, and population growth estimates. Locally, McGill’s CAMBAM Ecology group has ongoing collaborations with Environment Canada and Fisheries and Oceans Canada to create computational models of the tight link between water-based resources and human activity.

2.1.5.2 Importance to future industry-based research

Quantitative approaches have become a critical component for advancing life science research in industry. Many non-bioscience industrial sectors have already fully integrated mathematical and computational techniques in product development. For example, electrical circuits, automobiles and buildings are now completely designed and simulated using computer aided design techniques before physical manufacturing. While the impact of new computational techniques, such as predictive computer modeling, has affected many bioscience and health sectors including agriculture, medical devices, biodefense, bioremediation and cosmetics, the pharmaceutical industry has particular potential for benefit. The cost of developing a new drug is over one billion USD, and more than six out of seven drugs that undergo human testing ultimately fail\textsuperscript{5,22-24}. Both in vitro cell-line models and in-vivo animal models fall short of capturing the complexity of human physiology\textsuperscript{25}. Thus, even a modest improvement in predicting drug-discovery outcomes using computational methods would produce a substantial cost impact on the pharmaceutical industry\textsuperscript{26-30}. For example, researchers at Astrazeneca use predictive computer models to facilitate cancer immunotherapy research\textsuperscript{31}. Many other companies, such as Chemical Computing Group based in Montreal\textsuperscript{32}, now specialize in delivery of the quantitative and data-analysis methods needed for this new era of pharmaceutical research.

The BiologicalIT sector, a rapidly expanding area within the traditional information technology industry, is another area where quantitative methods are increasingly applied to problems in the life and health sciences. For example, Google has demonstrated its ability to alert healthcare professionals of developing pandemics in real time, with the potential to save thousands of lives per year\textsuperscript{33}. Microsoft has launched initiatives in bioinformatics and computational bioscience research to speed drug development\textsuperscript{34}. IBM has also embraced life science research with new initiatives dedicated to medical informatics, computational biology and biologically-inspired cognitive computing\textsuperscript{35}. Much of this research emphasis is directed at helping traditional life science researchers make sense of the vast amount of life science data generated. In a recent example of how quantitative data-analysis can generate new life science discoveries, IBM’s new cognitive-computing supercomputer system revealed exciting new relationships that were unknown in the existing cancer literature\textsuperscript{36}.  

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2.1.5.3 Importance to future healthcare

Quantitative life sciences approaches have provided governmental agencies with new tools for predicting and tracking disease outbreaks. Mathematics and computation are also rapidly improving how healthcare is delivered. Personalized medicine refers to the revolutionary idea that individuals respond differently to therapeutic interventions depending on their unique physiology. Thus, a patient may have hundreds (or thousands) of unique biomarkers (for example, genomic or proteomic identifiers) that can be used to predict how he/she responds to a given treatment or drug. The plummeting costs of generating biomarkers, a result of technological advances and improved analysis methods, means that the reality of personalized medicine is imminent. In addition, transformation of medical records to digital formats allows computational and data mining methods to identify promising treatment programs that would have gone unnoticed by individual healthcare professionals, and to identify unanticipated drug interactions. Research in the IT industry is now focused on achieving the full potential of personalized medicine. For example, Apple has launched research efforts with the Mayo Clinic to enhance healthcare delivery with its new HealthKit development system. Canada’s health delivery sector lags far behind many other industries and countries in adopting quantitative methods, and thus, CIHR has recently announced an eHealth initiative to advance the development and application of information systems in health delivery.

2.1.6 History and strength of Quantitative Life Sciences at McGill

There is a strong demand among undergraduate students at McGill for a graduate program in Quantitative Life Sciences. The current cohort of undergraduate university students has been quick to respond to this ongoing paradigm shift, but current disciplinary boundaries guiding academic education fail to embrace this exciting challenge. At McGill University, students can choose among 16 undergraduate programs or options that offer training in biological and other quantitative sciences such as physics, chemistry, computer science and mathematics (Table 1). The success of these Quantitative Life Sciences undergraduate initiatives has been remarkable: the number of participating undergraduate students has increased from approximately 650 in 2010 to 909 in 2016. Nevertheless, current disciplinary boundaries make it challenging for these graduating students, and those from other institutions, to find and choose appropriate graduate programs, since the opportunities are spread across so many departments and faculties.
Table 1. Enrollment in multidisciplinary undergraduate programs at McGill in quantitative life sciences.

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<td>430</td>
<td>539</td>
<td>525</td>
<td>571</td>
<td>561</td>
<td>644</td>
<td>599</td>
<td>630</td>
<td>602</td>
<td>635</td>
<td>609</td>
<td>612</td>
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<td></td>
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<tr>
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<td>26</td>
<td>23</td>
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<td>35</td>
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<td>COG SCI Interfaculty</td>
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<td>110</td>
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<td>142</td>
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<tr>
<td>ENVIR Interfaculty</td>
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<td>39</td>
<td>46</td>
<td>44</td>
<td>37</td>
<td>41</td>
<td>28</td>
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<td>33</td>
<td>29</td>
<td>30</td>
<td>25</td>
<td>32</td>
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<td>4</td>
<td>4</td>
<td>5</td>
<td>6</td>
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<tr>
<td>Sustainability, Sci &amp; Soc -H Honours</td>
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<td>5</td>
<td>11</td>
<td>13</td>
<td>19</td>
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<td>27</td>
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Interfaculty Program

<table>
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<th>145</th>
<th>141</th>
<th>190</th>
<th>185</th>
<th>215</th>
<th>209</th>
<th>233</th>
<th>232</th>
<th>275</th>
<th>265</th>
<th>289</th>
<th>272</th>
<th>297</th>
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<tr>
<td>Grand Total</td>
<td>603</td>
<td>571</td>
<td>729</td>
<td>710</td>
<td>786</td>
<td>770</td>
<td>877</td>
<td>831</td>
<td>905</td>
<td>867</td>
<td>924</td>
<td>881</td>
<td>909</td>
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</table>


We believe that the strong demand among undergraduates at McGill reflects similar demands at other universities in Quebec and Canada. In addition, the creation of many new interdisciplinary life science graduate programs in the US and Europe during the last decade (see section 2.4.2 below) suggests a market demand for this type of education, and without a dedicated program, McGill is currently unable to attract graduate students interested in this emerging field.

A diversity of programs, centres and networks at McGill could be envisaged as falling under a quantitative life sciences umbrella. In fact, the existence of so many different groups and departments working at the interface of quantitative methods and biology or medicine (Table 2) speaks strongly to the interest in this area, and to the fact that there are many interested students and faculty. However, many of the externally-funded training programs are reaching the end of their terms soon. Thus, the proposed Quantitative Life Science Program builds upon the success of these initiatives to create a vibrant and sustainable educational environment.

**Table 2. Programs, Centres and Networks in existence at McGill with relevance to Quantitative Life Sciences**

**Centres and Networks**
- Centre for Bioinformatics ([www.mcgill.ca/mcb](http://www.mcgill.ca/mcb)). Modelling biological systems using non-linear dynamics, networks, genomics, population genetics, etc.
- McConnell Brain Imaging Centre ([www.bic.mni.mcgill.ca/Research/Homepage](http://www.bic.mni.mcgill.ca/Research/Homepage)).
- Canadian Center for Computational Genomics ([computationalgenomics.ca/](http://computationalgenomics.ca/))

**Grant funded graduate-level training programs**
- Systems Biology Training Program ([www.mcgill.ca/osb/introduction](http://www.mcgill.ca/osb/introduction)) Applying a range of quantitative techniques to address large-scale research projects. This is a CIHR-funded training grant. (2009-2015)


CREATE Integrated Sensor Systems (www.mcgill.ca/miam/iss) Physics, biomedical engineering, medicine (2010-2016)

CREATE Neuroengineering (www.neuroengineering.ca/) chemists, physicists, engineers, neuroscientists (2011-2017)


<table>
<thead>
<tr>
<th>Interdisciplinary Graduate programs within existing departments</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Integrated program in Neuroscience (<a href="http://www.mcgill.ca/brain/welcome">www.mcgill.ca/brain/welcome</a>)</td>
</tr>
<tr>
<td>● Department of Epidemiology, Biostatistics and Occupational Health</td>
</tr>
<tr>
<td>● Graduate Option in Bioinformatics</td>
</tr>
</tbody>
</table>

2.1.7 Priority area as defined by government or other organizations

The increasingly interdisciplinary nature of academic bioscience research has motivated government funding agencies to reconsider the traditional segregation of the biological, medical and physical sciences. For example, NIH has targeted both Systems Biology and Computational Biology as focus areas in its intramural research program\(^7\). The UK’s Medical Research Council prominently highlights computational and system approaches in each stage of its 2014-19 Strategic Plan\(^8\). In CIHR’s Three Year Implementation Plan and Progress Report 2013-15, bioinformatics and computational biology are highlighted as recent successes\(^6\) and are part of the Institute of Genetics’ research priorities\(^16\). Finally, Génome Canada has promoted computational and bioinformatics-based methods to maintain Canada as a world-leader in genomic research\(^17\).

2.2 Academic/Professorial Staff

2.2.1 Staff resources required, available and projected

2.2.1.1 Full time Academic and Professorial Staff

All fifteen professorial staff associated with the Quantitative Life Science Ph.D. Program are actively engaged in research in one or more of the three streams that together form the proposed Ph.D. Program. The following table lists the participating professors, their position and their major areas of research focus.
<table>
<thead>
<tr>
<th>Name and Academic Training</th>
<th>Position</th>
<th>Research Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mathieu BLANCHETTE, Ph.D.</strong> Post-doctoral fellow (University of California in Santa Cruz). Ph.D. - Computer Science (University of Washington) MSc - Computer Science, (Université de Montréal). BSc - Mathematics and Computer Science (Université de Montréal).</td>
<td>Associate Professor Dept. of Computer Science</td>
<td>Computational genomics; Bioinformatics with applications in genomics, epigenomics, evolution, phylogenetics, gene regulation and proteomics (Ancestral genomics, 3D genomics, epigenetic and gene regulation, mRNA localization, transposable element annotation, plant genome assembly and evolution)</td>
</tr>
<tr>
<td><strong>Guillaume BOURQUE, Ph.D.</strong> Postdoctoral fellow (Centre de Recherches Mathématiques) Ph.D. - Applied Mathematics (Université de Montréal) MA - Applied Mathematiccs (University of Southern California) BSc- Computer Science and Mathematics (Université de Montréal)</td>
<td>Associate Professor Dept. of Human Genetics</td>
<td>Comparative functional genomics; evolution of regulatory sequences; role of transposable elements in host gene regulation; impact of genome rearrangements in evolution and in cancer.</td>
</tr>
<tr>
<td><strong>Erik COOK, Ph.D.</strong> Postdoctoral fellow (Harvard University) Postdoctoral fellow (Baylor College of Medicine) Ph.D. – Neuroscience (Baylor College of Medicine) MEng – Electrical Engineering (Rice University) BSc – Electrical &amp; Computer Engineering (Arizona State University)</td>
<td>Associate Professor Dept. of Physiology</td>
<td>Neuronal communication and neurotransmission; computational modeling of the visual system, neuronal and synaptic activity</td>
</tr>
<tr>
<td><strong>Ken DEWAR, Ph.D.</strong> Postdoctoral fellow (University of Pennsylvania) Ph.D. - Sciences Forestières (Université Laval)</td>
<td>Associate Professor Dept. of Human Genetics Dept. of Experimental Medicine</td>
<td>Advanced DNA sequencing technologies; bioinformatics; genome architecture; comparative genomics</td>
</tr>
<tr>
<td>Name</td>
<td>Degree and barrels</td>
<td>Position</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td><strong>Paul FRANÇOIS, Ph.D.</strong></td>
<td>MSc - Forestry (University of Toronto)</td>
<td></td>
</tr>
<tr>
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<td>BSc - Forestry (University of Toronto)</td>
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</tr>
<tr>
<td></td>
<td>Postdoctoral fellow (Rockefeller University)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ph.D. – Theoretical Physics (École Normale Supérieure Paris, France)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MSc - Theoretical Physics (École Normale Supérieure Paris, France)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diplôme d’Ingénieur – Physics (École Polytechnique Palaiseau, France)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Associate Professor Dept. of Physics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Biological physics; theoretical and computational modeling; theoretical aspects of evolution; signaling networks; vertebrate axis elongation</td>
<td></td>
</tr>
<tr>
<td><strong>Simon GRAVEL, Ph.D.</strong></td>
<td>MSc - Theoretical Physics (École Normale Supérieure Paris, France)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diplôme d’Ingénieur – Physics (École Polytechnique Palaiseau, France)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Postdoctoral fellow (Universität zu Köln, Germany &amp; Kavli Institute for Theoretical Physics, UCSB)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Postdoctoral fellow (Stanford University)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ph.D. – Physics (Cornell University)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MSc – Physics (Université de Montréal)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BSc – Mathematics &amp; Physics (Université de Montréal)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Assistant Professor Dept. of Human Genetics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Population genomics; integration of biological, historical and archaeological information; analysis and genetics of complex population cohorts (settlement of the Americas and Caribbean)</td>
<td></td>
</tr>
<tr>
<td><strong>Celia M T GREENWOOD, Ph.D.</strong></td>
<td>MSc - Theoretical Physics (École Normale Supérieure Paris, France)</td>
<td></td>
</tr>
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<tr>
<td></td>
<td>Postdoctoral fellow (McGill University)</td>
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<tr>
<td></td>
<td>Ph.D. – Biostatistics (University of Toronto)</td>
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</tr>
<tr>
<td></td>
<td>MMath – Mathematics in Statistics (University of Waterloo)</td>
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</tr>
<tr>
<td></td>
<td>BSc – Mathematics (McGill University)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Associate Professor Dept. of Oncology Dept. of Epidemiology, Biostatistics and Occupational Health</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Analysis of rare genetic variation; high dimensional data analysis; development of statistical methodology for genetic and genomics data</td>
<td></td>
</tr>
<tr>
<td><strong>Peter GRUTTER, Ph.D.</strong></td>
<td>MSc - Theoretical Physics (École Normale Supérieure Paris, France)</td>
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<td>Diplôme d’Ingénieur – Physics (École Polytechnique Palaiseau, France)</td>
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<tr>
<td></td>
<td>Habilitation (University of Basel)</td>
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<tr>
<td></td>
<td>Postdoctoral fellow (IBM Almaden Research Lab)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ph.D. (University of Basel)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Professor Dept. of Physics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nanoscience and scanning probe technology; development of atomic force microscopes; electron behaviour; molecular charge transport; solid-liquid</td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Degree Details</td>
<td>Position</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>--------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Frédéric GUICHARD, Ph.D.</td>
<td>Diploma – Experimental Physics (University of Basel)</td>
<td>Professor</td>
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<tr>
<td></td>
<td>Postdoctoral fellow (Princeton University)</td>
<td>Dept. of Biology</td>
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<tr>
<td></td>
<td>Ph.D. – Biology (Laval University)</td>
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<td></td>
<td>BSc – Biology (Université de Montréal)</td>
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<tr>
<td>Anmar KHADRA, Ph.D.</td>
<td>Diploma – Biology (Laval University)</td>
<td>Assistant Professor</td>
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<tr>
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<td>Postdoctoral fellow (Institute for Theoretical Biology, Humboldt University)</td>
<td>Dept. of Physiology</td>
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<td></td>
<td>Postdoctoral fellow (University of British Columbia)</td>
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<td></td>
<td>Ph.D. – Applied Mathematics (University of Waterloo)</td>
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<td>MMath – Applied Mathematics (University of Waterloo)</td>
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<tr>
<td></td>
<td>BSc – Pure Mathematics (Concordia University)</td>
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</tr>
<tr>
<td>Sabrina LESLIE, Ph.D.</td>
<td>Diploma – Physics (University of California, Berkeley)</td>
<td>Assistant Professor</td>
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<tr>
<td></td>
<td>Hon BSc – Physics &amp; Mathematics (University of British Columbia)</td>
<td>Dept. of Physics</td>
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<tr>
<td>Judith MANDL, Ph.D.</td>
<td>Diploma – Population Biology, Ecology &amp; Evolution (Emory University)</td>
<td>Assistant Professor</td>
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<tr>
<td></td>
<td>Hon. BSc – Computational Biology</td>
<td>Dept. of Physiology</td>
</tr>
<tr>
<td>Christopher PACK, Ph.D.</td>
<td>Diploma – Population Biology, Ecology &amp; Evolution (Emory University)</td>
<td>Associate Professor</td>
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</tr>
<tr>
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<td>Department</td>
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<tr>
<td><strong>Research Fellow (Harvard University)</strong>&lt;br&gt;Ph.D. – Cognitive and Neural Systems (Boston University)&lt;br&gt;BSc – Computer Science (Tufts University)</td>
<td>Dept. of Neurology and Neurosurgery</td>
<td>communication; eye movement behaviour; electrophysiology</td>
</tr>
<tr>
<td><strong>Tomi Markku PASTINEN, MD Ph.D.</strong>&lt;br&gt;Postdoctoral fellow (McGill University)&lt;br&gt;Ph.D. – Human Genetics (University of Helsinki)&lt;br&gt;MD – General Practitioner (University of Helsinki)</td>
<td>Associate Professor&lt;br&gt;Dept. of Human Genetics</td>
<td>Large-scale epigenome mapping; functional genomics of pediatric cancers; Genome-wide characterization of regulatory variation in human cells; human disease trait oriented population cell models; impact of perturbation on cis-regulatory variation; identification of causal and disease associated non-coding variants.</td>
</tr>
<tr>
<td><strong>Paul William WISEMAN, Ph.D.</strong>&lt;br&gt;Postdoctoral fellow (University of California, San Diego)&lt;br&gt;Postdoctoral fellow (University of Tokyo)&lt;br&gt;Ph.D. – Chemistry (University of Western Ontario)&lt;br&gt;Hon BSc – Chemistry (St. Francis Xavier University)</td>
<td>Professor&lt;br&gt;Dept. of Chemistry&lt;br&gt;Dept. of Physics</td>
<td>Imaging based fluorescence fluctuation methods; characterization of cellular signaling, receptor transport and protein interactions in living cells and neurons; application of new nonlinear microscopic techniques; application of nanoparticles for fluorescence fluctuation and single molecule measurements</td>
</tr>
</tbody>
</table>

### 2.2.1.2 Funded research

All professors associated with the Ph.D. Program in Quantitative Life Sciences are actively engaged in externally funded research projects. As Table 4 indicates, QLS Teaching Faculty are successful in securing multiple research grants, often holding numerous multi-year awards from a variety of funding agencies at the same time. It is worth noting that many awards are from provincial, federal and internationally recognized bodies (ie. FQRNT, Genome Canada, CIHR, NIH) and are awarded individually (ie. the NSERC Accelerator Grant) or to collaborative research efforts (ie. CIHR Team Grants, NSERC Create Grants). The following Table, lists research funding and grants held from 2011 onwards (including grants awarded before 2011 but still ongoing in 2011 or later).
<table>
<thead>
<tr>
<th>Grant</th>
<th>Year(s)</th>
<th>Total</th>
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<tbody>
<tr>
<td>Multilateral France-Germany-Canada call on Epigenomics of Complex Diseases</td>
<td>2015-2019</td>
<td>$1,623,720</td>
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<tr>
<td>Genome Canada Disruptive Innovation in Genomics Competition</td>
<td>2016-2018</td>
<td>$250,000</td>
</tr>
<tr>
<td>NSERC Accelerator*</td>
<td>2013-2017</td>
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</tr>
<tr>
<td>NSERC Discovery*</td>
<td>2013-2017</td>
<td>$276,000</td>
</tr>
<tr>
<td>Canadian Foundation for Innovation – Leader Edge Fund</td>
<td>2013-2017</td>
<td>$2,312,056</td>
</tr>
<tr>
<td>CIHR Canadian Epigenetics, Environment, and Health Research Consortium (CEEHRC) Epigenomics platform – Data coordination Center</td>
<td>2012-2017</td>
<td>$1,098,980</td>
</tr>
<tr>
<td>CIHR Canadian Epigenetics, Environment, and Health Research Consortium (CEEHRC) Epigenomics platform – Epigenomics Mapping Center</td>
<td>2012-2017</td>
<td>$4,532,000</td>
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<tr>
<td>Genome Canada Bioinformatics and Computational Biology Competition</td>
<td>2013-2016</td>
<td>$375,000</td>
</tr>
<tr>
<td>FQRNT Team Grant</td>
<td>2013-2016</td>
<td>$144,000</td>
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<tr>
<td>Genome Canada Bioinformatics and Computational Biology Competition*</td>
<td>2013-2015</td>
<td>$250,000</td>
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<tr>
<td>Genome Canada Bioinformatics and Computational Biology Competition</td>
<td>2013-2015</td>
<td>$250,000</td>
</tr>
<tr>
<td>NSERC Research Tools and Instrumentation*</td>
<td>2012-2013</td>
<td>$40,385</td>
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<tr>
<td>Genome Québec Health Program</td>
<td>2010-2013</td>
<td>$1,273,155</td>
</tr>
<tr>
<td>Grant</td>
<td>Year(s)</td>
<td>Total</td>
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<tr>
<td>----------------------------------------------------------------------</td>
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<td>------------</td>
</tr>
<tr>
<td>Genome Canada Competition IV</td>
<td>2009-2013</td>
<td>$4,709,132</td>
</tr>
<tr>
<td>NSERC Discovery Grant*</td>
<td>2008-2013</td>
<td>$155,000</td>
</tr>
<tr>
<td>CIHR Team Grant</td>
<td>2008-2012</td>
<td>$3,315,976</td>
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</table>

**Guillaume Bourque**

<table>
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<tr>
<th>Grant</th>
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<th>Total</th>
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<tr>
<td>CFI, Cyber-infrastructure</td>
<td>2016-2020</td>
<td>$5,000,000</td>
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<tr>
<td>CIHR, CEEHRC Consortium Network*</td>
<td>2015-2019</td>
<td>$2,000,000</td>
</tr>
<tr>
<td>CFI, Innovation Fund</td>
<td>2015-2019</td>
<td>$58,435,000</td>
</tr>
<tr>
<td>CFI, Innovation Fund</td>
<td>2015-2019</td>
<td>$2,893,000</td>
</tr>
<tr>
<td>NSERC, Discovery Frontiers*</td>
<td>2014-2018</td>
<td>$6,000,000</td>
</tr>
<tr>
<td>Genome Canada, GIN – Tech. Development</td>
<td>2015-2017</td>
<td>$527,000</td>
</tr>
<tr>
<td>Genome Canada, Genomics Innovation Network</td>
<td>2015-2017</td>
<td>$1,050,000</td>
</tr>
<tr>
<td>Genome Canada, Genomics Innovation Network</td>
<td>2015-2017</td>
<td>$2,000,000</td>
</tr>
<tr>
<td>Genome Canada, Genomics Innovation Network – Tech Development</td>
<td>2015-2017</td>
<td>$1,000,000</td>
</tr>
<tr>
<td>CIHR, CEEHRC (Canadian Epigenetics, Environment, and Health Research Consortium) Epigenomics Platform*</td>
<td>2012-2017</td>
<td>$1,500,000</td>
</tr>
<tr>
<td>CIHR, CEEHRC (Canadian Epigenetics, Environment, and Health Research Consortium) Epigenomics Platform*</td>
<td>2012-2017</td>
<td>$6,000,000</td>
</tr>
<tr>
<td>Genome Canada, Large-scale Applied Research*</td>
<td>2013-2016</td>
<td>$6,000,000</td>
</tr>
<tr>
<td>Brain Canada</td>
<td>2013-2016</td>
<td>$1,494,900</td>
</tr>
<tr>
<td>Grant</td>
<td>Year(s)</td>
<td>Total</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>----------</td>
<td>------------</td>
</tr>
<tr>
<td>CIHR, Operating Grant</td>
<td>2011-2016</td>
<td>$426,482</td>
</tr>
<tr>
<td>CIHR, Team Grant: Childhood Cancer*</td>
<td>2011-2016</td>
<td>$2,445,054</td>
</tr>
<tr>
<td>CANARIE, Research Middleware Program*</td>
<td>2011-2014</td>
<td>$771,000</td>
</tr>
<tr>
<td>Genome Quebec, Human Health Competition*</td>
<td>2011-2014</td>
<td>$2,000,000</td>
</tr>
<tr>
<td>CIHR, Advancing Technology Innovation*</td>
<td>2011-2012</td>
<td>$1,550,000</td>
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</table>

**Erik Cook**

<table>
<thead>
<tr>
<th>Grant</th>
<th>Year(s)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
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**Ken Dewar**

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Frédéric Guichard

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<td>Genome Canada*</td>
<td>2015-2017</td>
<td>$4,000,000</td>
</tr>
<tr>
<td>Crohn’s &amp; Colitis Foundation of Canada*</td>
<td>2014-2017</td>
<td>$371,460</td>
</tr>
<tr>
<td>Organization</td>
<td>Year(s)</td>
<td>Total</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>---------------</td>
<td>---------------</td>
</tr>
<tr>
<td>CIHR</td>
<td>2013-2017</td>
<td>No direct funds</td>
</tr>
<tr>
<td>Genome Canada*</td>
<td>2013-2017</td>
<td>$6,772,000</td>
</tr>
<tr>
<td>Multidimensional Epigenome Mapping Centre McGill. CIHR*</td>
<td>2012-2017</td>
<td>$5,850,000</td>
</tr>
<tr>
<td>Compute Canada Resource Allocation*</td>
<td>2015-2016</td>
<td>$198,000</td>
</tr>
<tr>
<td>Finnish Funding Agency for Innovation (TEKES)</td>
<td>2015-2016</td>
<td>€80,000</td>
</tr>
<tr>
<td>CIHR*</td>
<td>2012-2016</td>
<td>$850,000</td>
</tr>
<tr>
<td>NIH</td>
<td>2012-2016</td>
<td>~$125,000</td>
</tr>
<tr>
<td>Academy of Finland</td>
<td>2015</td>
<td>$629,280</td>
</tr>
<tr>
<td>Genome Canada</td>
<td>2013-2015</td>
<td>$9,610,984</td>
</tr>
<tr>
<td>Compute Canada*</td>
<td>2014</td>
<td>$0</td>
</tr>
<tr>
<td>CIHR</td>
<td>2013-2014</td>
<td>$20,000</td>
</tr>
<tr>
<td>FRSQ*</td>
<td>2010-2014</td>
<td>$2,400,000</td>
</tr>
<tr>
<td>CIHR*</td>
<td>2010-2014</td>
<td>$716,000</td>
</tr>
<tr>
<td>CIHR</td>
<td>2010-2013</td>
<td>$2,048,322</td>
</tr>
<tr>
<td>Genome Quebec</td>
<td>2010-2011</td>
<td>$100,000</td>
</tr>
<tr>
<td>Genome Quebec</td>
<td>2009-2011</td>
<td>$304,000</td>
</tr>
<tr>
<td>CIHR</td>
<td>2008-2011</td>
<td>$408,000</td>
</tr>
</tbody>
</table>

