UNIVERSITY OF TORONTO

Graduate Program Proposal

Master of Science (MSc) & Doctor of Philosophy (PhD) Program
in
Cell & Systems Biology

in
The Department of Cell & Systems Biology

April 2007

This document is to be completed for all graduate submissions requiring University of Toronto approvals. The template is developed in accordance with the "Guidelines for Assessment of Divisional Submissions, February 2005":
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1 Executive Summary

Academic

- The Department of CSB proposes to offer a master's program leading to the degree of Master of Science (MSc) and a doctoral program leading to the degree of Doctor of Philosophy (PhD) in the fields of Cell, Molecular and Systems Biology.
- The objective of the MSc program will be to provide students with skills in the generation, critical evaluation, assessment and communication of data so that they are equipped to proceed with further post-graduate degrees, or other career opportunities where such skills are desired.
- CSB PhD graduates will be expected to emerge from the program as independent and autonomous scientists, producing a written thesis that describes original research that stands as a testimony to their ability to generate publishable, stand-alone contributions to the peer-reviewed scientific literature. They will form part of the next generation of independent researchers in cell, molecular and systems biology.

Planning and Budget

- The Department of CSB, together with its sister department, the Department of Ecology and Evolutionary Biology (EEB), emerged from the reorganisation of the former Departments of Botany and Zoology.
- The faculty members of the Department of CSB are now eager to transform their successes with graduate training within the P&MB and Zoology programs, and offer their own, unique graduate program, specifically dedicated to Cell & Systems Biology.
- The proposed new CSB graduate program has been tailored to meet the graduate training needs of graduate students in this exciting area of biology, and builds on the collective experience of CSB faculty members in consultation with other graduate units and the current cohort of graduate students supervised by CSB faculty members.
- As the proposed CSB program will emerge from the reorganisation of the former Departments of Botany and Zoology, and the graduate programs associated therewith, there are no new resource allocations that are required for the new program.
- Creation of new graduate programs for CSB & EEB should have no new resource demands beyond those of the previous departments, and the CSB graduate program will have no new staffing beyond that agreed in the HR plan for CSB, which was instituted on July 1, 2006.

Space and Facilities

- The Department of CSB is located in the Earth Science Centre (ESC) and Ramsay Wright Zoological Laboratories (RWZL) on St. George Campus, and in the Science buildings on the University of Toronto at Mississauga (UTM), and University of Toronto at Scarborough (UTSC) campuses.
- Faculty and student office space on all three campuses conforms with space regulations established for the University of Toronto as a whole, and, in all cases, exceeds the minimum requirements for space allocation for office and laboratory work.
- No changes in physical facilities are required to support the new CSB program, although consolidation of CSB faculty and students at the St. George campus into one building is being considered as part of the ongoing planning process for the reorganisation of biological science.

- CSB faculty and students have access to excellent library and computing resources, and state-of-the-art, cutting-edge research facilities and infrastructure.

Students

- The Department of CSB guarantees its graduate students a minimum annual stipend, in

accordance with the Faculty of Arts and Science, University of Toronto policy.

- The Department of CSB is projecting an increase in graduate student enrolment.

2 Academic

2.1 Description and rationale for the proposal

2.1.1 Description of proposed program

The Department of Cell & Systems Biology (CSB) is committed to providing a strong graduate program that will train and mentor students in the fields of Cell, Molecular and Systems Biology. The Department of CSB will fulfill this commitment by maintaining and enhancing a world-class research, learning and training environment to ensure successful, rigorous, and internationally-recognised graduate education and research. In keeping with the interdisciplinary nature of the fields in the CSB graduate program, exposure to a breadth of research areas and approaches will be a key component of the program. Students will have access to state-of-the-art facilities and make use of cutting-edge approaches including functional genomics, genetics, metabolomics, proteomics, bioinformatics, computational biology, cell biology, developmental biology, molecular biology, and physiology. The Department of Cell & Systems Biology (CSB) will offer a master's program leading to the degree of Master of Science (MSc) and a doctoral program leading to the degree of Doctor of Philosophy (PhD).

MSc program:

The Department of CSB recognises the importance of the MSc degree as valuable research training for students whose career aspirations may or may not be aligned with proceeding with academic research. There is a high demand for MSc level scientists in many career paths, both within and outside academia. For example, the MSc provides ideal training for career paths in education, business and policy where science-based decision-making and the interpretation and transmission of scientific information is becoming increasingly important, particularly in many of the "knowledge-based" economies that are emerging the world over. The MSc program aims to produce scientists that are well suited to fill this demand.

The objective of the MSc program is to provide students with skills in the generation, critical evaluation, assessment and communication of data so that they are equipped to proceed with further graduate degrees, or other career opportunities where such skills are desired. As part of their training, MSc students will acquire skills in the communication of scientific research (including teaching skills), and acquire a good foundation of knowledge related to the theory and practice underpinning their chosen field.

The CSB MSc program objectives are achieved through: 1) independent research in the laboratories of CSB faculty; 2) successful completion of high level, module-based graduate courses; 3) oral presentations at formal Department seminars and informal group meetings, and, 4) production of a thesis that describes original research that is of a quality suitable for publication in a peer-reviewed journal.

PhD program:

The CSB PhD program aims to produce scientists who will form part of the next generation of independent researchers in cell, molecular and systems biology. The CSB PhD program aims to produce the future high-level teachers, frontier-expanders, and decision-makers in these fields of inquiry. In keeping with this, PhD graduates are expected to emerge from the program as independent and autonomous scientists, producing a written thesis that describes original research

that stands as a testimony to their ability to generate publishable, stand-alone contributions to the peer-reviewed scientific literature. As part of their training, PhD students will acquire skills in the communication of scientific research (including teaching skills), and acquire broad-based knowledge of the theory and practice underpinning their chosen field.

The CSB PhD program objectives are achieved through: 1) independent research in the laboratories of CSB faculty; 2) successful completion of high level graduate courses; 3) oral presentations at formal Department seminars and informal group meetings, and, 4) production of a thesis that contains work that can stand alone as a publishable, peer-reviewed contribution to the scientific literature.

2.1.2 Rationale for proposal

The Department of CSB, together with its sister department (Department of Ecology and Evolutionary Biology, EEB), emerged from the reorganisation of the former Departments of Botany and Zoology. The two new departments were founded on July 1st 2006. Together with the Department of EEB, the Department of CSB currently oversees the two graduate programs that were offered by the former Departments of Botany and Zoology, which are the Graduate Program in Plant & Microbial Biology (P&MB) and the Graduate Program in Zoology, respectively. The Department of CSB is responsible for the oversight of all aspects of graduate degree progression for P&MB and Zoology graduate students whose research interests are best aligned with those of CSB and who are supervised by faculty members affiliated with CSB.

The faculty members of the Department of CSB are now eager to transform their successes with graduate training within the P&MB and Zoology programs, and offer their own, unique graduate program, specifically dedicated to Cell & Systems Biology. The proposed new CSB graduate program has been tailored to meet the graduate training needs of graduate students in this exciting area of biology, and builds on the collective experience of CSB faculty members in consultation with other graduate units and the current cohort of graduate students.

