The Senate of York University

Notice of Meeting

to be held at 3:00 pm. on Thursday, January 22, 2015
in the Senate Chamber, N940 Ross Building.

AGENDA

1. Chair's Remarks (*R. Mykitiuk*)

2. Minutes of the Meeting of December 11, 2014 1

3. Business Arising from the Minutes

4. Inquiries and Communications

5. President's Items (*M. Shoukri)*.....5

6. Committee Reports

   6.1 Executive (*G. Comninel*) 7

   a. Addition of a Convocation in Absentia

   6.2 Appeals (*V. Saradakis*) 11

   6.3 Academic Standards, Curriculum and Pedagogy (*L. Sanders*).....17

   a. Establishment of a BSc Program in Mathematical Biology, Department of Mathematics and Statistics, Faculty of Science (Appendix A, page 22)

   b. Establishment of a Co-Op Option for BEng and BSc Engineering Programs, Lassonde School of Engineering (Appendix B, page 100)

   c. Closure of the Certificate in Non-Profit Management, Department of Social Science, Faculty of Liberal Arts & Professional Studies (page 19)

   d. Closure of the General Certificate in Professional Ethics, Department of Philosophy, Faculty of Liberal Arts & Professional Studies (page 19)

   e. Change in the Name of the BA Program in Portuguese Studies, Department of Literature, Languages & Linguistics, Faculty of Liberal Arts & Professional Studies (Appendix C, page 109)

   6.4. Academic Policy, Planning and Research (*R. Pillai Riddell)*.....131

7. Other Business

M. Armstrong, Secretary

Consent Agenda (ASCP Item)

a. Granting of Degrees, Certificates and Diplomas (Convocation in Absentia), Appendix D, page 111

Senate documents prepared by the Secretariat have been checked for accessibility.

The Senate of York University

Minutes

of the meeting held at 3:00 pm on Thursday, December 11, 2014
in the Senate Chamber, N940 Ross Building, Keele Campus.

G. Comninel *Acting Chair*	D. Golemi-Kotra	D. Leyton-Brown	J. O'Hagan	L. Sossin
P. Amarasooriya	R. Hache	S. Ling	R. Owston	J. Spencer
M. Amin	M. Hamadeh	M. Lockshin	S. Pagiatkis	D. Spokiene
M. Armstrong *Secretary*	M. Hamaoui	L. Lum	B. Pilkington	B. Spotton Visano
S. Benchimol	C. Heidari	A. MacLennan	R. Pillai Riddell	N. Sturgeon
M. Biehl	B. Heron	G. Malfatti	A. Pitt	G. Tourlakis
K. Bird	C. Heron	M. Martel	I. Roberge *Acting Vice-Chair*	P. Tsasis
G. Brewer	V. Hildebrand	G. McFadden	K. Rogers	S. Tufts
S. Brixey	D. Hunt	J.J. McMurtry	M. Roy	A. Vianei
B. Crow	C. Innes	G. Mianda	L. Sanders	J. Warren
C. Davidson	D. Ipperciel	K. Michasiw	D. Scheffel-Dunand	R. Wellen
R. DeCosta	R. Irving	M. Milo	A. Schrauwers	S. Wood
P. Delaney	V. Jain	T. Moore	T. Shanahan	L. Wright
M. Derayeh	A. Khazak	J. Morrison	M. Shoukri	
K. Dowler	J. Kozinshi	D. Mutimer	J. Simeon	
J. Garrido	A. Kumarakrishnan	R. Myers	M. Singer	
J. Goldberg	R. Lenton	P. Ng	H. Skinner	

1. Acting Chair's Remarks

The Acting Chair, Professor George Comninel, thanked Senators for attending despite the inclement weather and conveyed regrets from the Chair. He introduced Professor Ian Roberge, a member of Senate Executive, who served as Acting Vice-Chair. Senators were informed that the ASCP report contained two formal recommendations, one of which was inadvertently omitted from the list of action items on the agenda page.

2. Minutes

It was moved, seconded and *carried* "**that Senate approve the minutes of the meeting of November 27, 2014**."

3. Business Arising from the Minutes

a. November Report to Senate of the Academic Policy, Planning and Research Committee

Senate Executive authorized resumed consideration of APPRC's November report to Senate for the express purpose of creating space for the further discussion of AAPR Academic Task Force recommendations and the development of an Institutional Strategic Directions document. Among the matters raised was the role of Senate in the development of the strategic directions plan. Provost Lenton, noting that the AAPR exercise was originally conceived as an outgrowth of the administration-focused PRASE initiative, confirmed that Senate would be asked to approve academic planning aspects of the document. This may take the form of "approval in principle" or "endorsement" subject to advice from Academic Policy, Planning and Research and Senate Executive.

Among other questions raised and matters addressed were the following:

- The reports and their scatter point renderings are publically available, and this could be deleterious to some programs. What was being done to mitigate harm? (Response: The plots are not intended to be and should not be interpreted as absolute values – they point to relative positions. Alignment with UAP priorities was a key aspect of the assessment, but the UAP does not address all of the enduring values, missions and strengths of the University. Assessments should not be understood as facilitating comparisons of programs, and collegial processes will give rise to a variety of actions.)
- The AAPR process is compromised by faulty methodologies, incomplete or inaccurate data and other flaws. It should not constitute a basis for academic priority-setting. (Response: The administration responded to earlier concerns by slowing the process, accepting Senate input, and ultimately embracing a made-in-York approach. The task force report represents a collegial assessment of PIFs based on all available data, data that Faculty planners would use in any planning scenario. If the data are incomplete or erroneous, they can be supplemented or clarified. It makes sense to use what is valuable from the exercise, and also to augment or enhance whenever it is necessary or desirable.)
- What is the status of the exercise and what is it designed to yield? (Response: With the release of task force reports there has been a return to the regular planning mode. The Deans and Principal will present their 3-year budget plan update, and they will work with colleagues on academic planning challenges and strategies. From 2009-2010, Faculty deficits have spread and grown. Meanwhile, across-the-board cuts have entailed severe challenges. The process was designed to spur innovative thinking.)
- What are the consequences of taking no action? (Response: There will be across-the-board budget cuts.)
- No planning exercise has had the granularity and breadth of data as AAPR at York. The information is useful for introspection and also in comparative perspective. The Faculty of Education has conducted a well-attended and Task Force-focused discussion involving four break-out groups; colleagues will drive going forward and discussions have already produced concrete projects.
- There is grave concern about the reliability of the Task Force reports. Moreover, programs have received no guidance on what to do to improve or how to prioritize. Conduct more research? Focus on better teaching? Move more curriculum online? There has been no feedback, unlike Cyclical Program Reviews which are designed to develop recommendations and to foster structured interactions. (Response: There is no set course of action. The process was designed to stimulate creative thinking based on self-awareness and peer assessment.)

4. **Inquiries and Communications**

a. Senators on the Board of Governors

A synopsis of the Board meeting of December 8, 2014 conveyed by Professor Angelo Belcastro and Professor David Leyton-Brown was *distributed and noted*.

b. Academic Colleague to the Council of Ontario Universities

Professor George Tourlakis presented the most recent Issues Update prepared by COU. In doing so he drew special attention to a new curriculum approval regime adopted by MTCU and the implications for York and other Ontario universities.

5. **President's Items**

President Mamdouh Shoukri reported on a positive visit to Turkey as part of a mission led by the Minister of Training Colleges and Universities to explore opportunities for research and teaching partnerships in that country. He also indicated that senior government officials have intensified their review of the funding formula for universities, and Dr Shoukri continues working to ensure that York is properly understood in this context as a comprehensive, research-focused institution. Universities continue to press for the funding of international PhD students, and Dr Shoukri expressed optimism that these efforts would have a positive impact. The University will also seek to capitalize on the federal government's science and technology initiative even though it may discount emerging and innovative areas while privileging some universities. Looking back on a memorable and significant year, the President pointed to numerous accomplishments and milestones.

With regard to academic planning in the current context, he assured Senate that its authority would be fully respected and that collegial input would be essential in the creation of an Institutional Strategic Directions document. The University was at a critical juncture, and challenges could only be overcome by working together.

6. Committee Reports

6.1 Executive

The Executive Committee provided a rationale for holding a meeting of Senate in December, which was to deal with business arising from the November meeting and to take up other time-sensitive matters.

6.2 Academic Policy, Planning and Research

a. Vice-President Research and Innovation's Autumn Report

Vice-President Research and Innovation Robert Haché presented his autumn report on research performance and major initiatives. External funding amounts have increased markedly in recent years and rankings demonstrate a growing recognition of the quality and impact of York research. Even so, research intensity has not reached the levels called for in the University Academic Plan and Strategic Research Plan and steps are being taken to promote a broad dialogue leading to concrete measures to boost intensification. In response to a question about why CIHR results had been excluded, Vice-President Haché explained that that Council was undergoing a transition and stressed that there are plans to position the University's health researchers for greater success.

b. Other Information Items

Academic Policy, Planning and Research shared a report from its Sub-Committee on Organized Research Units, urged Senators to participate in consultations conducted by the Task Force on Sustainability Research, and reported that it had approved the discontinuation of the York Ad Hoc Research Fund and the transfer of funding to the Faculties.