**Paul Wiseman**

<table>
<thead>
<tr>
<th>Grant</th>
<th>Year(s)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canadian Institute for Advanced Research (CIFAR) Global Call for Ideas</td>
<td>2015-2021</td>
<td>$1,100,000</td>
</tr>
</tbody>
</table>
Table 5 shows research funding received by QLS Teaching Faculty from four major sources of funding in Quebec and Canada for research in quantitative, physical and biological life sciences. In some cases, research projects are proposed and undertaken by a single principal investigator, but in many cases successful research grants are the result of multidisciplinary projects and the collaboration of many researchers. For example, Guillaume Bourque, Erik Cook, Ken Dewar, Peter Grutter, Anmar Khadra, Sabrina Leslie, Judith Mandl and Paul Wiseman

<table>
<thead>
<tr>
<th>Funding Source</th>
<th>Years</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIH National Institute on Deafness and Other Communication Disorders R01 – DC005788-10</td>
<td>2014-2019</td>
<td>$439,000 (2014)</td>
</tr>
<tr>
<td>Brain Canada Platform Grant</td>
<td>2015-2018</td>
<td>$120,250</td>
</tr>
<tr>
<td>NSERC CREATE</td>
<td>2012-2018</td>
<td>$300,000</td>
</tr>
<tr>
<td>NSERC CREATE</td>
<td>2012-2018</td>
<td>$300,000</td>
</tr>
<tr>
<td>CFI Innovation Fund</td>
<td>2016-2017</td>
<td>$12,560,000</td>
</tr>
<tr>
<td>NSERC Discovery Grant*</td>
<td>2012-2017</td>
<td>$101,000</td>
</tr>
<tr>
<td>FRQS- Groupe d’étude des protéines membranaires (GEPROM) GEPROM Research Stimulus Grants</td>
<td>2016</td>
<td>$15,000</td>
</tr>
<tr>
<td>NSERC CREATE</td>
<td>2010-2016</td>
<td>$300,000</td>
</tr>
<tr>
<td>CFI Leading Edge Fund</td>
<td>2013-2015</td>
<td>$12,100,000</td>
</tr>
<tr>
<td>CIHR Strategic Training Grant</td>
<td>2009-2015</td>
<td>$375,000</td>
</tr>
<tr>
<td>CFI Innovation Grant</td>
<td>2009-2014</td>
<td>$26,600,000</td>
</tr>
<tr>
<td>FQRNT Team Grant</td>
<td>2009-2012</td>
<td>$84,000</td>
</tr>
<tr>
<td>NSERC Discovery Grant*</td>
<td>2007-2012</td>
<td>$53,400</td>
</tr>
<tr>
<td>American Academy of Otolaryngology Training grant</td>
<td>2011</td>
<td>$9,976</td>
</tr>
<tr>
<td>Canadian Institute for Photonic Innovations (CIPI) Technology Exploitation &amp; Networking</td>
<td>2010-2011</td>
<td>$25,000</td>
</tr>
</tbody>
</table>
have been involved in securing over $149,000,000 in funding for innovation research, infrastructure and operating grants from the Canadian Foundation for Innovation (CFI). Many of these are large scale grants that benefit not only the individual research groups, but the research field within the university as a whole.

Table 5: Research grants received by QLS Teaching Faculty from major Quebec and Canadian funding agencies

<table>
<thead>
<tr>
<th>Funding Agency</th>
<th>Total Amount</th>
<th>Faculty Members</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFI</td>
<td>$149,991,975</td>
<td>Guillaume Bourque, Erik Cook, Ken Dewar, Peter Grutter, Anmar Khadra, Sabrina Leslie, Judith Mandl, Paul Wiseman</td>
</tr>
<tr>
<td>CIHR</td>
<td>$47,216,367</td>
<td>Mathieu Blanchette, Guillaume Bourque, Erik Cook, Simon Gravel, Celia Greenwood, Peter Grutter, Judith Mandl, Christopher Pack, Tomi Pastinen, Paul Wiseman</td>
</tr>
<tr>
<td>FRQNT/FRQS</td>
<td>$12,261,033</td>
<td>Mathieu Blanchette, Paul François, Peter Grutter, Frédéric Guichard, Sabrina Leslie, Chris Pack, Tomi Pastinen, Paul Wiseman</td>
</tr>
<tr>
<td>NSERC</td>
<td>$15,404,701</td>
<td>Mathieu Blanchette, Guillaume Bourque, Erik Cook, Paul François, Celia Greenwood, Peter Grutter, Frédéric Guichard, Anmar Khadra, Sabrina Leslie, Judith Mandl, Christopher Pack, Paul Wiseman</td>
</tr>
</tbody>
</table>

2.2.1.3 Publications
The academic staff teaching in the Ph.D. Program in Quantitative Life Sciences have a consistent record of scholarly and professional publications. These professors regularly publish collaborative research findings in top tier journals, including Nature Genetics, Genome Biology, Cell, Lancet Oncology, and Nature Nanotechnology. Table 6 below lists the number of publications from 2011 onwards. For a detailed record of each publication by faculty member, please see the Appendix.
### Table 6: QLS Teaching Faculty Total Publications by Year

<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>Number of Publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathieu Blanchette</td>
<td>8</td>
</tr>
<tr>
<td>Guillaume Bourque</td>
<td>8</td>
</tr>
<tr>
<td>Erik Cook</td>
<td>2</td>
</tr>
<tr>
<td>Ken Dewar</td>
<td>2</td>
</tr>
<tr>
<td>Paul FranÇois</td>
<td>1</td>
</tr>
<tr>
<td>Simon Gravel</td>
<td>0</td>
</tr>
<tr>
<td>Celia Greenwood</td>
<td>6</td>
</tr>
<tr>
<td>Peter Grutter</td>
<td>12</td>
</tr>
<tr>
<td>Frédéric Guichard</td>
<td>8</td>
</tr>
<tr>
<td>Anmar Khadra</td>
<td>2</td>
</tr>
<tr>
<td>Sabrina Leslie</td>
<td>0</td>
</tr>
<tr>
<td>Judith Mandl</td>
<td>1</td>
</tr>
<tr>
<td>Christopher Pack</td>
<td>9</td>
</tr>
<tr>
<td>Tomi Pastinen</td>
<td>7</td>
</tr>
<tr>
<td>Paul Wiseman</td>
<td>7</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>73</strong></td>
</tr>
</tbody>
</table>

2.2.1.4 Graduate student supervision

All members of the Quantitative Life Sciences Program are actively engaged in supervision of student and postdoctoral research. The table below highlights the number of undergraduate, graduate and postdoctoral fellow supervision undertaken since 2010.
2.3 INSTITUTIONAL ORIENATIONS

2.3.1 Faculty and University development plan

The new Quantitative Life Sciences Ph.D. Program will promote multidisciplinary life science and health research at McGill University. This program will directly contribute to the success of McGill’s Strategic Research Plan of bringing together the life sciences, natural sciences, and engineering\(^\text{21}\). It is important to emphasize that this will be a McGill University wide graduate program, not constrained to a single department and faculty. Thus, students will not have to choose between a quantitative or life science department, and faculty members will be able to recruit students from a variety of academic backgrounds to form the interdisciplinary teams needed to advance their research aims. The result of this cross-fertilization of graduate students is that it will greatly facilitate interdisciplinary research at McGill by bringing investigators and students from the physical, computational, mathematical and biological sciences together.

<table>
<thead>
<tr>
<th>Supervisor</th>
<th>Undergraduate</th>
<th>Graduate</th>
<th>Postdoctoral fellow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Master’s</td>
<td>Ph.D.</td>
</tr>
<tr>
<td>Mathieu</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BLANCHETTE</td>
<td>10</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Guillaume</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BOURQUE</td>
<td>4</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Erik</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COOK</td>
<td>8</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Paul</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FRANCOIS</td>
<td>22</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Simon</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRAVEL</td>
<td>2</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Celia M T</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GREENWOOD</td>
<td>3</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Peter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRUTTER</td>
<td>45</td>
<td>16</td>
<td>21</td>
</tr>
<tr>
<td>Frederic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GUICHARD</td>
<td>11</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Anmar</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KHADRA</td>
<td>2</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Sabrina Rose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LESLIE</td>
<td>29</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Judith</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MANDL</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Christopher</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PACK</td>
<td>10</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Tomi</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PASTINEN</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Paul</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WISEMAN</td>
<td>6</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>TOTAL</td>
<td>154</td>
<td>75</td>
<td>94</td>
</tr>
</tbody>
</table>
2.3.2 Vertical and horizontal integration

The horizontal integration of the proposed Quantitative Life Sciences Ph.D. Program is to be viewed in relation to the other programs offered by traditional disciplines in the Faculties of Medicine and Science (see Figure 1 above). Traditional disciplines that are related to this Ph.D. program include Biology, Ecology, Biochemistry, Physiology, Pharmacology, Neuroscience, Human Genetics, Mathematics, Physics, Chemistry, Statistics, Computer Science, Material Science and others. By bridging the gap between the life and quantitative science departments at McGill, this new Ph.D. program will enhance these established disciplines. Because this program will be open to researchers involved in multidisciplinary life science research, vertical integration will be satisfied by the participation of faculty members across departments and faculties. Although a new core curriculum will be organized within the Quantitative Life Sciences Ph.D. Program, appropriate elective courses will be offered in collaboration with other departments in the Faculties of Medicine and Science.

2.4 Relevance to the University Networks

2.4.1 Related Programs

There are no graduate programs or graduate options at McGill that approach the breadth of the proposed Ph.D. Program in Quantitative Life Sciences, although the proposed program builds on McGill’s existing Graduate Option in Bioinformatics and synergizes with the new Bioengineering and Biomedical Engineering graduate program. The proposed program also builds on several externally funded department-centered training programs (outlined in Table 2 above) that have been very successful in establishing the quantitative life sciences. Although most of these training programs are nearing their funding completion, these programs have laid the critical foundation for the new Quantitative Life Sciences Ph.D. Program. In addition, McGill has an exemplary track record in graduate training in Biomedical Engineering (now Biological and Biomedical Engineering), which is complementary to the proposed program in Quantitative Life Sciences. To capitalize on these shared interests, we intend to invite students and faculty members associated with Biological and Biomedical Engineering program to participate in the proposed QLS seminar series outlined in Section 4 and take part in any workshops offered by QLS.

2.4.1.1 Relationship to existing Graduate Option in Bioinformatics

The Graduate Option in Bioinformatics has existed at McGill since 2006, at both the Masters and Ph.D. levels. Students in the Graduate Option in Bioinformatics are registered in one of 14 departments and have to satisfy the admission and progress requirements of their home department, but can replace two of the courses they would normally take within their home department with one of five bioinformatics courses offered by this option, and need to attend a seminar series. The program currently attracts both students with very strong quantitative background from Computer Science, Math, Biostatistics, or Physics, as well as students whose background focusses on life sciences and who often lack solid quantitative skills. Because of this spectrum of quantitative skills, the depth of the training on the quantitative aspects is limited. Students learn fundamental concepts of bioinformatics and become qualified bioinformatics users, but most lack the training to push the limits of bioinformatics through the development of new approaches. Contrary to the Graduate Option in
Bioinformatics, the new Quantitative Life Sciences Ph.D. Program targets students with strong quantitative and computational skills, and aims to train future researchers who will develop innovative computational approaches to solve a variety of important life science problems that go beyond traditional bioinformatics. Thus, the Graduate Option in Bioinformatics and the Quantitative Life Sciences Ph.D. Program will be complementary in both their scope and clientele.

2.4.1.2 Relationship to existing training programs in Biological and Biomedical Engineering

McGill’s Bioengineering Department in the Faculty of Engineering, and the Biomedical Engineering Department in the Faculty of Medicine, have recently been integrated to create a single graduate training program. This will provide a unique training environment for students interested in linking engineering to the biosciences. The combination of Quantitative Life Science (QLS) and Biological and Biomedical Engineering (BBME) programs at McGill will enhance student training in these two disciplines. Although students with strong quantitative or computational backgrounds could potentially enroll in either the BBME or Quantitative Life Science graduate programs, the type of students targeted by the two programs are quite different. The BBME Ph.D. program largely (though not exclusively) targets students with an engineering undergraduate degree. Its prerequisites include courses in electromagnetics, mechanics, biophysics and physical chemistry, which are not part of the standard curriculum of Science undergraduates. It also requires a Masters in BBME or equivalent, a program that mostly aims at recruiting engineering graduates. In contrast, the QLS program mostly targets students from the Science streams, with the mathematical, statistical, and computational skills needed for biological data analysis. Students that seek advanced training from a program that focuses on engineering-related skills would likely choose Biological or Biomedical Engineering, while those with more fundamental bioscience backgrounds and interests, would gravitate to the Quantitative Life Sciences Ph.D. Program.

Evidence that bioengineering and quantitative bioscience provide complementary training environments can be found in McGill’s successful quantitative bioscience undergraduate programs (Table 1) and the newly created undergraduate Bioengineering program, where demand for these programs is high. Further evidence that a graduate training program in the Quantitative Life Sciences is complementary to Biological or Biomedical Engineering arises from the large number of research-intensive universities that have both programs. For example, all universities with comparable programs to Quantitative Life Science listed in Table 8 below, also have strong Biological or Biomedical Engineering training programs. Although the QLS and BBME programs clearly differ in the types of students they aim to recruit and in the training they provide, every effort will be made to maximize the synergy between the two programs, e.g. through jointly offered seminars, cross-listing of courses, and multi-disciplinary projects. Students from the two programs will be encouraged to collaborate whenever possible, e.g. in situations where a device developed by a BBME student may be used by an QLS student who would develop approaches to analyze the data it produces.

2.4.2 Similar programs offered elsewhere

Within Canada, no degree-granting program currently exists with a similar breadth to the proposed Ph.D. program in Quantitative Life Sciences. There are, however, a number of smaller programs usually based within a faculty or department. The University of Ottawa has had a successful NSERC-CREATE training program in
Quantitative Biomedicine [http://www.qbm.uottawa.ca]. For statistical methods in genetics and genomics, Toronto [http://www.stage.utoronto.ca/] has the only formal training program in Canada. There are several Bioinformatics programs across the country, such as at the University of Montreal [https://admission.umontreal.ca/programmes/doctorat-en-bio-informatique/], and the University of British Columbia [www.bioinformatics.ubc.ca/program/]. One of the broadest programs with overlap in scope is the Collaborative Program in Genome Biology and Bioinformatics at the University of Toronto which provides a unifying genomic theme for students in 10 departments ranging from Engineering to Ecology to Physics. Students are first admitted to their home departments and then request admission to the Collaborative Program [http://gbb.utoronto.ca/index.php/Main_Page]. Although broad, this program is focused around genetic and genomic research.

Elsewhere, as at McGill, there are numerous research groups with interests overlapping those in the Quantitative Life Sciences, but most are not degree granting Programs. To give a few examples, research interests at the Donnelly Centre for Cellular and Biomolecular Research at the University of Toronto [http://tdccbr.med.utoronto.ca/] span integrative biology, bioengineering and structural biology, and models of disease. At UBC, the Mathematical Biology group [http://www.math.ubc.ca/Research/MathBio/graduate.php], unites faculty with interests in research applying mathematics to various fields within biology. Similarly, the Centre for Mathematical Biology at the University of Alberta [http://www.math.ualberta.ca/~mathbio/index.html], the Pacific Institute for the Mathematical Sciences [https://www.pims.math.ca/], and the University of Waterloo Applied Mathematics, Mathematical Medicine and Biology [https://math.uwaterloo.ca/applied-mathematics/research-areas/mathematical-medicine-and-biology] each represent centres or groups of faculty or researchers with interests in mathematical biology.

In many Quebec universities, there are programs or options that overlap with some elements of the proposed Ph.D. Program in Quantitative Life Sciences program. As mentioned above, a Graduate Option in Bioinformatics already exists at McGill [https://www.mcgill.ca/mcb/academic], while a complete degree-granting bioinformatics program exists at Université de Montréal [http://www.bioinfo.umontreal.ca/home/]. There is a graduate diploma in Biotechnology and Genomics at Concordia [http://www.concordia.ca/artsci/biology/programs/graduate/diploma-biotechnology-genomics.html], and a Physiology and Biophysics program at the University of Sherbrooke [http://www.usherbrooke.ca/dep-physiologie-biophysique/en/]. For other quantitative life science topics outside of bioinformatics at McGill, many active research groups exist, and students registered in an appropriate department can get involved in their area of interest by linking with such groups. However, these research groups cannot facilitate cross-topic interactions, through courses or through peer groups that allow comparisons of similar quantitative research methods applied to a variety of areas.

Outside of Canada, the interest and the demand for interdisciplinary research in quantitative life sciences has led to the formation of various programs, both nationally and internationally, that emphasize quantitative research skills applied to biology. These programs span a wide variety of different administrative structures, and vary in the breadth addressed. Among comprehensive degree-granting programs focused at the doctoral level, several examples can be found in the US, mostly among top-ranking universities with which McGill is competing (Table 8). It is notable that all of these programs were recently formed and this reflects the fact that quantitative life science is a new and evolving discipline. In addition to the programs in Table 8, several
universities have created informal groupings of disciplines to facilitate interdisciplinary research in these fields. University of California, Irvine has a gateway year prior to Ph.D. degrees in 6-7 departments and UC San Francisco groups 3 Ph.D. programs in quantitative biology. Internationally, the same trend can be seen, for example at the University of Munich, Germany (Graduate Program in Quantitative Bioscience) and Imperial College London (MSc in Computational Methods in Ecology and Evolution).

Table 8. A selection of comparable programs outside Canada

<table>
<thead>
<tr>
<th>University</th>
<th>Name of program</th>
<th>Degree(s)</th>
<th>Fields of focus</th>
<th>Year started: # per year: Total cohort:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Princeton (USA)</td>
<td>Quantitative and Computational Biology</td>
<td>Ph.D.</td>
<td>Genomics, computational biology, systems biology, biophysics, quantitative genetics, molecular evolution, microbial interactions</td>
<td>Started: 2009 Per year: 5-9 Total: ~30</td>
</tr>
<tr>
<td>Harvard (USA)</td>
<td>Systems Biology</td>
<td>Ph.D.</td>
<td>Understanding complex biological systems. There is also a Bioinformatics/Computation Biology Masters program linked with Biostatistics</td>
<td>Started: 2008 Per year: 10-15 Total: 60</td>
</tr>
<tr>
<td>University of California Merced (USA)</td>
<td>Quantitative and systems biology</td>
<td>Ph.D. and MSc</td>
<td>Integration of systems at molecular, cellular, organ, organismal or ecological levels to better understand the overall function of biological systems as a whole</td>
<td>Started: 2007 Per year: 10-25 (13 in 2013) Total: 59</td>
</tr>
<tr>
<td>University of Pennsylvania (USA)</td>
<td>Graduate group in genomics and computational biology</td>
<td>Ph.D.</td>
<td>Require synthesis and integration of biology, computer science, mathematics, statistics and</td>
<td>Started: 2002 Per year: 5-8</td>
</tr>
</tbody>
</table>
It is worth noting (see section 2.1.4.2) that all the Universities listed above have separate Biological or Biomedical Engineering programs or streams, often more focused on development of devices or technology than the Quantitative Life Science, Biology or Systems groups.

2.4.3 Originality and anticipated contribution of the proposed program

The Interdisciplinary Program in Quantitative Life Science is original and makes several important contributions that are distinct from existing programs at McGill. First, this new program provides a common teaching framework by uniting the subdomains of the discipline (e.g., computational biology, bioinformatics, biophysics, mathematical biology, and computational ecology) that share many of the same mathematical and quantitative methods. Second, although there are many smaller initiatives in quantitative life sciences at McGill, they are independent and located locally within departments or faculties. Thus, the proposed program enhances collaborative interactions among researchers and students. Third, this new program facilitates interdisciplinary life science research at McGill by providing a mechanism for researchers in the faculties of science and medicine to recruit students for joint graduate supervision. Fourth, the Quantitative Life Sciences Ph.D. Program will prepare a new breed of Ph.D. researchers that are in high demand and provide an academic community in which they can thrive and develop. Finally, this new program allows McGill to retain and recruit highly-talented graduate students that would have enrolled in similar programs that are currently only available outside of Quebec and Canada.

A hypothetical example may clearly illustrate the original contributions this new program will have on life science research at McGill. Suppose a professor in biochemistry has extensive experimental results that defy traditional methods of analysis. Through the Quantitative Life Sciences Ph.D. Program, this professor establishes a collaboration with a professor in computer science, and together, they recruit and co-supervise a Ph.D. student with an undergraduate background in physics. Thus, an interdisciplinary team of experts in biochemistry, computer science and physics has been established to develop the novel solutions and interpretations needed for a successful outcome. In the process, a new Ph.D. scientist has been uniquely trained in the interdisciplinary skills that will contribute to the future advancements of the life sciences.
2.4.4 Student mobility

Students in the Quantitative Life Sciences Ph.D. Program will have mobility both within McGill University and through various international summer schools. By establishing an interdisciplinary community, our students will be encouraged to participate in a variety of seminars and symposiums that allows them to “break out” of their comfort zone and experience new research directions. Our graduate students will be encouraged to participate in the many international summer schools that now focus on topics in quantitative life science. This includes the yearly summer schools organized by McGill’s Centre for Applied Mathematics in Bioscience and Medicine in collaboration with Ohio State University’s Mathematical Biosciences Institute and US National Institute for Mathematical and Biological Synthesis. Other examples include the Frontiers in Neurophotons at Université Laval and the Cold Spring Harbor Laboratory (CSHL) Summer School in Computational Cell Biology in New York.

2.4.5 Inter-university collaboration and relevance to Quebec network

The proposed Ph.D. Program in Quantitative Life Sciences will facilitate inter-university collaborations in Quebec. For example, many McGill faculty that will take part in this training program belong to multi-university centers or networks. Examples include the Centre de Recherches en Mathématiques (of which McGill’s Centre for Applied Mathematics in Bioscience and Medicine belongs), that spans 12 universities in Quebec and Ontario including Université de Montréal, Université du Québec à Montréal, Concordia University, Université Laval, Université de Sherbrooke, École Polytechnique, HEC Montréal, Université du Québec à Trois-Rivières, University of Ottawa, Carleton University and Queen's University. Each of the laboratories hosts an average of 20 professors, 50 graduate students, and 7 postdoctoral fellows, organizes workshops and inter-university seminars on a regular basis, and coordinates a unified graduate school (involving five, six or seven universities), with funding coming from a wide variety of sources. Another example is Le Regroupement Québécois sur les Matériaux de Pointe, an FRQNT sponsored network in advanced materials, which includes a strong biophysics stream. Both the Neurophotons and Biophotonics centres at Université Laval have close interactions with faculty at McGill. In addition, the Bioinformatics program at Université de Montréal will provide many opportunities for local collaborations with the Quantitative Life Sciences Ph.D. Program. Finally, quantitative life science research has become an important component of Calcul Québec, which is part of Canada’s national high performance computing network and Génome Quebec’s research mission in bioinformatics and computational biology.

2.5 Timetable of program implementation and projected student enrolment

Forecast growth of student enrolment for the Ph.D. Program Quantitative Life Science is presented in Table 9 below. Beginning with the first year of implementation and approximately 10 to 20 new Ph.D. students per year over the next five years, for a total of approximately 80 enrolled students. This is based on the assumption that the program will receive approval from the Ministère de l’Éducation et de l'Enseignement supérieur (MEES) to enable us to enroll students starting in the 2017-2018 academic year. If a 10% attrition rate is forecast, we expect to award about 10 Ph.D. per year starting in the year 2021. Thus, we expect a steady-state enrollment of between 70 to 80 students when the program reaches equilibrium. Based on a survey of the potential undergraduate
clientele at McGill (see section 2.1.6 above), we expect most of our new graduate students from Quebec will come from the current cohort of top students that have been leaving the province to attend similar graduate programs in the US and Europe. Along with attracting new students from outside of Quebec, the Interdisciplinary Program in Quantitative Life Science will produce a net gain in life science graduates students with no reduction from other graduate programs at McGill.

Table 9. Expected program enrollment during the program's first five years.

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>New students from Quebec</td>
<td>7</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>New students from Canada</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>New international students</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Annual total enrolled</td>
<td>10</td>
<td>22</td>
<td>40</td>
<td>60</td>
<td>80</td>
</tr>
</tbody>
</table>

2.6 SOCIOECONOMIC MOTIVES

2.6.1 Clientele

As discussed in Section 2.1.6 above (and outlined in Table 1) there is a strong student demand for an interdisciplinary Quantitative Life Sciences Program at McGill University, as well as other universities in Quebec and Canada. Similar programs offered in the United States and Europe are well developed, having been created within the last 10 years, indicating McGill University must act swiftly to attract students interested in this dynamic and innovative research area.