The proposed graduate program is unique in Canada in that it will be the first graduate program to offer explicit training in cell, molecular and systems biology. While an Institute of Systems Biology exists in Canada (University of Ottawa), it does not offer a graduate program. Only a handful of universities offer graduate programs in systems biology worldwide, but the number is growing. To date these include: Harvard University (Systems Biology Program), MIT (Computational & Systems Biology), University of Southern California (PhD Program in Systems Biology and Disease), and Cornell University / Sloan Kettering Institute (Physiology, Biophysics and Systems Biology Program). The focus of these programs is biomedical and human-biology based, which is in contrast to the proposed CSB program, which covers a breadth of biological systems, which is relatively unique at this point in time.

2.2 Pedagogical and other academic issues, including expected benefits of the proposed program

The fields of cell, molecular and systems biology are at the vanguard of post-genome biology, as they play the key role in deciphering the interplay between biological molecules, how that interplay gives rise to functioning organisms, and how failures in those molecules impinge on organism performance and survival. Thus, particularly in a

post-genome world, cell, molecular & systems biology offer an unprecedented opportunity to understand how organisms function, as well as providing key insights into the mechanisms that underpin how organisms interact with each other and their environment. Not surprisingly, cell, molecular and systems biology have emerged as fields that lay the foundation for future basic biological research ranging from understanding fundamental molecular mechanisms underpinning organism development and health, to understanding how organisms survive in an ever-changing environment. Related to this, cell, molecular, and systems biology are viewed as key facets of applied research and development aimed at understanding and treating disease, improving human and animal health, improving plant productivity, and understanding and sustaining organism survival against a backdrop of environmental change. Given the prominent role played by cell, molecular and systems biology in these endeavours, it should come as no surprise that these fields enjoy great growth, with trainees in these fields readily finding employment across a range of positions – ranging from medicine to agriculture, from government and academia to the private sector. The disciplines covered by Cell & Systems Biology, including molecular biology and bioinformatics, are important endeavours in knowledge-based economies, and have exceedingly good prospects for future employment.

The creation of a new graduate program specifically entitled Cell & Systems Biology creates high visibility for this attractive field. Therefore, the new program is likely to attract not only students who had identified this subject area of interest within the former P&MB and Zoology programs, but also students who are interested in the field who would not have readily identified the field as being associated with P&MB and Zoology.

The MSc in CSB will provide ideal training for career paths in education, business and policy where science-based decision-making and the interpretation and transmission of scientific information is becoming increasingly important, particularly in many of the "knowledge-based" economies that are emerging the world over. The MSc program will produce scientists that are well suited to fill this demand. Thus, the objective of the MSc program is to provide students with skills in the generation, critical evaluation, assessment and communication of data so that they are equipped to proceed with further post-graduate degrees, or other career opportunities where such skills are desired.

The CSB PhD program aims to produce scientists who will form part of the next generation of independent researchers in cell, molecular and systems biology. The CSB PhD program aims to produce the future high-level teachers, frontier-expanders, and decision-makers in these fields of inquiry. In keeping with this, PhD graduates are expected to emerge from the program as independent and autonomous scientists, producing a written thesis that describes original research that stands as a testimony to their ability to generate publishable, stand-alone contributions to the peer-reviewed scientific literature. As part of their training, PhD students will acquire skills in the communication of scientific research (including teaching skills), and acquire broad-based knowledge of the theory and practice underpinning their chosen field.

2.3 Projected student demand

PROJECTED INTAKE AND ENROLMENTS Master's (M) and Doctoral (D) Programs						
YEAR	**FULL-TIME**				**TOTAL ENROLMENT**	
	Intake		**Enrolments**			
	M	**D**	**M**	**D**	**M**	**D**
2008/09	35	18	47	58	83	76
2009/10	35	20	40	70	75	90
2010/11	35	22	40	68	75	90
2011/12	35	22	40	68	75	90
2012/13	35	22	40	68	75	90
2013/14	35	22	40	68	75	90
2014/15	35	22	40	68	75	90

As is the case for most graduate programs at the University of Toronto, the new Department of CSB is projecting an increase in graduate student enrolment. The Department proposes to increase graduate student enrolment from its current level of ca 120 students to greater than 160 students within the next 3-4 years. This is in fact a priority for the Province of Ontario and the University as a whole, both to accommodate the double-cohort of undergraduate students as they graduate and to work towards a "knowledge-based economy".

The Department of CSB is very well poised to increase graduate student enrollment. The Department believes that the projected increased in enrolment is realistic for several reasons. These reasons are as follows:

1) Growth of the fields of cell, molecular and systems biology
The fields of research covered by the graduate program in Cell & Systems Biology are progressive and cutting-edge. The demand for cell & systems biologists in recent years, as evidenced by position advertisements, is testimony to the growth of this particular field. Demand in all of these fields is liked to proceed unabated given the wealth of genome biology-based data which continues to grow on a daily basis. It will be the role of cell, molecular and systems biologists to make sense of this data for many years to come. The graduate program in CSB can play a role in providing the next generation of trainees in this growth area.

2) Student demand, and visibility to students
The fields of research covered by the graduate program in Cell & Systems Biology are attractive to students, particularly given that graduates have the flexibility to pursue a vast diversity of future employment opportunities post-graduation, and that the field

offered are ones of growth and foreseeable demand (see point 1 above). The creation of a new graduate program specifically entitled Cell & Systems Biology creates high visibility for this attractive field. Therefore, the new program is likely to attract not only students who had identified this subject area of interest within the former P&MB and Zoology programs, but also students who are interested in the field who would not have readily identified the field as being associated with P&MB and Zoology. Aside from these factors, student demand for graduate studies in the near future is likely to be positively impacted by the fact that the so-called "double cohort" of students in Ontario, arising from the graduation of two years of high school students in a single year in 2003, will soon be graduating from their undergraduate degree programs. This will undoubtedly create a relatively high demand for graduate studies in the near future, with a sustained demand after that. In fact, enrolment in life sciences has remained at levels significantly higher than "pre-double-cohort", suggesting that student demand for graduate studies in the life sciences, particularly in an area as attractive as Cell & Systems Biology, has the potential to be sustained for a period beyond that of the double cohort.

3) Faculty demographics

The recent growth in faculty members in CSB provides a significant opportunity to enhance the quality and quantity of graduate students enrolled in the CSB graduate program as these new faculty grow their research endeavour. Increased graduate enrolment will need to keep pace with the increase in faculty with active research programs. Given the demographic breakdown of the department, with many new faculty and others set to join the department, the department is in growth mode, as new faculty establish and expand their programs. The proposed enrolment is in keeping with the projected increase in lab sizes anticipated as new faculty grow their labs to meet their supervisory capacity. A robust supervisory capacity is anticipated given the success of CSB faculty members in securing funding support for their research. What's more, established CSB faculty members have provided excellent opportunities for graduate training and have been very successful in recruiting excellent graduate students over the past 7 years, and this is likely to continue unabated for the coming years.

All told, all of the factors listed above argue that the CSB enrolment plan is realistic and the targets attainable. In keeping with the aim of increasing graduate student enrolment, CSB is currently engaged in a vigorous graduate student recruitment campaign, including offering admissions scholarships, establishing a scholarship endowment to reward students in program, and new web-based recruitment.