6.3 Academic Standards, Curriculum and Pedagogy

a. Establishment of a BSc Program in Psychology, Department of Psychology, Glendon

It was moved, seconded and *carried* "**that Senate approve the establishment of a BSc Program in Psychology, Glendon, effective Fall-Winter 2015-2016**."

b. Closure of the Master in Public Administration Program, Schulich School of Business / Faculty of Graduate Studies

It was moved, seconded and *carried* "**that Senate approve the closure of the Master in Public Administration (MPA) Program, housed in the Schulich School of Business, effective Fall-Winter 2015-2016**."

c. Information Items

By way of a correction to its previous report, Academic Standards, Curriculum and Pedagogy confirmed that it had agreed to a change in rubric for interdisciplinary Fine Arts courses from INFA to PANF. The Committee also reported that it had approved a series of minor modifications as follows:

Glendon

- a minor change to degree requirements for BA programs in Drama Studies, Arts, Media, Performance and Design

Faculty of Graduate Studies

- de-listing of the Diploma in Justice System Administration and the Diploma in Democratic Administration from the MPA program [diplomas will continue to be offered by the Masters in Public Policy, Administration and Law (MPPAL) program and the graduate program in Political Science respectively]

Health

- a minor change to degree requirements for the BA and BSc programs in Global Health

7. **Other Business for Which Due Notice Has Been Given**

a. Accommodation for Students on March 11, 2015

Documentation in the form of a motion authorized for consideration by Senate Executive and circulated prior to the meeting via the Senate listserv was *noted*. It was moved, seconded and *carried* "**that Senate declare March 11, 2015 a day of academic accommodation; and that all course directors be asked through the Deans/Principal to: avoid scheduling exams, tests, presentations or other work on that day and to establish reasonable extensions of deadlines for other graded work due that date and to provide reasonable academic accommodations to students who choose to attend the March 11, 2015 Day of Action, including reasonable alternative access to materials covered during their absence**."

8. **Other Business**

There being no further business, Senate adjourned.

George Comninel, Acting Chair _____

Maureen Armstrong, Secretary _____

DECEMBER 2014 – JANUARY 2015

DECEMBER

York U was honoured with a York West Centennial Citation, awarded to businesses, individuals and groups for ongoing and outstanding contributions to the people and communities of York West, from MP Judy Sgro.

School of the Arts, Media, Performance & Design student Eui Yong Zong won the $5000 Manulife Best Student Film Award for *Leftover*, a short drama about a North Korean refugee family living in Toronto.

Lassonde professor Andrew Eckford was one of seven finalists in the prestigious Bell Labs Prize competition, selected from almost 500 applicants in 30 countries. Professor Eckford's project, entitled "Small Talk: Molecular Communication for Medical Nanorobotics," explores the medical possibilities for being able to communicate with our bodies' cells.

This year York's Fall Recruitment event saw a 15 per cent increase in online student registration for the event and an 18 per cent increase in attendance compared to last year. The increases resulted in more than 4,300 visitors attending this year's event on the Keele campus.

A number of York University community members were among the 95 new appointees to the Order of Canada, including:

- Julia Foster, Chair, York University Board of Governors
- Susan McGrath, a professor in the School of Social Work
- Robert Cox, a professor emeritus in the Department of Political Science
- Edgar J. Dosman, a professor in the Department of Political Science
- And York alumni Michael DeGagné (LLM '10), Patrick Johnston (BA '73), Adèle M. Hurley (BA '74, MES '76), Barker Lawson (LLB '51), Robert Walters (BA '79, BSW '82, MSW '86), and Catherine Zahn (BSc '74).

Schulich professor Trina McQueen was honoured with the Special Jury Award of Distinction at the 2014 Women in Film and Television Toronto Crystal Awards.

David Phipps, Executive Director Research and Innovation Services, was appointed to the Association of Commonwealth Universities' (ACU) new Engage Community.

Osgoode professor Poonam Puri was appointed by Ontario's Minister of Finance as the expert adviser to assist with the review of the Credit Unions and Caisses Populaires Act, 1994.

Alumnus Albert Shin (BFA '06) won the $5,000 Scotiabank Jay Scott Prize for his feature film *In Her Place*, which received its world premiere at TIFF last fall.

Faculty of Science student Kiu Ming April Kong is one of six winners of the Genetics Society of America (GSA) Victoria Finnerty Undergraduate Travel Award. This award will allow her to travel to Chicago to present her research at the 56th annual Drosophila Research Conference.

JANUARY

Team Schulich defeated teams from 21 other Canadian graduate business schools to win the 2015 MBA Games. The MBA games are composed of both academic and athletic challenges.

Schulich Professor Don Thompson's latest book, *The Supermodel and the Brillo Box*, was listed as one of the best non-fiction books of 2014 by *Maclean's* magazine.

Adam Douglas, Head Strength and Conditioning Coach at York University, helped the Canadian Junior hockey team win their gold medal at the 2015 IIHF World Junior Championship.

Three students have won this year's Centre for Research on Latin America and the Caribbean (CERLAC) Michael Baptista Essay Prize for outstanding scholarly papers relevant to Latin American and Caribbean Studies:

- Undergraduate LA&PS student Jorge Villatoro won for his paper, "The Emergence of the Regional Cult of El Señor de Esquipulas."
- Osgoode graduate student Nadia Halum Arauz won for "Atahualpa's Legacy: Analyzing the Impact of Gold Mining on Peru's Campesino Community."
- Osgoode graduate student Jenna Meguid won for "Columbia's Peace Talks."

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EXECUTIVE COMMITTEE

Report to Senate
at its Meeting of January 22, 2015

FOR ACTION

1. Addition of a Convocation *In Absentia*

Senate Executive recommends

that Senate approve the addition of an annual Convocation *In Absentia* normally in February.

The idea of establishing a Convocation *In Absentia* emerged from discussions involving the Registrar and the Coordinating and Planning Sub-Committee of Academic Standards, Curriculum and Pedagogy earlier in 2014. The Registrar advised that an increasing number of students are completing their degrees at the conclusion of the Fall term and are requesting their parchments as soon as possible. In many cases, degrees are required for employment, education and immigration purposes.[1] Without the formal conferral mechanism of a winter convocation, students who finish their studies in December must wait until the Spring convocation to receive their parchments. This can create hardships and inconvenience.

Convocations *in absentia* will not require ceremonies. However, they will enable students to receive their parchments promptly. The omnibus convocation motion approved by Senate in September each year will stipulate that degrees, certificates and diplomas will be awarded at regular and *In Absentia* convocations during the year.

The Sub-Committee on Honorary Degrees and Ceremonials took up the matter, and supported its own recommendation to Senate Executive with this rationale:

> It is proposed that a convocation date be established annually in February, upon which students who have successfully completed all their degree requirements may obtain their parchment. Providing a Convocation in Absentia option would address the employment and immigration challenges students are increasingly encountering, and illustrate the University's desire and willingness to support them right through to the point of degree conferral. Setting the convocation date in February provides sufficient time for the Registrar's Office to confirm students' eligibility for graduation following the completion of the Fall term in late December. The recommendation has the full support of the University Registrar.

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1 In the past, letters issued by the Office of the Registrar confirming that students have completed degree requirements have been accepted for immigration and employment purposes. In recent years more rigorous documentation practices for students hoping to study and work abroad have been instituted, particularly by the United States. Such letters are no longer considered sufficient.

Several universities in Ontario have implemented a Convocation In Absentia option in February/March for the purpose of accommodating students who complete their degree by December/January. Western University and the University of Toronto are two examples. Reportedly the option works well and supports students' needs.

Legislative pathway

Proposed by Academic Standards, Curriculum and Pedagogy September 22, 2014
Approved by the Sub-Committee on Honorary Degrees and Ceremonials November 25, 2014
Approved by Senate Executive January 13, 2015

FOR INFORMATION

1. Approval of Senate Committee Members Nominated by Student Senators

Senate Executive has approved the following individuals nominated by student Senators to serve on the committees indicated:

Academic Policy, Planning and Research

Gayle McFadden
Houman Tahmasebi

The Committee thanks these Senators for serving on APPRC.

2. Renewal / Addition of Candidates for the Pool of Prospective Honorary Degree Recipients

In a confidential report from the Chair of the Sub-Committee on Honorary Degrees and Ceremonials, Professor Stan Tweyman, the Committee received a number of recommendations to include or extend the term of individuals in the pool of prospective recipients of honorary degrees. The Committee concurred with the recommendations and, as a result, sixteen individuals previously approved have been renewed for a further term while another twelve have been added to the pool.

Senate Executive urges Senators to nominate worthy individuals for honorary degrees and renews its special call for the nomination of women candidates and scientists. It also noted that, in light of the PanAm Games being held on the Keele campus in summer 2015, it is timely to consider nominees from throughout the Americas.

3. Approval of Faculty Council Membership for 2014-2015

Senate Executive is authorized to approve the membership lists of Faculty Councils annually (Senate rule VII. 3. c.). Based on recommendations of the Secretary, who is responsible for determining if memberships comply with Senate rules, the Committee has approved the lists of ten Faculty Councils. One list remains outstanding but will be reviewed shortly.

4. Working Group on Senate Membership

In May 2013 Senate approved changes to the composition of Senate along with new principles to guide future adjustments to seat distribution. See Appendix A for the current rules. With regard to

elected full-time faculty member seats, which are capped at 99, “each Faculty is entitled to a number of seats proportionate to their full-time faculty complement based on the most recently available authoritative data when calculations are made” and “no Faculty shall have fewer than four seats.” The legislation also requires Senate Executive to “review changes in structures, faculty complements and student enrolments every two years” with a view to determining if changes are necessary due to shifts in complement balance. If reallocations are necessary, they must be consistent with the new rules. The Committee has established a working group to conduct the mandated review. It will be composed of the Vice-Chair, George Comninel, Sonia Lawrence and Ian Roberge and supported by the Secretariat.

5. Thanks to David Cappadocia

The Committee was recently informed that student Senator David Cappadocia has resigned his seat on Senate Executive. David has been an active, valued colleague, making sterling contributions to University governance through his participation in the work of three standing Senate committees as well as the Search Committee that recommended Chancellor Sorbara to the Board of Governors. He has also served as the Co-Chair of the student Senator caucus since the autumn of 2013. David is nearing the completion of his PhD studies and will be devoting time to finishing his dissertation. We thank David for all he has done, and wish him well in his scholarly endeavours.