2.6.2 Labour Market

McGill University’s proposed Ph.D. Program in Quantitative Life Sciences has broad applicability to academia, government and industry and will contribute to economic growth in key sectors of the economy. Recent market studies have estimated that the global quantitative life science market is growing from USD $760 million in 2011 to a projected $4.2 billion in 2020\textsuperscript{40,41}. This does not include the related pharmaceutical and medical devices market which are more than 50 times larger\textsuperscript{42}. Importantly, the quantitative life science sectors are expanding at a compounded annual growth rate of over 20%\textsuperscript{40,41} and will form a substantial component of the “green economy” that is central to the economic development of Quebec and Canada\textsuperscript{43}. In this section, we present evidence that students trained in the Quantitative Life Sciences will be in high demand by academia,
government and industry.

2.6.2.1 Employment opportunities in the academic and government sectors

Graduates of the Ph.D. Program in Quantitative Life Sciences will be part of the next generation of academic and government researchers that will change how life science research is conducted. As evident by the number of new and expanding graduate programs in the quantitative life sciences at the top research universities in North America (outlined in section 2.4.2 below), there will be ample opportunities for academic employment. As research becomes more interdisciplinary, traditional life science departments will seek individuals with quantitative backgrounds. For example, Genome Quebec and Genome Canada rely heavily on computer-based bioinformatic analysis to advance their genomic innovation mandate. Other academic opportunities for graduates of the quantitative life sciences can be found in university engineering departments and faculties. In addition, the quantitative skills acquired by our graduates will also be applicable to academic research in non-bio related fields such as computational chemistry and computational material science.

Quantitative analysis of life science data is routinely performed by many different government agencies when developing public policy. Government agencies benefit from the application of predictive models of future health care demand and agricultural resources. For example, Fisheries and Oceans Canada rely on computational biologists to construct mathematical models of changing environments and its impact on food supply. Our graduates will have developed the skills needed to collect the relevant data and then create predictive models to explain complex, interlinked biological systems.

2.6.2.2 Employment opportunities in the life science industrial sectors

The industrial demand for mathematical and computational life scientists is expanding rapidly and with it the need for graduates with relevant research expertise. Examples of this new demand is evident in the large-enterprise pharmaceutical sector such as Novartis, which has recently established a modeling and simulation group which tackles a wide range of translational problems, and AstraZeneca where the new predictive sciences group is focused on developing computational solutions to improve traditional research and development. Other examples include Eli Lilly, Pfizer and Merck that have placed greater emphasis on their system and computational biology efforts, and have corresponding positions available. Worldwide, there are numerous examples of small companies applying new quantitative approaches to a variety of life science and health services such as personalized medicine (Selventa and GNS Healthcare), predictive biosimulation (Entelos) and data-mining (Genedata).

With strong life sciences and biotechnology industries in Quebec and Canada, our graduates will have many career opportunities in the pharmaceutical, medical devices, and sustainable environment sectors. Canadian employment opportunities for our graduates will be at both multinational as well as small and medium sized enterprises (SMEs), which account for 60% of Canada's economic output and 80% of national employment. Increasingly, the SMEs in the Canadian life science sectors are looking for personnel capable of performing a wide-range of research activities. For example, Chemical Computing Group, an SME with an office in Montreal,
focuses on computational methods for drug discovery and is interested in recruiting graduate students with the interdisciplinary skills our program will provide. Another example is Rogue Research in Quebec, who need personnel with interdisciplinary training to develop state-of-the-art computational techniques to link brain imaging to real-time surgical intervention. Overall, the large and growing national and global biotechnology sector will offer many employment opportunities for graduates of our Quantitative Life Sciences Ph.D. Program.

2.6.2.3 Employment opportunities in the technology industrial sector

It is important to emphasize that the skills developed by the students in the Ph.D. Program in Quantitative Life Sciences will go beyond the immediate application of life science research, since many technology sectors share similar quantitative methods. An example is the United States National Science Foundation (NSF) and National Institutes of Standards and Technology (NIST) funded ‘Materials Genome Initiative’ which aims to translate data mining and other techniques developed for life-science ‘omics’ research to discover, develop and deploy new material systems deemed critical for advanced manufacturing. The students who graduate from our program will be experts in describing and understanding complex systems using a variety of quantitative tools and techniques. They will also acquire valuable multidisciplinary teamwork, communication, and project management skills. Because graduates of the Ph.D. Program in Quantitative Life Sciences will have a strong foundation of mathematical, computer programming and data analysis abilities, they will have skills that are highly desired by almost all employers and government organizations throughout Quebec, Canada and the world. For example, according to a recent report from the International Labour Organization employment opportunities in the information and communication technology sectors will continue to outpace the supply of qualified University graduates throughout the developed economies of North America and Europe.

2.6.2.4 Employment examples of multidisciplinary trained McGill graduate students

An example of how a multidisciplinary training program leads to successful employment is McGill graduate student Ali Yehia who received his Ph.D. in Physiology (1998). As part of the Center for Nonlinear Dynamics, one of McGill’s earliest initiative to nurture quantitative methods in bioscience and medicine, Ali’s Ph.D. research had a large computational component. The interdisciplinary graduate training that Ali received enabled him to develop a career in the biotechnology sector, where he is now director of product and business development at Fluxion Biosciences. A second example of how a student trained in both the physical and biosciences is Alan Schoen. Alan received a B.Sc. in Physics (2010) and a Master’s in Neuroscience (2012) from McGill and has been employed as a data scientist with technology companies Qlaym and Backtrack. Thus, the proposed Quantitative Life Sciences graduate program will produce graduates with strong interdisciplinary skills, such as Ali and Alan, that will be readily equipped to contribute to the fast growing green economy of science, technology, engineering and mathematics that are key components for the future of technology development in Quebec and Canada’s broader economic action plan.

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3. **ACADEMIC DOSSIER**

3.1 **OBJECTIVES**

3.1.1 General objective

The general objective of the Ph.D. Program in Quantitative Life Science is to educate students on quantitative approaches (technological, computational, and statistical) for the collection, analysis, and interpretation of complex data from life sciences. Our students will ask questions that will drive biology and medicine tomorrow, and will be equipped to answer them.

3.1.2 Specific objectives

1. To understand the challenges facing and the opportunities afforded by quantitative approaches in life sciences.
2. To communicate and collaborate across areas, from physics and technological development, to computer science, statistics, and life sciences.
3. To have an in-depth understanding of one area of life science (genetics, molecular biology, physiology, neuroscience, ecology, etc) and of the quantitative approaches that pertain to that field.
4. To enable breakthroughs in specific aspects of life science through the development of cutting-edge quantitative approaches.
5. To develop skills that contribute to solving life science problems of societal importance.

3.2 **STRUCTURE AND ACADEMIC REGULATIONS**

The proposed Ph.D. program is structured so as to educate scientists who will be able to have a significant impact on life sciences through the development and use of quantitative approaches. Students wishing to specialize in one of the main areas of quantitative life sciences can follow an area of research or stream (computational and statistical molecular biology, biophysics, or ecosystems) that allows students to specialize while maintaining contacts with students in other areas. Following a stream is not mandatory, although it is expected that most students will.

The academic structure of the program includes the following elements (described in more detail in section 3.3). At the center of the program is a **two semester core foundations course**, required for all students in the program, that will ensure that they receive the necessary breadth of knowledge to be able to communicate effectively across fields, to comprehend the methodological commonalities across fields, and to understand the challenges faced and fundamental techniques used in each of the streams.

Beyond this, students will be required to take a set of specialized quantitative and life science courses. Students enrolled in specific areas of research will be required to select their courses from predefined lists of quantitative and life science courses, thus ensuring that they receive the depth required. Students who do not enroll in any of the program’s streams will select their courses in conjunction with their supervisory committee. In all cases, students will have the opportunity to learn about existing and upcoming technologies for data collection, the
computational and statistical approaches required for their analysis, and the biological interpretation of the results.

Breadth of knowledge and communication skills will be further enhanced through attendance at a regular seminar series. A comprehensive exam within the first year and a half will ensure quality control and a research thesis will demonstrate original scholarship.

Contact between students in different research areas and streams is critical in order to ensure the cross-fertilization of ideas between students working in very different areas. To build a community of students and researchers working in quantitative life sciences a number of student centric events will be organized, including monthly journal clubs (before research seminars) and an annual research retreat to ensure regular meetings of all cohorts.

Each student will be advised and mentored by an interdisciplinary supervisory committee. Co-supervision is encouraged, but not mandated. Progress tracking and program compliance will be performed by the Graduate Program Director.

### 3.2.1 Admission requirements and selection process

Applications will be welcomed from individuals who have prior education and/or training in many different fields. Applicants are expected to have demonstrated strong quantitative skills and a background in mathematics, statistics and computer science. In addition, all potential students must have a strong interest in interdisciplinary research in quantitative life sciences. It is expected that applicants have prior research experience and have taken advanced, in depth training courses at the undergraduate or Master’s level.

#### 3.2.1.1 General and specific requirements

1. Applicants are expected to hold an undergraduate degree in one of the following areas (or equivalent):
   - Biology, chemistry, physiology, genetics, engineering, computer science, mathematics, statistics, physics, or chemistry.
2. Applicants must have a **strong quantitative background**. Such a background may be obtained by having at least the equivalent of a minor in computer science, mathematics, statistics, physics, chemistry or engineering.
3. Applicants who do not have a formal education in life sciences need to have a demonstrated interest for that field, for example in the form of an undergraduate research project or the completion of life-science courses.

Applicants need to satisfy the following **program-wide** prerequisites or their equivalents (focused on foundations in quantitative approaches). Students who wish to follow in one of the program’s streams (Section 3.4) may need to satisfy additional admission prerequisites. Applicants who may be missing one prerequisite may still be admitted to the program but would be required to take an additional course during their first year in the program.
Program-wide prerequisites:

A. Computer science
- Entry-level algorithms (McGill course COMP 250 or equivalent)
- Entry-level programming (McGill course COMP 206 or equivalent)

B. Mathematics and Statistics
- Advanced Calculus (McGill course MATH 314 or equivalent)
- Entry-level Linear Algebra (McGill course MATH 223 or 236 or equivalent)
- Entry-level Probabilities (McGill course MATH 323 or equivalent) or Statistics (McGill course MATH 324 or equivalent)

C. Biology
- Entry Level Molecular or Cell Biology (McGill courses BIOL 200 or 201 or equivalent)

3.2.1.2 Selection criteria

Two letters of reference will be required, both of which should attest to the candidate’s strong aptitude for research, quantitative skills and interest in quantitative life sciences. Applicants must submit a copy of their most recent curriculum vitae and a 1-2 page personal statement describing their background, research interests and reasons for wishing to undertake the proposed program. Top candidates may be invited to an interview with faculty members who are interested in potentially supervising each candidate.

Applications are selected on the basis of the following criteria: superior academic performance (CGPA of 3.4 or higher), level of relevant research experience, motivation for graduate study, demonstration of a high interest in interdisciplinary research, and awards received for scholarly excellence. Strong letters of support attesting the applicant’s aptitude in conducting research are closely considered.

3.2.1.3 Selection process

Each applicant’s dossier will be carefully reviewed by the Admissions Committee (see section 3.4.2.6 for a detailed description). Applicants who do not meet the program criteria are not considered further in the review process. The remaining applicants will be evaluated on the basis of letters of recommendations, academic performance and relevant work experience. The number of students accepted will depend on the number of open spots that are available with each supervisor in the program. Students will be admitted to the program through one of two mechanisms:

- Students without external or internal scholarships. The admission committee will forward to potential supervisors the files of applicants who satisfy the program’s requirements in terms of background and excellence. If at least one supervisor (or group of supervisors) wants to admit and fund the student, he/she will be admitted. The student would then join the supervisor(s) lab(s) immediately upon starting in the program.
Students with external or internal scholarships. Exceptional students, e.g. those with their own scholarships or to whom funding from the program will be offered, will be given the possibility of being admitted to the program without an assigned supervisor. We do not anticipate that these students will have significant difficulties finding a supervisor, because of the excellence of their dossier and the fact that they have access to independent sources of funding.

3.2.2 Length of program

3.2.2.1 Total number of credits

The Interdisciplinary Program in Quantitative Life Sciences is a Ph.D. program and is expected to last 4 to 5 years, similar to other Ph.D. programs at McGill. To graduate, students will generally need to take a minimum of 4 courses, for a total of 15 credits (including a two-semester required foundational course, as well as stream-specific complementary courses), attend regular research seminars, successfully pass a comprehensive exam, perform original, scholarly research and write a Thesis. Some students, upon the recommendation of the student’s supervisory committee, may take up to two 600-level “directed reading” courses required to address gaps in a student’s background.

3.2.2.2 Credit distribution by term

The credit distribution by term will be the same for all students who enter the program in the fall of each year. However, some students may take more courses than others due to the research topic and the supervision committee’s discretion.

3.2.2.3 Study mode

Students must enroll on a full-time basis and complete the two term foundational course that is “cohort based”. Students can take other courses at their own discretion and within a two-year time frame. The comprehensive exam must be passed within the first two years.

3.2.2.4 Student supervision and evaluation

Each student will be required to form a supervisory committee consisting of the supervisor(s) and at least two other professors. The supervisory committee will need to include researchers representing a broad spectrum of the proposed program with complementary expertise, from biology to quantitative approaches. The student will meet with his/her committee at least annually. The role of the supervisory committee is to help guide the student through his/her studies, identify issues and propose approaches to fix them, and ensure that the student’s research program remains at the intersection of life and quantitative science.

Students are evaluated in each course, according to standard evaluation procedures for these courses; these include a combination of exams, term papers, essays, and problem-based questions, etc. For graduate studies, Grades A through B- are deemed satisfactory passes, and F is a failure. Students must obtain grades of B- or better in courses used to fulfill program requirements. Grades of C and D do not exist in graduate studies.
Ph.D. Thesis will be evaluated according to the rules set by the Office of Graduate and Postdoctoral Studies at McGill University, i.e. external and internal review by experts as well as an oral defence.

<table>
<thead>
<tr>
<th>Grades</th>
<th>Grade points</th>
<th>Numerical scale of marks</th>
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<tbody>
<tr>
<td>A</td>
<td>4</td>
<td>85 - 100%</td>
</tr>
<tr>
<td>A-</td>
<td>3.7</td>
<td>80 - 84%</td>
</tr>
<tr>
<td>B+</td>
<td>3.3</td>
<td>75 - 79%</td>
</tr>
<tr>
<td>B</td>
<td>3</td>
<td>70 - 74%</td>
</tr>
<tr>
<td>B-</td>
<td>2.7</td>
<td>65 - 69%</td>
</tr>
<tr>
<td>F</td>
<td>0</td>
<td>0-64%</td>
</tr>
</tbody>
</table>

3.2.3 Academic regulations and environment

Academic regulations are determined by the Office of Graduate and Postdoctoral Studies and those regulations will be applied to this program. All other academic regulations comply with those of the University as a whole, which are available on the website.¹

3.2.4 Program administration

The Quantitative Life Sciences Ph.D. Program will be an Interfaculty program comprised of the participating faculties (i.e. Science, Medicine) and will be directed by a Steering Committee and Program Executive Committee with representation from all faculties involved. Its structure follows that of all interdisciplinary programs at McGill.

¹ coursecalendar.mcgill.ca/gps201011/wwhelp/wwhimpl/js/html/wwhelp.htm
3.2.4.1 Academic Program Administration

Supervisory Membership

- Members of any Faculty (ie. Medicine, Science, Engineering and Agricultural & Environmental Science) interested in obtaining supervisory privilege within this program must submit their CV to the Program Executive Committee for approval.
- The potential supervisor’s home unit must approve the participation of the faculty member’s involvement as an associate member in writing. Written approval by the home unit must accompany the faculty member’s CV when submitted for consideration of supervisory privilege. QLS program participation must be acknowledged by the home unit in faculty member workload, merit, promotion, etc.
- Continuation of supervisory privileges is contingent on adequate participation and involvement in the program.

Steering Committee

- **Mandate.** The Steering Committee provides the overall program governance and administration for the QLS Ph.D. program.
- **Composition.** The Steering Committee is composed of
  - the Dean of Graduate and Postdoctoral Studies (GPS)
  - Deans of participating faculties
  - QLS program representatives (2)
  - QLS Graduate Program Director (GPD)
● **Meetings.** The Steering Committee meets at least once per year. More frequent meetings may be necessary until the program is fully established.

● **Assignments (non-exclusive).** The Steering Committee appoints the GPD and Associate GPD, upon the recommendation of the Program Executive Committee.
  
  o The Steering Committee reaches decisions with regard to space allocation, program budget and staff recruitment for the QLS Ph.D. Program.

● **Representation.** When not in session, the Steering Committee is represented by the Chair (Dean of GPS)

**Program Executive Committee**

● **Mandate.** The Program Executive Committee provides academic oversight, quality assurance and establishes academic policy subject to approval of Steering Committee.

● **Composition.** The Program Executive Committee is composed of
  
  o The Graduate Program Director, who chairs the Committee and sets the agenda for meetings of the committee;
  o The Associate GPD (if appointed)
  o One member representing the Biophysics Stream
  o One member representing the Computational and Statistical Molecular Biology Stream
  o One member representing the Ecosystems Stream
  o If adequate representation of participating faculties is not achieved with the GPD, Associate GPD and Stream representatives, additional members will be nominated by the respective faculty.
  o Two student representatives by special invitation

● **Meetings.** The Program Committee should meet at least once per term, or as required.

● **Decisional Process.** Whenever possible, the decisions are reached by consensus. If the general consensus cannot be reached, decisions are reached by the vote of all members except the GPD. The GPD only votes in the case of a tie.

● **Assignments (non-exclusive).**
  
  o The Program Executive Committee nominates the GPD and the Associate GPD to the Steering Committee.
  o The Program Executive Committee appoints the chairs of the Curriculum, the Admissions and the Fellowship sub-committees, and any other sub-committees needed.
  o The Program Executive Committee approves and reviews supervisory privileges.
  o The Program Executive Committee receives and approves reports and policy recommendations from GPD and all sub-committees.
  o The Program Executive Committee approves award recommendations by the Fellowships and Awards committee

**Graduate Program Director (GPD)**

● **Mandate.** The GPD manages the day-to-day operations of the QLS graduate program, with consultation from the Associate GPD, according to the policies set by the Program Executive Committee.

● **Role term and rotation.** The term of the GPD and associate GPD is normally 3 years. This is renewable at the discretion of the Steering Committee.

● **Assignments (non-exclusive).**
  
  o Overall responsibility for management of QLS graduate program
• Chairs the Program Executive Committee
• Responsible for detecting student/supervisor issues at an early stage and taking corrective action
• Implements academic policies as defined by the Program Executive Committee for academic management of QLS graduate program
• Establishes administrative procedures for operational management of QLS graduate program.
• Monitors supervisor performance and takes corrective actions if needed (can recommend removal of supervisor rights, as needed, to the Program Executive Committee)
• Approves student leaves
• Selects Chair’s representative for all Ph.D. committees
• Monitors student progress and reviews minutes of Ph.D. meetings
• Approves choice of examiners for thesis review
• Approves makeup of Oral Examination Committees
• Organizes and chairs the Annual Faculty Meeting at the QLS retreat.

• Delegation
  • Any of the roles listed above can be delegated to the Associate GPD as needed by the GPD.

Admissions Committee

• Mandate. Devise policies and regulations regarding admissions, which are proposed to the Program Committee for approval. Review applications to determine if the student meets all entrance requirements.
• Composition. The Admissions Committee is composed of three members (at minimum) in addition to the Student Affairs officer (ex officio member without vote).
• Membership: The chair of the admissions committee selects members for the committee with approval from the respective departmental chair.
• Meetings. The Committees meet as necessary or as requested by the GPD.
• Assignments (non-exclusive).
  • Reviews applications to determine if the student meets all entrance requirements
  • Determines whether or not to accept a student who does not meet all requirements (e.g. missing prerequisites, GPA too low)
  • Determines prerequisites (if any) student must fulfill if accepted
  • Determines any other admission requirements
  • Approves all acceptances

Curriculum Committee

• Mandate. Devise policies and regulations regarding the QLS curriculum, which are proposed to the Program Executive Committee for approval
• Composition. The Curriculum Committee is composed of a three members (at minimum)
• Meetings. The Committees meet as necessary or as requested by the GPD.
• Assignments (non-exclusive).
  • Reviews course proposals and makes recommendations to the Program Executive Committee
  • Reviews and approves list of suggested non program courses
  • Advises GPD/Program Executive Committee w.r.t. course consultations
Develops proposal for modifications to the curriculum of program

Fellowships and Awards Committee

- **Mandate.** Develops policy for distribution of GPS funds for graduate support and submits to Program Executive Committee for approval of policy. Evaluates student dossiers for internal and external awards.
- **Composition.** The Fellowships and Awards Committee is composed of five (at minimum) members in addition to the QLS Student Affairs officer (ex officio member without vote).
- **Meetings.** The Committees meet as necessary or as requested by the GPD.
- **Assignments (non-exclusive).**
  - Implements approved policies for allocation of GPS awards
  - Reviews candidate applications and recommends to the GPD and associate GPD for:
    - Student Recruitment Awards
    - Student Excellence Awards
    - Graduate Research Enhancement and Travel (GREAT) Awards
    - External fellowships
    - Awards for graduate student funding

3.2.4.2. Administrative Resources

Resources at McGill tend to be distributed through existing Faculty mechanisms and since multi-Faculty interdisciplinary graduate programs are outside of Faculty resource networks, independent interdisciplinary programs require different bases for gaining and distributing resources. The Quantitative Life Sciences Ph.D. Program requires:

- Budgetary unit identification so that graduate programs can control and report financial resources
- Human resources mechanism to provide permanent operational resources to support director stipend and staff salaries

Initially, operational resources to support the program will be provided in-kind by the units involved in the program. Once success of the Quantitative Life Sciences Ph.D. Program has been established (one full year of operation), permanent resources will be secured by the Steering Committee and managed by IFS.

3.3 REQUIRED ACADEMIC ACTIVITIES

3.3.1 Academic requirements

The program will include 5 basic elements:

1. **[Breadth]** One two-semester required foundational course (shared across streams).
2. **[Breadth]** A research seminar with invited speakers (shared across streams).
3. **[Depth]** Complementary courses, including both life science courses and quantitative courses, to be selected based on the student’s area of research or conjunction with the student’s supervisory
committee, to fill gaps in a student’s background and allow depth in a desired area.

Students enrolled in one of the program’s streams may need to satisfy additional requirements (see Section 3.4).

3.3.2 Advisory Committee
Within one month of entry to the Ph.D. Program, each student, in conjunction with their supervisor, will select an advisory committee comprised of the supervisor and at least one faculty member from each of the relevant Quantitative and Life Science departments with expertise and knowledge in the intended area of research. Within 3 months of entry, students will be expected to have an initial meeting with their advisory committee to determine the rationale and overall objectives of the planned research project. The advisory committee will also review the student’s academic background and training and recommend course work to complement and/or strengthen the student’s knowledge base. Advisory committee meetings will take place on an annual basis to evaluate the student’s progress towards completion of the thesis.

3.3.3 Courses
Students will be required to take a minimum of 4 courses, for a total of 15 credits (but see below for course reductions):

- 1 two-semester foundational course, shared across streams [6 credits]
- 1 to 2 “quantitative” courses [3 - 6 credits]
- 1 to 2 “life science” courses [3 - 6 credits]

In addition, and upon the recommendation of the student’s supervisory committee, up to two 600-level “directed reading” courses may be required to address gaps in a student’s background. Such courses may take the form of a combination of the course material from an undergraduate course and additional reading or project.

Course load reduction: Students entering the program with a Masters or having taken extra graduate courses during their undergraduate degree will have the opportunity to apply for a course reduction, if they have taken courses that are analogous to those listed below. Up to three stream-specific courses may be waived, leaving at a minimum the foundational 2-semester course.

3.3.3.1 Required Course - “Foundations of Quantitative Life Sciences”
All students will take the “Foundations of Quantitative Life Sciences” course (6 credits), offered over two consecutive semesters. The main topics to be addressed in these two courses are:

- Foundations of life science, with a focus on how quantitative approaches can best contribute to scientific advancement.
- Advanced technologies and tools used to measure living systems and their limitations.
● Linking experimental techniques to analysis methods, including how to analyze large life science data sets.
● Quantitative models and computer simulations of life science systems.
● Identifying similar mathematical, computational and statistical techniques that can be applied across life science levels.
● Effective communication and collaboration between traditional and quantitative life scientist.

The course will be divided into 3 week modules that will each focus on specific applications of and methods for quantitative life science. During the first few weeks of the term, depending on demand and need, a series of intensive workshops and/or bootcamps will be offered to train students in specific software programs, and to build community. A detailed course outline and description of the Foundations of Quantitative Life Sciences course is included in the Appendix.

3.3.3.2 Comprehensive Exam

Students will be required to pass a Comprehensive Exam early in their graduate careers. Before the end of the second year (18-24 months since entering the program), students must be prepared to complete the Comprehensive Exam. The Comprehensive Exam is evaluated by the student’s advisory committee, in addition to two members external to the committee. One external committee member must be from a Quantitative discipline, while the other from a Life Sciences discipline. The Comprehensive Exam consists of the following three components:

**Written Thesis Proposal:** The student must present a written Thesis Proposal and circulate it to the members of the advisory committee. The proposal should be between ten and twenty pages long, and address the following topics:

- Central hypothesis, main research question, specific objectives
- Review of relevant literature, rationale
- New findings and knowledge to be gained, how this research will advance science and/or health
- Work plan, timelines, analysis of results, potential limiting factors, contingency plans and alternatives
- Preliminary data and initial findings supporting the proposed project

**Thesis Proposal Presentation:** The student will deliver a 30 minute oral presentation of their Thesis Proposal to the advisory committee

**Oral Examination:** The oral examination portion of the Comprehensive Exam will include both a breadth component (knowledge of applications of and methods in QLS, i.e. material covered in the two foundational courses), and field-specific depth component. For students enrolled in a stream, the Comprehensive Exam will evaluate the understanding of the biological phenomena under study as well as the fundamental quantitative approaches in their stream. For students who are not enrolled in a stream, the Comprehensive Exam will
similarly test depth of understanding of the specific biological concepts and quantitative approaches related to the student’s research topic. In addition, students will be expected to answer questions relating directly to the material presented in the Thesis Proposal.