2.4 Impact on the Department's and Division's program of study, including impact on other divisions

The establishment of a graduate program in Cell & Systems Biology will have a very strong positive impact on the Department of CSB's program of study, and is likely to have a positive, if any, impact on the Division or on other Divisions. The reasons for this are quite straightforward. While the creation of a graduate program in CSB represents the creation of a "new" graduate program, the graduate program is founded by merging completely overlapping fields of study from two existing graduate programs (P&MB & Zoology). The creation of this graduate program is crucial in the establishment of a program of study "identity" for the fledgling Department of CSB. While it represents no new commitments on the part of the faculty or staff in terms of time or effort relative to the existing programs in CSB, the proposed graduate program in CSB would establish a program of study that is completely aligned with the research interests of CSB faculty

members and current graduate students, and, therefore, would function as a defining feature of the CSB program of study. While this has very significant positive implications for the Department of CSB, it should have only a limited impact on the Division and other divisions, as the new program would identify a graduate program effort that already exists in many ways, although not in name. Thus, the only impact that the proposed program would have within and between Divisions is a more visible entity that specifically identifies graduate studies in CSB in name. The graduate units that this increased visibility is likely to impact are Medical Genetics, Medical Biophysics, and Biochemistry. The reason for this is because the establishment of the proposed program in CSB would identify a graduate program with clearly aligned interests, with great potential for programmatic collaboration and learning. This can only be a positive thing given the inter-disciplinary nature of the fields offered by these graduate units. What's more, the establishment of a graduate program in CSB would provide a complementary training focus to Medical Genetics, Medical Biophysics, and Biochemistry, which tend to be more biomedical and human biology oriented, relative to CSB, which covers a wider breadth of biological systems, including microbes, plants and a range of animals that complement and expand knowledge beyond medicine and human biology.

The proposed program is likely to have a positive impact on the collaborative programs in Neuroscience, Developmental Biology, and Proteomics and Bioinformatics (Genome Biology and Bioinformatics) where CSB faculty already play prominent roles. Increasing graduate student enrolment, and enhancing graduate student training in CSB should bolster these collaborative graduate programs, providing new opportunities for the recruitment and training of students through the collaborative programs.

2.5 Evidence of consultation with other affected divisions

The Chair and Associate Chair for Graduate Studies in the Department of Systems Biology undertook an extensive consultative process with other departments that might be affected by a new program in Cell & Systems Biology. The major part of this process involved scheduled person-to-person meetings with the Chairs and/or Associate Chairs for Graduate Studies of those units that were most likely to be affected. This included the following departments: Molecular & Medical Genetics (Chair: Howard Lipshitz; Associate Chair: Alan Davidson); Medical Biophysics (Chair: David Rose; Associate Chair: Dwayne Barber); Biochemistry (Chair: Rheinhardt Reithmeier); and Computer Science (Chair: Craig Boutilier; Interested Faculty Members: Ryan Lilien, Michael Brudno). Discussions also transpired with the Faculty of Forestry (Dean: Tattersall Smith; Former Graduate Director: Sandy Smith) and members of the Department of Chemical Engineering (Interested Faculty Members: Elizabeth Edwards, Emma Master). Discussions were also held with the director of the Collaborative Graduate Program in Proteomics and Bioinformatics (Nicholas Provart), the director of the Collaborative Graduate Program in Developmental Biology (Ulrich Tepass), and the interim director of the Centre for the Analysis of Genome Evolution and Function (David Guttman). Throughout the development of the graduate program in Cell & Systems Biology, meetings were also held with the Department of Ecology & Evolutionary Biology (Chair: Robert Baker; Associate Chair: Gary Sprules).

In all instances, discussions involved provision of information about the emerging CSB graduate program, and request for feedback pertaining to execution of the proposed CSB program, impact of the proposed CSB program on the unit in question, and potential opportunities for collaboration between the units on account of the proposed CSB graduate program. In all instances potentially affected divisions were incredibly

supportive, indicating that the niche identified by the proposed CSB graduate program was complementary and offered excellent opportunities for interunit cooperation if not collaboration. In one instance (Molecular & Medical Genetics) the input allowed CSB to reshape the program design, specifically the design of modular courses, so that the CSB proposal was better aligned with the unit's existing graduate program. In all instances, pains were taken not to duplicate fields of study or other major facets of graduate training. In the other hand, pains were also taken to design the CSB graduate program following the best practices already established in existing graduate programs.

2.6 Appropriateness of the name and designation of the new program

The chosen fields are logical and obvious choices based on the strengths and expertise of the Department of CSB, and are well aligned with the research interests of the faculty that self-identified as wishing to be members of the Department of CSB.

The master's program comprises the following fields:
1) Cell & Molecular Biology
2) Systems Biology

The PhD program comprises the following fields:
1) Cell & Molecular Biology
2) Systems Biology

A description of each of the fields follows:

Cell and Molecular Biology:

The molecular biology revolution that dominated the life sciences in the second half of the 20th century has given us an unprecedented ability to explore the behaviour of cells - the fundamental units of life – in terms of molecular processes within and between cells. The cell as the fundamental unit of life will remain the focus of attention in the molecular life sciences. Cell & Molecular Biology is a vibrant and broad field that seeks to understand the underlying molecular principles that control cell behaviour in a developmental and physiological context. In this broad sense, Cell & Molecular Biology comprises cell biology, molecular biology, developmental biology, genetics and physiology and their sub-disciplines (e.g. neurobiology, morphogenesis, etc.). The practitioners of Cell & Molecular Biology use hypothesis-driven experimental research to address the function of individual or small groups of genes and their products or the function of metabolites in cells and organisms.

The Cell & Molecular Biology field is a direct continuation of fields of nearly identical name in the graduate programs offered by the former Departments of Botany and Zoology, and is therefore a logical program offering for the faculty that self-identified as members of the new Department of CSB. At University of Toronto, one other graduate program, Medical Biophysics, offers the field "Cellular and Molecular Biology". Following consultations with the Chair and the Associate Chair of Graduate Studies for Medical Biophysics, it was agreed that offering this field was both logical and desirable for both graduate units. The field of Cell & Molecular Biology is very large, covering investigation of a diversity of cell types, sub-cellular structures, and biomolecules. Moreover, there are many differences in methodology that can be employed to answer scientific questions in this field, with each methodological approach offering different perspectives on even the same biological question. Thus, while the field name may imply overlap, practitioners in this field in Medical Biophysics and CSB have carved out

fundamentally different niches in their field. Perhaps most importantly, the emphases of Medical Biophysics and CSB are significantly different. For the field of Cell & Molecular Biology, Medical Biophysics largely focuses on answering scientific questions in human biology / medicine and with a stronger emphasis on methodological development. By contrast, CSB is focused on addressing cell & molecular biology questions in model organisms and organisms of agronomic and environmental importance, including microbes, insects, fish and plants. Thus, while equivalent in name, the precise aspects of the field of cell & molecular biology differ between Medical Biophysics and CSB.

Systems Biology:
Since the 1990s, the rapid development of new technology platforms has resulted in a massive increase of detailed information about the genome (genomics), the temporal and spatial distribution of all gene transcripts (transcriptomics), cellular proteins and their physical interactions (proteomics), and small molecules that cells assimilate or synthesise (metabolomics). The challenge is no longer to collect those data but to make sense of them. The integration of "-omics" approaches with computer modeling and hypothesis driven experimentation has recently crystallised into the new biological field referred to as Systems Biology. Systems biology is that field focused on extracting biological meaning from large biomolecule datasets. Systems Biology can be simply defined as the study of the dynamic networks of interacting biological elements. Moreover, Systems Biology aims to use this information to predict how networks of biomolecules interact so as to give rise to a functioning organism that interacts with other organisms and its environment. Systems biologists may be involved in every aspect of such work, from the development of high throughput analytical approaches, to the generation of large biomolecular datasets to the use of computational biology and bioinformatics in the organisation and exploitation of those vast datasets. Computer modeling is frequently used by Systems biologists to integrate and visualise large networks of cellular components and to generate hypotheses about functional interactions that control cell behaviour. These hypotheses are then be tested experimentally through more conventional approaches, and the results of those experiments used to improve model building and inform the strategies used to collect and organise large datasets.