Roxanne Mykitiuk, Chair

Appendix A

Composition of Senate and Allocation of Seats
Rules as Amended in 2013

a) Senate shall have no more than 167 members distributed as follows:

i) members specified by the York University Act:

Chancellor
President and Vice-Presidents
Deans and Principal of Glendon
University Librarian
2 to 4 members of the Board of Governors (estimated as 2)

ii) 99 faculty members elected by Faculty Councils (except the Faculty of Graduate Studies) such that

- each Faculty is entitled to a number of seats proportionate to their full-time faculty complement based on the most recently available authoritative data when calculations are made
- no Faculty shall have fewer than four seats
- until June 30, 2015 only, Glendon shall have 8 seats
- departmentalized Faculties shall elect a minimum number of chairs and directors: Fine Arts 2, Glendon 1, Health 2, Lassonde 1, LA&PS 13, Science 2;
- 2 of the faculty members elected by LA&PS shall be contract faculty members

iii) 2 Librarians elected by Librarians

iv) 2 students for each Faculty as reported by Faculty Councils, except for the Faculty of Liberal Arts and Professional Studies which shall have 6 student seats

v) 1 member designated by the York Student Federation Association and 1 member designated by the Graduate Student Association

vi) the chairs of Senate committees who are not otherwise members of Senate (estimated at 5)

vii) other members:

- Chair of Senate, Vice-Chair of Senate, Secretary of Senate
- Academic Colleague to the Council of Ontario Universities
- President of the York University Faculty Association (or designated alternate)
- a member designated by the York University Staff Association (or designated alternate)
- a member designated by the Canadian Union of Public Employees of CUPE 3903 (or designated alternate)
- 2 alumni designated by the Alumni Association
- a non-Faculty College Master
- the Registrar, Vice-Provost Academic, and Vice-Provost Students

b) Senate Executive shall review changes in structures, faculty complements and student enrolments every two years and seats will be reallocated per rule a) ii as necessary.

c) These rules shall be published in section B of the Senate Handbook.

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Senate Appeals Committee

Report to Senate
at its meeting of January 22, 2014

FOR INFORMATION

1. Annual Student Appeals Statistics, 2013-14

In this annual report, the Senate Appeals Committee (SAC) describes its activities for the past year, and presents data on Senate and Faculty-level cases.

Between July 1, 2013 and June 30, 2014 the committee completed consideration of 88 files. The type of appeals filed and breakdown by Faculty remained much the same as in previous years, with late withdrawal accounting for half of petitions and appeals at the Faculty level, and 58% of the appeals to Senate, down from 72% in 2012-2013. The majority (79.5%) of Faculty-level decisions on appeals were upheld.

Table 1
SENATE APPEALS COMMITTEE CASE LOAD BY YEAR

Year	Cases
2008-2009	137
2009-2010	120
2010-2011	98
2011-2012	84
2012-2013	76
2013-2014	88

Table 2
OUTCOME OF CONSIDERATION BY YEAR AND DECISION

	2008-2009		2009-2010		2010-2011		2011-2012		2012-2013		2013-2014	
	G	D	G	D	G	D	G	D	G	D	G	D
Leave to Appeal of Faculty Decisions	12	107	19	86	8	81	19	65	20	53	24	63
Reconsideration of Leave To Appeal Decisions	3	15	3	12	1	8	2	9	0	12	3	15
Appeal Hearing Decisions	6	9	6	16	6	3	16	5	16	4	18	8

G=Granted D=Denied

Notes:
Where the decision on appeal is to refer a case back to the Faculty, it is counted as a granted appeal.
One case granted leave to appeal was withdrawn prior to the appeal hearing. In one case the appeal denied at hearing was reconsidered and granted on reconsideration.

Table 3
SENATE LEVEL APPEALS BY TYPE, YEAR AND NUMBER

Type of Appeal to SAC	2010-11 98 Appeals	2011-12 84 Appeals	2012-2103 76 Appeals	2013-2014 88 Appeals
Late Withdrawal	61	61	55	51
Reconsideration of SAC decision	9	13	11	19
Deferment	5	7	7	8
Academic Honesty	4	2	1	5
Waiver of Required Withdrawal / debarment/early lifting/ readmission	9	8	8	8
Grade Reappraisal	13	5	2	2
Late Enrolment	1	2	0	3
Other	12	4	1	6
Waiver of degree/program requirement		2	5	4

2. Annual Faculty-level Petition and Appeals Statistics, 2013-2014

In the past the year-end used in reporting petitions and appeals statistics has varied by Faculty. For the 2013-2014 report, the SAC has requested that all Faculties use a June 30, 2014 year end. For some Faculties this means the data covers more or less than 12 months, which is indicated in the footnotes to the table below. Beginning with the 2014-2015 report, all Faculties will be reporting on the July 1 to June 30 academic year.

As well, there were a number of changes to staff and to Faculty procedures over the last year, resulting in some difficulty in getting complete statistics for both petitions and appeals, as is noted in footnotes to Table 5.

Table 4
NUMBER OF FACULTY–LEVEL PETITIONS & APPEALS IN ENROLMENT CONTEXT
2010-2011 TO 2013-2014

Faculty	2010-2011 YU Enrolment: 54,237	2011-12 YU Enrolment 54,507	2012-13 YU Enrolment 54,590	2013-2014 YU Enrolment: 53,974
Education	134 Enrolment: 742	119 Enrolment: 650	125 Enrolment: 566	117 Enrolment: 580
Environmental Studies[1]	N/A Enrolment: 901	76 Enrolment: 850	74 Enrolment: 810	69 Enrolment: 643
Fine Arts/AMPD[2]	119 Enrolment: 3,015	213 Enrolment: 3,022	195 Enrolment: 3,024	147 Enrolment: 2,960
Glendon	292 Enrolment: 2571	335 Enrolment: 2,563	243 Enrolment: 2,535	257 Enrolment: 2,577
Graduate Studies		776 Enrolment: 5,198	904 Enrolment: 5,959	812 Enrolment: 5,905
Health	1,046 Enrolment:9,550	1,099 Enrolment: 9,752	1,296 Enrolment: 9,821	996 Enrolment: 9,960
Lassonde Engineering				246 Enrolment: 1,219
Liberal Arts and Professional Studies[1]	3,660 Enrolment: 24,837	3,910 Enrolment: 25,081	3,688 Enrolment: 24,962	4471 Enrolment: 24,081
Osgoode[3]	30 Enrolment: 920	51 Enrolment: 934	59 Enrolment: 934	104 Enrolment: 938
Schulich	252 Enrolment: 1,650	362 Enrolment: 1,641	393 Enrolment: 1,673	404 Enrolment: 1,730
Science	985 Enrolment: 4,045	876 Enrolment: 4,096	774 Enrolment: 4,297	638 Enrolment: 3,381

1. Environmental Studies and LA&PS Petitions only
2. AMPD report covers petitions September 1, 2013 - June 30, 2014
3. Osgoode report covers two years, July 1, 2012 - June 30, 2014.

Table 5
FACULTY-LEVEL PETITIONS AND APPEALS BY TYPE
FALL/WINTER 2013-2014

Type of Petition	AMPD	ED	FES	FGS	GL	HH	LAPS	LSE	OS	SSB	SC	Totals By Type
Late Withdrawal	70	1	39	34	190	543	2729	163		35	322	4126
Def/Supp Exam or paper	4	2	4	102		76	428	16	53	11	106	803
Waive Required Withdrawal/Debarment		26	2			152	395	28		66	21	691
Waive Honours Standing Requirement			3			77		2			1	83
Change of Status				255						14		269
Late Enrolment	12			3	27	15	110	8		74	12	261
Leave of Absence				278						59		337
Waive Degree/ Prog/ Gen Ed Requirement	49		2		4	24	497	11		11	7	606
Dept/Program Waiver		48	9	63	1	2					62	185
Other	1	14		68						72	15	166
Course Overload	8		6			20	82	11		6	22	155
Take/repeat additional credits to Upgrade GPA						26	186				8	220
Grade Reappraisal		2	2	3	3	1			51			62
Waiver of repeat course legislation			1		2	51	37	7		1		99
Waive deadline					24						42	80
Stop Out (BEd)		23										23
LOP	3		1			5	5				2	16
Pass/Fail Option					6	4	2				1	13
Financial Appeal (FGS)				6								6
External (FGS)												0
Delay Convocation (Bed)												0
Exemptions												0
Waive Required GPA											1	1
Take a Course out of Sequence										55		55
Waive Elective Requirement		1									2	3
TOTAL	147	117	69	812	257	996	4471	246	104	404	638	8261

Table 6
STUDENT ENROLMENT AND APPEALS BY YEAR

	2010-2011	2011-2012	2012-2013	2013-2014
TOTAL ENROLMENT	54,237	54,507	54,590	53,974
FACULTY PETITIONS AND APPEALS	7279	7766	7751	8261
%AGE OF STUDENTS PETITIONING	13.61%	14.25%	14.20%	15.30%
APPEALS TO SENATE	89	84	76	88
PERCENT OF FACULTY DECISIONS APPEALED	1.21%	1.08%	0.98%	1.07%

Table 7
APPEALS TO SENATE APPEALS COMMITTEE BY FACULTY OF ORIGIN

	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014
Education	**1**	**0**	**1**	**0**	**1**
Environmental Studies	**0**	**0**	**0**	**0**	**0**
Fine Arts/AMPD	**1**	**0**	**1**	**1**	**0**
Glendon	**8**	**10**	**11**	**3**	**6**
Graduate Studies	**7**	**4**	**1**	**0**	**2**
Health	**13**	**19**	**7**	**14**	**19**
Liberal Arts and Professional Studies	**48**	**40**	**35**	**35**	**43**
Osgoode	**8**	**3**	**3**	**1**	**2**
Schulich	**6**	**3**	**4**	**1**	**2**
Science	**13**	**10**	**22**	**20**	**13**

Table 7 is a source-Faculty breakdown of the SAC caseload in recent years.

3. Annual Faculty-level Academic Honesty Statistics, 2013-2014

SAC includes in its annual report, statistics on Faculty considerations of charges of breaches of academic honesty. The majority of cases involved plagiarism and the charges were generally resolved at the Faculty level, the majority at the exploratory meeting stage. The large increase at Schulich reflects a case where a large proportion of a particular cohort was caught collaborating across groups. For 2013-2014, there were 571 reported cases of breaches of academic honesty equal to 1% of the total student body at York (54,590 students). See Table 6. The number of appeals to SAC regarding academic honesty remains low and generally relate to appeals of the penalty rather than of the finding of a breach.