3.3.3.3 Complementary courses

The choice of the complementary courses will be made by the student and his/her supervisory committee, but should include at least one course on “quantitative methods” and one course on “Life sciences”. Students enrolled in an existing stream will need to select courses from stream-specific lists of complementary courses. Those not enrolled in a stream will need to get their course selection approved by their supervisory committee and by the program director. We note that it is not expected that every incoming student will have sufficient background to take every complementary course listed. It will be the student’s and supervisory committee’s responsibility to ensure that he/she has the prerequisites for the selected courses.

3.3.4 Community building activities

Contact between students in different research areas and streams is critical in order to ensure cross-fertilization of ideas between students working in very different areas. Therefore, we propose several complementary elements in order to build a community of students and faculty and to facilitate interactions.

3.3.4.1 Monthly half-day research seminar

- Once a month during the academic year, one high-profile researcher will be invited to give a seminar. Topic areas for the invited speakers will rotate across the streams, so there will be approximately 2 speakers from each stream within each academic year. Students will nominate potential speakers to be invited in the following academic year.
- Prior to the seminar, there will be a student-led journal club, where one or two papers, relevant to the seminar, will be read and discussed. The students will choose the papers to be discussed.
- Following the seminar, the speaker will be invited to join an informal discussion with the students over lunch.
- Student attendance at the monthly research half-day will be mandatory for the first 3 years of the Ph.D. program. Students with course conflicts may apply for a temporary exemption. Faculty members will also be encouraged to attend.

3.3.4.2 Annual retreat

A full-day retreat for all students and supervisors in the program will occur once a year. QLS students will be required to present their research to the academic community through short talks and presentations. An annual meeting of all faculty members with supervisory privilege in the QLS program will also occur at the retreat as a forum for discussions regarding the status and progress of the QLS graduate program. This event will strengthen and maintain interdisciplinary discussions and encourage new collaborations.
3.3.4.3 Dissemination of relevant events and seminars

The Program coordinator will collate seminars or workshops of potential interest across the campus (and city-wide), and send an announcement each week to students and associated faculty. This information will also be posted on the Program web site.

3.3.4.4 Round tables

From time to time, an opportunity to meet with potential employers will be facilitated through a Round Table. Representatives from companies or agencies with applications and interest in quantitative life sciences will be invited to speak and to be available for questions from students.

3.3.5 Thesis

The thesis expectations follow the guidelines established by Graduate and Postdoctoral Studies at McGill University. In general, the thesis must demonstrate a mastery of appropriate research as well as contributing original scholarship relating to the area of specialization. An oral examination of the content and implications of the thesis will be held in a public forum to determine the quality of the written thesis document and the student’s oral defence of the thesis.

The following table provides an overview of the typical 5 year timeline for a student enrolled in the QLS PhD Program

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 1 Winter</th>
<th>Year 2</th>
<th>Year 2 Winter</th>
<th>Year 3</th>
<th>Year 3 Winter</th>
<th>Year 4</th>
<th>Year 4 Winter</th>
<th>Year 5</th>
<th>Year 5 Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Courses</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foundations of QLS</td>
<td>Foundations of QLS</td>
<td>Complement Course 3</td>
<td>Complement Course 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complement Course 1</td>
<td>Complement Course 2</td>
<td></td>
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</tr>
<tr>
<td>Community Building Activities</td>
<td>QLS Retreat</td>
<td>QLS Retreat</td>
<td>QLS Retreat</td>
<td>QLS Retreat</td>
<td>QLS Retreat</td>
<td>QLS Retreat</td>
<td>QLS Retreat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Program Benchmark</td>
<td>Initial Advisory Committee Meeting</td>
<td>Thesis Proposal and Comp Exam</td>
<td>Advisory Committee Meeting</td>
<td>Advisory Committee Meeting</td>
<td>Submit Thesis</td>
<td>Defend Thesis</td>
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</tbody>
</table>

3.4 SPECIALIZED AREAS OF RESEARCH/STREAMS

Students will have the opportunity to follow one of several well-defined streams, although participation in a stream of research is not mandatory. A stream represents a course of study that is focused on a well-defined research discipline, and furthermore is of sufficient interest to attract multiple interested students. Each stream provides a structured complement to the basic program requirements, training around cohesive themes.
Initially, three streams are proposed and program requirements for these streams are described in detail below (Computational and Statistical Molecular Biology, Biophysics, Ecosystems). As knowledge and fields of research evolve, new streams may be created to suit demand. Such flexibility is essential to staying at the forefront of evolving methods and fields of application in quantitative life sciences. However, it is important to note that for students whose research interests do not align with one of these three streams, or where the research topic crosscuts multiple streams in a significant manner, a personalized program can be designed, guided by the basic program requirements, and the student's supervisory committee.

The proposed streams are divided according to the scale of biological phenomena and systems being studied:

- **Computational and Statistical Molecular Biology**: Computational, statistical and mathematical approaches for the study of genetic and molecular biology questions.
- **Biophysics**: Applications of physics to the design of cutting edge tools to study biological questions, and to model biomolecules, molecular machines, cellular processes, and complete cells.
- **Ecosystems**: Mathematical and computational approaches in ecology, evolution, and infectious disease.

We note that the streams are conceptually interconnected, which is why it makes sense to include them under the same program. For example, cancer is an area that is fruitfully studied at all scales (search for driver mutations that alter the function of the cell division machinery, identification of key pathways, regulators and targets, competitive interactions between tumor and normal cells within organ systems, and the evolution of tumor cells - e.g. from benign to metastatic). The boundaries between the three streams are meant to be malleable and a student whose project would lie at the boundary of two or three of these streams would be allowed to select courses for each of them, under the guidance of his/her progress committee.

### 3.4.1 Computational and Statistical Molecular Biology Stream

Computational and Statistical Molecular Biology includes the fields of computer science, statistics and mathematics applied to the analysis of data from molecular biology and genetics. As biological assays become increasingly high-throughput (while often remaining quite noisy), sophisticated algorithms and efficient computational analyses are now intrinsic part of biology. Key challenges include: (i) How to store and retrieve huge data sets (e.g. those produced by a massively parallel sequencing machine)? (ii) how to process, normalize, and analyze such data sets? (iii) How to translate biological questions into algorithmic questions, and how to solve them efficiently while keeping in mind the potential sources of bias and error? (iv) how to develop high-dimensional predictive models and machine learning approaches to gain insights leading to formulate testable biological hypotheses?

Students in the Computational and Statistical Molecular Biology stream will receive training in databases, computational biology algorithms, biostatistics, and machine learning. They will also be required to train in the life science field of their choice (genomics, structural biology, evolution, proteomics, cancer, etc.) and become expert in both the specific computational and statistical aspects of their area of application, but also in their biological aspects. With time, we expect graduates from the Computational and Statistical Molecular Biology
stream to be able to (i) formulate new, cutting-edge biological questions, (ii) understand the experimental approaches needed to acquire the relevant data, (iii) understand existing approaches for their analysis, and be equipped to develop new approaches when necessary, (iv) be able to interpret the results of their analyses in a biological context. Co-supervision between bioinformatics researchers and life scientists will be encouraged.

3.4.1.1 Computational and Statistical Molecular Biology Stream admission requirement

- One of the following: Entry-level computational biology (COMP 462), Regression and ANOVA (MATH 423), or Biophysics (BIOL/PHYS 319).

3.4.1.2 Computational and Statistical Molecular Biology Stream program requirements

Students will be required to take one or two courses from each of the Quantitative and Life Science blocks below, for a total of three courses.

**Complementary Courses**

<table>
<thead>
<tr>
<th>Quantitative Block</th>
<th>Life Sciences Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMDE 502 BME Modelling &amp; Identification</td>
<td>BIOC 603 Genomics and Gene Expression.</td>
</tr>
<tr>
<td>BIOS 601 Epidemiology: Introduction and statistical models.</td>
<td>HGEN 661 Population Genetics</td>
</tr>
<tr>
<td>MATH 523 Generalized Linear Models</td>
<td>HGEN 692 Human Genetics.</td>
</tr>
<tr>
<td>HGEN 677 Advanced statistical methods in genetics and genomics.</td>
<td>EXMD 602 Techniques in Molecular Genetics.</td>
</tr>
<tr>
<td>COMP 561 Computational Biology Methods and Research</td>
<td>BIOL 551 Principles of Cellular Control</td>
</tr>
<tr>
<td>COMP 598: Topics in Computer Science: Advanced Computational Biology Methods</td>
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</tr>
<tr>
<td>MATH 680 Computation Intensive Statistics</td>
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</tbody>
</table>

3.4.2 Biophysics Stream

The increasingly quantitative nature of biology requires a physical understanding of the organization of cellular structures, from macromolecules to organelles, from biopolymers to cytoskeleton. Specific tools have been designed to probe properties of this living matter, including sophisticated imaging techniques and algorithms, micro and nanofluidics, force microscopy, along with biophysical models at the nexus of soft condensed matter and out of equilibrium physics.

Students in the biophysical stream will receive a broad training in physical approaches applied to biology, both on the experimental and theory side. Life science training will focus on necessary techniques from molecular
biology and concepts from systems biology for physical applications. They will also conduct research within
biophysical groups or cross-departmental teams between physics and life-science departments.

3.4.2.1 Biophysics stream admission requirement

- One of the following: Thermal and Statistical Physics (PHYS 333), Statistical Mechanics (PHYS 362), or
  Introduction to Biophysics (BIOL/319) or equivalent.

3.4.2.2 Biophysics stream program requirements

Students will be required to take one or two courses from each of the Quantitative and Life Science blocks below,
for a total of three courses.

**Complementary Courses**

<table>
<thead>
<tr>
<th>Quantitative Block</th>
<th>Life Sciences Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIEN 530 Imaging and Bioanalytical Instrumentation</td>
<td>BIOC 604 Macromolecular Structure.</td>
</tr>
<tr>
<td>BMDE 519 Biomedical Signals &amp; Systems</td>
<td>PHGY 520 Ion Channels</td>
</tr>
<tr>
<td>BMDE 512 Finite-Element Modelling: BME</td>
<td>PHGY 518 Artificial Cells</td>
</tr>
<tr>
<td>CHEM 514 Biophysical Chemistry.</td>
<td>BIOL 551 Principles of Cellular Control</td>
</tr>
<tr>
<td>CHEM 520 Methods in Chemical Biology</td>
<td></td>
</tr>
<tr>
<td>COMP 551 Applied Machine Learning</td>
<td></td>
</tr>
<tr>
<td>PHYS 519 Advanced Biophysics</td>
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</tr>
<tr>
<td>PHYS 559 Advanced Statistical Mechanics</td>
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</tbody>
</table>

3.4.3 Ecosystems Stream

Ecosystems can be contained in a vial or they can extend over the biosphere, but they represent the highest
level of biological organization. They constitute a great scientific challenge and define many of our goals for a
sustainable planet. Ecological, evolutionary, and epidemiological systems have provided many historical case
studies in quantitative fields such as mathematics and computer sciences. However, the large complexity of
natural ecosystems has repeatedly limited their quantitative study in favor of more observational methods.
Students participating in the Ecosystem stream will receive an in-depth training in classic quantitative methods
such as statistics and dynamical systems that have been historically adopted by mathematicians to study
ecosystems. They will also be trained in statistical physics and advanced molecular methods that have been
more recently applied to the study of whole-ecosystems. They will conduct their research under the guidance of
scientists working across these areas and will apply cutting edge physical and mathematical methods to the
understanding and forecasting of ecosystem response to natural and human impacts.
3.4.3.1 Ecosystems stream admission requirements

- One of the following: Ecological Dynamics (BIOL 308), Evolution (BIOL 304), Conservation Biology (BIOL 465), or equivalent.

3.4.3.2 Ecosystems stream program requirements

Students will be required to take one or two courses from each of the Quantitative and Life Science blocks below, for a total of three courses.

Complementary Courses

<table>
<thead>
<tr>
<th>Quantitative Block</th>
<th>Life Sciences Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENVB 506 Quantitative Methods in Ecology</td>
<td>BIOL 509 Methods in Molecular Ecology</td>
</tr>
<tr>
<td>MATH 556 Mathematical Statistics 1</td>
<td>BIOL 510 Community Ecology</td>
</tr>
<tr>
<td>MATH 525 Sampling Theory and Applications</td>
<td>BIOL 594 Advanced Evolutionary Ecology</td>
</tr>
<tr>
<td>MATH 533 Honours Regression and Analysis of Variance</td>
<td>ENVR/Biol 540 Ecology of Species Invasion</td>
</tr>
<tr>
<td>MATH 537 Mathematical Models in Biology</td>
<td></td>
</tr>
<tr>
<td>MATH 547 Stochastic Processes</td>
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</tr>
<tr>
<td>MATH 523 Generalized Linear Models</td>
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</tbody>
</table>

3.5 Examples of typical coursework

Here, we give four examples of the coursework that may be assigned to students entering the program with different types of backgrounds, as a function of their stream and their specific research program, and as determined by the student and his/her supervisory committee.

Example 1. Computational and Statistical Molecular Biology stream.

A student is admitted with a major in statistics and a minor in biology. He wants to develop new statistical approaches for the analysis of population genomics data. He lacks background in computer science.
<table>
<thead>
<tr>
<th>Semester 1</th>
<th>Semester 2</th>
<th>Semester 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation course - part 1</td>
<td>Foundation course - part 2</td>
<td>COMP 561: Computational Biology Methods and Research.</td>
</tr>
<tr>
<td>Reading course (based on COMP 250 - Intro.to comp. sci.)</td>
<td>MATH 680 Computation Intensive Statistics</td>
<td></td>
</tr>
<tr>
<td>HGEN 692: Human Genetics</td>
<td>HGEN 661 Population Genetics</td>
<td></td>
</tr>
</tbody>
</table>

**Example 2. Biophysics stream.**

A student is admitted with a major in physics and a Masters in Biology. He wants to model the stochastic aspects of microtubule assembly during cell divisions, under the supervision of a biologist expert in imaging and a physicist.

<table>
<thead>
<tr>
<th>Semester 1</th>
<th>Semester 2</th>
<th>Semester 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation course - part 1</td>
<td>Foundation course - part 2</td>
<td></td>
</tr>
<tr>
<td>BIOL 551: Principles of Cellular Control</td>
<td>BIEN 530 Imaging and Bioanalytical Instrumentation</td>
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</tr>
<tr>
<td>PHYS 519: Advanced Biophysics</td>
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</table>

**Example 3. Ecosystems stream.**

A student is admitted with a major in biology and a minor in mathematics. She wants to model the impact of climate change on the arrival of invasive species in the St-Lawrence River.
<table>
<thead>
<tr>
<th>Semester 1</th>
<th>Semester 2</th>
<th>Semester 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation course - part 1</td>
<td>Foundation course - part 2</td>
<td>MATH 525 Sampling Theory and Applications</td>
</tr>
<tr>
<td>Reading course (based on COMP 350: Numerical computing)</td>
<td>BIOL 509: Methods in Molecular Ecology.</td>
<td></td>
</tr>
<tr>
<td>BIOL 594: Advanced Evolutionary Ecology</td>
<td>ENVR/BIOL 540 Ecology of Species Invasion</td>
<td></td>
</tr>
</tbody>
</table>

**Example 4. Cross-cut of computational molecular biology and ecosystems (no Stream)**

A student admitted with an undergraduate degree in physics wants to work on developing a microfluidics device to analyze the human gut microbiome. She lacks background in microbiology.

<table>
<thead>
<tr>
<th>Semester 1</th>
<th>Semester 2</th>
<th>Semester 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation course - part 1</td>
<td>Foundation course - part 2</td>
<td>PARA 655: Host-Parasite Interactions.</td>
</tr>
<tr>
<td>Reading course (based on MIMM 211 - Intro. microbiology)</td>
<td>PHYS 519: Advanced Biophysics.</td>
<td></td>
</tr>
<tr>
<td>BMDE 519 Biomedical Signals and Systems</td>
<td>BIOL 540: Ecology of Species Invasions.</td>
<td></td>
</tr>
</tbody>
</table>
4. **RESOURCES**

4.1 **STAFF RESOURCES REQUIRED, AVAILABLE AND PROJECTED**

4.1.1 **Teaching staff**

4.1.1.1 **Academic Staff in Place**

The proposed program has adequate faculty for teaching and supervision at McGill University.

The following McGill University faculty members will be teaching the required two semester capstone course. This selection of professors from across a variety of departments highlights the true interdisciplinary and collaborative nature of the proposed program.

*Table 10: List of Academic Staff in Place*

<table>
<thead>
<tr>
<th>Departmental Affiliation</th>
<th>Faculty Member</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology</td>
<td>Frederic Guichard, Ph.D.</td>
</tr>
<tr>
<td>Computer Science</td>
<td>Mathieu Blanchette, Ph.D.</td>
</tr>
<tr>
<td>Epidemiology &amp; Biostatistics/Oncology</td>
<td>Celia Greenwood, Ph.D.</td>
</tr>
<tr>
<td>Human Genetics</td>
<td>Guillaume Bourque, Ph.D.</td>
</tr>
<tr>
<td></td>
<td>Ken Dewar, Ph.D.</td>
</tr>
<tr>
<td></td>
<td>Simon Gravel, Ph.D.</td>
</tr>
<tr>
<td></td>
<td>Tomi Pastinen, Ph.D.</td>
</tr>
<tr>
<td>Neurology &amp; Neurosurgery</td>
<td>Christopher Pack, Ph.D.</td>
</tr>
<tr>
<td>Physiology</td>
<td>Erik Cook, Ph.D.</td>
</tr>
<tr>
<td></td>
<td>Anmar Khadra, Ph.D.</td>
</tr>
<tr>
<td></td>
<td>Judith Mandl, Ph.D.</td>
</tr>
<tr>
<td>Physics</td>
<td>Paul François, Ph.D.</td>
</tr>
<tr>
<td></td>
<td>Sabrina Leslie, Ph.D.</td>
</tr>
<tr>
<td></td>
<td>Paul Wiseman, Ph.D.</td>
</tr>
</tbody>
</table>
4.1.2 New Staff Required

No new teaching staff are required or requested for the proposed program.

4.1.2 Administrative and support staff

4.1.2.1 Staff in place

McGill University will eventually appoint the required full-time Program Director, Associate Program Director and Graduate Program Coordinator. Their responsibilities are outlined in sections 3.2.4.4.-3.2.4.7.

4.2 Physical and other resources

4.2.1 Library resources

4.2.1.1 Quality of collections and quantity

The McGill Library consists of 12 branches covering all subjects taught at McGill, and includes 5.6 million print and electronic items in a variety of different formats. Of particular interest to students in the Quantitative Life Sciences Program are the Schulich Library of Science & Engineering and the Macdonald Campus Library, both part of the McGill Library system. The Schulich Library of Science and Engineering supports the teaching and research activities of all departments in the Faculties of Engineering, Science, Medicine, and Dentistry. The Macdonald Campus Library supports the teaching and research activities of the Faculty of Agricultural and Environmental Sciences, the School of Dietetics and Human Nutrition, the McGill School of Environment, the Institute of Parasitology, the Morgan Arboretum, and the Macdonald Farm. The collections of these libraries include books, journals, government publications, standards, and technical reports in engineering and the sciences.

McGill students, faculty, and staff can borrow from any of the Library’s branches with their university ID card and have 24/7 access to the Library’s electronic information resources. The latter includes use of approximately 2.2 million electronic books, circa 126,000 electronic journals, and EndNote and RefWorks citation software. The McGill community has access to many of the large, aggregated e-journal packages, including: the American Chemical Society, the American Medical Association, BMJ, Elsevier Science, the Institute of Physics, Nature Publishing Group, Springer, Taylor & Francis, Wiley-Blackwell, and Wolters Kluwer. In addition, the library subscribes to research databases that enable searching for references to the published literature such as: BIOSIS Previews, CAB Abstracts, Cochrane Library, Compendex, Embase, Inspec, Medline (via Ovid), SciFinder, Scopus, Web of Science, ProQuest Dissertations & Theses, and Derwent Innovations Index (for patent literature).

4.2.1.2 Accessibility; assistance and reference services provided; access to resources available at other institutions.

The Macdonald Campus Library and the Schulich Library of Science & Engineering are open for service 6 days per week (52 hours and 57 hours a week respectively) in the Fall and Winter semesters, and 5 days per week (40
hours a week) in the summer. During service hours, there are professional librarians available to help library users whether in person, by phone, email or online chat. Both libraries also have extended study hours throughout the Fall and Winter semesters. Faculty members and graduate students can request permanent, 24/7 after-hours access to the Schulich Library, which is valid for the duration of their employment or studies at McGill. The auto-loan machines in the library enable individuals to borrow items themselves outside of service hours. Off-campus or remote access to all of the Library’s electronic resources is available to students, faculty, and staff via McGill’s EZproxy service or Virtual Private Network (VPN) connection. The McGill Library also participates in Eduroam (“education roaming”), which allows students and staff to use their McGill credentials to obtain Internet connectivity at other participating universities for the purpose of accessing McGill Library’s electronic resources on their own laptops.

The Macdonald Campus Library and the Schulich Library have seating for approximately 230 and 635 people respectively, including group and quiet study areas that together house 155 computers, 14 photocopiers, and 9 scanners available for use. Some of this equipment is located in the libraries’ three electronic classrooms which are each equipped with 19-25 desktop computers, a built-in projector, podium and screen. These classrooms are used by librarians for teaching, and by students on a daily basis for work and access the library’s electronic resources. Wireless network access is available throughout the library. Many desk carrels and tables in the library contain power outlets for personal laptops. Individuals can access any of the McGill Library’s 12 branches for similar physical resources.

Fourteen librarians (11 at the Schulich Library and 3 at the Macdonald Campus Library) support the learning, research, and teaching needs of the departments they serve in numerous ways including assisting students, faculty, and staff with finding specific information, developing optimal database search strategies, identifying highly influential journals in their fields, and managing their citations; providing library orientation and hands-on information literacy instruction to students (both inside and outside the classroom); purchasing books and other materials; creating and maintaining online subject guides that pull together resources in a specific area; and communicating updates on library services and resources.

McGill students and researchers working at any of the university’s affiliated teaching hospitals also have access to libraries on site that are equipped with computers, study spaces, and staffed with their own librarians and library assistants. All electronic resources provided by the McGill Library system are accessible to McGill students, faculty and research staff of the affiliated hospitals and research institutes. These include:

- Douglas Mental Health University Institute
- McGill University Health Centre:
  - Montreal Chest Institute
  - Montreal Children’s Hospital
  - Montreal General Hospital
  - Montreal Neurological Institute & Hospital
  - Royal Victoria Hospital
McGill University’s Graduate and Postdoctoral Studies unit in partnership with Teaching and Learning Services and McGill University librarians also offer a 4-part “MyResearch” workshop series (totaling 8 hours) for graduate students to advance their library research skills. Graduate students discover how to use the citation software EndNote; understand and locate different types of information produced at each stage of the research cycle; learn advanced search strategies and techniques to make the best use of specialized resources for their disciplines; and gain a better understanding of citation analysis tools and metrics. Students who complete all 4 of these modules receive a certificate signed by both the Trenholme Dean of Libraries and the Dean of Graduate and Postdoctoral Studies. The MyResearch workshop series is also added to the students’ co-curricular records upon completion.

Graduate students, faculty, and staff can directly borrow materials in person from other Canadian libraries with a BCI (Bureau de Coopération Interuniversitaire) card, which can be obtained from the service desk of any McGill Library branch. Furthermore, a worldwide interlibrary loan/document delivery service is available to obtain materials that are not in the McGill Library’s print or electronic collections. The McGill community is also encouraged to submit comments, suggestions, and request book purchases. McGill librarians continually monitor use of the library system’s services, facilities, and resources, as well as acquire new and/or more relevant resources to allow efficient and timely access to information. In 2016, as in previous years, the Library has also sent out the LibQual+ survey to students, faculty, and staff to collect feedback about its services, facilities, and resources. The McGill Library system implements changes in response to emerging trends and concerns as identified in the survey.

4.2.2 Computer facilities

4.2.2.1 Quality and quantity

McGill Library offers over 500 computer work stations throughout the Library system for use by McGill student and faculty members. These workstations are in addition to the hundreds of computers available to students in individual hospital, laboratory and office settings. Wireless network connectivity is accessible to students, faculty and staff through the McGill Wireless Zone on campus, and remote wireless access to the network and its resources can be easily configured with a username and password. Users of the McGill wireless network can attain speeds of up to 54 Mbps using the 802.11g or 802.11a standards.

4.2.2.2 Accessibility; technical support; training and maintenance), networks.

Participants in the QLS Program will have access to significant state-of-the-art advanced research computing (ARC) systems, storage and software solutions through Compute Canada (https://www.computecanada.ca) in partnership with its regional partner organization, Calcul Quebec (http://www.calculquebec.ca/en/). Compute
Canada helps researchers who need ARC in all disciplines and at all scales; from individual researchers to some of the largest international research collaborations in the world. Compute Canada serves several disciplines as diverse as computational criminology, chemistry, aerospace engineering, medicine, and analysis of great works of fiction. Powered by a nationally coordinated network of hardware and software resources, Compute Canada provides a broad spectrum of advanced computing services in support of research, including technical support, training, application and development. Compute Canada supports an extensive range of research computing needs on a case-by-case basis, including (but not limited to):

- large scale computation
- large memory machines
- accelerated systems (GPUs)
- scientific gateways, portals, etc.
- cloud services
- high-throughput storage and compute systems
- archival storage

Calcul Quebec provides world class High Performance Computing (HPC) infrastructures to its member institutions and industry, and provides support and training to researchers in areas of code development, code optimization, numerical methods and others so as to help researchers efficiently exploit modern computational and data analytics resources. The computational platforms accessible within Calcul Quebec include large scale multi-processor systems. The Calcul Quebec centre at McGill University (McGill HPC) offers various courses on high performance computing, computer programming, Big Data Analytics techniques and high performance computing methods. Topics include: MPI, OpenMP, Linux, Python, C++, R, CUDA, Matlab, Hadoop and MapReduce and others. The McGill HPC Centre also develops customized courses around these and other topics of advanced computing in partnership with McGill and other university units. The McGill HPC Centre is able to offer class participants access to all elements of the HPC platform for the duration of the course period, providing students with the resources for direct, hands-on learning via exercises and related course projects.