Systems Biology is a new field at the University of Toronto, emphasising the aim of the new Department of CSB to fulfill the role of functioning at the forefront of biological science by training scientists in this burgeoning new field.

2.7 Program description and requirements, course titles/numbers, and faculty members

2.7.1 Program description and requirements

Degree of Master of Science

Admission Requirements
In addition to fulfilling University of Toronto School of Graduate Studies (SGS) general requirements for admission, applicants must achieve a minimum equivalent of a University of Toronto B+ average in their last year of study in an honours BSc program, plus minimally a mid-B overall average in the previous year of study.

Program Requirements

Normally the MSc program should be completed within 24 months (6 sessions). Students in the MSc program must complete the CSB1000H^{o} module course (0.5 full course equivalent, FCE), the CSB1010Y^{o} MSc seminar series (CR/NCR, attendance at 24 seminars per year, plus attendance at two CSB PhD Proposal/Transfer Days per year), a thesis on a research project, a public presentation of the thesis research, and defence of the thesis at an oral examination.

Degree of Doctor of Philosophy

Admission Requirements

Students will be accepted into the CSB PhD program through one of three possible entry routes:

1) Transfer from the CSB MSc Program: Students may reclassify from the MSc program after 12 months of study. Students must reclassify at one of the two available Transfer Days, one of which occurs in September, and the other in February.
2) Following completion of an MSc: Applicants applying from an MSc degree program or equivalent from a recognised university must have an average of A- in their MSc program.
3) Direct entry from BSc: Students with an exceptional record in an honours BSc program (minimally, University of Toronto A^{-} average or equivalent) may apply to be considered for direct admission into the PhD program.

Program Requirements

Students entering the PhD program following transfer from the MSc program should complete the PhD program within 5 years from the start date at which they enrolled in the MSc program. Students entering the PhD program directly from a BSc program also should complete the PhD program within 5 years. Students entering the PhD program following completion of an MSc degree should complete the CSB PhD program within 4 years.

Students in the PhD program must complete one CSB1000H^{o} module course (0.5 full course equivalent, FCE), one additional CSB100XH^{o} module course (0.5 FCE) or equivalent, the CSB1011Y^{o} PhD seminar series (CR/NCR, attendance at 24 seminars per year, plus attendance at two CSB PhD Proposal/Transfer Days per year), a thesis on a research project, a public presentation of the thesis research, and defence of the thesis at the final oral examination.

All PhD students and MSc students wishing to reclassify as PhD students must successful complete a PhD Proposal / Transfer Examination. The PhD Proposal / Transfer Examination involves three components: 1) preparation of a written research proposal; 2) presentation to the department and questioning by the public at the Departmental PhD Proposal / Transfer Day; and, 3) *in camera* questioning by an PhD Proposal Examination Committee within 2 weeks of the public presentation. There are two dates available for the Proposal / Transfer process per year, one in September and the other in February. Students must successfully complete their Proposal / Transfer Examination at either one of these dates, at either 12 months or 17 months after the start date of enrollment in their graduate program. If the research proposal is deemed unsatisfactory by the examining committee, there is a single opportunity to present a revised proposal three months later. PhD candidates make an oral presentation of their thesis for evaluation to the Department as a

whole and to a departmental evaluation committee before proceeding to the School of Graduate Studies' Final Oral Examination.

Students that transfer from the CSB MSc program to the PhD program may apply course credits earned as CSB MSc students toward their PhD course requirements. Students entering the PhD program following completion of an MSc will normally have to complete all the PhD program course requirements.

Progress through the MSc and PhD programs is summarised in the table below.

CSB General Graduate Program Requirements

Expected progress through program		
	MSc	**PhD**
Year 1	• CSB1000H^{o} (0.5 FCE) • CSB1010Y^{o} - MSc Seminar series (CR/NCR, includes seminar attendance & attendance at CSB Transfer / Proposal Day) • Supervisory committee meetings (2) • MSc Thesis research	• CSB1000H^{o} - 1-2 modules or equivalent (0.25-0.5 FCE) • CSB1011Y^{o} - PhD Seminar series (CR/NCR, includes seminar attendance & attendance at CSB Transfer / Proposal Day) • Supervisory committee meetings (2) • Thesis research
Year 2	• CSB1010Y^{o} - MSc Seminar series (CR/NCR, includes seminar attendance & attendance at CSB Transfer / Proposal Day) • Supervisory committee meeting • MSc Thesis research completed & thesis written • Public presentation of thesis research • MSc Thesis defense	• CSB100XH^{o} - 1-2 modules or equivalent (0.25-0.5 FCE) • CSB1011Y^{o} - PhD Seminar series (CR/NCR, includes seminar attendance & attendance at CSB Transfer / Proposal Day) • Thesis proposal (combined with supervisory committee meeting) • Thesis research
Year 3	---	• CSB100XH^{o} - 1-2 modules or equivalent (0.25-0.5 FCE) • CSB1011Y^{o} - PhD Seminar series (CR/NCR, includes seminar attendance & attendance at CSB Transfer / Proposal Day) • Supervisory committee meeting • Thesis research
Year 4	---	• CSB1011Y^{o} - PhD Seminar series (CR/NCR, includes seminar attendance & attendance at CSB Transfer / Proposal Day) • Supervisory committee meeting • Thesis research completed & thesis written • Thesis approval committee meeting • Public presentation of thesis research

		• Final oral examination

Additional Details on Program Requirements

Additional application requirements
All applications for admission for graduate studies (MSc or PhD) in Cell & Systems Biology in the Department of Cell & Systems Biology, University of Toronto must be submitted to the Graduate Office and reviewed and approved by the Graduate Studies Committee. Application forms and instructions are available on the CSB website: www.csb.utoronto.ca

The normal start date for graduate programs in CSB is September 1st. Applications are accepted beginning December 1st, 9 months prior to the September 1st start date. All application materials (including transcripts, letters of reference, etc.) must be received by the end of the first week of February in order for an applicant to be considered for University of Toronto Fellowships for the September 1st start date.

Applicants to the graduate program (MSc or PhD) must arrange for three letters of reference to be sent to the Department from three referees who are familiar with the applicant and the applicant's suitability for graduate studies.

All visa applicants whose first language is not English must obtain a satisfactory score on the Test of English as a Foreign Language (TOEFL). The School of Graduate Studies requires a minimum overall score of 580 (paper-based test) or 237 (computer-based test), and a score of at least 5.0 on the Test of Written English (TWE) or essay rating portion of the test.

As CSB graduate programs are primarily research oriented, all students accepted in the Department must have a faculty member who is willing to supervise their research and provide financial support. Consequently, applicants must indicate in their application the names of faculty members who might be prospective supervisors, faculty by whom they wish to be considered for admission into the graduate program. Applicants can list multiple faculty members as prospective supervisors. Prospective supervisors select graduate students after applications have been submitted.