Table 8
ACADEMIC HONESTY CASES BY FACULTY
2009-2010 TO 2013-2014

Faculty	2009-2010 n=654	2010-2011 n=515	2011-2012 n=498	2012-2013 n=575	2013-2014 n=571
Arts, Media Performance & Design	9	19	46	12	**39**
Education[1]	3	2*	2*	3*	**0**
Environmental Studies	18	No data	25	26	**11**
Glendon	12	26	15	28	**23**
Graduate Studies	27	21	10	4	**23**
Health	85	44	11	66	**43**
Lassonde					**23**
Liberal Arts and Professional Studies	351	252	247	326	**254**
Osgoode	10	3	2	2	**2**
Schulich	15	32	16	15	**65**
Science	127	118	126	97	**88**

1.Corrected data is provided for the Faculty of Education, 2010-11 to 2012-13.

4. Committee Actions

The committee is working with the Senate Committee on Academic Standards, Curriculum and Pedagogy to changes to legislation regarding course withdrawals, with the aim to balance fairness to students and academic standards. The committees will also consider revisions to the Senate Appeals Committee Procedures to provide more clarity, particularly to student appellants, with an aim to finalizing the changes by the end of 2014-2015.

5. Hail and Farewell

The members of the Senate Appeals Committee and the support staff of the Secretariat would like to extend their thanks and appreciation to our departing members for their work on and commitment to, the Senate Appeals Committee this past year: Professors Ali Asgary, Jen Gilbert, Anne MacLennan, and Teresa Pryzbylski and our student members Sayjon Ariyarathnam, Jonathan Silver and Samuel Weiss.

A warm welcome is extended to new faculty members: Professors Othon Alexandrakis, Roopa Desai-Trilokekar, Petros Faloutsos and Valeria Tsoukanova, as well as new student members Alamgir Khandwala, Melinda Phuong and Ryan Robski.

Vivian Saridakis, Chair

The Senate of York University

COMMITTEE ON ACADEMIC STANDARDS, CURRICULUM AND PEDAGOGY

Report to Senate
at its meeting of 22 January 2015

FOR ACTION

I. NEW PROGRAMS

1. Establishment of a BSc Program in Mathematical Biology • Department of Mathematics & Statistics • Faculty of Science

The Committee on *Academic Standards, Curriculum and Pedagogy* recommends that Senate **approve the establishment of a BSc Program in Mathematical Biology to be housed in the Department of Mathematics & Statistics, Faculty of Science, effective FW 2015-16.**

Rationale
Documentation is attached as Appendix A. York's 2014-2017*Strategic Mandate Agreement* (SMA) with MTCU identifies health and applied science as emerging areas of significance for the University, and articulates plans to strategically develop programming in these fields. The proposed BSc program in Mathematical Biology, with Specialized Honours, Honours and Honours Minor options, contributes to the SMA goals. It is an interdisciplinary program that combines applied mathematics and the use of computational tools to understand biological processes. Mathematical modelling is an expanding area of research worldwide and, through its MITACS Centre for Disease Modelling, York is establishing its research strength in this field. The Centre will play a valuable role in the delivery of the Mathematical Biology program through collaboration, support of independent research projects and summer programs.

A small number of Ontario universities currently offer an option to pair the study of mathematics and biology within a degree program (Section 3.1 of the proposal), however York would be the first to offer a formal degree program in Mathematical Biology. A key feature of the program is the fourth year independent research project, for which students will partner with their supervisor on a specific application. None of the existing programs at other universities include this requirement. The BSc program is expected to be attractive to students as it offers career preparation for several fields, including public health, disease control, medical research and natural resource management. It also provides avenues for graduate studies in mathematical biology or mathematics programs for those who opt for advanced studies.

The Senate Committee has confirmed that the student learning outcomes of the program have been articulated and mapped to the requirements, and that the requirements are consistent with the pan-University BSc degree structure. Related programs within the Faculty of Science and the Faculty of Health were consulted and have confirmed their support for the new

program. The Dean and the Provost endorse establishment of the program for its complementarity with academic plans and research strengths, and have confirmed that the necessary resources are in place; their statements are included in the appended documentation.

The Senate Committee is pleased to recommend the approval of the new program.

Approved by: Science Council 11 November 2014 • ASCP 26 November 2014 • APPR 8 January 2015

II. MAJOR MODIFICATIONS

2. Establishment of a Co-Op Option for BEng and BSc Programs • Lassonde School of Engineering

The Committee on *Academic Standards, Curriculum and Pedagogy* recommends that Senate **approve the establishment of a Co-Op option within BEng Engineering programs and BSc Earth and Atmospheric Science programs housed in the Lassonde School of Engineering, effective Summer 2015.**

Rationale
For several years eligible students in the engineering programs at York have had the option to participate in the *Technology Internship Program* (TIP) offered in partnership with the University's Career Centre. Building on the success of that program, the Lassonde School of Engineering is proposing to establish a Co-Op option for all BEng Engineering programs and the BSc programs in Earth and Atmospheric Science. The detailed proposal is attached as Appendix B.

The Co-Op would be an option for students in good standing (5.0 GPA), but not a mandatory requirement for the degree program. A student's participation in the program is recorded on their transcript. It is structured to provide at least 12 months (up to 16 months) of paid employment over two work periods, interspersed with study. Participants will also be required to successfully complete two online 2-credit courses which interweave the practical experiences with classroom studies.

Co-Op options are increasingly common - and expected – features of university engineering programs. Student surveys indicate that the option of an engineering co-op program significantly influences University choice for more than half of all engineering students. Adding the option to Lassonde's programs maintains their competitiveness and sustainability. Lassonde projects that approximately 40 students will enrol in the option in the inaugural Su'15 session, increasing to a steady state of 100-150 (out of a 450 eligible students) once fully implemented. The program model is a cost-recovery one, with resources provided by the tuition fees for the two 2-credit co-op courses. Cost recovery is anticipated after approximately four years. The Career Centre will continue to facilitate the arrangements for the co-op program jointly with the Lassonde School.

Approved by: Lassonde Faculty Council 7 January 2014 • ASCP 26 November 2014

III. PROGRAM CLOSURES

3. Closure of the Certificate in Non-Profit Management • Department of Social Science • Faculty of Liberal Arts & Professional Studies

The Committee on *Academic Standards, Curriculum and Pedagogy* recommends that Senate **close the Certificate in Non-Profit Management offered by the Business & Society program within the Department of Social Science, Faculty of Liberal Arts & Professional Studies, effective FW 2015-16.**

Rationale
The certificate requirements consist of the following four courses housed in the Schulich School of Business:

SB/NPMG 3000 3.00
SB/NPMG 3200 3.00
SB/NPMG 4100 3.00
SB/NPMG 4300 3.00

In 2013 Schulich stopped offering each of the four required courses. The continuation of the certificate would require LA&PS to offer alternatives. In light of its fiscal constraints, low enrolments in the certificate program, and limited in-house disciplinary expertise in this scholarly area, the replacement of the lost courses by LA&PS is not a feasible option. The Faculty has decided to close the certificate and the Senate Committee concurs with the decision.

Approved by: LA&PS Faculty Council 11 September 2014 • ASCP 10 December 2014

4. Closure of the General Certificate in Professional Ethics • Department of Philosophy • Faculty of Liberal Arts & Professional Studies

The Committee on *Academic Standards, Curriculum and Pedagogy* recommends that Senate **close the General Certificate in in Professional Ethics within the Department of Philosophy, Faculty of Liberal Arts & Professional Studies, effective FW 2015-16.**

Rationale
The Department has reported that historically there has been low demand for the Certificate. On average only 1-2 students complete it each year. Moreover, most business degrees now include a course on professional ethics taught directly by the program, further reducing demand for the Certificate from the Faculty's professional programs. To that end, the Department has decided to close the Certificate. The Senate Committee concurs with the proposed closure.

Approved by: LA&PS Faculty Council 11 September 2014 • ASCP 10 December 2014

IV. PROGRAM NAME CHANGES

5. Change in the Name of the BA Program in Portuguese Studies • Department of Literature, Languages & Linguistics • Faculty of Liberal Arts & Professional Studies

The Committee on *Academic Standards, Curriculum and Pedagogy* recommends that Senate approve the **change in name of the BA program in Portuguese Studies to P*ortuguese and Luso-Brazilian Studies*, effective FW 2015-16.**

Rationale
As detailed in the proposal, attached as Appendix C, the new name better reflects:

- the breadth of the program's curriculum
- its mission to educate students about the Lusophone world, including its language, cultures and literary expressions;
- the program's goal of strengthening ties with the growing Brazilian communities in the GTA; and
- the Department's growing research and scholarly activities in Latin American & Caribbean Studies, and Brazil Studies

The new name has the support of the Department and the Faculty.

Approved by: LA&PS Faculty Council 9 October 2014 • ASCP 10 December 2014

CONSENT AGENDA

6. Granting of Degrees, Certificates and Diplomas (Convocation *In Absentia*)

The Senate Executive Committee is recommending to Senate the addition of a Convocation *In Absentia* option (Item 6.1 a). In anticipation of the approval of that recommendation, the Committee on *Academic Standards, Curriculum and Pedagogy* recommends that:

i) Senate authorize the granting of degrees at the University's Convocation *In Absentia* in February 2015 to those students who have fulfilled the degree program requirements and who have been recommended by the Councils of the Faculties and Colleges for receipt of the degrees listed in Appendix D;
ii) Senate authorize the forwarding of recommendations for certification by the Faculty of Education to the Ontario College of Teachers for those students who have been deemed "recommended for certification" by the Council of the Faculty of Education; and that
iii) Senate authorize the granting of diplomas and certificates at the University's Convocation *In Absentia* in February 2015 to those students who have fulfilled requirements and who have been recommended by the Councils of the Faculties for receipt of the diplomas and certificates listed in Appendix D.