Many Principal Investigators at McGill have accounts for their research groups at Compute Canada and Calcul Quebec. Access to these resources is through desktops located in the supervisor’s labs or through student laptops.

4.2.3 Laboratories

Supervisors in the QLS Ph.D. Program will be expected to provide their students access to all necessary research equipment, tools and laboratory space to effectively collect their data and perform their research. McGill University assigns and supports laboratory spaces for all faculty members whose research requires such specialized infrastructure. The QLS Ph.D. Program encourages active collaboration across different disciplines and hence, students can potentially have access to multiple laboratories and research tools in their graduate career.
4.2.4 Space

4.2.4.1 Teaching space

The required core course for students in the QLS Ph.D. Program will be taught in a classroom associated with either the Faculty of Medicine, Science or Engineering. Classrooms in these faculties are well designed to accommodate the needs of course instructors and students, and equipped with all the equipment necessary (furniture, overhead projectors, chalkboards and audio visual connections). There will be no need to renovate or design new classroom space. The teaching spaces of complementary courses are similarly well organized and capable of accommodating the lecture material and resources necessary to effectively deliver course content within the departments of Biology, Biochemistry, Epidemiology, Mathematics, Computer Science, Biomedical Engineering, Human Genetics, Experimental Medicine, Physics, Chemistry, Physiology and Environmental Biology.

4.2.4.2 Office and Study Space

Many laboratories at McGill University incorporate desk and study space within the laboratory environment, providing students convenient work space in close proximity to their research. If desk space is not available in the supervisor’s laboratory, it will be made available in a nearby office or study room alongside other graduate students. Students also have access to the various libraries on both McGill’s Downtown and Macdonald campuses. Six of the 12 library branches feature private, quiet, and secure working spaces dedicated to graduate students. These include a Ph.D. study room with 36 desks equipped with two lockable drawers and two bookshelves each, study carrels that can be reserved for an entire semester, locked cubicles, graduate study rooms for thesis and comprehensive exam preparation, and semi-private desks with locking cabinets. As discussed above, QLS Ph.D. students can request permanent, 24/7 after-hours access to the Schulich Library, which is valid for the duration of their studies at McGill.

Laboratories and libraries located on campus or within hospitals and research institutes are part of a collective of academic units that feature seminars and departmental activities on a regular, ongoing basis. Students whose laboratories and offices are physically located at these sites will have access to these offerings, especially those highlighting related and relevant topics. Moreover, in an effort to build a sense of community amongst participants of the QLS Ph.D. Program, the mandatory monthly half day seminar series will be held at various locations throughout the university campus and the city of Montreal to ensure all students are familiar with the laboratories and physical spaces associated with the QLS program.

4.2.5 Financial Support for Ph.D. Students

Students in the QLS Ph.D. Program will be supported financially in several ways. All students registered in the program will draw a guaranteed minimum annual stipend from their supervisor’s research grants that will cover the cost of tuition and living expenses in Montreal. In any given semester, students will also have the option of being hired as a teaching assistant for complementary courses related to their field of study. In this case, students will gain valuable teaching experience as well as financial support. These arrangements will be in observance of McGill University’s regulations concerning maximum hours that can be worked weekly by the
student.

It is also anticipated that students in the QLS Ph.D. Program will be competitive applicants for fellowships and awards. McGill University has almost $1 million in internal funding endowments for graduate students engaged in medical and scientific research. In many cases students are automatically considered for, and offered, internal funding throughout their graduate careers. These awards include multidisciplinary research fellowships such as the Tomlinson Doctoral Fellowships (valued at $35,000 a year and held for up to three years), the Max Stern Recruitment Fellowships (valued at $14,000) and the Schulich Graduate Fellowships (minimum stipend of $25,000).

Students applying for external federal and provincial funding are well supported during the application process. McGill University’s Graduate and Postdoctoral Studies unit offers a number of information sessions that are in-person presentations followed by a live question and answer period. Each session focuses on the application process for a particular federal or provincial agency award, and covers everything from eligibility and deadlines to supporting documents and best practices. A staff of four graduate funding specialists at McGill University handle all questions and concerns regarding graduate funding opportunities throughout the year and regularly assist individual students for all matters pertaining to graduate funding fellowships and awards.

The McGill Writing Centre offers two fellowship writing workshops for students to develop their writing skills and write with the fellowship selection committee in mind. McGill University’s Teaching and Learning Services, through the SKILLSETS Program, offers a further layer of application review with the “Would You Fund It? Fellowship Consultation Session” open to graduate students applying for external funding opportunities. Students in the workshop have their two page project summary reviewed by a former Tri-Council or Quebec committee reviewer who provides feedback on the structure, relevance and language accuracy with suggestions on how to improve the draft.

4.3 REQUIRED FUNDING

The tables provided in Appendix provide an estimated cost of the program expenses projected over the first five years (2017-2021) as well as a cost analysis of the predicted revenue to the university. The expenses for the first year include administrative salaries, office supplies, promotional materials (e.g., website, pamphlets), webinars, software licensing, travel costs related to guest speakers for graduate seminars and promotional materials.
APPENDICES

A: Foundational Course Syllabus
B: List of Complementary Courses
C: List of Interested Faculty (in progress)
D: Letters of Support (in progress)
E: List of Grants Awarded to Teaching Faculty Members
F: List of Publications of Teaching Faculty Members
APPENDIX A: FOUNDATIONAL COURSE SYLLABUS

FOUNDATIONS OF QUANTITATIVE LIFE SCIENCE

Duration: 2 semesters

Course Schedule: Two 90-minute sessions per week

Course Credits: 6 (three per semester)

RATIONAL

This graduate course will train the next generation of multidisciplinary researchers needed to bridge the life and quantitative sciences. Quantitative life science is the broad application of mathematical, computational and other quantitative methods to study life science and biological systems. This course fits centrally into the rapidly expanding interdisciplinary field where mathematical and computer algorithms are becoming just as important as traditional approaches in biology and medicine. Worldwide, governments, universities and industries have begun to invest in quantitative life science, and these skills are already in high demand.

COURSE SUMMARY AND ORGANIZATION

Objectives

1. Give students an overview of the different types of biological questions that can be addressed using mathematical, computational and statistical approaches combined with cutting-edge measurement technologies.
2. Introduce students to the modern technologies for biological data acquisition.
3. Identify the key challenges related to the analysis of these data and provide a sample of the key set of mathematical, computational, and statistical approaches involved in their solution.
4. Teach students a common language to communicate across biological, physical, mathematical, and computational sciences.
5. Build a community of student scientists with an appreciation for the breadth of quantitative approaches in the life sciences.

Prerequisites (or equivalent)

- BIOL 200 Molecular Biology or BIOL 201 Cell Biology and Metabolism
- COMP 250 Introduction to Computer Science
- COMP 206 Introduction to Software Systems
- MATH 314 Advanced Calculus
- MATH 223 Linear Algebra or MATH 236 Algebra 2
- MATH 323 Probability or MATH 324 Statistics
Students without the prerequisites can register with approval from the course director upon demonstration of the above knowledge and skills.

**Format**

This course is divided into eight modules, with each module 3 weeks long. Modules will be taught by one or two professors who will present students with a broad view of the key biological questions in the topic area and of the quantitative approaches available to address them.

**Methods of Evaluation**

**Project Based Homework Assignments.** Each module will have a set of homework assignments that will include data analysis and computer programming. Assignments are due approximately one week after they are assigned.

**Small Group Presentation.** Students will participate in at least one small group presentation each semester. At the beginning of each module, two relevant research papers will be assigned for class reading. At the end of the module one group will briefly present the relative strengths and weaknesses of each paper utilizing ideas and concepts from the module.

**Critical Reviewer Questions.** Students not involved in the Small Group Presentation for the module will submit five critical questions analyzing the two research papers of the module. Questions should focus on topics such as rationale, methodology, research findings or conclusions that could be posed as critical reviewers of the research articles. Questions should be submitted to the module instructors the day before the presentation and will be posted to the class website.

**Discussion & Class Participation.** Participation in lecture sessions and small group presentations is considered beneficial to generating discussion and ideas in the course, and as such will be part of the overall grade.

**Peer Collaboration**

Students will be assigned to work in groups for the assignments and the small group presentation. Groups will change for each module. However each student must write his/her own assignment report and individually present a portion of the journal club presentation in class.

**Grading scheme**

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Based Assignments</td>
<td>70%</td>
</tr>
<tr>
<td>Journal Club Presentation</td>
<td>10%</td>
</tr>
<tr>
<td>Critical Reviewer Questions</td>
<td>10%</td>
</tr>
<tr>
<td>Discussion &amp; Class Participation</td>
<td>10%</td>
</tr>
</tbody>
</table>
COURSE CONTENT

BOOTCAMPS

In conjunction with the Foundations of Quantitative Life Sciences course, a “Bootcamp” skill series will be offered in the first week of each semester. This skill series offers incoming students the opportunity to learn or brush-up on software relevant to the course.

Fall Semester

Bootcamp 1: Introduction to scientific computing in Python and R (Week 1 Fall Semester)

Instructor: Mathieu Blanchette (Computer Science)

Interactive exercises in a computer-lab that review basic programming in Python and statistical analysis in R. These hands-on exercises will help the students understand Python’s visualization of data, functions, and programmatic elements (loops and conditional statements), while statistical testing and model fitting will be demonstrated in R.

Winter Semester

Bootcamp 2: Introduction to scientific computing in MATLAB (Week 1 Winter Semester)

Instructor: Sabrina Leslie (Physics)

Interactive exercises in a computer-lab that review basic programming in MATLAB. These hands-on exercises will help the students understand MATLAB’s visualization of data, functions, and programmatic elements (loops and conditional statements) by focusing on random walks, along with their statistical properties, by directly simulating the walks, and then comparing simulated observations to the theory.

MODULES

Eight modules will introduce students to the diverse set of quantitative approaches used to address a variety of current life science questions. Modules will be 3 weeks and share a common organizational structure. Modules are presented in an order that reflects the progression of scales in the life sciences: from genes to systems to ecosystems.

First, each module will introduce a specific instance of a cutting-edge biological question. Second, a review of the relevant biological concepts will be provided. Third, the module will discuss the technologies that allow collecting data relevant to the question at hand, focusing not only on the techniques themselves but also on their limitations that will need to be taken into consideration at the analysis step. Fourth, each module will
introduce the mathematical formalism that describes the data, which together with the computational approaches, solve the resulting biological problem. Modules will use a combination of lectures, presentations of recent scientific papers, computer-based assignments and small group discussion.

**Fall Semester Modules**

**Module 1: Genome sequencing and annotation** (Weeks 2-4 Fall Semester)

**Instructors:** Mathieu Blanchette (Computer Science) and Ken Dewar (Human Genetics)

<table>
<thead>
<tr>
<th>Question</th>
<th>What is the genetic makeup of an organism?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological concepts</td>
<td>Genome architecture and function</td>
</tr>
<tr>
<td>Technology</td>
<td>High-throughput sequencing</td>
</tr>
<tr>
<td>Quantitative analyses</td>
<td>Quality assessment; read mapping and genome assembly; gene prediction</td>
</tr>
</tbody>
</table>

**Module 2: Genetic links to disease** (Weeks 5-7 Fall Semester)

**Instructors:** Celia Greenwood (Oncology and Epidemiology) and Simon Gravel (Human Genetics)

<table>
<thead>
<tr>
<th>Question</th>
<th>How are genes associated with ancestry and disease?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological concepts</td>
<td>Population genetics; links between genotype and phenotype; linkage disequilibrium</td>
</tr>
<tr>
<td>Technology</td>
<td>Genome sequencing; genotyping</td>
</tr>
<tr>
<td>Quantitative analyses</td>
<td>Estimating haplotypes; imputation; genome-wide association studies; population structure; genomic ancestry; multiple testing</td>
</tr>
</tbody>
</table>

**Module 3: Gene regulation** (Weeks 8-10 Fall Semester)

**Instructors:** Guillaume Bourque (Human Genetics) and Tomi Pastinen (Human Genetics)

<table>
<thead>
<tr>
<th>Question</th>
<th>What are the mechanisms that govern gene expression and how do mutations in non-coding sequences contribute to disease?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological concepts</td>
<td>Chromatin; protein-DNA interactions; regulation of transcription; splicing; allelic expression; eQTLs; mRNA stability; IncRNAs and micro-RNAs</td>
</tr>
</tbody>
</table>
Module 4: *Nonlinear dynamics in biological systems* (Weeks 11-13 Fall Semester)

**Instructors**: Anmar Khadra (Physiology) and Judith Mandl (Physiology)

<table>
<thead>
<tr>
<th>Question</th>
<th>How do the different components of biological systems interact?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological concepts</td>
<td>Immune and autoimmune cell responses; population dynamics; interaction dynamics (cell-cell, protein-protein, virus-host); positive feedback loops in cellular migration; spatio-temporal heterogeneity</td>
</tr>
<tr>
<td>Technology</td>
<td>Single cell tracking; imaging cellular dynamics in live organisms</td>
</tr>
<tr>
<td>Quantitative analyses</td>
<td>Deterministic models and differential equations; bifurcation theory in low dimension to pattern formation in high dimension; simulating finite-populations; Markov processes</td>
</tr>
</tbody>
</table>

Winter Semester Modules

**Module 5: *Biological and neural time series* (Weeks 2-4 Winter Semester)**

**Instructors**: Erik Cook (Physiology) and Christopher Pack (Neurology & Neurosurgery)

<table>
<thead>
<tr>
<th>Question</th>
<th>How do we model biological and neural signals that vary in time?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological concepts</td>
<td>Membrane biophysics; ion channels; neural systems; Hodgkin-Huxley equations</td>
</tr>
<tr>
<td>Technology</td>
<td>Electrophysiological measurements</td>
</tr>
<tr>
<td>Quantitative analyses</td>
<td>Nyquist sampling; filtering; Fourier transform; linear models; nonlinear models; Volterra and Weiner model frameworks</td>
</tr>
</tbody>
</table>
Module 6: Biophysical imaging (Weeks 5-7 Winter Semester)

Instructors: Paul Wiseman (Physics) and Sabrina Leslie (Physics)

<table>
<thead>
<tr>
<th>Question</th>
<th>How do we image subcellular biological components and molecules?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological concepts</td>
<td>Biophysics of DNA, proteins and organelles</td>
</tr>
<tr>
<td>Technology</td>
<td>Optical microscopy; photon detectors; super-resolution molecular localization; structured illumination microscopy; light sheet and lattice sheet microscopy</td>
</tr>
<tr>
<td>Quantitative analyses</td>
<td>Image formation; diffraction and the resolution limit; Abbe’s criterion; Fourier optics and the spatial frequency bandwidth; photon detection statistics; PALM and STORM methods; molecular localization; Fluorescence fluctuation techniques</td>
</tr>
</tbody>
</table>

Module 7: Biophysical networks (Weeks 8-10 Winter Semester)

Instructor: Paul Francois (Physics)

<table>
<thead>
<tr>
<th>Question</th>
<th>How do interacting agents form networks and what is their emergent behavior?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological concepts</td>
<td>Regulatory protein-protein interaction; signaling dynamics; metabolic networks; subcellular networks during development</td>
</tr>
<tr>
<td>Technology</td>
<td>Yeast two-hybrid; metabolomics; fluorescence-activated cell sorting; fluorescent in situ hybridization</td>
</tr>
<tr>
<td>Quantitative analyses</td>
<td>Dynamical systems; control theory; self-organization; information theory; graph theory</td>
</tr>
</tbody>
</table>

Module 8: Ecosystem dynamics (Weeks 11-13 Winter Semester)

Instructor: Fred Guichard (Biology)

<table>
<thead>
<tr>
<th>Question</th>
<th>How do the different components of an ecosystem interact?</th>
</tr>
</thead>
</table>

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<table>
<thead>
<tr>
<th>Biological concepts</th>
<th>Population regulation; mutualistic interactions; niche differentiation; community structure; trophic interactions in lake ecosystems; metrics to food web stability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>Experimental ecology; morphometrics; stock assessment; stable isotopes analysis</td>
</tr>
<tr>
<td>Quantitative analyses</td>
<td>Numerical analysis of dynamical systems; continuation analysis; derive null expectations from statistics; linearization and local stability; analysis of species assemblages of increasing size and complexity</td>
</tr>
</tbody>
</table>

**PRELIMINARY SCHEDULE**

**Fall 2017**

*Mathieu Blanchette*

Bootcamp 1: *Introduction to scientific computing in Python and R*

Sessions 1-2, Week 1, Early Sept 2017

*Mathieu Blanchette & Ken Dewar*

Module 1: *Genome sequencing and annotation*

Sessions 3-8, Weeks 2-4, Mid Sept to early Oct 2017

*Celia Greenwood & Simon Gravel*

Module 2: *Genetic links to disease*

Sessions 9-14, Weeks 5-7, Early Oct to late Oct 2017

*Guillaume Bourque & Tomi Pastinen*

Module 3: *Gene regulation*

Sessions 15-20, Weeks 8-10, Late Oct to Mid Nov 2017

*Anmar Khadra & Judith Mandl*

Module 4: *Nonlinear dynamics in biological systems*

Sessions 21-26, Weeks 11-13, Mid Nov to early Dec 2017

**Winter 2018**

*Sabrina Leslie*

Bootcamp 2: *Introduction to scientific computing in Matlab*
Sessions 1-2, Week 1, Early Jan 2018

Erik Cook & Chris Pack
Module 5: Biological and neural time series
Sessions 3-8, Weeks 2-4, Mid Jan to early Feb 2018

Paul Wiseman & Sabrina Leslie
Module 6: Biophysical imaging
Sessions 9-14, Weeks 5-7, Early Feb to late Feb 2018

Paul Francois
Module 7: Network biophysics
Sessions 15-20, Weeks 8-10, Late Feb to Mid March 2018

Fred Guichard
Module 8: Ecosystem dynamics
Sessions 21-26, Weeks 11-13, Mid March to early April 2018
APPENDIX B: LIST OF COMPLEMENTARY COURSES

Students will be required to take one or two courses from each of the Quantitative and Life Science Blocks, for a total of three courses.

Biophysics Stream

<table>
<thead>
<tr>
<th>Quantitative Block</th>
<th>Life Sciences Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIEN 530 Imaging and Bioanalytical Instrumentation</td>
<td></td>
</tr>
<tr>
<td>BMDE 519 Biomedical Signals &amp; Systems</td>
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<tr>
<td>BMDE 512 Finite-Element Modelling: BME</td>
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<tr>
<td>CHEM 514 Biophysical Chemistry.</td>
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<tr>
<td>CHEM 520 Methods in Chemical Biology</td>
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<tr>
<td>COMP 551 Applied Machine Learning</td>
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<tr>
<td>PHYS 519 Advanced Biophysics</td>
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<tr>
<td>PHYS 559 Advanced Statistical Mechanics</td>
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<tr>
<td>BIOC 604 Macromolecular Structure.</td>
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<td>PHGY 520 Ion Channels</td>
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<tr>
<td>PHGY 518 Artificial Cells</td>
<td></td>
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<tr>
<td>BIOL 551 Principles of Cellular Control</td>
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</table>

Computational and Statistical Molecular Biology Stream

<table>
<thead>
<tr>
<th>Quantitative Block</th>
<th>Life Sciences Block</th>
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</thead>
<tbody>
<tr>
<td>BMDE 502 BME Modelling &amp; Identification</td>
<td></td>
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<tr>
<td>BIOS 601 Epidemiology: Introduction and statistical models.</td>
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<tr>
<td>MATH 523 Generalized Linear Models</td>
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<tr>
<td>HGEN 677 Advanced statistical methods in genetics and genomics.</td>
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<tr>
<td>COMP 561 Computational Biology Methods and Research</td>
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<tr>
<td>COMP 598 Topics in Computer Science: Advanced Computational Biology Methods</td>
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<tr>
<td>MATH 680 Computation Intensive Statistics</td>
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<tr>
<td>BIOC 603 Genomics and Gene Expression.</td>
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<td>HGEN 661 Population Genetics</td>
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<tr>
<td>HGEN 692 Human Genetics.</td>
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<tr>
<td>EXMD 602 Techniques in Molecular Genetics.</td>
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</tr>
<tr>
<td>BIOL 551 Principles of Cellular Control</td>
<td></td>
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</tbody>
</table>

Ecosystems Stream

<table>
<thead>
<tr>
<th>Quantitative Block</th>
<th>Life Sciences Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENVB 506 Quantitative Methods in Ecology</td>
<td></td>
</tr>
<tr>
<td>MATH 556 Mathematical Statistics 1</td>
<td></td>
</tr>
<tr>
<td>MATH 525 Sampling Theory and Applications</td>
<td></td>
</tr>
<tr>
<td>MATH 533 Honours Regression and Analysis of Variance</td>
<td></td>
</tr>
<tr>
<td>MATH 537 Mathematical Models in Biology</td>
<td></td>
</tr>
<tr>
<td>MATH 547 Stochastic Processes</td>
<td></td>
</tr>
<tr>
<td>MATH 523 Generalized Linear Models</td>
<td></td>
</tr>
<tr>
<td>BIOL 509 Methods in Molecular Ecology</td>
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<tr>
<td>BIOL 510 Community Ecology</td>
<td></td>
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<tr>
<td>BIOL 594 Advanced Evolutionary Ecology</td>
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<tr>
<td>ENVR/BIOL 540 Ecology of Species Invasion</td>
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</tbody>
</table>
**APPENDIX C: LETTERS OF INTERESTED FACULTY (IN PROGRESS)**

List of McGill Faculty members who have expressed interest in obtaining supervisory privilege in the QLS Ph.D. Program

<table>
<thead>
<tr>
<th>Name</th>
<th>Professorial Rank</th>
<th>Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robert Nadon</td>
<td>Associate Professor</td>
<td>Human Genetics</td>
</tr>
<tr>
<td>Heungsun Hwang</td>
<td>Associate Professor</td>
<td>Psychology</td>
</tr>
<tr>
<td>Alan Evans</td>
<td>Professor</td>
<td>Neurology and Neurosurgery; Biomedical Engineering</td>
</tr>
<tr>
<td>Rob Sladek</td>
<td>Associate Professor</td>
<td>Experimental Medicine; Human Genetics</td>
</tr>
<tr>
<td>Dave Alan Stephens</td>
<td>Professor</td>
<td>Mathematics &amp; Statistics</td>
</tr>
<tr>
<td>Jacek Majewski</td>
<td>Associate Professor</td>
<td>Human Genetics</td>
</tr>
<tr>
<td>Alexandra Schmidt</td>
<td>Associate Professor</td>
<td>Epidemiology, Biostatistics &amp; Occupational Health</td>
</tr>
<tr>
<td>Jérôme Waldispühl</td>
<td>Associate Professor</td>
<td>Computer Science</td>
</tr>
<tr>
<td>Joëlle Pineau</td>
<td>Associate Professor</td>
<td>Computer Science</td>
</tr>
<tr>
<td>Daniel Schoen</td>
<td>Professor</td>
<td>Biology</td>
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<tr>
<td>Melania Cristescu</td>
<td>Associate Professor</td>
<td>Biology</td>
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<td>Jackie Vogel</td>
<td>Associate Professor</td>
<td>Biology</td>
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<tr>
<td>Uri David Akavia</td>
<td>Assistant Professor</td>
<td>Biochemistry</td>
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<tr>
<td>Nicolas Moitessier</td>
<td>Associate Professor</td>
<td>Chemistry</td>
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<tr>
<td>Claudia Kleinman</td>
<td>Assistant Professor</td>
<td>Human Genetics</td>
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<tr>
<td>Robert Kearney</td>
<td>Professor</td>
<td>Biomedical Engineering</td>
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<tr>
<td>Paul Harrison</td>
<td>Associate Professor</td>
<td>Biology</td>
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<tr>
<td>Leon Glass</td>
<td>Professor</td>
<td>Physiology</td>
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<tr>
<td>Hamed S. Najafabadi</td>
<td>Assistant Professor</td>
<td>Human Genetics</td>
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<tr>
<td>Mark Lathrop</td>
<td>Professor</td>
<td>Human Genetics</td>
</tr>
<tr>
<td>Brian Leung</td>
<td>Associate Professor</td>
<td>Biology and School of Environment</td>
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<tr>
<td>Rodrigo Reyes</td>
<td>Assistant Professor</td>
<td>Biology</td>
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<tr>
<td>Name</td>
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<td>Gregor Fussmann</td>
<td>Professor</td>
<td>Biology</td>
</tr>
<tr>
<td>Gary Brouhard</td>
<td>Associate Professor</td>
<td>Biology</td>
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<tr>
<td>Stephanie Weber</td>
<td>Assistant Professor</td>
<td>Biology</td>
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<tr>
<td>Brent Richards</td>
<td>Associate Professor</td>
<td>Experimental Medicine; Human Genetics; Epidemiology &amp; Biostatistics</td>
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<tr>
<td>Ian Robert Watson</td>
<td>Assistant Professor</td>
<td>Biochemistry</td>
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APPENDIX D: LETTERS OF SUPPORT (IN PROGRESS)
16 September 2016

Celia Greenwood  
Senior Investigator, Lady Davis Institute for Medical Research  
Associate Professor, McGill University

RE: Interdisciplinary McGill PhD program in Quantitative Life Sciences

Dear Celia,

This program in Quantitative Life Sciences looks very exciting and you have our strongest support for this initiative. We at STAGE are strong proponents of fostering and nurturing young scientists to develop strong quantitative skills and solid foundation in life sciences to become talented scientists well equipped to answer complex biological questions. We strongly believe that this can be best achieved through interdisciplinary mentoring research teams.