Selection of successful applicants
Following submission of a complete application, faculty members evaluate the applications of all prospective students. This evaluation may also involve an oral interview of the applicant, either by telephone or in person. After faculty members have identified applicants who they wish to accept as graduate students, the names of these applicants are forwarded to the CSB Graduate Studies Committee (GSC). The CSB GSC reviews these applications, ensuring that the applicants meet minimum requirements, and considering the applicants for Departmental scholarships. If the CSB GSC approves the application forwarded by a prospective supervisor, a letter of offer is sent to the successful applicant. If more than one prospective supervisor indicated that they would be willing to supervise the successful applicant, then the applicant has the opportunity to choose the supervisor with whom they would like to undertake their degree program. Successful applicants must indicate that they will accept the offer of admission within a window of time indicated on the letter of offer (generally before the end of March in the year of offer). Successful applicants who have accepted their offer then undertake the registration process indicated below.

Qualifying Year Applicants
Applicants whose grades clearly do not meet the admission requirements would be required to take an additional qualifying year of 3-5 undergraduate courses if they wish to be admissable. Course selection for the qualifying year will be determined by the applicant's prospective supervisor and the CSB GSC. Students are expected to earn at least a B+ in each of the FCEs taken in their qualifying year and upon completion, may then apply to the MSc program. Entry into the program will depend upon commitment from the supervisor and availability of financial support, and will require approval of the CSB GSC.

Course Work
Graduate courses, in the form of half courses (0.5 FCE) composed of two modules as outlined in the sections above, are a graduate program requirement for all students in Cell & Systems Biology. The modules taken by an individual student should be selected in consultation with the Supervisor in the first term, and with the Supervisory Committee thereafter, and should be those most suitable for providing an academic background for the thesis research. MSc students must complete their course requirements by the end of their first year; whereas, PhD students must complete theirs before the end of their third year of study. The department will adhere to the grading practices and grade requirements for successful completion of courses, which are set by the School of Graduate Studies.

Two 6-week modules will constitute one half course offering (i.e., 0.5 FCE). A student registers for a "continuous" half course (e.g., CSB100XH^{o}) that is completed once the student has successfully completed two modules. A grade is entered after both modules have been completed. The course grade is calculated as the average of the two module grades that were used to make up the 0.5 FCE course completed by the student. The calculation of the course grade is handled by the CSB graduate administrator, and only one grade is entered on the University Student Information System, ROSI, for the 0.5 FCE CSB100XH^{o} course.

So as to provide maximum flexibility in graduate training, generally any two modules can be paired to make up one course. Most modules are seminar-based modules that are 6 weeks in duration, with 2 hours devoted to the module per week. The weekly meetings generally comprise a combination of student seminars and discussion of the seminar topics. In contrast to the seminar-based module, several modules are offered as workshop-style modules over a compressed timescale. Workshop-based modules are primarily focused on practical aspects of cell, molecular and/or systems biology.

Some modules will emphasise new techniques, technologies or approaches, and how these are applied to research problems; whereas, others focus on fundamentally important concepts in cell, molecular and systems biology. Modules serve three main objectives: i) to develop an awareness of current progress in research, including important mechanistic insights into biological organisms, as well as cutting-edge techniques, approaches and technologies in cell, molecular and systems biology, ii) to develop abilities in interpreting and criticising scientific approaches and data, iii) to improve writing and/or verbal skills.

Research Seminar Attendance
All students will be enrolled in a "continuous" seminar series (CSB1010Y^{o} for MSc students, CSB1011Y^{o} for PhD students) that lasts for the duration of their degree

program. The seminar series is for "credit only" and is not graded. Successful completion of the seminar series involves the student attending on average, one seminar per week during each 12-week term, for each of the autumn (September-December) and winter (January-April) terms plus each of the two CSB PhD Proposal/Transfer Days (see below) offered per year. It is anticipated that the majority of this requirement will be fulfilled by attendance at departmental seminars at the student's home campus, but may include seminars offered at other campuses, in other departments, or at other institutions. The mixture of seminars attended by a student will be decided in consultation with the supervisor and supervisory committee and set at the beginning of each term. It is the supervisor's responsibility to function as a positive role model in the attendance at seminars and to monitor their students' attendance at seminars. If a student does not attend the requisite number of seminars, the student risks not receiving credit for this program requirement.

The seminar series is composed of invited guest lecturers, seminars by post-doctoral fellows in the Department, and the presentation component of the MSc thesis defence and the public PhD thesis presentation seminar that precedes the School of Graduate Studies (SGS) PhD Final Oral Examination (FOE). The number of seminars that students are required to attend will be established and announced in September.

The CSB PhD Proposal/Transfer Days are held at the beginning of September and during reading week in February each year. The days comprise 30 minute seminars presented by MSc students transferring to the PhD program, and second year PhD students who were admitted directly into the PhD program. In each instance, the students are presenting proposals for their future PhD research, and are completing one of the requirements for either transfer into the PhD program or continuation in the PhD program respectively (see below for more details). All other students are expected to attend these seminars. The venue for CSB PhD Proposal/Transfer Days alternates between the 3 campuses, with the September meeting always held on St. George campus, and the February meeting alternating between UTM and UTSC campuses. Each CSB PhD Proposal/Transfer Day will feature a departmental social event at the end of the day.

Thesis Research
Original research and the completion and defense of a thesis are requirements for students in both the Master's and Doctoral programs in the graduate program in Cell & Systems Biology.

MSc Thesis and Defence
The MSc thesis should minimally comprise a written report of a series of reproducible, sophisticated experiments that may be set up within the context of a larger research project, but do not necessarily stand alone as a publishable entity. The experimental protocols used and the data generated, however, should be of sufficient rigour and quality to be used for peer-reviewed publications. There should be an adequate literature review to provide an introduction and requisite background for the experimental work that follows, as well as materials and methods that accurately report on the approach that was taken with sufficient detail to allow the work to be reproduced, a discussion that considers the research in the context of historical literature and future experiments, as well as a reference section that completely cites the literature that was used throughout the thesis.

There are two components to the MSc Thesis Examination: 1) a public presentation of the MSc thesis, and 2) an *in camera* defence of the MSc thesis. The two components of the thesis must be completed within two (2) months of each other. Ideally, the public presentation takes place immediately before the *in camera* defence, but this is not obligatory and the two may be separated in time. The public presentation of the MSc thesis will take place before the *in camera* defence.

The MSc Thesis Examination Committee is composed of the supervisor, one examiner who is a member of the candidate's Supervisory Committee, and one examiner who is from the department but not on the Supervisory Committee. In the *in camera* defence, each examiner should question the student for approximately 20-30 minutes. General background questions that do not have significant, direct relevance to the subject matter of the thesis should be avoided in the early stages of the examination although questions of this type may be relevant later. The examination, including the seminar, should not exceed two hours.

PhD Proposal / Transfer from MSc to PhD Examination
All PhD students and MSc students wishing to reclassify as PhD students must successful complete a PhD Proposal / Transfer Examination. The purpose of the Proposal Examination is to ensure that the research proposal is sound and that the study has every expectation of being completed within the time indicated. It also serves to determine if the student has sufficient knowledge in the field to pursue the proposed research. It provides a forum for discussion and suggestions from members of the department that may enhance the quality of the work and the achievements of the student. The PhD Proposal / Transfer Examination involves three components: 1) preparation of a written research proposal; 2) presentation to the department and questioning by the public at the Departmental PhD Proposal / Transfer Day; and, 3) *in camera* questioning by an PhD Proposal Examination Committee within 2 weeks of the public presentation.