FOR INFORMATION

1. New MTCU Program Approvals Process

In the discussion of the Council of Ontario Universities' Update at the December meeting of Senate, the Provost briefly spoke to the new MTCU process for program approvals. In addition to introducing target timelines for its review of program proposals, the Ministry has stipulated new evaluation criteria for program approval, and is requiring additional information for universities' Annual Program Development Reports to MTCU. The Vice-Provost Academic, Alice Pitt, briefed ASCP on the revised program approval process; a copy of the presentation slides is attached as Appendix E. The revisions carry significant implications for curriculum planning within Faculties and for the development of new programs. In the coming weeks, the *York University Quality Assurance Procedures* (YUQAP), which govern York's program approvals process, will be updated as necessary to incorporate the new MTCU criteria.

Vice-Provost Pitt will brief Senate on the new MTCU approval process at its meeting in January.

2. Minor Curriculum / Academic Standards Items Approved by ASCP

Minor modifications to degree requirements were made for the following:

Faculty of Liberal Arts & Professional Studies

- BA programs in German Studies
- BA programs in Italian Culture
- BA programs in Italian Studies
- iBA programs in LA&PS (Anthropology; Communication Studies; European Studies; French Studies; Geography; German Studies; History; Humanities; Italian Studies; Gender, Sexuality & Women's Studies; Political Science; Social Science; Urban Studies)

School of Arts, Media, Performance and Design

- BA and BA Minor Film programs: Cinema & Media Studies stream
- BFA Film program: Production stream
- BFA Film program: Screenwriting stream
- Honours Minor program in Computational Arts & Technology

School of Arts, Media, Performance and Design / Lassonde School of Engineering

- Specialized Honours BA program in Digital Media

Faculty of Science

- BSc programs in Environmental Biology

Leslie Sanders, Chair
Academic Standards, Curriculum & Pedagogy

New Undergraduate and Graduate Degree Program
New Program Brief Template

The development of new undergraduate and graduate degree programs follows the protocol for new degree approvals as outlined in the York University Quality Assurance Process and also complies with the Quality Council's Quality Assurance Framework.

The Program Brief for new degree programs that require full approval includes two components for undergraduate programs and three components for graduate programs, as follows:

- program proposal, including letters of consultation/support and other relevant appendices
- curricula vitae of the faculty, including program-specific appointment criteria (for new graduate programs only)
- external reviewer nominations

To ensure that all of the evaluation criteria are addressed in the proposal under development, program proponents are required to submit the New Program Brief in the following format.

York University

New Program Brief
of the
Bachelor of Science
in
Mathematical Biology

Submitted: August 2013
Revised: January 2015

1. Introduction

1.1 Provide a brief statement of the degree program(s) being proposed, including commentary on the appropriateness and consistency of the degree designation(s) and program name with current usage in the discipline or area of study.

We propose Specialized Honours, Honours Major and Honours Minor programs in Mathematical Biology. Mathematical Biology is a field of Applied Mathematics with a range of applications in biology. Studies in Mathematical Biology aim to represent biological processes using a variety of mathematical techniques and tools. It has applications in biology, epidemiology, immunology, virology, medicine, public health, chemistry, biochemistry, ecology and environmental science. Mathematical tools used to conduct studies in Mathematical Biology include dynamical systems, bioinformatics, geometry, imaging theory, stochastic modeling, numerical methods, statistics and probability.

Mathematical Biology has a long history, but recently this field has experienced an explosion of interest. Reasons for this include: the availability of large and rich datasets (genomics, increased sensitivity in laboratory and clinical tools), the development of robust mathematical tools that can be used to understand complex nonlinear systems, an increase in computing power (calculations, simulation and visualization can be easily accessed), and increasing interest in the computer simulation of biological mechanisms so that complications incurred in human and animal research (i.e. ethical considerations, cost, risk, unreliability, etc) are reduced.

The "Biology" component of this proposed program should be understood in a very general and broad sense to include, for example, chemistry, biophysics, cell biology, ecology, kinesiology, health sciences and bioinformatics. As such, this proposed program is expected to enhance the coordination and collaboration between the Department of Mathematics & Statistics and other units within the Faculty of Science and the Faculty of Health.

1.2 For graduate programs that wish to have a Quality Council endorsed field(s), please indicate the field(s) for each of the master's and PhD programs.
NA

1.3 Provide a brief description of the method used of the development and preparation of the New Program Brief, including faculty and student input and involvement.

The proposed program has been developed within the Applied Mathematics section in the Department of Mathematics & Statistics, and incorporates suggestions from the Statistics and Pure Mathematics sections. Input from the departments of Chemistry and Biology, and the Faculty of Health was solicited. Feedback was integrated into the proposal. Letters of support from these entities are attached.

The proposal development team determined the need and attractiveness of a program in Mathematical Biology. The team also determined a format which would best appeal to students. This was determined through discussion with some students majoring in both mathematics and biology at York University.

1.4 Indicate the Faculty/unit in which the program will be housed (for undergraduate programs) or anchored (for graduate programs).

The proposed program will be housed in the Department of Mathematics & Statistics within the Faculty of Science. This structure has been agreed upon by Biology, Chemistry departments and the Faculty of Health, since students will be taking some courses in these disciplines, but the majority of the degree program consists of mathematics courses. A program coordinator will lead administration of the program consistent with Appendix P of the YUFA Collective Agreement and the Mathematics & Statistics workload document. Initially, the Applied Mathematics coordinator will be responsible for coordination of the Mathematical Biology program. Feedback from Biology, Chemistry and the Faculty of Health on the program will be solicited in the early stages of the degree offering. Opportunities for feedback from Biology, Chemistry and the Faculty of Health in later years will also occur. Such feedback will provide for an enhanced multidisciplinary program for the students.

2. General Objectives of the Program

2.1 Provide a brief description of the general objectives of the program.

Mathematical Biology is concerned with the mathematical representation, treatment and modelling of biological processes, using a variety of mathematical techniques and tools. The main objective of the proposed program is to provide the foundational knowledge in mathematics and in the application of mathematics to biological processes. Individuals graduating from the program will have knowledge in biology, will be able to reduce a complex biological issue to a key question, determine an appropriate mathematical model to describe/reflect this biological process, analyze the model with mathematical theory and numerical methods, produce mathematical results, interpret the results in terms of the original biological question, and identify areas where the mathematical model can be refined and expanded.

2.2 Describe how the general objectives of the program align with University and Faculty missions and academic plans.

As outlined in the 2013 Strategic Research Plan and the 2010 University Academic Plan, York University is committed to supporting research and teaching and learning in interdisciplinary studies, in areas of study that support global health and sustainability. The 2010 White Paper, Canada's Engaged University: Strategic Directions for York University 2010–2020 includes a major focus on the expansion of teaching and research activities in the areas of medicine, health and applied sciences. This goal is also included in the President's December 2007 vision statement, and

previous documents, including the 1999 *Provostial White Paper* and the 1992 *Vision 2020* Green Paper. York University's recent Strategic Mandate Agreement with the Ministry of Training, Colleges and Universities also highlights "Healthy Individuals and Communities" as a program area for growth. A degree program in Mathematical Biology fits the foci of these documents, and contributes an avenue towards the establishment of a medical school, a goal of the York University community, as this program will aid in an increase in applied science and it will increase the status of York University in medical and health research.

Recently, MITACS (Mathematics for Information Technology and Complex Systems), a NCE centre, officially established the MITACS Centre for Disease Modelling (CDM) at York University. Although relatively new, the CDM has established itself as a leader in the use of biomathematics as a core tool for setting disease control policies and advancing public health capacity to detect and manage emerging crises in Canada and globally. This is clearly evident from contributions and involvement of the CDM at the national level, where modelling research outcomes provided clear and understandable information to help inform stakeholders and policy makers, and guide Canada's response to the 2009 H1N1 pandemic in times of uncertainty. The CDM has already attracted many researchers and students to York University, as well as external funding support and interdisciplinary collaboration opportunities with industry and government agencies. The CDM has been in full support of the development of an undergraduate program in Mathematical Biology. The CDM has communicated that CDM training and outreach programs will provide summer schools, internships and projects for senior students of this proposed undergraduate program in Mathematical Biology. Such undertakings have been common practice of the CDM. Recent summer schools held at York by the CDM have included a York University course credit component at the graduate level. A letter of support outlining this contribution from the CDM is attached.

The Department of Mathematics & Statistics has many faculty members with active research in Mathematical Biology and related areas (see Table 1, Section 7). Mathematical Biology has been identified as an area for growth in the department (departmental 5 year plan). A program in Mathematical Biology, thus, is in line with departmental strengths and objectives.

3. Need and Demand

More universities are opening programs in Mathematical Biology as enrolments/demands for these programs are increasing. Minisymposia focusing on undergraduate mathematical biology programs now exist at major international meetings in mathematical biology and applied mathematics in general. There is a great opportunity for York to initiate a program in the field of Mathematical Biology due to this general environment, the demand and our growing faculty strength in multiple disciplines.

This proposed degree program will elevate York's reputation in interdisciplinary research and training. It will attract and retain students, who would otherwise not consider York as an undergraduate university, and it will provide important connections to industry and government through our research courses and our future graduates. This program will attract a wide range of

students considering careers in mathematical, medical, biological or environmental research, academia, teaching, public health, public health policy, ecology (animal and plant), and practical medicine.

3.1 Identify similar programs offered at York and/or by other Ontario universities, with special attention paid to any innovative and distinguishing aspects of the proposed program.

There are no programs at York University similar to the proposed program in Mathematical Biology that integrates a range of mathematics and statistics with Biology, Chemistry and Kinesiology and Health Sciences. Mathematical Biology degree programs exist at other universities, however, there are very few in Canada, and these mainly exist at the graduate level (Appendix A). Undergraduate programs in Applied Mathematics with Biology or Life Sciences as an option for combination are offered at some Ontario universities: Waterloo, Western, McMaster, Wilfred Laurier. These programs, however, are not named degrees in Mathematical Biology. The undergraduate degree programs in Ontario that combine Biology and Mathematics requirements are outlined below.