As you know, we are co-Directors of the Toronto CIHR STAGE program (Strategic Training for Advanced Genetic Epidemiology), which has been in operation since 2010 training students in genetic epidemiology and statistical methods in genetics and genomics. From the beginning, our training program has included strong interdisciplinary aspects, so that every STAGE trainee has a research project supervision committee containing at least 3 members from different disciplinary fields. We have found this setup to be very successful; students have done extremely well in obtaining scholarships, postdoctoral fellowships at prestigious institutions, or excellent jobs.

To exemplify the success this interdisciplinary mentorship team format has on the development of trainees as well-rounded scientists, we note:

1. Originating from a CIHR investment of less than $1.8M, STAGE trainees have generated over $2M in external funding in the first four years of the training program alone;
2. Practically every trainee has received some form of external funding;
3. Several trainees have received highly competitive awards and recognitions, including Vanier Canada Graduate Scholarship, CIHR Clinical Investigatorship Award (ranking first), International Genetic Epidemiology Society Williams Award, and Connaught International Scholarship.
4. All trainees have found positions in their discipline: post-docs moving into faculty positions, clinical-scientist positions, and leadership positions in the
industry; PhD students pursuing their training in high profile international research teams (e.g. at Vanderbilt University, University of Michigan).

We look forward to hearing about the progress of this new program.

Warm regards,

France Gagnon, MSc, PhD
Canada Research Chair in Genetic Epidemiology
Co-Director, CIHR STAGE (Strategic Training for Advanced Genetic Epidemiology)
Associate Professor, Division of Epidemiology,
Dalla Lana School of Public Health
University of Toronto

Shelley B. Bull, PhD
Senior Investigator, Lunenfeld-Tanenbaum Research Institute, Sinai Health System
Co-Director, CIHR STAGE (Strategic Training for Advanced Genetic Epidemiology)
Professor, Division of Biostatistics,
Dalla Lana School of Public Health
University of Toronto
August 30, 2016

Celia Greenwood, PhD  
Senior Investigator  
Lady Davis Institute Associate Professor, McGill University  
H414 - 3755 Cote Ste Catherine, Montreal, QC H3T 1E2  
celia.greenwood@mcgill.ca

Re: Proposed McGill graduate program in Integrative Quantitative Life Sciences.

Dear Celia,

It is a great pleasure to write a letter of support for the proposed graduate program in Integrative Quantitative Life Sciences (IQLS). As Director of the Montreal Neurological Institute, I come into contact with many graduate students who work in highly interdisciplinary research areas, many of which require advanced mathematics and physics knowledge.

For some years now, McGill has had an Integrative Program in Neuroscience (IPN), which has proven to be extremely popular with both students and supervisors, and has enriched the training experience for all involved. Interdisciplinary programs, when well designed, are needed to develop the next generation of researchers able to work at the interface of traditional disciplines.

After examining the proposed program, I can see that it requires all students to have a very strong quantitative background at enrollment, and then builds on this base to encourage rigorous quantitative research. Given the ground-breaking advances in imaging that are ongoing at the MNI, together with the ever-increasing data sharing resources that we are putting in place, the need for excellent training in quantitative life sciences has never been greater.

Sincerely,

Dr. Guy Rouleau
August 25, 2016

Celia Greenwood, PhD
Senior Investigator, Lady Davis Institute
Associate Professor, McGill University
H414 - 3755 Cote Sainte Catherine
Montreal, QC H3T 1E2

Dear Celia,

I have had the chance to review the excellent proposal for a new interdisciplinary graduate program in Quantitative Life Sciences, and I am delighted to write this letter of support.

As Director of the Lady Davis Institute at the Jewish General, and as former Scientific Director of the Institute of Genetics of CIHR, I am intimately aware that the advances in technology in the laboratory are challenging all biological researchers to become more quantitatively competent. Terabytes of data are now routinely generated, and trainees often must spend more time at their computers than at the bench.

I am very enthusiastic about the possibility of McGill training new researchers who not only have the quantitative skills to develop new approaches, but who also are capable of communicating and working synergistically with those from other disciplines in life sciences.

Let me know if I can provide any further support for this excellent initiative.

Sincerely,

Roderick R. McInnes, CM, MD, PhD, FRSC
Director, Lady Davis Institute
Jewish General Hospital
Alva Chair in Human Genetics
Canada Research Chair in Neurogenetics
Professor of Human Genetics, Professor of Biochemistry
McGill University
September 22, 2016

Erik P. Cook, Ph.D.
Co-director, Centre for Applied Mathematics in Biosciences and Medicine
Department of Physiology
McGill University
3655 Sir William Osler
Montreal, QC H3G 1Y6
Canada

Re: Proposed graduate training program in Quantitative Life Sciences at McGill University

Dear Erik,

I am delighted to write in support of McGill University’s new interdisciplinary graduate training program in Quantitative Life Sciences. As the Director of the Grossman Institute for Neuroscience, Quantitative Biology and Human Behavior at the University of Chicago, I know first-hand of the importance of training new interdisciplinary researchers.

There is a shortage of scientists able to harness the power of both modern computation and biological techniques necessary to advance research and education across all areas of the life sciences. Many new high-throughput technologies are generating staggering volumes of biological data, creating the need for researchers who are thoroughly versed with quantitative methods. These skills are a critical component for the successful translation of life-science research into beneficial solutions.

Like your proposed program in Quantitative Life Science, the Grossman Institute takes to heart the idea that an interdisciplinary approach is critical for solving the most challenging and complex problems in the biological sciences. Although our Institute was established primarily to serve the Neuroscience community at the University of Chicago, we work alongside faculty in Chemistry, Psychology, Computer Science, Human Genetics, Cellular and Molecular Biology, and Statistics to foster an interdisciplinary research environment. An exciting component of your program is its bridging of traditional Departments and Divisions to facilitate research partnerships and enhance student training.

I am very supportive of McGill’s new initiative to train graduate students in the Quantitative Life Sciences. I expect that your new program will make McGill competitive with similar programs across North America that are now actively recruiting students with quantitative backgrounds. I wish you much success in the launch of your new training program.

Sincerely,

John H.R. Maunsell, PhD

John H.R. Maunsell, Ph.D.
Director
Albert Lasker Professor in Neurobiology
APPENDIX E: LIST OF GRANTS AWARDED TO TEACHING FACULTY MEMBERS

Mathieu Blanchette


Jérôme Waldispühl, Mathieu Blanchette, Derek Ruths. : A development and deployment platform for citizen science games in biology. Genome Canada Bioinformatics and Computational Biology Competition. $125,000 annually (2013-2015)

Nicholas Provart. Genomics Large Data Sets and Novel Tools for Plant Biology for use International Infrastructure-Tier Data Repositories and Portals. Genome Canada Bioinformatics and Computational Biology Competition. $125,000 annually (2013-2016)


Mathieu Blanchette, Eric Lecuyer, Jerome Waldispuhl. Évolution des gènes d'ARN de transfert à l'échelle génomique. FQRNT Team grant. $48,000 annually (2013-2016)


Guillaume Bourque. Integrative Epigenomic Data Coordination Centre (EDCC) at McGill. CIHR CEEHRC Epigenomics platform – Data coordination Center. $219,796 annually (2012-2017)

Mark Lathrop. Epigenomics Mapping Centre (EMC) at McGill. CIHR CEEHRC Epigenomics platform – Epigenomics Mapping Center. $906,400 annually (2012-2017)
Mathieu Blanchette, Derek Ruths and Jérôme Waldispuhl. Computing infrastructure for bioinformatics web services. NSERC Research Tools and Instrumentation. $40,173 annually (2012-2013)

John White, Mathieu Blanchette, Rob Sladek. Host macrophage transcriptomic responses to M. tuberculosis infection. Genome Québec Health Program. $424,385 annually (2010-2013)

Thomas Bureau, Mathieu Blanchette, Stephen Wright, John Stinchcomb, Alan Moses, Paul Harrison, Daniel Schoen, Anwar Naseem and Ken Dewar. Bridging comparative, population and functional genomics to identify and experimentally validate novel regulatory regions and genes for crop improvement. Genome Canada Competition IV. $1,177,283 annually (2009-2013)

Silvia Vidal, Mathieu Blanchette, Philippe Gros, Danielle Malo, Maya Saleh, Salman Qureshi. An integrative forward genetic approach to identify novel pathways in host response to infection: from mouse models to patients. CIHR Team grant. $828,994 annually (2008-2012)

Mathieu Blanchette. Algorithms for whole-genome comparative and regulatory genomics. NSERC Discovery Grant. $31,000 annually (2008-2013)

Guillaume Bourque
2016 – 2020 CFI, Cyber-infrastructure $5,000,000
Role: co-Project Lead. Title: CanDIG: Canadian Distributed cyber-Infrastructure for Genomics

Title: Canadian Center for Computational Genomics (C3G)

2015 – 2017 Genome Canada, Genomics Innovation Network $1,050,000 Role: Project Lead
Title: Canadian Center for Computational Genomics (C3G)

2012 – 2017 CIHR, CEEHRC Epigenomics Platform $1,500,000 Role: Principal Investigator
Title: Integrative Epigenomic Data Coordination Centre (EDCC) at McGill

2011 – 2016 CIHR, Operating Grant $426,482 Role: Principal Investigator Title: Functional characterization of the endogenous retrovirus HERV-H family in human embryonic stem cells

2015 – 2019 CIHR, CEEHRC Consortium Network $2,000,000 Role: Principal Applicant (NPA Hirst, share 7%)
Title: Canadian Epigenetics, Environment and Health Research Consortium Network

2015 – 2019 CFI, Innovation Fund $58,435,000 Role: Principal User (PL Jones, share 8%)
Title: Canada's Genomics Enterprise (CGEn): A national genomic tools network for transforming life science research
2015 – 2019 CFI, Innovation Fund $ 2,893,000 Role: Principal User (PL Meaney, share 0%)
Title: Treatment Outcomes in Mood Disorders

2015 – 2017 Genome Canada, Genomics Innovation Network $ 2,000,000 Role: co-Lead (PL Lathrop, share 15%)
Title: McGill University and Génome Québec Innovation Center

2015 – 2017 Genome Canada, GIN – Tech. Development $ 1,000,000 Role: co-Lead (PL Lathrop, share 10%)
Title: McGill University and Génome Québec Innovation Center

2014 – 2018 NSERC, Discovery Frontiers $ 6,000,000 Role: co-Investigator (PI Stein, share 7%)
Title: The Cancer Genome Collaboratory

2013 – 2017 Genome Canada, Large-scale Applied Research $ 6,000,000 Role: co-Investigator (PIs Jabado – Majewski, share 5%)
Title: Biomarkers for Pediatric Glioblastoma through Genomics and Epigenomics

2013 – 2016 Brain Canada $ 1,494,900 Role: co-Investigator (PI Meaney, share 0%)
Title: Epigenetics and Mental Health

2012 – 2017 CIHR, CEEHRC Epigenomics Platform $ 6,000,000 Role: co-Investigator (PI Lathrop, share 15%)
Title: Multidimensional Epigenomics Mapping Centre (EMC) at McGill

2011 – 2016 CIHR, Team Grant: Childhood Cancer $ 2,445,054 Role: co-Investigator (PI Sinnett, share 0%)
Title: Genomic determinants of common long-term treatment effects in childhood acute lymphoblastic leukemia survivors

2013 – 2015 CANARIE, Research Middleware Program $ 771,000 Role: Principal Investigator
Title: Genetics and Genomics Analysis Platform (GenAP)

2011 – 2014 Genome Quebec, Human Health Competition $ 2,000,000 Role: co-Inv (PI Moreau, share 10%)
Title: Development of comprehensive diagnostic assays for scoliosis

2011 – 2012 CIHR, Advancing Technology Innovation $ 1,550,000 Role: co-Inv (PI Sorensen, share 10%)
Title: The Canadian Pediatric Cancer Genome Consortium: Translating next-generation sequencing technologies into improved therapies for high-risk childhood cancer.

Erik Cook

2016/4 - 2026/3 Co-applicant Targeted Manipulation of Neural Microcircuits for Understanding and Correcting Brain Dysfunction, Grant, Infrastructure Canada Foundation for Innovation (CFI)
Innovation fund Total Funding - 5,600,000 (Canadian dollar) Principal Applicant: Kathleen Cullen

2012/4 - 2017/3 Principal Investigator Information coding in neurons: bridging the gap between cellular and behavioral neuroscience, Grant, Operating Natural Sciences and Engineering Research Council of Canada (NSERC) Discovery grant Total Funding - 200,000 (Canadian dollar)
2009/4 - 2014/3 Principal Investigator Physiology of Visual Perception, Fellowship Canada Research Chairs (CRC) Tier 2 Salary Award Total Funding - 500,000 (Canadian dollar)

2009/10 - 2013/9 Principal Investigator Neural encoding in the visual cortex: engineering principles for advanced neural prosthetics, Grant, Canadian Institutes of Health Research (CIHR) Operating grant Total Funding - 370,000 (Canadian dollar)

2009/1 - 2011/12 Principal Investigator Neural correlates of time perception in visual cortex, Grant, EJLB Foundation Scholar Research Program Total Funding - 350,000 (Canadian dollar)

2009/4 - 2011/3 Collaborator Centre for Applied Mathematics in Bioscience and Medicine, Grant, Operating Mathematics of Information Technology and Complex Systems (MITACS) Centre of Excellence Total Funding - 67,000 (Canadian dollar). Principal Investigator: Mackey, Michael

2010/4 - 2011/3 Principal Applicant Joint CPS/CAPnet winter meeting: Physiological mechanisms of perception, cognition and action, Grant, Operating Canadian Institutes of Health Research (CIHR) Meetings, plannings and dissemination grant Total Funding - 6,000 (Canadian dollar) Co-applicant : Doug Crawford; Randy Flanagan; Jody Culham; Paul Cisek

2006/4 - 2011/3 Principal Investigator Information coding in neurons: bridging the gap between cellular and behavioral neuroscience, Grant, Operating Natural Sciences and Engineering Research Council of Canada (NSERC) Discovery Grant Total Funding - 157,500 (Canadian dollar)

Ken Dewar
CV Pending

Paul François

Fonds Québécois de Recherche Nature Technologie (FQRNT, Québec natural science research fund) Projet de recherche en équipe (2015-2018), $ 144,000 (CAD total) main PI in collaboration with Jackie Vogel, Gary Brouhard (McGill) and Steve Michnick (Université de Montreal). Share: 50 %.


Natural Sciences and Engineering Research Council of Canada (NSERC) Discovery grant (2016-2021), $ 240,000 (CAD) total.

Human Frontier Science Program (HFSP) Program grant (2012-2015), $ 1,050,000 (US) total for our research team in collaboration with O. Pourquié (IGBMC Strasbourg), Rusty Lansford (Caltech). Share : 30 %.

Fonds Québécois de Recherche Nature Technologie (FQRNT, Québec natural science research fund) Nouveaux Chercheurs grant (2013-2015), $ 40,000 (CAD) total.
Natural Sciences and Engineering Research Council of Canada (NSERC) Discovery grant (2011-2016), $100,000 (CAD) total.

Simon Gravel


Celia Greenwood


A Bureau, A Labbe (PI), K Burkett, J Graham, C Greenwood, MJ Lakhal Chaieb, F Larrière, K Oualkacha, M-H Roy-Gagnon, I Ruczinski, A Brooks-Wilson, C Laprise, M Maziade, B Richards, J Simard. Rare DNA variants and human complex traits: improving analyses of family studies by better modeling the dependence structures. CANSSI Collaborative Research Team Project. $180,000 (2016-2019)


C Greenwood. Finding important associations in genetic and genomic data. NSERC Discovery grant. $10,000 annually (2014-2019)


C Greenwood, A Ciampi. Modeling the relationship between genotypic configurations and traits. CIHR Operating Grant. $72,109 annually (2011 – 2014)

C Greenwood. Identifying useful predictors from genome-wide SNP association studies. NSERC Discovery Grant. $15,000 annually (2009 – 2014)

M Cotterchio, S Gallinger, C Greenwood. Association between allergy history, immunologic genetic variants and pancreatic cancer risk. CIHR Operating grant. $485, 100 annually (2010 – 2013)

M. Hudson, C Greenwood. Epigenetic Signatures of Systemic Autoimmune Rheumatic Diseases- A Pilot Study. LDI CLiPP competition. $49, 670 (2012-2013)

C Greenwood, P Tonin. How to measure the impact of copy number aberrations in ovarian cancer. The Week-End to End Women’s Cancer Pilot Projects Grant. $38,866 annually (2011 – 2012)

Peter Grutter

$ 98,000 2011-2016 NSERC Discovery Scanning Probe Microscopy Applied to Nanoscience (PI)

$ 43,000 2013-2016 FRQNT Team Grant Contrale et organisation d'assemblages discrets de nanoparticules d'or avec l'ADN (PI)

$ 43,000 2013-2016 FRQNT Team La comprehension des processus photogeneration des porteurs de charge dans des cellules solaires organiques (PI Cook)

$100,000 2014-2018 NSERC CRD The Design and Mapping of Next Generation Nano Lithium-ion Battery Cathodes

$25,000 2013 NSERC ENGAGE Combined Scanning Kelvin Probe Force Microscopy and Scanning Maxwell Stress Microscopy for Improved Semiconductor Dopant Profiling (PI)

$25,000 2014 NSERC ENGAGE Development of new micropositioner systems compatible with high resolution optical microscopy

$15,000 2013-2018 McGill University Dawson/James McGill Chair research stipend

$10,000 2013-2018 McGill University Chair’s research stipend

$300,000 2010-2016 NSERC CREATE Integrated Sensor Systems (PI Kirk, 9 others)

$300,000 2011-2017 NSERC CREATE Neuroengineering (PI Lennox, 9 others)

$300,000 2011-2017 NSERC CREATE NanoBioMachines (PI Gehring, 9 others)
$325,000 2009-2015 CIHR Training Pgm Neurophysics; Setting new frontiers in neuroscience with Material Sciences, Photonics and Computational Sciences (PI de Koninck)

$ 576,000 2015-2021 FQRNT Le Regroupement québécois sur les matériaux de pointe (RQMP)

$ 925,000 2009-2015 FQRNT Le Regroupement québécois sur les matériaux de pointe (RQMP) (PI)

$ 300,000 2013-2015 FQRNT INstitut TRansdisciplinaire d'Informatique Quantique (INTRIQ) (PI Hilke)

$ 697,595 2014-2016 CFI LEF System to study the mechanics of single molecules with high spatial and temporal resolution (PI D. Rassier)

$ 11,300,370 2013-2016 CFI LEF Tools for Nanoscience and Technology upgrade ('Nanotools 2') (PI)

$ 44,050 2013-2015 FRQNT Team Controle et organisation d'assemblages discrets de nanoparticules d'or avec l'ADN

**Fred Guichard**

FRQNT. Strategic Cluster program. *Centre de Recherches Mathématiques (CRM)*. Luc Vinet (PI), Frederic Guichard and 14 others (Lab Directors), and 104 other co-PIs. 2015-21. $3,045,200.

NSERC. CREATE (graduate training grant). *Biodiversity, Ecosystem Services and Sustainability* (BESS). Andrew Hendry (PI) and 10 co-PIs. 2015-21. $1,650,000.

Coastal Healthy Ocean Network II (CHONe II). Strategic NSERC network. *Optimization of MPA selection based on spatial connectivity and on metapopulation and metacommunity dynamics*. $164,000. Frederic Guichard (Co-PI) and Marie-Josée Fortin (PI, University of Toronto). 2015-2018 (3 years).

NSERC. Strategic Project. Impact of genetic connectivity for marine protected areas. Frederic Guichard (co-PI), Marie-Josée Fortin (PI), Isabelle Côté (co-PI). 2013-2016. $600,000.

NSERC. Discovery Grant. $165,000. *Non-equilibrium dynamics of marine metaecosystems*. 2012-2017

NSERC. Emerging Opportunity Fund, Coastal Healthy Ocean Network (CHONe). Metaanalysis of biodiversity and ecosystem function in oceans. 2011-12. $50,000.

FRQNT. Strategic Cluster program. *Quebec-Ocean Centre*. Maurice Levasseur (PI) and ~50 co-PI. 2009-16. $3,630,000.


Coastal Healthy Ocean Network (CHONe). Strategic NSERC network. Larval transport and metacommunity dynamics: a graph-theoretical approach. $150,000. Frederic Guichard (PI) and David Pike (Co-PI, Memorial University). 2009-2011 (3 years).

NSERC. Discovery Grant. $96,250. Variability across scales in coastal ecosystems. 2007-2012 (5 years).


Anmar Khadra

Grant/Agency: NSERC Canada/RGPIN Khadra (PI) 04/01/13–03/31/18. Title: Computational Models for the Study of Various Immunological and Electrophysiological Systems. Amount: CAN$32,000/year [Total = CAN$160,000] Role: PI

Grant/Agency: Canadian Foundation for Innovation CFI Vogel (PI) 09/01/15–08/31/18. Title: Integrated Quantitative Bioscience of Adaptation. Amount: ~CAN$11.4M. Role: User

Grant/Agency: McGill University CFI-JELF Brown (PI) 04/30/16–03/31/17. Title: Photo-Manipulation & Increased Throughput for a Combined TIRF/SDCM. Amount: CAN$31,000. Role: Co-PI

Grant/Agency: McGill University NSERC GRF-RTI Brown (PI) 04/30/14–03/31/15. Title: Spinning Disk Confocal Microscope for Measuring Protein Dynamics and Interactions. Amount: CAN$27,500. Role: Co-PI


Grant/Agency: McGill University Khadra (PI) 01/01/12–12/31/14. Title: Startup Fund. Amount: CAN$20,000/(year 1) + CAN$50,000/(year 2) [Total = CAN$70,000]. Role: PI

Grant/Agency: R01 DK53456 (NIH) Pietropaolo (PI) 01/01/13–12/31/14. Title: Enhancement of Biomarkers for Type 1 Diabetes. Amount: US$40,000/year [Total: US$3.2M; US$80,000 was allocated to my project]. Role: Co-investigator

Grant/Agency: The Fields Institute Khadra (PI) 04/30/13–03/31/14. Title: 2014 Workshop on Diabetes Systems Biology Anmar Khadra Curriculum Vitae. 10 Amount: CAN$12,000. Role: Organizer

Sabrina Leslie


Collaborative Health Research Project (CHRP). Nanoconfinement Based Single-Cell Cytogenetic Platform for Pre-/Post-Implantation Genetic Diagnosis. Reisner, Leslie, Sladek (Genome Center), Ao (Montreal Children's Hospital), 05/2013-05/2016. With Quorum Technologies.


NSERC Research Tools and Instruments Grant. Force-And-Fluorescence Microscopy Of DNA


Physics Start-up Funding. Leslie, 04/2012-04/2017.