There are two dates available for the Proposal / Transfer process per year, one in September and the other in February. Students must successfully complete their Proposal / Transfer Examination at either one of these dates, at either 12 months or 17 months after the start date of enrollment in their graduate program. If the research proposal is deemed unsatisfactory by the examining committee, there is a single opportunity to present a revised proposal three months later.

PhD Thesis
The PhD thesis describes original research that stands as a testimony to the candidate's ability to generate publishable, stand-alone contributions to the peer-reviewed scientific literature. Historically, the PhD thesis has taken one of two distinct forms. The first is a traditional format that includes separate sections for the Introduction, Materials and Methods, Results and Discussion. The second is a series of published, submitted or in-preparation articles in the primary literature of which the candidate is an author. Either format can be used.

Thesis Approval Meeting
The Cell & Systems Biology PhD program requires that all PhD candidates present their thesis for evaluation to a Thesis Approval Committee before proceeding to the School of Graduate Studies (SGS) PhD Final Oral Examination. The Thesis Approval Meeting must be held six to eight weeks prior to the SGS PhD Final Oral

Examination. The Thesis Approval Meeting will be based on: (1) an assessment of the thesis containing the results of an original research study, (2) the ability of the candidate to defend the thesis and (3) the ability of the candidate to show a mastery of the research topic. The candidate must demonstrate that he/she understands the topic, can defend the thesis, and can place the findings in a general context. The candidate may also be asked to comment on the research developments in his major field of study. While not a formal exam, it is conducted in a way that will prepare the student for the School of Graduate Studies Final Oral Examination. The committee for the Thesis Approval Meeting, consisting of the Supervisor, other members of the Supervisory Committee, one CSB faculty member who is not a member of the Supervisory Committee, and a Chair appointed by the Graduate Studies Committee will meet with the candidate *in camera* at a meeting time organised by the candidate.

Pre-Final Oral Examination Public Presentation of the Thesis
After the thesis is approved at the departmental Thesis Approval Committee, the candidate arranges a public seminar, generally held within the context of the departmental seminar series, to present the thesis to a general audience. This seminar will occur immediately before the School of Graduate Studies Final Oral Examination.

School of Graduate Studies PhD Final Oral Examination
After the thesis is approved at the departmental Thesis Approval Committee, the SGS Final Oral Examination (FOE) is arranged. The FOE is conducted according to SGS regulations, and is composed of an *in camera* defence of the thesis with the Thesis Examination Committee, including the external examiner.

2.7.2 Course titles/numbers

Courses Offered to Graduate Students in the Past Three Years				
Course[1]	**Faculty member(s) responsible[2]**	**2004/05**	**2005/06**	**2006/07**
BOT1355Y* **Introductory Virology**	**M. AbouHaidar**	0G/319U	0G/363U	1G/479U
BOT1450H* **Plant Proteomics & Metabolomics**	**D. Christendat**	5G/21U	0G/32U	0G/35U
BOT1460H* **Plant Molecular Genetics**	**T. Berleth, S. Cutler & P. McCourt** (McCourt/Cutler in 04/05; Berleth/Cutler in 05/06; Berleth/McCourt in 06/07)	1G/22U	1G/13U	4G/24U
BOT1629H* **Cell. and Molecular Aspects of Plant Development**	**T. Berleth & P. McCourt**	Not offered	1G/77U	2G/54U

BOT1700H **The Early Evol. Of Life**	**D. Guttman & T. Feild**	7G		
BOT1700H*** **Signalling in Plant Growth & Development**	**M. Campbell**	8G	4G/2U	Not offered
BOT1700H **Systems Biol.**	**D. Guttman & N. Provart**		6G	
BOT1700H **Proteomics and Signalling Networks**	**D. Christendat & D. Desveaux**			9G
JBZ1472H** **Computational Genomics and Bioinformatics**	**D. Guttman & N. Provart**	5G/24U	6G/26U	10G/38U
JBZ1473H* **Chem. Genomics**	**S. Cutler**	3G/28U	0G/30U	2G/37U
JZB1018H **Advanced Microscopy**	**C. Hasenkampf & R. Harrison**	Not offered	9G	Not offered
ZOO1002H **Advanced Research and Reading Course**	**Various**	24G	17G	29G
ZOO1002H **Cell Adhesion and Migration in Dev.**	**M. Ringuette**	3G	Not offered	6G
ZOO1002Y **Advanced Research and reading Course**	**Various**	1G	1G	1G
ZOO1006H **Recent Advances in Integrative Physiology**	**D. Lovejoy & L. Buck**	7G	11G	7G

ZOO1501H **Biology of Signal Transduction**	**A. Lange & D. O'Day**	Not offered	10G	Not offered
ZOO1506H **Concepts in Dev. Biology**	**D. Godt & U. Tepass**	6G	11G	11G
ZOO2217H **Animal Sound and Vibration**	**A. Mason & G.K. Morris**	1G	6G	Not offered
JDB1025Y **Developmental Biology**	**U. Tepass / Staff**	9G	10G	10G
JDB1026Y **Student Seminars in Dev. Biology**	**U. Tepass / Staff**	31G	24G	19G

* Course is an undergraduate course occasionally taken by graduate students for graduate credit. Graduate/undergraduate enrolment (G/U). Graduate students must complete additional work, typically a critical literature review paper.

** Course is habitually taken by graduate for graduate credit. Graduate/undergraduate enrolment (G/U). Graduate students must complete additional work, typically a critical literature review paper.

*** Course is a graduate course occasionally taken by undergraduate students. Graduate/undergraduate enrolment (G/U). Graduate students must complete additional work, typically a critical literature review paper.

In the past, in all instances where graduate students were enrolled in senior undergraduate courses, additional course work was required of the graduate students. Moreover, in all circumstances, no more than 1/3rd of any given graduate student's program was composed of undergraduate courses. In fact, in the vast majority of cases, the entire graduate course requirement was fulfilled by the student enrolling in solely graduate courses. This will be the case for students in the proposed CSB graduate program as well. There should be little, if any, need for CSB students to enroll in senior undergraduate courses, and, if they do, there will, of course, be an extra graduate requirement, and these courses will comprise no more than 1/3rd of the graduate course requirement for any given student.

2.7.3 Faculty members

There are 43 "core" CSB faculty members. In the last 4 years, 16 new faculty (Aarts, Bruce, Campbell, Christendat, Desveaux, Gazzarrini, Harris, Harrison, Nash, Peever, Provart, Reid, Stewart, Tropepe, Woodin, Yoshioka) have been recruited to the former biology departments who are now members of the Department of CSB. Almost all have been successful in securing substantial CFI funding, and two (Harris, Stewart) have been appointed to Canada Research Chair positions. The Department of CSB is also completing the process of recruiting four new faculty members in each of the following areas: Biotechnology (UTM), Metabolomics (St. George), Systems Biology (St. George) and Cell Biology (St. George). The

individuals filling these positions will be in post as of July 1 2007. In addition to these four new faculty hires, the Department of CSB aims to hire one to two new faculty members in the coming two years. At least one of these two will be in the area of Systems Biology. The individuals currently involved in negotiations to fill these positions are emerging leaders in their respective fields. All have very strong research records, and have received significant global recognition and accolades for their contributions to cell and systems biology. In the interest of confidentiality while these positions are under negotiation, the Assistant Professors who will fill these posts are listed as "TBA" in the table below.