University of Waterloo
Applied Mathematics/Biology Option
This program has the same course requirements as an Honours program in Applied Mathematics, and requires additional credits in Cell Biology and Genetics. The required component in Biology is low, with only 4 full courses needed. The specialization is only in Cell Biology. A final year thesis is not required.
http://ugradcalendar.uwaterloo.ca/page/MATH-Applied-Mathematics-or-Biology-Option

Western University
Applied Mathematics and Biology
Students interested in this area are advised to take a major in Applied Mathematics and a minor which incorporates Evolutionary Biology, Ecology and/or Genetics. One course, housed in the Applied Mathematics Department, “An Introduction to Mathematical Biology” is recommended.
http://www.apmaths.uwo.ca/ugradprogram.shtml

McMaster
Honours Biology and Mathematics
Enrolment in this program is on completion of Year 1 with a cumulative average of at least a C+. Enrolment is limited and is not guaranteed if the requirements are satisfied. The program requires 36 units of Biology, 6 units of Chemistry, 3 units of Life Sciences, 42 units Mathematics and Statistics, and 120 units total. The program does not require a final year project thesis.
http://registrar.mcmaster.ca/calendar/2012-13/pg1532.html

Wilfred Laurier
Honours BSc in Biology and Mathematics

The Honours BSc Biology and Mathematics program consists of a minimum of 20.0 credits, including at least 6.5 senior credits in each of Biology and Mathematics. Not more than 6.0 credits may be at the 100 level. This program does not require a fourth year thesis.
http://www.wlu.ca/calendars/program.php?cal=1&d=1038&p=2098&s=501&y=53

York University would have the fifth formalized degree program in Mathematics and Biology in Canada, but this degree would be the first to be granted as a degree in Mathematical Biology. There are advantages to a program with this name. For example, it carries the name of the field to which it applies, thus applicants interested in this field have an immediate program to apply to. Also, it has currency to a field that is exploding, and becoming a major field of international research, which will aid in program advertisement. Finally, if applicants have queries related to the application of Mathematics to Biology, the degree name can be easily searched by these individuals online, and thus, can provide a pool of applicants that might otherwise have been interested in applying to different programs, and other universities.

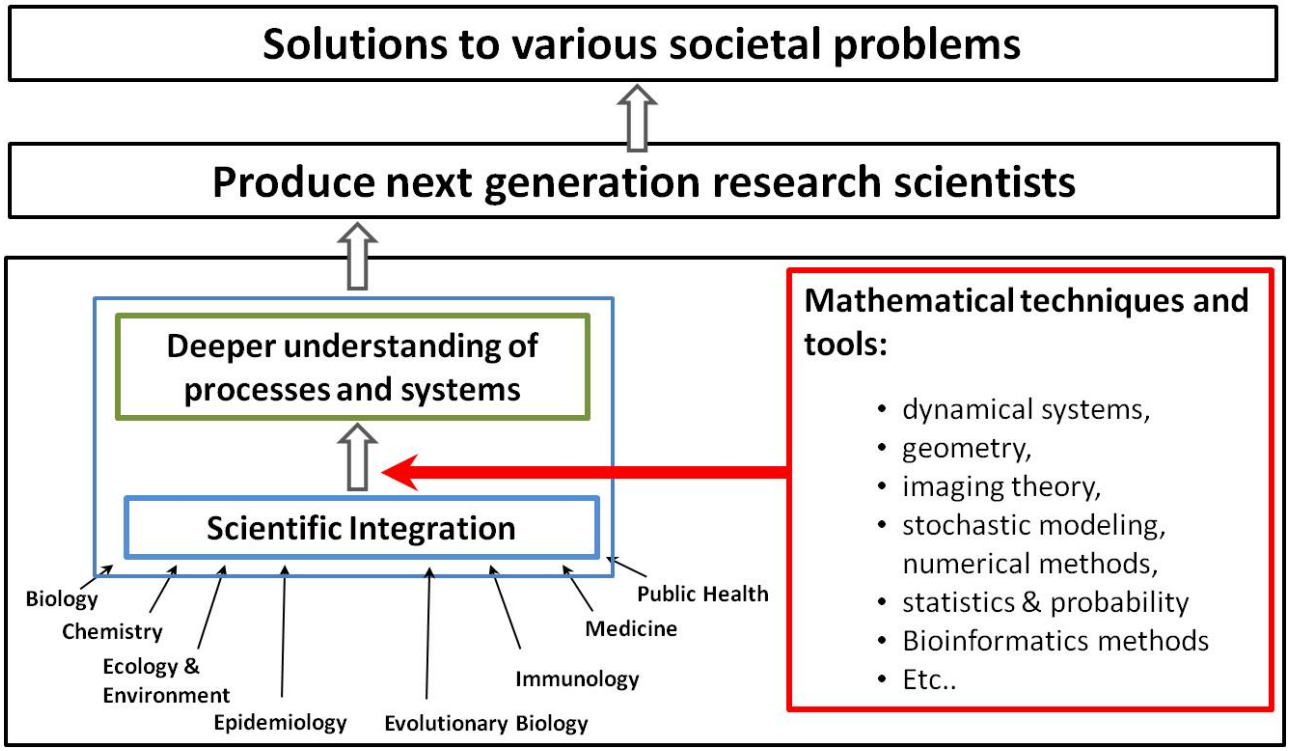
The Department of Mathematics & Statistics has one of the largest groups of researchers in Mathematical Biology in Ontario, and Canada (See Section 7.1 for more details). The Centre for Disease Modelling (CDM), a core group of researchers in disease modelling globally, is housed within this department and the York Institute for Health Research. This is a distinguishing aspect of the proposed program, in that no other Ontario program that combines mathematics with biology has contact/access to such a large group of researchers in Mathematical Biology.

An innovative and distinguishing aspect of the proposed program is that a fourth year research project is a requirement. This is not true for any other program in Ontario that combines Mathematics and Biology. It is through this course that students will truly 'experience' a Mathematical Biology project. Critical thinking and problem-solving skills are best learned in an environment of an independent research project. It is expected that this experience will enhance the marketability of York Mathematical Biology graduates. Plans to expand the fourth year project course to include co-op placements will further augment the marketability of the program graduates.

3.2 Provide brief description of the need and demand for the proposed program, focusing as appropriate on student interest, social need, potential employment opportunities for graduates, and/or needs expressed by professional associations, government agencies or policy bodies.

Solutions for 21st-century challenges involve complex systems that no single discipline can fully address. As many of the key problems are found in the biological sciences, future scientists must be ready to work in diverse settings in interdisciplinary collaborations. Mathematical Biology involves using mathematical techniques and computational tools to answer problems that arise in Biology. New and exciting challenges in the life sciences are now being met using mathematical modelling, which is having a direct impact on health, social and ecological aspects of modern life.

Figure 1: Role of Mathematical Biology from Research (in Academia, Government or Industry) to Society



Since 2003, various reports and peer-reviewed articles have been published on transforming undergraduate-level education for future research scientists. Notably the National Research Council of National Academics (Washington USA) recommended a new program that relies on integrating knowledge from many disciplines to derive deeper understanding of mathematical and biological systems [1-4]. As a result, programs in Mathematical Biology at the undergraduate and graduate levels have been emerging (Appendix A). However, there is still a need to develop more of these programs, especially at the undergraduate level, since the mathematical biology community is still quite small compared with the demands of the biosciences [5], especially with the recent emergence of the fields of Systems Biology and Mathematical Immunology. A program in Mathematical Biology at York University will aid in this respect.

An increasing demand for knowledge in mathematics within the medical sciences has also been recognized. Several US medical organizations already have mathematics as a medical degree requirement [6], and Canada will follow.

Government agencies have also recognized the usefulness of quantitative scientists within their ranks. In the field of public health and disease control and prevention, for example, the Public Health Agency of Canada (PHAC) recognizes the importance of modelling and has hired mathematical modellers for years. The recently established Public Health Ontario also houses mathematical modellers, and so does the BC Center for Disease Control (BCCDC) and various NRC Institutes. The US Center for Disease Control (CDC) and the World Health Organization (WHO)

also employ modellers. Other places where mathematical biologists have been employed and are in great demand include: major research hospitals, medical research centres, pharmaceutical companies, universities and colleges, intelligence agencies, the armed forces, natural resource management, the Ministry of the Environment and many other government agencies and ministries. A survey of Mathematical Biology programs in the United States of America shows close links and collaborations between these programs and many potential employers, including zoos and aquariums; National Parks services; Departments of transportation, land management and water treatment; research institutes; oil and gas companies; scientific consulting companies; cyber-security and security companies; electronics companies; and space and aeronautics research companies. Specific examples include: Mitre, NASA, Boeing, Metron and Philips. [7,8].

Interest in combining mathematics and biology has been seen by the proposal writing committee members over the past few years. Potential applicants to undergraduate programs have solicited advice, as well as undergraduate students majoring in mathematics and biology (with combinations of Major/Major, Major/Minor).

After Graduation

A recent study of careers that combine Mathematics with Biology [9] reports that Biomathematicians mainly work in careers in research and development services in human genetics, health care, pharmaceuticals and conservation. A recent report from the Bureau of Labor Statistics in the USA forecasts employment growth of 16% for all mathematicians, including biomathematicians, between 2012-2020 [10].

Mathematics and Applied Mathematics graduates have been successful in obtaining careers after graduation. It is expected that companies that hire Mathematics and Applied Mathematics majors are also likely to hire majors in Mathematical Biology. An advantage that a Mathematical Biology degree holder from York University will have over individuals with other Mathematics degrees, however, is that this individual will have had: training in interpreting the real world to mathematics and vice versa; hands on experiences with data; experience writing reports and giving presentations to individuals with mathematics, biology and other backgrounds; experience conducting their own mathematical modelling study on a current issue in the real world from start to finish. These are experiences/skills that will be seen as assets on a resumes and during interviews.