Judith Mandl

2015/4 - 2020/4 Principal Applicant CRC in Immune Cell Dynamics Canada Research Chairs (CRC). Tier 2 Canada Research Chair (CRC). Total Funding - 500,000 (Canadian dollar)

2015/1 - 2016/12 Principal Applicant Startup Funds McGill University Total Funding - 250,000 (Canadian dollar)

2015/7 - 2016/12 Principal Applicant CFI Leaders Opportunity Fund: Program in T cell interaction and migration dynamics in health and immunodeficiency. Canada Foundation for Innovation (CFI). Leaders Opportunity Fund. Total Funding - 450,000 (Canadian dollar)

2015/1 - 2015/12 Principal Applicant Equipment Funds. McGill University Total Funding - 225,000 (Canadian dollar).
2015/6 – 2015/12 Principal Applicant Phyllis Butterworth Endowment for Intravital Imaging Laboratory (McGill University). McGill Endowment Fund Phyllis Butterworth Endowment. Total Funding - 250,000 (Canadian dollar)

2010/9 - 2011/9 Co-investigator Visualizing in vivo effector T cell killing and surveillance to quantify dynamics relevant to HIV vaccine design Co-investigator : Germain, Ronald National Institutes of Health (NIH) (USA) Office of AIDS Research Total Funding - 122,000 (United States dollar)

Christopher Pack

FRQS Senior Scholar (2016 – 2017)

Merck, Sharpe & Dohme Corporation (2014-2016; co-applicant)


Neuro Early Career Award (2013)
NSERC Discovery Grant (2012-2017 [renewal])
MDEIE Grant: Programme de Soutien à la Recherche (2012-2015)
CIHR Operating Grant (2011-2016 [renewal])
Canada Research Chair (2005-2015 [renewed 2010])
NSF Collaborative Research in Computational Neuroscience Grant (2010-2013)
MITACS Centre Grant (2009-2012; P.I.: M. Mackey)
NARSAD Young Investigator (2008-2010)
MDEIE Grant: Programme de Soutien à la Recherche (2008-2011)
EJLB Scholar Research Program (2008-2011)
NSERC Discovery Grant (2007-2012)
Killam Scholar (2007-2012)
Alfred P. Sloan Foundation Research Fellow (2006-2008)
CIHR Operating Grant (2006-2011)
CFI Infrastructure Grant (2005-2010)
NSF Cognitive Neuroscience Grant (2003-2007)

Tomi Pastinen

Oncohistones: Role of Histone H3 Mutations in the Oncogenesis of Pediatric Cancer. NIH (USA). $3,095,720/yr. 2015-2019 Role: Co-PI (my lab receives $120K USD per year)

Father's lasting influence: Molecular foundations of intergenerational transmission of the paternal environment. CIHR. $298,800/yr. 2014-2018 Role: Co-I ($25K to my lab)

Dietary Gluten-induced Disease Entities -from Genomics to Personalized Health and Well-being. Academy of Finland. $629,280/yr. 2015-Role: Co-I (my lab receives $100K per year)

CEEHRC (Epigenetics): Research Consortium. CIHR and Genome Canada. 2015-2019 $500,000/yr. Role: Principal Applicant (my lab receives $238K per year)
Genomic risk in asthma susceptibility accessed by next-generation integrative tools. CIHR. $205,326/yr. Role: Co-PI (my lab receives $80K per year)

FRSQ Network: Reseau de Medecine Genetique Appliquee RMGA. Role co-PI Pastinen. 2014-2018 $2.7M (my lab receives $30K per year)

Resolving Systems Epigenomes of T-cells in Autoimmune and Inflammatory Diseases. CIHR, FRQS, ANR, BMBF. 2016-2019 $757,736/yr. Role: PI, Consortium Coordinator

Pollution, Epigenetics, and Serologic Markers of Rheumatoid Arthritis. Department of Defense (USA). 2016-2017 $142,500/yr. Role: Co-PI (my lab receives $40K per year)

Brain Imaging, cognition, Dementia and next generation GEonics: a Transdisciplinary approach to search for risk and protective factors of neurodegenerative disease. JPND and CIHR. $111,000/yr. Role: PI for Canadian program

Genomics Innovation Network Technology Development. Genome Canada. $1,646,988/yr. 2015-2017 Role: Co-PI (my lab receives $400K per year)

Orthogonal genomic tools to pinpoint causal variants for multiple sclerosis as potential therapeutic targets. Merck & Co. Inc. 2015-2017 $97,500/yr. Role: PI


Genomics Innovation Network. Genome Canada. 2015-2017 $2,000,000/yr. Role: Co-PI (no direct funds to my lab)

Multidimensional Epigenome Mapping Centre McGill. CIHR. 2012-2017 $1,170,000/yr. Role: PI

The ICHANGE (International CHildhood Astrocytomas iNtegrated Genomics and Epigenomics) Consortium. Genome Canada. $1,693,000/yr. 2013-2017 Role: Co-PI (my lab receives $180K per year)

2016 Compute Canada Resource Allocation. 2015-2016 $198,000/yr. Role: PI.


Analysis of DNA Methylation Data. CIHR. 2013-2017 My role: Co-investigator (no direct funds to my group)

“Role of chromatin remodeling in the genesis of pediatric and young adult astrocytomas” CIHR 2013-2018 My role: Co-investigator (no direct funds to my group)
CIHR “Pinpointing Causal Variants for Osteoporosis” 2012 – 2016. **My role:** PI with Dr. B. Richards ($850,000 CDN)

National Institutes of Health (NIH) (USA) R01 (subcontract). “Allele-specific Mapping in Alzheimer’s Disease” 2010 – 2015. **My role:** Principal Investigator for subcontract (~$125,000 CDN)

FRSQ “Réseau de Médecine Génétique Appliquée” 2010 – 2014. **My role:** Co-PI ($2,400,000 CDN)

CIHR “CIHR Training Program in Integrative Approaches to Human Health” **My role:** Co-Applicant ($1,766,127 CDN)

Genome Canada “RENEWAL OF SCIENCE AND TECHNOLOGY INNOVATION CENTRE OPERATIONS SUPPORT for McGill University and Génome Québec Innovation Centre” 2013-2015. **My role:** Head of Integrated Genomics (one of five named applicants for the Centre) ($9,610,984 CDN)

CIHR “ImmunoSeq: novel immunogenetic discovery tool and its translation to personalized medicine in Finnish and Canadian partnership” 2013-2014. Principal Investigator(s): PASTINEN, Tomi; LATHROP, Mark **My role** PI

Compute Canada “HPC Resource Allocation” 2014-2014. **My Role:** PI

CIHR “Map of cis-regulatory variants in human genome” 2010 – 2014. **My role:** PI ($716,000 CDN)

CIHR “CAN-STAR - CAnadian Network for SysTemic Autoimmune Rheumatic diseases” 2013-2014. **My role** Co-Principal Investigator with Drs. HUDSON, Marie; BARON, Murray; BERNATSKY, Sasha R; COLMEGNA, Ines

CIHR operating grant and Terry Fox team grant. “Investigation of the genomic determinants of childhood leukemia using next-generation sequencing” 2010 – 2013. **My role:** Co-applicant ($2,048,322 CDN; $600,000 CDN for my group)

Genome Quebec “High Throughput Genotyping and Sequencing Using Pooled DNA/RNA” 2010 – 2011. Co-Applicant ($100,000 CDN; $10,000 CDN for my group)

Canadian Institutes of Health Research “Genomewide analysis of functional polymorphisms affecting human bone phenotypes” 2008 – 2011. Principal Investigator ($408,000 CDN)

Genome Quebec “International Collaboration Initiatives in Functional Population Genomics” 2009-2011 Principal Investigator ($304,000 CDN)

**Paul Wiseman**


2015-? Brain Canada Brain Canada Platform Grant Y. DeKoninck (Laval U. + 9 others) The Canadian Neurophotonics Platform TBD TBD

2015-2021 Canadian Institute for Advanced Research (CIFAR) Global Call for Ideas (4 funded out of 262 LOIs) RJD Miller (Max Planck Institute) + 11 others Molecular Architecture of Life ~1.1M ~45 k

2010- 2016 NSERC CREATE P. DeKoninck (Laval U. + x others) Training Program in Biophotonics $300k $21k

2012-2018 NSERC CREATE R. B. Lennox (McGill U. + 10 others) Training Program in Neuroengineering $300k $21k

2012-2018 NSERC CREATE K. Gehring (McGill U. + 10 others) Training Program in Bionanomachines $300k $21k

2016 FRQS-GEPROM GEPROM research stimulus grants Wiseman (+ 1 other) Understanding the nature of GPCR dimerization using biophysical approaches $15 k $7.5 k

2012-2017 NSERC Discovery Grant Wiseman Image correlation studies of distributions and dynamics of macromolecules in cells $101 k $101 k

2013-2015 CFI Leading Edge Fund K. Gehring (McGill U. + 20 others) Structural Biology at the Crossroads of Biology and Medicine $12.1 M (total) $346k (total)

2011 American Academy of Otolaryngology Training grant for medical scientists Wiseman Ultrafast laser ablation of tissue $9976 $9976

2010-2011 CIPI Technology Exploitation & Networking Wiseman Ultrafast laser ablation of tissue $25k $25k

2007-2012 NSERC Discovery Grant Wiseman Image correlation methods for biophysical chemistry studies of living cells $53.4 k $53.4 k

2009-2014 CFI Innovation Grant D. Thomas (+ 30 others) McGill University Life Sciences Complex: Disease to therapy initiative $26.6 M (total) $200k (total)

2009-2012 FQRNT Team Grant A. Geitmann (U. Montreal) Quantification of secretory vesicle trafficking in plant cells using high temporal resolution confocal imaging and spatio-temporal image $84k $42k correlation spectroscopy

2009-2015 CIHR Strategic Training Grant Y. DeKoninck (Laval U.) (+ 14 others) Neurophysics; Setting new frontiers in Neuroscience with Material Sciences, Photonics and Computational Sciences $375 k $30 k
2006-2010 CIHR New Emerging Team Grant D. Colman (McGill U.) (+8 others) Neuro-engineering $295 k $42.2 k

2005-2010 CIHR New Emerging Team Grant Y. DeKoninck (Laval U.) (+4 others) Nanotools for Neuropharmacology $300 k $50 k
APPENDIX F: LIST OF PUBLICATIONS OF TEACHING FACULTY MEMBERS

Mathieu Blanchette


Page 107 of 144


Guillaume Bourque


Page 111 of 144


Erik Cook


Ken Dewar


Paul François


Simon Gravel


Celia M T Greenwood


Peter GRÜTTER


Paul W., Oliver D., Miyahara Y., Grütter P. 2013. Transient adhesion and conductance phenomena in initial nanoscale mechanical contacts between dissimilar metals. Nanotechnology. 24(47):475704.


Frédéric GUICHARD


Pedersen E., Guichard, F. 2016. At what scales does aggregated dispersal lead to coexistence? Oikos. in press.


Xue Z., Guichard F., Costopoulos A. 2015. The supply of phenotypic variation can drive long-term evolutionary trends even with strong natural selection. Complexity. DOI: 10.1002/cplx.21660


Anmar KHADRA


Sabrina Leslie


Judith Mandl


**Christopher Pack**


Pack C.C. 2014. Eye movements as a probe of corollary discharge function in schizophrenia. ACS Chemical Neuroscience. 5:326-328.


**Tomi Pastinen**


of Allergy and Clinical Immunology.

Laprise C., mineral density.

Metspalu A., O'Donnell C.

Nieminen M.E., Nieminen M.S.


Paul Wiseman


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APPENDIX B

CONSULTATION REPORT FORM
RE NEW COURSE PROPOSAL
QLSC 600 Foundations of Quantitative Life Sciences

DATE: February 22, 2016

TO: Bioengineering – Dan Nicolau (for/acting chair)

FROM: Peter Grutter

We are requesting a consultation on a new course: QLSC 600 Foundations of Quantitative Life Sciences.

The goal of this course is to provide graduate students in the life and quantitative sciences an overview of the different types of biological questions that can be addressed using mathematical, computational and statistical approaches. This course will also introduce students to modern technologies used in acquisition of biological data and the key challenges associated with complex data analyses.

QLSC 600 will also serve as a capstone (or required) course for students in a multidisciplinary quantitative life sciences graduate program currently being developed at McGill University.

Would you kindly review the attached proposal and let us know whether or not your department has any objections to, or comments regarding, the course proposal. We would be grateful to receive your response by February 26th 2016.

√ NO OBJECTIONS

COMMENTS (included here or emailed separately):

Signature: A. Korneff

Date: Feb 23, 2016

Please return to Sabine Dhir, PhD, GPS OFFICE ADDRESS or fax 514-398-6283 or email academicprograms.gps@mcgill.ca.
CONSULTATION REPORT FORM
RE NEW COURSE PROPOSAL
QLSC 600 Foundations of Quantitative Life Sciences

DATE: February 22, 2016

TO: Biology – Graham Bell

FROM: Peter Grutter

We are requesting a consultation on a new course: QLSC 600 Foundations of Quantitative Life Sciences.

The goal of this course is to provide graduate students in the life and quantitative sciences an overview of the different types of biological questions that can be addressed using mathematical, computational and statistical approaches. This course will also introduce students to modern technologies used in acquisition of biological data and the key challenges associated with complex data analyses.

QLSC 600 will also serve as a capstone (or required) course for students in a multidisciplinary quantitative life sciences graduate program currently being developed at McGill University.

Would you kindly review the attached proposal and let us know whether or not your department has any objections to, or comments regarding, the course proposal. We would be grateful to receive your response by February 26th 2016.

X NO OBJECTIONS

SOME OBJECTIONS

COMMENTS (included here or emailed separately):
This proposal for QLSC600 was reviewed by Irene Gregory-Eaves (Chair, Curriculum Committee, Biology) and Lauren Chapman (Chair, Graduate Training Committee, Biology). The proposed course seems like an excellent capstone course for the Quantitative Life Science program. It might be valuable if the bootcamp skill series could be made available more broadly to students outside QLSC600, depending on availability, but we have no objections to the course proposal.

Signature: Lauren Chapman, Graduate Program Director, Biology

Date: February 29th, 2016

Please return to Sabine Dhir, PhD, GPS OFFICE ADDRESS or fax 514-398-6283 or email academicprograms.gps@mcgill.ca.
DATE: August 5, 2016

TO: Biomedical Engineering – Dr. Robert Kearney

FROM: Peter Grutter

We are requesting a consultation on a new course: QLSC 600 Foundations of Quantitative Life Sciences.

The goal of this course is to provide graduate students in the life and quantitative sciences an overview of the different types of biological questions that can be addressed using mathematical, computational and statistical approaches. This course will also introduce students to modern technologies used in acquisition of biological data and the key challenges associated with complex data analyses.

QLSC 600 will also serve as a capstone (or required) course for students in a multidisciplinary quantitative life sciences graduate program currently being developed at McGill University.

Would you kindly review the attached proposal and let us know whether or not your department has any objections to, or comments regarding, the course proposal. We would be grateful to receive your response at your earliest convenience.

X NO OBJECTIONS SOME OBJECTIONS

COMMENTS (included here or emailed separately):

An interesting and very ambitious course.

Signature: __________________________

Date: 15 Aug 2016

Please return to Sabine Dhir, PhD, GPS OFFICE ADDRESS or fax 514-398-6283 or email sabine.dhir@mcgill.ca.
DATE: June 22, 2016

TO: Computer Science – Gregory Dudek

FROM: Peter Grutter

We are requesting a consultation on a new course: QLSC 600 Foundations of Quantitative Life Sciences.

The goal of this course is to provide graduate students in the life and quantitative sciences an overview of the different types of biological questions that can be addressed using mathematical, computational and statistical approaches. This course will also introduce students to modern technologies used in acquisition of biological data and the key challenges associated with complex data analyses.

QLSC 600 will also serve as a capstone (or required) course for students in a multidisciplinary quantitative life sciences graduate program currently being developed at McGill University.

Would you kindly review the attached proposal and let us know whether or not your department has any objections to, or comments regarding, the course proposal. We would be grateful to receive your response by February 26th 2016.

_____ X _____ NO OBJECTIONS  ___________ SOME OBJECTIONS

COMMENTS:

We would like to thank you for your revised QLS graduate program proposal which we received on May 10, 2016. We have engaged in extensive and spirited debate since then. The revised proposal better explains the context of the current proposed course.

There is much support in spirit for the new course, and in general for the new program which creates a mechanism for PhD students to do interdisciplinary work. As a department we support this effort and hope we can participate fully.

Signature:

Date: June 17, 2016

Please return to Sabine Dhir, PhD, GPS OFFICE ADDRESS or fax 514-398-6283 or email academicprograms.gps@mcgill.ca.
APPENDIX B
CONSULTATION REPORT FORM
RE NEW COURSE PROPOSAL
QLSC 600 Foundations of Quantitative Life Sciences

DATE: February 22, 2016

TO: Epidemiology & Biostatistics – Gilles Paradis

FROM: Peter Grutter

We are requesting a consultation on a new course: QLSC 600 Foundations of Quantitative Life Sciences.

The goal of this course is to provide graduate students in the life and quantitative sciences an overview of the different types of biological questions that can be addressed using mathematical, computational and statistical approaches. This course will also introduce students to modern technologies used in acquisition of biological data and the key challenges associated with complex data analyses.

QLSC 600 will also serve as a capstone (or required) course for students in a multidisciplinary quantitative life sciences graduate program currently being developed at McGill University.

Would you kindly review the attached proposal and let us know whether or not your department has any objections to, or comments regarding, the course proposal. We would be grateful to receive your response by February 26th, 2016.

[Signature]

NO OBJECTIONS          SOME OBJECTIONS

COMMENTS (included here or emailed separately):

Signature: ____________________  Date: ________________

Please return to Sabine Dhii, PhD, GPS OFFICE ADDRESS or fax 514-398-6283 or email academicprograms.gps@mcgill.ca.
DATE: February 22, 2016

TO: Human Genetics – Eric Shoubridge

FROM: Peter Grutter

We are requesting a consultation on a new course: QLSC 600 Foundations of Quantitative Life Sciences.

The goal of this course is to provide graduate students in the life and quantitative sciences an overview of the different types of biological questions that can be addressed using mathematical, computational and statistical approaches. This course will also introduce students to modern technologies used in acquisition of biological data and the key challenges associated with complex data analyses.

QLSC 600 will also serve as a capstone (or required) course for students in a multidisciplinary quantitative life sciences graduate program currently being developed at McGill University.

Would you kindly review the attached proposal and let us know whether or not your department has any objections to, or comments regarding, the course proposal. We would be grateful to receive your response by February 26th 2016.

x NO OBJECTIONS

COMMENTS (included here or emailed separately):

Excellent course that will take quantitative biology to a new level at McGill. Essential to train the next generation of computational scientists.

Signature:  

Date: 23 February, 2016
APPENDIX B

CONSULTATION REPORT FORM
RE NEW COURSE PROPOSAL
QLSC 600 Foundations of Quantitative Life Sciences

DATE: March 11, 2016

TO: Dr. Jim Fyles – Natural Resource Sciences

FROM: Dr. Peter Grutter

We are requesting a consultation on a new course: QLSC 600 Foundations of Quantitative Life Sciences.

The goal of this course is to provide graduate students in the life and quantitative sciences an overview of the different types of biological questions that can be addressed using mathematical, computational and statistical approaches. This course will also introduce students to modern technologies used in acquisition of biological data and the key challenges associated with complex data analyses.

QLSC 600 will also serve as a capstone (or required) course for students in a multidisciplinary quantitative life sciences graduate program currently being developed at McGill University.

Would you kindly review the attached proposal and let us know whether or not your department has any objections to, or comments regarding, the course proposal. We would be grateful to receive your response at your earliest convenience.

X NO OBJECTIONS

SOME OBJECTIONS

COMMENTS (included here or emailed separately):

We agree that this course is appropriate to the program and that the program is appropriate to the anticipated student body. We continue to feel, as expressed in previous communications, that the program and course could be more broadly oriented to make it more accessible to students with a biological background. Nevertheless, we agree that this may be something for consideration in a future version of the course/program.

Signature: ____________________________________________

Date: 15 mar 2016

Please return to Sabine Dhir, PhD, James Administration Building, Room 400, 845 Sherbrooke St. West, Montreal, Quebec, or email academicprograms.gps@mcgill.ca.
APPENDIX B

CONSULTATION REPORT FORM
RE NEW COURSE PROPOSAL
QLSC 600 Foundations of Quantitative Life Sciences

DATE: February 22, 2016

TO: Neurology & Neurosurgery – Guy Rouleau

FROM: Peter Grutter

We are requesting a consultation on a new course: QLSC 600 Foundations of Quantitative Life Sciences.

The goal of this course is to provide graduate students in the life and quantitative sciences an overview of the different types of biological questions that can be addressed using mathematical, computational and statistical approaches. This course will also introduce students to modern technologies used in acquisition of biological data and the key challenges associated with complex data analyses.

QLSC 600 will also serve as a capstone (or required) course for students in a multidisciplinary quantitative life sciences graduate program currently being developed at McGill University.

Would you kindly review the attached proposal and let us know whether or not your department has any objections to, or comments regarding, the course proposal. We would be grateful to receive your response by February 26th 2016.

[Signature]

NO OBJECTIONS

SOME OBJECTIONS

COMMENTS (included here or emailed separately):

Signature: 

[Signature]

Date: Feb 25, 2016

Please return to Sabine Dhir, PhD, GPS OFFICE ADDRESS or fax 514-398-6233 or email academicprograms.gps@mcgill.ca.
APPENDIX B

CONSULTATION REPORT FORM
RE NEW COURSE PROPOSAL
QLSC 600 Foundations of Quantitative Life Sciences

DATE: February 22, 2016

TO: Peter Grutter (Physics)

FROM: Sabine Dhir

We are requesting a consultation on a new course: QLSC 600 Foundations of Quantitative Life Sciences.

The goal of this course is to provide graduate students in the life and quantitative sciences an overview of the different types of biological questions that can be addressed using mathematical, computational and statistical approaches. This course will also introduce students to modern technologies used in acquisition of biological data and the key challenges associated with complex data analyses.

QLSC 600 will also serve as a capstone (or required) course for students in a multidisciplinary quantitative life sciences graduate program currently being developed at McGill University.

Would you kindly review the attached proposal and let us know whether or not your department has any objections to, or comments regarding, the course proposal. We would be grateful to receive your response by February 26th 2016.

____ x____ NO OBJECTIONS

 COMMENTS (included here or emailed separately):

Excellent course!

Signature: __________________________

Date: 22.2.2016 __________________________

Please return to Sabine Dhir, PhD, GPS OFFICE ADDRESS or fax 514-398-6283 or email academicprograms.gps@mcgill.ca.
DATE:    February 22, 2016

TO:    Physiology – John Orlowski

FROM:    Peter Grutter

We are requesting a consultation on a new course: QLSC 600 Foundations of Quantitative Life Sciences.

The goal of this course is to provide graduate students in the life and quantitative sciences an overview of the different types of biological questions that can be addressed using mathematical, computational and statistical approaches. This course will also introduce students to modern technologies used in acquisition of biological data and the key challenges associated with complex data analyses.

QLSC 600 will also serve as a capstone (or required) course for students in a multidisciplinary quantitative life sciences graduate program currently being developed at McGill University.

Would you kindly review the attached proposal and let us know whether or not your department has any objections to, or comments regarding, the course proposal. We would be grateful to receive your response by February 26th 2016.

_________________   NO OBJECTIONS   X   SOME OBJECTIONS

COMMENTS (included here or emailed separately):

Very impressive line-up for the course. The course appears to be designed for students with a quantitative background (i.e. who were in programs with multiple math and comptsci courses). However, there are some concerns that the students will not have grasped the biology adequately by the end of the course. They need to have some biological background going in or be spoon-fed one by the program before taking the course.

The program needs a basic biology course for people with purely quantitative backgrounds; i.e. a stand-alone course that gives students an overview of physiology/biochemistry/genetics. The boot camps will be more of the same for quantitative students and largely about the technology and not the biology. It would be important that students have the basics of DNA-RNA-protein before diving into modules 1-3. I would also argue that module 2 should come after module 3. The students should have a more “organic” grasp of what a gene is and how it is regulated before diving into more abstract concepts like linkage disequilibrium, etc. In other words, they may need another bootcamp first, which should be the basics of DNA-RNA-protein (2 lectures),
basic organelle biology (1-2 lectures), immunology (innate and adaptive; 1-2 lectures), basic neuroscience (2 lectures). As it stands, the first two bootcamps will be essentially completely out of context.

Signature: ________________________________

Date: __________________ February 25, 2016

Please return to Sabine Dhir, PhD, GPS OFFICE ADDRESS or fax 514-398-6283 or email academicprograms.gps@mcgill.ca.
APPENDIX B

CONSULTATION REPORT FORM
RE AD HOC PROGRAM PROPOSAL
PhD Program in Quantitative Life Sciences

DATE: March 10, 2016

TO: Dr. Albert M. Berghuis
   Chair, Department of Biochemistry

FROM: Dr. Sabine Dhir, on behalf of Dr. Josephine Nalbantoglu, Dean Graduate and Postdoctoral Studies

We are requesting consultation from your department regarding a new multidisciplinary quantitative life sciences graduate program currently being developed at McGill University. The proposed Ad Hoc Interdisciplinary PhD Program in Quantitative Life Sciences fits into a rapidly expanding interdisciplinary field that includes ecology, physiology, genetics, systems biology, computational biology, bioinformatics, mathematical biology, evolutionary biology and biophysics. Key elements of the program have been designed to broaden the contextual knowledge of students and to encourage interactions between different fields of research. The three areas of specialization within the program are: Computational and Statistical Molecular Biology, Biophysics and Ecosystems. There is strong interest and demand for quantitative research skills to be applied to the life sciences, and we feel this program proposal is quite timely.

We would like to include the following courses from your department in the list of complementary courses that students could register for as part of the PhD Program:

- BIOC 603: Genomics and Gene Expression.
- BIOC 605: Protein Biology and Proteomics

Would you kindly review the attached proposal and let us know whether or not you any objections or comments regarding the complementary course(s) from your department to be included as part of the Ad Hoc PhD Program in Quantitative Life Sciences. We would be grateful to receive your response at the earliest.

X NO OBJECTIONS

SOME OBJECTIONS

COMMENTS (included here or emailed separately):

Signature: [Signature]
(Prof. John Silvius, Chair, Curriculum Committee, Dept of Biochemistry)

Date: Mar. 10, 2016

Please return to Sabine Dhir PhD, James Administration Building, Room 400, 845 Sherbrooke St.West, Montreal, Quebec, or email academicprograms.gps@mcgill.ca.
APPENDIX B

CONSULTATION REPORT FORM
RE AD HOC PROGRAM PROPOSAL
PhD Program in Quantitative Life Sciences

DATE: February 23, 2016

TO: Dr. Dan Nicolau
Chair, Department of Bioengineering

FROM: Dr. Sabine Dhir, on behalf of Dr. Josephine Nalbantoglu, Dean Graduate and Postdoctoral Studies

We are requesting consultation from your department regarding a new multidisciplinary quantitative life sciences graduate program currently being developed at McGill University. The proposed Ad Hoc Interdisciplinary PhD Program in Quantitative Life Sciences fits into a rapidly expanding interdisciplinary field that includes ecology, physiology, genetics, systems biology, computational biology, bioinformatics, mathematical biology, evolutionary biology and biophysics. Key elements of the program have been designed to broaden the contextual knowledge of students and to encourage interactions between different fields of research. The three areas of specialization within the program are: Computational and Statistical Molecular Biology, Biophysics and Ecosystems. There is strong interest and demand for quantitative research skills to be applied to the life sciences, and we feel this program proposal is quite timely.

We would like to include the following course from your department in the list of complementary courses that students could register for as part of the PhD Program:

- BIEN 530 Imaging and Bioanalytical Instrumentation

Would you kindly review the attached proposal and let us know whether or not you any objections to, or comments regarding the complementary course(s) from your department to be included as part of the Ad Hoc PhD Program in Quantitative Life Sciences. We would be grateful to receive your response by February 29th 2016.

X NO OBJECTIONS

SOME OBJECTIONS

COMMENTS (included here or emailed separately):

The Department of Bioengineering is pleased to support, with no objections, the inclusion of BIEN 530 Imaging and Bioanalytical Instrumentation as a complementary course in the Quantitative Life Sciences curriculum.

The Bioengineering Department will be happy to contribute more courses to the curriculum if needed, for example, BIEN 570 Active Mechanics in Biology, and BIEN 550 Biomolecular Devices.

Signature:  
Date:  Feb 24, 2016

Please return to Sabine Dhir PhD, James Administration Building, Room 400, 845 Sherbrooke St. West, Montreal, Quebec, or email academicprograms.epi@mcgill.ca.
APPENDIX B

CONSULTATION REPORT FORM
RE AD HOC PROGRAM PROPOSAL
PhD Program in Quantitative Life Sciences

DATE: February 23, 2016

TO: Dr. Graham Bell
Chair, Department of Biology

FROM: Dr. Sabine Dhir, on behalf of Dr. Josephine Nalbantoglu, Dean Graduate and Postdoctoral Studies

We are requesting consultation from your department regarding a new multidisciplinary quantitative life sciences graduate program currently being developed at McGill University. This program will be presented at an upcoming meeting of the Faculty of Science. The proposed Ad Hoc Interdisciplinary PhD Program in Quantitative Life Sciences fits into a rapidly expanding interdisciplinary field that includes ecology, physiology, genetics, systems biology, computational biology, bioinformatics, mathematical biology, evolutionary biology and biophysics. Key elements of the program have been designed to broaden the contextual knowledge of students and to encourage interactions between different fields of research. The three areas of specialization within the program are: Computational and Statistical Molecular Biology, Biophysics and Ecosystems. There is strong interest and demand for quantitative research skills to be applied to the life sciences, and we feel this program proposal is quite timely.