Table 1 lists the faculty members involved in the graduate program, identifies their field affiliation and gender.

TABLE 1

Faculty Members by Field					
				Fields[3]	
Faculty Name & Rank	**M/F**	**Home Unit[1]**	**Supervisory Privileges[2]**	**Cell & Molecular Biology**	**Systems Biology**
Category 1[4]					
M.G. AbouHaidar Professor	M	Cell & Systems Biology	Full	X	
M. Aarts Assistant Professor	F	Life Sciences UTSC	Full	X	
T. Berleth Professor	M	Cell & Systems Biology	Full	X	X
I. Brown Professor	M	Life Sciences UTSC	Full	X	
A. Bruce Assistant Professor	F	Cell & Systems Biology	Full	X	
L. Buck Associate Professor	M	Cell & Systems Biology	Full	X	
M. Campbell Associate Professor	M	Cell & Systems Biology	Full	X	X
D. Christendat Assistant Professor	M	Cell & Systems Biology	Full	X	X
J. Coleman Professor	M	Cell & Systems Biology	Full	X	X
D. Desveaux Assistant Professor	M	Cell & Systems Biology	Full	X	X
Category 1 (cont.)					

G. Espie Professor	M	Biology UTM	Full	X	
S. Gazzarrini Assistant Professor	F	Life Sciences UTSC	Full	X	
D. Godt Associate Professor	F	Cell & Systems Biology	Full	X	X
D.R. Goring Professor	F	Cell & Systems Biology	Full	X	X
D.S. Guttman Associate Professor	M	Cell & Systems Biology	Full	X	X
T. Harris Assistant Professor	M	Cell & Systems Biology	Full	X	X
R. Harrison Assistant Professor	F	Life Sciences UTSC	Full	X	
C. Hasenkampf Associate Professor	F	Life Sciences UTSC	Full	X	
A. Lange Professor	F	Biology UTM	Full	X	
E. Larsen Professor	F	Cell & Systems Biology	Full	X	
D. Lovejoy Associate Professor	M	Cell & Systems Biology	Full	X	X
P. McCourt Professor	M	Cell & Systems Biology	Full	X	X
J. Nash Assistant Professor	F	Life Sciences UTSC	Full	X	
D. O'Day Professor	M	Biology UTM	Full	X	
I. Orchard Professor	M	Biology UTM	Full	X	
J. Peever Assistant Professor	M	Cell & Systems Biology	Full	X	
N. Provart Assistant Professor	M	Cell & Systems Biology	Full	X	X
S. Reid Associate Professor	M	Life Sciences UTSC	Full	X	
Category 1 (cont.)					

C.D. Riggs Associate Professor	M	Life Sciences UTSC	Full	X	X
M. Ringuette Associate Professor	M	Cell & Systems Biology	Full	X	
P. Romans Associate Professor	F	Cell & Systems Biology	Full	X	
J.J.B. Smith Professor	M	Cell & Systems Biology	Full	X	
R. Stephenson Associate Professor	M	Cell & Systems Biology	Full	X	
B. Stewart Assistant Professor	M	Biology UTM	Full	X	
U. Tepass Professor	M	Cell & Systems Biology	Full	X	
S. Tobe Professor	M	Cell & Systems Biology	Full	X	
V. Tropepe Assistant Professor	M	Cell & Systems Biology	Full	X	X
G. Vanlerberghe Associate Professor	M	Life Sciences UTSC	Full	X	
S. Varmuza Professor	F	Cell & Systems Biology	Full	X	
J.T. Westwood Associate Professor	M	Biology UTM	Full	X	X
R. Winklbauer Associate Professor	M	Cell & Systems Biology	Full	X	
M. Woodin Assistant Professor	F	Cell & Systems Biology	Full	X	
K. Yoshioka Assistant Professor	F	Cell & Systems Biology	Full	X	X
Metabolomics TBA Assistant Professor		Cell & Systems Biology	Full	X	X
Systems Biology TBA Assistant Professor		Cell & Systems Biology	Full	X	X
Cell Biology TBA Assistant Professor		Cell & Systems Biology	Full	X	X

Category 1 (cont.)					
Biotechnology TBA Assistant Professor		Biology UTM	Full	X	X

Category 2					
None					

Category 3					
J.B. Anderson Professor	M	Biology UTM	Full	X	
B. Chang Assistant Professor	F	Ecology & Evolutionary Biology	Full	X	X
E.A. Edwards Assistant Professor	F	Chemical Engineering	Full	X	
A. Mason Assistant Professor	M	Life Sciences UTSC	Full	X	
M. Sokolowski Professor	F	Biology UTM	Full	X	
F.J. Vaccarino Professor	M	Psychology	Full	X	
J. Yeomans Professor	M	Psychology	Full	X	

Category 4					
S. Cutler Assistant Professor	M	UC Riverside	Full	X	X
G.L. Boulianne Assistant Professor	F	Hospital for Sick Children	Associate	X	
J.-M. Moncalvo Assistant Professor	M	Royal Ontario Museum	Full	X	

Category 5					
S.S. Desser Emeritus Professor	M	Cell & Systems Biology (Zoology)	Emeritus	X	
N. Mrosovsky Emeritus Professor	M	Cell & Systems Biology (Zoology)	Emeritus	X	

Category 6					
None					

Category 1: tenured or tenure-track core faculty members whose graduate involvement is exclusively in the graduate program under review. For this purpose the master=s and doctoral streams of a program are considered as a single program. Membership in the graduate program, not the home unit, is the defining issue.

Category 2: non-tenure-track core faculty members whose graduate involvement is exclusively in the graduate program under review.

Category 3: tenured or tenure-track core faculty members who are involved in teaching and/or supervision in other graduate program(s) in addition to being a core member of the graduate program under review.

Category 4: non-tenured or tenure-track core faculty members who are involved in teaching and/or supervision in other graduate program(s) in addition to being a core member of the graduate program under review.

Category 5: other core faculty: this category may include emeritus professors with supervisory privileges and persons appointed from government laboratories or industry as adjunct professors. Please explain who would fall into this category at your institution.

Category 6: non-core faculty who participate in the teaching of graduate courses.

3 Students

3.1 Student affairs and services

Students will have access to all the usual resources and services provided for graduate students by the School of Graduate Studies and the University of Toronto.

3.2 Student conduct and discipline

Student conduct and discipline will be dictated by existing policies established by SGS.

3.3 Student registration and information systems

Student registration and information systems follow existing practices established by SGS.

Appendix 1 Chief Librarian's Report for CSB

REPORT ON LIBRARY RESOURCES FOR GRADUATE PROGRAM IN CELL AND SYSTEMS BIOLOGY

BACKGROUND

The University of Toronto libraries provide a rich resource for the support of graduate study in the field of cell and systems biology. While there is a specific literature that focuses on cell and systems biology which we collect extensively, the research collection in this area is enhanced by its location in a university library system which through its collections and acquisitions policy supports research and teaching in all areas of the biological, health, physical, social and behavioural sciences and the humanities. The increasingly cross-disciplinary nature of much of the research in the life sciences means that it is extremely difficult to draw firm boundaries around an area or speciality.