Following a BSc in Mathematical Biology, there will be many avenues for graduate study. The students shall have completed an Honours Degree in Mathematics, and shall have covered all the material included in general graduate examinations such as the Graduate Record Exam in Mathematics. As such they will be admissible to a number of graduate programs in Mathematics and Applied Mathematics in North America, as well as professional programs, such as an MBA, in which other Mathematics Majors currently enroll. Graduates from the Mathematical Biology program will also be admissible to graduate programs in Mathematical Biology globally. For other more specialized graduate programs, students may have to tailor their elective course selections to be fully prepared. They will also be well prepared for admission to interdisciplinary graduate programs.

The Mathematical Biology program will be attractive to students preparing for careers in medicine or public health. The program satisfies the requirements needed to prepare students for the MCAT and medical school. Also, higher education in mathematics is listed in the recommendations of most medical schools for admission, and is required by some [6,11], and mathematical modeling is listed as a recommendation to medical schools by the AAMC-HHMI Scientific Foundations for Future Physicians [12]. The program also prepares students well to contribute to public health studies and policy making.

Students preparing to work in ecology will also be attracted to York's program in Mathematical Biology. Such students will choose to focus the biology portion of this program in ecology courses including field work studies.

It has been identified within Ontario and other geographical regions that there is a need for educators for Mathematics and Sciences courses [13]. The Ontario curriculum identifies Modelling, Reflecting, Problem Solving, Representing and Communicating as important areas for high school education within Mathematics and the Sciences, which are areas of training in the Mathematical Biology degree. The Mathematical Biology program will be attractive to students preparing to complete a B.Ed. (concurrent or consecutive) to teach at the Intermediate/Senior (high school) level. Such a B.Ed. requires two subjects (disciplines) as 'teachable' subjects. We have ensured that the degree requirements will give students a mathematics teachable as well as ensure adequate room for courses in a second subject (18-24 credits), which could be Biology, Chemistry or Kinesiology and Health Science within the biology part of the Mathematical Biology degree. The minor below will also provide a second teachable in Mathematics for students majoring in another discipline.

We conducted a small survey of Ontario Universities to determine an interest level in Mathematical Biology related programs. Two universities were able to share enrolment data. Data from these two respondents show that at least 25 students are currently pursuing double degrees that combine mathematics with biology, chemistry or kinesiology. There are currently ten individuals that are pursuing major/major or major/minor degrees with mathematics and biology, chemistry or kinesiology at York University. Thus, there are at least 35 students at three Ontario universities pursuing degrees that lie within the field of Mathematical Biology. This limited sample speaks to a broad interest in Mathematical Biology in Ontario. It is expected that the program will have an intake of 20-35 students per year (see Section 8). This is comparable to other programs in Mathematics & Statistics.

There are other formalized degree programs in existence at York and at other universities that combine Biology with other fields at study. Biochemistry and Biophysics represent two such examples. At York, there are at least 70 students majoring in the Biochemistry Honours program and 20 majoring in Biophysics over all years of study. It is also important to note that there are over 500 applications to York University each year for degree programs in these fields. It is expected that a degree program in Mathematical Biology will increase the intake of students interested in studies that combine Biology with another area of Science.

4. Program Content and Curriculum

4.1 Describe the program requirements, including the ways in which the curriculum addresses the current state of the discipline or area of study. Identify any unique curriculum or program innovations or creative components.

The Mathematical Biology program requires students to complete a range of Mathematics and Statistics courses and courses in Biology, Chemistry, and/or Kinesiology and Health Sciences. Students will graduate as specialized Applied Mathematicians, with mathematical knowledge, and knowledge in the utility of applications of Mathematics to Biology, Chemistry, Kinesiology and Health Sciences.

The program is designed for both domestic and international students. Arrangements with selected international universities (eg. China and India, etc) will be explored as a mechanism for attracting top international students after the first years of program delivery.

As stated in Section 3, solutions for 21st-century challenges involve complex systems that no single discipline can fully address. Many of the issues society faces today stem from problems within Biology and the Life Sciences. Graduates from the program in Mathematical Biology will have the tools and knowledge that can be applied to answer questions in Biology and have a direct impact on health, social, and ecological aspects of modern life.

This new degree is in keeping with recommendations for transforming undergraduate programs to ones that integrate knowledge from many disciplines [1-4]. It is also in keeping with the observed and growing need for Mathematical Biologists [5].

The program structure has been chosen to provide flexibility to students. Students can choose an area of biology of interest (see suggested streams below), or can opt to generalize, taking courses in different areas. This is an attractive structure as it can accommodate students pursuing careers in Health, Biology, Ecology, Environmental Science, Biochemistry, Public Health and Medicine. Thus, it is expected that this program will attract a wide range of students considering careers in Mathematical, Medical, Biological or Environmental research, academia, teaching, public health, public health policy, ecology (animal and plant), and practical medicine.

The Specialized Honours and Honours Major programs require 60 and 48 credits in Mathematics courses respectively. Additionally they require 1000-level credits in biology, chemistry and computer science. The Specialized Honours program requires a further 15 credits in Biology courses, while the Honours Major may be completed either by taking a further 15 credits in Biology or by combining with a Minor in Biology or Kinesiology, in which case it is an Honours Major/Minor program. The Honours Major, when completed by taking the additional 15 credits in Biology, may be combined with any other Honours Major in an Honours Double Major program. The Honours

Minor must be combined with an Honours Major either in Biology or Kinesiology and requires the 1000-level credits in biology, chemistry and computer science, and 30 credits in Mathematics.

All students must meet the general requirements for a BSc program in the Faculty of Science (see Appendix B). Specifically, this includes the General Education and breadth requirements shared by the BSc programs in the Faculty of Science. To declare, proceed and graduate from the Honours program requires successful completion of all Faculty requirements and departmental required courses, a minimum cumulative credit-weighted grade-point average of 6.00 (B) over all Mathematics & Statistics (MATH), Biology (BIOL), and Chemistry (CHEM) and Computer Science (EECS) courses, and a minimum cumulative credit-weighted grade-point average of 5.00 (C) over all courses completed. If these requirements are not satisfied, students will be transferred to the Applied Mathematics BSc degree program. Mathematical Biology may only be a Minor in an Honours Major/Minor program if it is combined with an Honours Major BSc in Biology or Kinesiology and Health Science. Note that the minimum B (6.00) average is not required where Mathematical Biology is the minor in an Honours Major/Minor program. In this case, the minimum GPA is determined by Biology or Kinesiology and Health Science.

The GPA of 6.00 (B) over all required MATH, BIOL, and CHEM courses is required to continue in the Honours program as it is imperative that a student have a sound background in Mathematics and the area of application in order for the student to be successful in developing mathematical models describing biological processes in upper year courses.

Most courses that would be required for the degree program already exist. A new course in the third year MATH 32xx 3.0 Mathematical Biology will be required. A final year thesis course MATH 42xx 6.0 will be developed in the future when enrollments reach a critical mass where individual projects take more faculty time than the courses would. The new courses will boost the program's status significantly when they are fully implemented. In the meantime however, when the program is small, and with transfers from other programs courses such as Mathematical Modelling SC/MATH 4090 3.0 and the Individual Project Course SC/MATH 4000 6.0 (as long as the project includes an application in biology) may suffice.

A unique feature of this program, compared to other programs in Mathematical Biology, is that a 4th year project course is required. It is through this course that students will truly 'experience' a Mathematical Biology project. Critical thinking and problem-solving skills are best learned in an environment of an independent research project. Students will be partnered with supervisors in the Department of Mathematics & Statistics and will have one or more collaborators in their field of application, within the university or industry. As such, research projects will be current i.e. directly related to important questions in Mathematical Biology research areas. As part of this course, there will be some classroom training on scientific writing, a skill required for all jobs in academia, government and industry in Mathematical Biology. There are plans to expand the fourth year project course to include a co-op placement. Such an experience will further enhance the marketability of the Mathematical Biology graduates.

Apart from the 4th year thesis course, innovative teaching methods will be introduced in MATH 32xx Mathematical Biology, a required course for this degree program. Such innovative teaching methods include an emphasis on case studies and problem solving skills. Current research questions in Mathematical Biology will be discussed and addressed (this may lead to undergraduate research opportunities with professors in the Mathematics & Statistics Department, and their collaborators). Reflection papers, relating mathematical and computational techniques to problems in the Biological Sciences are also required. This will fulfill requirements to learn communication skills, describing mathematics and how it is applied. Communication skills will also be acquired through oral presentations, and written project proposals and final papers. Students in this course will also be given experience learning special software packages that are widely used in Mathematical Biology, using symbolic computation and numerical solutions (Maple, Matlab, Mathematica, Octave).

It is recognized that experiences in e-learining and e-collaboration (i.e. discussions and working in teams over the internet, for example) are important, as current work and research activities include discussion forums, working documents, conference call, and long-distance collaborations over the internet. An e-learning component in the Mathematical Biology program will include discussion forums between students and faculty on current research questions, and the development of information pages (wikis) that can be used as topic references. The fourth year project, depending on the research question and location of any collaborators, may also include some e-learning aspects. As the Mathematics & Statistics Department and York University adopt more e-learning tools, the Mathematical Biology program will also move towards more integration of such learning methods.

Course Requirements for Degrees Offered

Mathematics and Statistics Core:

SC/MATH 1021 3.0 Linear Algebra I
SC/MATH 1131 3.0 Introduction to Statistics I
SC/MATH 1200 3.0 Problems, Conjectures and Proofs
SC/MATH 1300 3.0 Differential Calculus with Applications
SC/MATH 1310 3.0 Integral Calculus with Applications
SC/MATH 2022 3.0 Linear Algebra II
SC/MATH 2030 3.0 Elementary Probability
SC/MATH 2310 3.0 Calculus of Several Variables with Applications

Summary: 24 credits of MATH

Required courses from the Faculty of Science, Lassonde School of Engineering, or Faculty of Health:

LE/EECS 1560 3.0 Computing in Mathematics & Statistics
SC/BIOL 1000 3.0, SC/BIOL 1001 3.0 Biology I and Biology II (or SC/BIOL 1010 6.0 Biological Science)
SC/CHEM 1000 3.0, SC/CHEM1001 3.0 Chemical Structure and Chemical Dynamics

And:

(1) Specialized Honours

A minimum of 15 additional credits at the 2000 level or higher from Biology with at least 9 credits from the 3000 level or higher.