We would like to include the following courses from your department in the list of complementary courses that students could register for as part of the PhD Program:

- BIOL 551 Principles of Cellular Control
- BIOL 509 Methods in Molecular Ecology
- BIOL 510 Community Ecology
- BIOL 540 Ecology of Species Invasion
- BIOL 434 Theoretical Ecology
- BIOL 594 Advanced Evolutionary Ecology
- BIOL 551 Principles of Cellular Control

Would you kindly review the attached proposal and let us know whether or not you any objections to, or comments regarding the complementary course(s) from your department to be included as part of the Ad Hoc PhD Program in Quantitative Life Sciences. We would be grateful to receive your response by February 29th, 2016.

X NO OBJECTIONS

COMMENTS (included here or emailed separately):
Our only minor comment is that we have the capacity to absorb a few more students in the proposed courses (indicated above). I suspect that that is in the neighborhood of what the program is anticipating as Peter Grutter previously indicated on his foundations course proposal for this program that it has an anticipated enrollment of 10 students (and there are 3 streams, of which only one includes Biology).

Signature: [Signature]
Date: April 13, 2016

Please return to Sabine Dhir PhD, James Administration Building, Room 400, 845 Sherbrooke St. West, Montreal, Quebec, or email academicprograms.gps@mcgill.ca.
DATE: March 11, 2016

TO: Dr. Robert Kearney
Chair, Department of Biological

FROM: Dr. Sabine Dhir, on behalf of Dr. Josephine Nalbantoglu, Dean Graduate and Postdoctoral Studies

We are requesting consultation from your department regarding a new multidisciplinary quantitative life sciences graduate program currently being developed at McGill University. The proposed Ad Hoc Interdisciplinary PhD Program in Quantitative Life Sciences fits into a rapidly expanding interdisciplinary field that includes ecology, physiology, genetics, systems biology, computational biology, bioinformatics, mathematical biology, evolutionary biology and biophysics. Key elements of the program have been designed to broaden the contextual knowledge of students and to encourage interactions between different fields of research. The three areas of specialization within the program are: Computational and Statistical Molecular Biology, Biophysics and Ecosystems. There is strong interest and demand for quantitative research skills to be applied to the life sciences, and we feel this program proposal is quite timely.

We would like to include the following courses from your department in the list of complementary courses that students could register for as part of the PhD Program:

- BMDE 502 BME Modelling & Identification
- BMDE 519 Biomedical Signals & Systems
- BMDE 512 Finite-Element Modelling: BME

Would you kindly review the attached proposal and let us know whether or not you have any objections to, or comments regarding the complementary course(s) from your department to be included as part of the Ad Hoc PhD Program in Quantitative Life Sciences. We would be grateful to receive your response at your earliest convenience.

X NO OBJECTIONS

COMMENTS (included here or emailed separately):

Signature: ________________________________

Date:

Please return to Sabine Dhir PhD, James Administration Building, Room 400, 845 Sherbrooke St. West, Montreal, Quebec, or email academicprograms.gps@mcgill.ca.
APPENDIX B

CONSULTATION REPORT FORM
RE AD HOC PROGRAM PROPOSAL
PhD Program in Quantitative Life Sciences

DATE: February 23, 2016

TO: Dr. Masad Damha
   Chair, Department of Chemistry

FROM: Dr. Sabine Dhir, on behalf of Dr. Josephine Nalbantoglu, Dean Graduate and Postdoctoral Studies

We are requesting consultation from your department regarding a new multidisciplinary quantitative life sciences graduate program currently being developed at McGill University. This program will be presented at an upcoming meeting of the Faculty of Science. The proposed Ad Hoc Interdisciplinary PhD Program in Quantitative Life Sciences fits into a rapidly expanding interdisciplinary field that includes ecology, physiology, genetics, systems biology, computational biology, bioinformatics, mathematical biology, evolutionary biology and biophysics. Key elements of the program have been designed to broaden the contextual knowledge of students and to encourage interactions between different fields of research. The three areas of specialization within the program are: Computational and Statistical Molecular Biology, Biophysics and Ecosystems. There is strong interest and demand for quantitative research skills to be applied to the life sciences, and we feel this program proposal is quite timely.

We would like to include the following courses from your department in the list of complementary courses that students could register for as part of the PhD Program:

- CHEM 514 Biophysical Chemistry
- CHEM 520 Methods in Chemical Biology

Would you kindly review the attached proposal and let us know whether or not you any objections to, or comments regarding the complementary course(s) from your department to be included as part of the Ad Hoc PhD Program in Quantitative Life Sciences. We would be grateful to receive your response by February 29th 2016.

[Signature]

Date: March 16, 2016

Please return to Sabine Dhir PhD, James Administration Building, Room 400, 845 Sherbrooke St. West, Montreal, Quebec.
APPENDIX B
CONSULTATION REPORT FORM
RE AD HOC PROGRAM PROPOSAL
PhD Program in Quantitative Life Sciences

DATE: February 23, 2016

TO: Dr. Gregory Dudek
Chair, Department of Computer Science

FROM: Dr. Sabine Dhir, on behalf of Dr. Josephine Nalbantoglu, Dean Graduate and Postdoctoral Studies

We are requesting consultation from your department regarding a new multidisciplinary quantitative life sciences graduate program currently being developed at McGill University. This program will be presented at an upcoming meeting of the Faculty of Science. The proposed Ad Hoc Interdisciplinary PhD Program in Quantitative Life Sciences fits into a rapidly expanding interdisciplinary field that includes ecology, physiology, genetics, systems biology, computational biology, bioinformatics, mathematical biology, evolutionary biology and biophysics. Key elements of the program have been designed to broaden the contextual knowledge of students and to encourage interactions between different fields of research. The three areas of specialization within the program are: Computational and Statistical Molecular Biology, Biophysics and Ecosystems. There is strong interest and demand for quantitative research skills to be applied to the life sciences, and we feel this program proposal is quite timely.

We would like to include the following courses from your department in the list of complementary courses that students could register for as part of the PhD Program:

- COMP 652 Machine Learning
- COMP 561 Computational Biology Methods and Research
- COMP 618 Functional Genomics
- COMP 522 Modeling and Simulations

Would you kindly review the attached proposal and let us know whether or not you any objections to, or comments regarding the complementary course(s) from your department to be included as part of the Ad Hoc PhD Program in Quantitative Life Sciences. We would be grateful to receive your response by February 29th 2016.

________ NO OBJECTIONS ________ X ______ SOME OBJECTIONS

COMMENTS:

- COMP 652 is advanced course which concentrates more on theory than practice, and as such we do not feel it is suitable for the proposed QLS program. It should be replaced by COMP 551 Applied Machine Learning (taught by Prof. Joelle Pineau) which will be offered starting Fall 2016.
- COMP 618 should be dropped from the list, since its future is uncertain. We are planning to replace it with a new 500 level course that would be a follow up to COMP 364 (Computer Tools for the Life Sciences). If this new course it is approved, it would be offered in Fall 2017. This new course would be more suitable for this program.
- COMP 522 is no longer offered because the instructor has left McGill, and so it should be removed from the list.

N.B. For other comments on the Proposed Program itself, please refer to our Consultation for QLSC 600.

Signature: ___________________________

Date: April 1, 2016.

Please return to Sabine Dhir PhD, James Administration Building, Room 400, 845 Sherbrooke St. West, Montreal, Quebec, or email academicprograms.gps@mcgill.ca.
CONSULTATION REPORT FORM
RE AD HOC PROGRAM PROPOSAL
PhD Program in Quantitative Life Sciences

DATE: October 3, 2016

TO: Dr. Bettina Kemme
Chair, Department of Computer Science

FROM: Dr. Sabine Dhir, on behalf of Dr. Josephine Nalbantoglu, Dean Graduate and Postdoctoral Studies

We are requesting consultation from your department regarding a new multidisciplinary quantitative life sciences graduate program currently being developed at McGill University. This program will be presented at an upcoming meeting of the Faculty of Science. The proposed Ad Hoc Interdisciplinary PhD Program in Quantitative Life Sciences fits into a rapidly expanding interdisciplinary field that includes ecology, physiology, genetics, systems biology, computational biology, bioinformatics, mathematical biology, evolutionary biology and biophysics. Key elements of the program have been designed to broaden the contextual knowledge of students and to encourage interactions between different fields of research. The three areas of specialization within the program are: Computational and Statistical Molecular Biology, Biophysics and Ecosystems. There is strong interest and demand for quantitative research skills to be applied to the life sciences, and we feel this program proposal is quite timely.

We would like to include the following courses from your department in the list of complementary courses that students could register for as part of the PhD Program:

- COMP 551 Applied Machine Learning
- COMP 561 Computational Biology Methods and Research
- COMP 598 Topics in Computer Science: Advanced Computational Biology Methods

Would you kindly review the attached proposal and let us know whether or not you have objections to, or comments regarding the complementary course(s) from your department to be included as part of the Ad Hoc PhD Program in Quantitative Life Sciences. We would be grateful to receive your response at your earliest convenience.

__________ NO OBJECTIONS __________ SOME OBJECTIONS

COMMENTS (included here or emailed separately):

Signature: ____________________________

Date: ____________________________

Please return to Sabine Dhir PhD, James Administration Building, Room 400, 845 Sherbrooke St. West, Montreal, Quebec, or email sabine.dhir@mcgill.ca
APPENDIX B

CONSULTATION REPORT FORM
RE AD HOC PROGRAM PROPOSAL
PhD Program in Quantitative Life Sciences

DATE: February 23, 2016

TO: Dr. Gilles Paradis
    Chair, Department of Epidemiology & Biostatistics

FROM: Dr. Sabine Dhir, on behalf of Dr. Josephine Nalbantoglu, Dean Graduate and Postdoctoral Studies

We are requesting consultation from your department regarding a new multidisciplinary quantitative life sciences graduate program currently being developed at McGill University. The proposed Ad Hoc Interdisciplinary PhD Program in Quantitative Life Sciences fits into a rapidly expanding interdisciplinary field that includes ecology, physiology, genetics, systems biology, computational biology, bioinformatics, mathematical biology, evolutionary biology and biophysics. Key elements of the program have been designed to broaden the contextual knowledge of students and to encourage interactions between different fields of research. The three areas of specialization within the program are: Computational and Statistical Molecular Biology, Biophysics and Ecosystems. There is strong interest and demand for quantitative research skills to be applied to the life sciences, and we feel this program proposal is quite timely.

We would like to include the following course from your department in the list of complementary courses that students could register for as part of the PhD Program:

- BIOS 601 Epidemiology: Introduction and Statistical Models

Would you kindly review the attached proposal and let us know whether or not you any objections to, or comments regarding the complementary course(s) from your department to be included as part of the Ad Hoc PhD Program in Quantitative Life Sciences. **We would be grateful to receive your response by February 29th, 2016.**

[Signature]

NO OBJECTIONS

SOME OBJECTIONS

COMMENTS (included here or emailed separately):

Signature: [Signature]

Date: Feb 17, 2016

Please return to Sabine Dhir PhD, James Administration Building, Room 400, 845 Sherbrooke St. West, Montreal, Quebec, or email academicprograms.epsc@mcgill.ca.
APPENDIX B

CONSULTATION REPORT FORM
RE AD HOC PROGRAM PROPOSAL
PhD Program in Quantitative Life Sciences

DATE: February 23, 2016

TO: Dr. Eric Shoubridge
    Chair, Department of Human Genetics

FROM: Dr. Sabine Dhir, on behalf of Dr. Josephine Nalbantoglu, Dean Graduate and Postdoctoral Studies

We are requesting consultation from your department regarding a new multidisciplinary quantitative life sciences graduate program currently being developed at McGill University. The proposed Ad Hoc Interdisciplinary PhD Program in Quantitative Life Sciences fits into a rapidly expanding interdisciplinary field that includes ecology, physiology, genetics, systems biology, computational biology, bioinformatics, mathematical biology, evolutionary biology and biophysics. Key elements of the program have been designed to broaden the contextual knowledge of students and to encourage interactions between different fields of research. The three areas of specialization within the program are: Computational and Statistical Molecular Biology, Biophysics and Ecosystems. There is strong interest and demand for quantitative research skills to be applied to the life sciences, and we feel this program proposal is quite timely.

We would like to include the following courses from your department in the list of complementary courses that students could register for as part of the PhD Program:

- HGEN 661 Population Genetics
- HGEN 677 Advanced Statistical Methods in Genetics and Genomics
- HGEN 692 Human Genetics

Would you kindly review the attached proposal and let us know whether or not you any objections to, or comments regarding the complementary course(s) from your department to be included as part of the Ad Hoc PhD Program in Quantitative Life Sciences. **We would be grateful to receive your response by February 29th 2016.**

x

_________ NO OBJECTIONS ________ SOME OBSTRUCTIONS

COMMENTS (included here or emailed separately):

This is a terrific initiative, which I wholeheartedly support!

Signature: ____________________________

Date: 5April, 2016

Please return to Sabine Dhir PhD, James Administration Building, Room 400, 845 Sherbrooke St. West, Montreal, Quebec, or email academicprograms.gps@mcgill.ca.
CONSULTATION REPORT FORM  
RE AD HOC PROGRAM PROPOSAL  
PhD Program in Quantitative Life Sciences

DATE: March 16, 2016

TO: Dr. David A. Stephens  
Chair, Department of Mathematics and Statistics

FROM: Dr. Sabine Dhir, on behalf of Dr. Josephine Nalbantoglu, Dean Graduate and Postdoctoral Studies

We are requesting consultation from your department regarding a new multidisciplinary quantitative life sciences graduate program currently being developed at McGill University. This program will be presented at an upcoming meeting of the Faculty of Science. The proposed Ad Hoc Interdisciplinary PhD Program in Quantitative Life Sciences fits into a rapidly expanding interdisciplinary field that includes ecology, physiology, genetics, systems biology, computational biology, bioinformatics, mathematical biology, evolutionary biology and biophysics. Key elements of the program have been designed to broaden the contextual knowledge of students and to encourage interactions between different fields of research. The three areas of specialization within the program are: Computational and Statistical Molecular Biology, Biophysics and Ecosystems. There is strong interest and demand for quantitative research skills to be applied to the life sciences, and we feel this program proposal is quite timely.

We would like to include the following courses from your department in the list of complementary courses that students could register for as part of the PhD Program:

- MATH 680 Computation Intensive Statistics
- MATH 523 Generalized Linear Models
- MATH 525 Sampling Theory and Applications
- MATH 537 Mathematical Models in Biology
- MATH 547 Stochastic Processes
- MATH 533 Honours Regression and ANOVA
- MATH 556 Mathematical Statistics 1

Would you kindly review the attached proposal and let us know whether or not you any objections to, or comments regarding the complementary course(s) from your department to be included as part of the Ad Hoc PhD Program in Quantitative Life Sciences. We would be grateful to receive at your earliest convenience.

X NO OBJECTIONS

SOME OBJECTIONS

COMMENTS (included here or emailed separately):

I am happy to support this initiative.

Signature:

Date: 17th March 2016

Please return to Sabine Dhir PhD, James Administration Building, Room 400, 845 Sherbrooke St. West, Montreal, Quebec, or email academicprograms.gps@mcgill.ca.
APPENDIX B
CONSULTATION REPORT FORM
RE AD HOC PROGRAM PROPOSAL
PhD Program in Quantitative Life Sciences

DATE: February 23, 2016

TO: Dr. Anne-Marie Lauzon
   Chair, Department of Medicine

FROM: Dr. Sabine Dhir, on behalf of Dr. Josephine Nalbantoglu, Dean Graduate and Postdoctoral Studies

We are requesting consultation from your department regarding a new multidisciplinary quantitative life sciences graduate program currently being developed at McGill University. The proposed Ad Hoc Interdisciplinary PhD Program in Quantitative Life Sciences fits into a rapidly expanding interdisciplinary field that includes ecology, physiology, genetics, systems biology, computational biology, bioinformatics, mathematical biology, evolutionary biology and biophysics. Key elements of the program have been designed to broaden the contextual knowledge of students and to encourage interactions between different fields of research. The three areas of specialization within the program are: Computational and Statistical Molecular Biology, Biophysics and Ecosystems. There is strong interest and demand for quantitative research skills to be applied to the life sciences, and we feel this program proposal is quite timely.

We would like to include the following course from your department in the list of complementary courses that students could register for as part of the PhD Program:

- EXMD 602 Techniques in Molecular Genetics

Would you kindly review the attached proposal and let us know whether or not you any objections to, or comments regarding the complementary course(s) from your department to be included as part of the Ad Hoc PhD Program in Quantitative Life Sciences. We would be grateful to receive your response by February 29th, 2016.

☐ NO OBJECTIONS ☐ SOME OBJECTIONS

COMMENTS (included here or emailed separately):

Both the department and the course coordinators think this new program is a great idea. One comment which we wish to make is that, as appears from the program proposal which was sent, the course EXMD602 is part of the Computational and Statistical Molecular Biology Stream - Life Science Block. It should be noted that, although there are some statistical principles and computational approaches taught in EXMD-602, this is only a minor aspect of the course. The course is intended to expose the students to the most recent molecular approaches used to study human genetic diseases and their general applications to understand mechanisms of disease.

Finally, it should be noted that this course normally requires “Instructor Approval” due to the fact that students who wish to take this course must have a basic knowledge of molecular biology and at least 1 course of basic genetics.

I attach an outline of the course for the current year for your information.

Signature: ____________________________
Date: 25/2/2016

Please return to Sabine Dhir PhD, James Administration Building, Room 400, 845 Sherbrooke St. West, Montreal, Quebec, or email academicprograms.gps@mcgill.ca.
### ADVANCED TECHNIQUES IN MOLECULAR GENETICS 2016

**EXMD-602**

**WEDNESDAY 1h00 – 3h00 PM**

**McIntyre Building, ROOM 1345**

<table>
<thead>
<tr>
<th>DATE</th>
<th>TOPIC</th>
<th>FACULTY</th>
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<tbody>
<tr>
<td>January 13 2016</td>
<td>Detection of gene product and quantification of gene expression</td>
<td>D. Radzioch</td>
</tr>
<tr>
<td>January 20 2016</td>
<td>Immunohistochemistry</td>
<td>D. Radzioch</td>
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<tr>
<td>January 27 2016</td>
<td>Anti-sense technology</td>
<td>D. Radzioch</td>
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<td>February 3 2016</td>
<td>Complex Trait Genetics</td>
<td>E. Schurr</td>
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<tr>
<td>February 10 2016</td>
<td>Human Linkage and Association Studies</td>
<td>J. Engert</td>
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<tr>
<td>February 17 2016</td>
<td>Gene therapy</td>
<td>D. Cournoyer</td>
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<tr>
<td>February 24 2016</td>
<td>Students' presentations</td>
<td>Malo/Radzioch</td>
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<tr>
<td>March 2 2016</td>
<td>READING WEEK</td>
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<td>March 9 2016</td>
<td>Gene regulatory network</td>
<td>R. Sladek</td>
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<td>March 16 2016</td>
<td>Next generation sequencing: technologies and applications</td>
<td>G. Bourque</td>
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<td>March 23 2016</td>
<td>Mouse genetics</td>
<td>D. Malo</td>
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<td>March 30 2016</td>
<td>Mouse genetics</td>
<td>D. Malo</td>
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<tr>
<td>April 6 2016</td>
<td>Mutagenesis and transgenesis</td>
<td>M. Bouchard</td>
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<tr>
<td>April 13 2016</td>
<td>Students' presentations</td>
<td>Malo/Radzioch</td>
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<td>April 20 2016</td>
<td>EXAM_N2/2 Stewart Building</td>
<td>Malo/Radzioch</td>
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</table>

**Evaluation:** Presentation 40%; Final Exam 60%

*In accord with McGill University’s Charter of Students’ Rights, students in this course have the right to submit in English or in French any written work that is to be graded.*

McGill University values academic integrity. Therefore all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures (see [http://www.mcgill.ca/integrity](http://www.mcgill.ca/integrity) for more information).
APPENDIX B

CONSULTATION REPORT FORM
RE AD HOC PROGRAM PROPOSAL
PhD Program in Quantitative Life Sciences

DATE: March 16, 2016

TO: Dr. Jim Fyles
Chair, Department of Natural Resource Sciences

FROM: Dr. Sabine Dhir, on behalf of Dr. Josephine Nalbantoglu, Dean Graduate and Postdoctoral Studies

We are requesting consultation from your department regarding a new multidisciplinary quantitative life sciences graduate program currently being developed at McGill University. The proposed Ad Hoc Interdisciplinary PhD Program in Quantitative Life Sciences fits into a rapidly expanding interdisciplinary field that includes ecology, physiology, genetics, systems biology, computational biology, bioinformatics, mathematical biology, evolutionary biology and biophysics. Key elements of the program have been designed to broaden the contextual knowledge of students and to encourage interactions between different fields of research. The three areas of specialization within the program are: Computational and Statistical Molecular Biology, Biophysics and Ecosystems. There is strong interest and demand for quantitative research skills to be applied to the life sciences, and we feel this program proposal is quite timely.

We would like to include the following courses from your department in the list of complementary courses that students could register for as part of the PhD Program:

- ENVB 506 Quantitative Methods in Ecology
- ENVR 540 Ecology of Species Invasion

Would you kindly review the attached proposal and let us know whether or not you any objections to, or comments regarding the complementary course(s) from your department to be included as part of the Ad Hoc PhD Program in Quantitative Life Sciences. We would be grateful to receive your response at your earliest convenience.

X NO OBJECTIONS

COMMENTS (included here or emailed separately):

Note that ENVR 540 ‘Ecology of Invasion’ is a course of the McGill School of Environment, jointly listed with Biology. Hence, as Chair of NRS, I cannot officially sign for this course.

Signature: [Signature]
Date: June 3/2016

Please return to Sabine Dhir PhD, James Administration Building, Room 400, 845 Sherbrooke St. West, Montreal, Quebec, or email academicprograms.gps@mcgill.ca.
DATE: February 22, 2016

TO: Dr. Peter Grutter
Chair, Department of Physics

FROM: Dr. Sabine Dhir

We are requesting consultation from your department regarding a new multidisciplinary quantitative life sciences graduate program currently being developed at McGill University. The proposed Ad Hoc Interdisciplinary PhD Program in Quantitative Life Sciences fits into a rapidly expanding interdisciplinary field that includes ecology, physiology, genetics, systems biology, computational biology, bioinformatics, mathematical biology, evolutionary biology and biophysics. Key elements of the program have been designed to broaden the contextual knowledge of students and to encourage interactions between different fields of research. The three areas of specialization within the program are: Computational and Statistical Molecular Biology, Biophysics and Ecosystems. There is strong interest and demand for quantitative research skills to be applied to the life sciences, and we feel this program proposal is quite timely.

We would like to include the following courses from your department in the list of complementary courses that students could register for as part of the PhD Program:

- PHYS 519 Advanced Biophysics
- PHYS 559 Advanced Statistical Mechanics

Would you kindly review the attached proposal and let us know whether or not you any objections to, or comments regarding the complementary course(s) from your department to be included as part of the Ad Hoc PhD Program in Quantitative Life Sciences. We would be grateful to receive your response by February 26th, 2016.

_____ x _____ NO OBJECTIONS  _______________ SOME OBJECTIONS

COMMENTS (included here or emailed separately):

Great program!

Signature:  

Date: 22.2.2016

Please return to Sabine Dhir, PhD, GPS OFFICE ADDRESS or fax 514-398-6283 or email academicprograms.gps@mcgill.ca.
APPENDIX B
CONSULTATION REPORT FORM
RE AD HOC PROGRAM PROPOSAL
PhD Program in Quantitative Life Sciences

DATE:  February 23, 2016

TO:   Dr. John Orlowski
       Chair, Department of Physiology

FROM: Dr. Sabine Dhir, on behalf of Dr. Josephine Nalbantoglu, Dean Graduate and Postdoctoral Studies

We are requesting consultation from your department regarding a new multidisciplinary quantitative life sciences graduate program currently being developed at McGill University. The proposed Ad Hoc Interdisciplinary PhD Program in Quantitative Life Sciences fits into a rapidly expanding interdisciplinary field that includes ecology, physiology, genetics, systems biology, computational biology, bioinformatics, mathematical biology, evolutionary biology and biophysics. Key elements of the program have been designed to broaden the contextual knowledge of students and to encourage interactions between different fields of research. The three areas of specialization within the program are: Computational and Statistical Molecular Biology, Biophysics and Ecosystems. There is strong interest and demand for quantitative research skills to be applied to the life sciences, and we feel this program proposal is quite timely.

We would like to include the following courses from your department in the list of complementary courses that students could register for as part of the PhD Program:

- PHGY 520 Ion Channels
- PHGY 518 Artificial Cells

Would you kindly review the attached proposal and let us know whether or not you any objections to, or comments regarding the complementary course(s) from your department to be included as part of the Ad Hoc PhD Program in Quantitative Life Sciences. We would be grateful to receive your response by February 29th 2016.

X NO OBJECTIONS  SOME OBJECTIONS

COMMENTS (included here or emailed separately):

While PHGY 520 Ion Channels would provide solid training in electrophysiology and biophysics, I am not sure of the basis for recommending PHGY 518 Artificial Cells. It might be more beneficial for the students to include a more basic course in molecular and cellular biology or physiology, unless this is already addressed in prerequisite courses required for the program (or offered in the other courses).

Signature:  

Date:  February 25, 2016

Please return to Sabine Dhir PhD, James Administration Building, Room 400, 845 Sherbrooke St. West, Montreal, Quebec, or email academicprograms.gps@mcgill.ca.