DESCRIPTION OF THE COLLECTION

Monographs

The Library's holdings related to cell and systems biology specifically, and the life sciences more generally, have been built up in a systematic way since 1966 when Dealer Selection Orders were established and librarians employed to monitor the plans and to actively and systematically select research materials that fall outside the plans.

Research material supporting the cell and systems biology program comes from a wide range of subject areas across the life sciences including the plant sciences, animal sciences, molecular biology, genetics, genomics, cell biology, cytology, developmental biology, systems biology, bioinformatics, proteomics, the neurosciences, biotechnology and evolutionary biology.

In the life sciences, as in other areas of the collection, it is the policy of the Library to acquire a single copy of all books published in English that are considered to be of research value. This includes the proceedings of conferences and symposia, technical handbooks and reference tools in addition to research monographs. The cross-disciplinary nature of research in cell and systems biology makes a simple evaluation of the Library's holdings difficult. However, the 2001 edition of the North American Title

Count 1 can be useful in comparing the University of Toronto's holdings with that of other similar institutions.

Books that relate to all areas of biology and natural history are classed by the Library of Congress within the call number range *QH*. Within this range, the University of Toronto Library, with 19,554 titles, ranked sixth of sixty-one libraries in the survey. When compared only to other academic libraries in the survey the Library ranked fifth.

Books that discuss zoology in all its aspects are classed by the Library of Congress in the call number *QL*. In this range the University of Toronto Library, with 19,646 titles ranked eighth. When measured against other academic libraries, the University of Toronto Library would take the seventh position in the survey.

Books relating to microbiology are classed by the Library of Congress in the range *QR* and by the National Library of Medicine in *QW*. In a count of libraries using either classification system the University of Toronto Library, with 5,194 titles ranked fifth. When measured against other academic libraries the University of Toronto Library would take the third position.

Books discussing plant sciences are classed by the Library of Congress in *QK*. In a count of books in this range the University of Toronto Library with 11,373 titles ranked thirteenth of sixty-one libraries. Among academic libraries the University of Toronto Library ranked twelfth.

1 *North American Title Count, 2001*. Chicago: American Library Association.

The currency of the collection is also important. There have been ongoing improvements in the library's ability to get English language materials to the shelves quickly, and at present there is not a backlog for books in the life sciences.

Journals

The journal holdings of the University of Toronto Library are substantial. However, like all North American libraries we are experiencing great difficulty in keeping up with the rising cost of serial subscriptions. From 1986 until the past few years we were able to buy few new titles. During the 1990's the Library, in consultation with faculty, actually cancelled subscriptions equal in cost to approximately 10% of the total serials budget. However the situation has improved significantly during the past several years due to the Library's holdings of electronic journals. At the present time over 33,000 such journals are available to students and staff at the university. Many of these are new to the Library's holdings.

The most recent statistics compiled by the Library show the total number of journal subscriptions currently held in the life and health sciences is 3,140.2 A check of the ISI journal citation reports (2005) 3 (JCR) can often provide some insight into the strength of the Library's holdings in particular disciplines. In the subject category "Cell Biology," the University of Toronto Library holds twenty-four of the top twenty-five journals ranked by Impact Factor. All twenty-four journals held by the Library are available online for staff and students at the University.

In the subject category "Biochemistry and Molecular Biology," the University of Toronto Library holds all the top twenty-five journals ranked by Impact Factor. Of these journals, twenty-two are available electronically to staff and students.

In the category "Developmental Biology," the University of Toronto Library holds all the top twenty-five journals ranked by Impact Factor. Of these, twenty-one are available online to staff and students.

In the subject category "Biology," the University of Toronto Library holds twenty-four of the top twenty-five journals ranked by Impact Factor. All twenty-four are available online to staff and students.

In the category "Evolutionary Biology," the University of Toronto Library holds all of the top twenty-five journals as ranked by Impact Factor. All of these journals are available electronically to staff and students.

In the subject category "Zoology" the Library holds all the top twenty-five journals ranked by Impact Factor; each of these is available online to staff and students.

Electronic Resources

The electronic information services at the University of Toronto Library have been evolving since 1987, when the first online catalogue was mounted.4 Within a year the online catalogue was available in all the campus libraries, and dial-in access was introduced with a small number of lines. Abstracts and indexes had been computerised since the early 1970's and up until the 1980's were searched by trained intermediaries. Beginning in the late 1980's CD-ROM's and networked databases widened the access of electronic databases to the end-user to perform his or her own searches. In 1991 the Library added seven H.W. Wilson periodical index databases to its electronic network. Today the Library offers over 350 periodical index databases through a variety of information systems to all members of the University of Toronto community. Some of these indexes allow users to search and retrieve citations to journal articles and then to display the full text of that article electronically. Specialists in cell and systems biology will find

2 University of Toronto Library. Annual statistics, May1, 2004 – April 30, 2005. Toronto: The Library, 2005

3 *Science Citation Index Journal Citation Reports, 2004.* Philadelphia: Institute for Scientific Information, 2005.

4 Clinton, Peter. From Felix to the digital library and beyond. UTLibrary news, winter 1997/98, p. 2-3.

the following databases of interest: Science Citation Index; Biosis Previews; Biological Sciences; Faculty of 1,000 Biology; Zoological Records Plus; Entomology Abstracts; Cab Abstracts; Animal Behavior Abstracts; Scopus; Medline; ISI Conference Proceedings; and Proquest Digital Dissertations.

As mentioned earlier the Library also offers links to 15,000 electronic journals to the University of Toronto community via the Library's web pages. Some 60% of these journals have the full text of their articles available for viewing, printing, and in some cases emailing, by University of Toronto staff and students.

The Library is also committed to building a collection of electronic books in appropriate subject areas and has recently purchased a comprehensive collection of ebooks published by Springer from 2005 through 2007. As with electronic journals, these books are available online to all staff and students at the University.

SUPPORTING COLLECTIONS

Although the main life sciences collections are housed in the Gerstein Science Information Centre and the Noranda Earth Sciences Centre, graduate students in cell and systems biology can also make use of the large collection of life sciences materials held by the Library of the Royal Ontario Museum. Among other areas the Library collects books and journals related to botany, entomology, herpetology, ichthyology, invertebrate zoology, mammalogy, mycology, ornithology,

REFERENCE SERVICES

Given the cross-disciplinary nature of much of the research in the life sciences, and the increasing importance of electronic resources, including the World Wide Web, it is important to recognise that the reference and instructional services offered by the Library play a key role both in making our own collections accessible and in facilitating access to the national and international information networks. The Library is increasingly playing an important role in the linking of teaching and research in the university.

Reference services offered at the Noranda Earth Sciences Centre include help in searching the collection, the verification of citations, training in the use of databases and electronic journals, the searching of online and print union list files to locate materials not available on campus, and the handling of interlibrary loans. For some locations, e.g. CISTI, it is now possible to process transactions electronically thereby decreasing the time required to fill requests.

BUDGET AND COMMITMENT

The strength of the Library's financial commitment to purchasing material over the next five to seven years depends upon University policy and government funding. To date it has been the University of Toronto's stated policy to protect, as far as possible, the Library's acquisitions budget from rising costs and to maintain this protected status. This present financial policy allows the Library to maintain its current purchasing levels for publications relevant to cell and systems biology and ensures continued support for the programme.