(2) Honours Major

A minimum of 15 additional credits at the 2000 level or higher from Biology with at least 9 credits from the 3000 level or higher.

(3) Double Major, or Major in a Major/Minor Program

A minimum of 15 additional credits at the 2000 level or higher from Biology with at least 9 credits from the 3000 level or higher if Biology or Kinesiology is not the second major or minor

Or a minor in Biology

Or a minor in Kinesiology and Health Sciences

Summary: At least 27 credits

Additional Recommendation: One or more of

SC/PHYS 1010 6.0 Physics
Or SC/PHYS 1410 6.0 Physical Science
Or SC/PHYS 1420 6.0 Physics with Applications to Life Sciences
Or HH/KINE 2011 3.0 & 2031 3.0 Human Physiology 1 and Human Anatomy
Or ES/ENVS 1000 6.0 Earth in Our Hands: Introduction to Environmental Studies

All students registered in a Bachelor of Science (BSc.) program must complete a minimum of 12 non-science credits from at least two different departments. No more than 9 credits in one subject area will be counted towards the non-science requirement.

Note that students who complete additional credits from Biology, Kinesiology and Health Science or Chemistry may satisfy the requirements for a minor in that field in an Honours Major/Minor Program. An Honours Major/Minor with Mathematical Biology as the Major and another subject area other than Biology, Kinesiology, Environmental Science or Chemistry declared as the Minor is also permitted. Students may also complete a double major in Mathematical Biology and another field. Examples include: Biology, Chemistry, Physics, Kinesiology, etc. Students are encouraged to speak to an advisor if considering an Honours Double Major or Honours Major/Minor program.

SPECIALIZED HONOURS

SC/MATH 2001 3.0 Real Analysis
SC/MATH 2041 3.0 Symbolic Computational Lab I
SC/MATH 2270 3.0 Differential Equations
SC/MATH 3010 3.0 Vector Integral Calculus
SC/MATH 3241 3.0 Numerical Methods I

SC/MATH 32xx 3.0 Mathematical Biology
SC/MATH 3410 3.0 Complex Variables
SC/MATH 3050 6.0 Introduction to Geometries
or 3090 3.0 Computational Mathematics
or 3171 3.0 Linear Optimization
or 3172 3.0 Combinatorial Optimization
or 3242 3.0 Numerical Methods II
or 3260 3.0 Introduction to Graph Theory
or 3271 3.0 Partial Differential Equations
SC/MATH 42xx 6.0 Practicum in Mathematical Biology (SC/MATH 4000 6.0 may substitute*)
6 additional credits selected from:
SC/MATH 4090 3.0 Mathematical Modelling
SC/MATH 4170 6.0 Operations Research II
SC/MATH 4271 3.0 Dynamical Systems
SC/MATH 4430 3.0 Stochastic Processes
SC/MATH 4431 3.0 Probability Models

Summary: 24+36 (at least) credits of MATH + 3 EECS + 6 BIOL + 6 CHEM + at least 15 credits from BIOL at the 2000 level or higher

*SC/MATH 4000 6.0 may substitute for SC/MATH 42xx 6.0 ONLY if the project completed in SC/MATH 4000 included an application to biology

HONOURS MAJOR, DOUBLE MAJOR, or MAJOR in a MAJOR /MINOR PROGRAM.

SC/MATH 2041 3.0 Symbolic Computational Lab I
SC/MATH 2270 3.0 Differential Equations
SC/MATH 32xx 3.0 Mathematical Biology
SC/MATH 3090 3.0 Computational Mathematics
or 3171 3.0 Linear Optimization
or 3172 3.0 Combinatorial Optimization
or 3241 3.0 Numerical Methods I
or 3260 3.0 Introduction to Graph Theory
or 3271 3.0 Partial Differential Equations
SC/MATH 42xx 6.0 Practicum in Mathematical Biology (SC/MATH 4000 6.0 may substitute*)
6 additional credits selected from
SC/MATH 4090 3.0 Mathematical Modelling
SC/MATH 4170 6.0 Operations Research II
SC/MATH 4271 3.0 Dynamical Systems
SC/MATH 4430 3.0 Stochastic Processes
SC/MATH 4431 3.0 Probability Models

Summary: 24+24 credits of MATH + 3 EECS + 6 BIOL + 6 CHEM + at least 15 credits from BIOL at the 2000 level or higher OR a minor in Biology OR a minor in Kinesiology and Health Sciences

*SC/MATH 4000 6.0 may substitute for SC/MATH 42xx 6.0 ONLY if the project completed in

SC/MATH 4000 included an application to biology

Apart from the degree programs above, a minor in Mathematical Biology can be achieved. The minor in Mathematical Biology can only be combined with an Honours Major in Biology or an Honours Major in Kinesiology and Health Science.

HONOURS MINOR

SC/MATH 1021 3.0 Linear Algebra I
SC/MATH 1300 3.0 Differential Calculus with Applications
SC/MATH 1310 3.0 Integral Calculus with Applications
SC/MATH 2310 3.0 Calculus of Several Variables with Applications
SC/MATH 32xx 3.0 Mathematical Biology
6 additional credits from:
- SC/MATH 2022 3.0 Linear Algebra II
- SC/MATH 2030 3.0 Elementary Probability
- SC/MATH 2041 3.0 Symbolic Computational Lab I
- SC/MATH 2222 3.0 Linear Algebra with Applications II
- SC/MATH 2270 3.0 Differential Equations

3 additional credits from:
- SC/MATH 3090 3.0 Computational Mathematics
- SC/MATH 3171 3.0 Linear Optimization
- SC/MATH 3172 3.0 Combinatorial Optimization
- SC/MATH 3241 3.0 Numerical Methods I

6 additional credits from:
- SC/MATH 4090 3.0 Mathematical Modelling
- SC/MATH 4170 6.0 Operations Research II
- SC/MATH 4430 3.0 Stochastic Processes
- SC/MATH 4431 3.0 Probability Models
- SC/MATH 42xx 6.0 Practicum in Mathematical Biology (SC/MATH 4000 6.0 may substitute*)

EECS 1560 3.0 Computing in Mathematics & Statistics (or equivalent)

Summary: 30 credits of MATH + 3 EECS

*SC/MATH 4000 6.0 may substitute for SC/MATH 42xx 6.0 ONLY if the project completed in SC/MATH 4000 included an application to biology

Students may choose an area of application in biology, but are not required to do so. Examples include: Biochemistry and Molecular Biology, Cell Biology, Human Biology/Anatomy, Genetics/Molecular Genetics, Plant Science, Ecology, Epidemiology, Immunology, Virology, Biomechanics, etc. Students are advised to choose their 2000-level biology courses wisely, based on the prerequisites for the courses they wish to take at the 3000 level or higher. The program director and professors of the Mathematical Biology program will be provided with examples of

course choices within Biology, Chemistry and Kinesiology and Health Sciences that are among the streams listed. This is for counselling purposes.

In each year of the Mathematical Biology program there are courses that address each one of the UUDLES listed below. Key courses include MATH 1200, MATH 2030, MATH 2041, MATH 32xx, MATH 4090, MATH 42xx.

The modes of delivery of the required and suggested courses include: lecture formats, hands-on computer labs, interactive tutorials, internet-based discussion forums, and laboratory/discovery modules. The variety in course delivery is important for this program. Students graduating from this program will need to interact with individuals in other fields, perhaps perform some field work, employ computer techniques and programs, read the literature, learn from colleagues and give presentations or lectures (see UUDLES). An effective mathematical biologist will be able to perform these effectively (these are included in the assessment tools of the program courses), and will benefit from the experience of these delivery methods in their education.

With the exception of the Honours Minor, Mathematical Biology students are required to complete a project course MATH 42xx 6.0 in their final year of the program. This course includes researching the current literature, identifying a problem of study, determining key components of this problem, determining a model describing the problem at hand, analyzing the model, performing computer simulation, refining the model, writing progress and final reports and presenting results. The Mathematical Biology program will be the only program in the Mathematics & Statistics department where a fourth year project course is required. It is essential that students in an interdisciplinary program learn how to effectively apply their knowledge to their field of application (see UUDLES). MATH 42xx ensures that students have the opportunity to apply mathematical tools to an area of biology.

4.2 Provide a list of courses that will be offered in support of the program. The list of courses must indicate the unit responsible for offering the course (including cross-lists and integrations, as appropriate), the course number, the credit value, the short course description, and whether or not it is an existing or new course. For existing courses, the frequency of offering should be noted. For new courses, full course proposals are required and should be included in the proposal as an appendix. (The list of courses may be organized to reflect the manner in which the courses count towards the program requirements, as appropriate; e.g. required versus optional; required from a list of specified courses; specific to certain concentrations, streams or fields within the program, etc.)

See Appendix C for courses and descriptions

4.3 For undergraduate programs, comment on the anticipated class sizes. For graduate programs, comment on how the course offerings will ensure that each graduate student in the program will take a minimum of two-thirds of the course requirements from among graduate level courses.

Class sizes will vary from year 1 to year 4. It is expected that MATH 32xx and MATH 42xx will include the entire class cohort in that year of study (see Section 8). In situations where the course is also offered for other degree programs, the class size may be larger, ranging from 30–150 students, with the larger class sizes experienced in the first and second year of study, and smaller sizes in third and fourth year.

4.4 As an appendix, provide a copy of the program requirements as they will appear in the Undergraduate Calendar or Graduate Calendar, as appropriate.

See Appendix D for Calendar Copy

5. Program Structure, Learning Outcomes and Assessment

The intent of this section is to provide reviewers with an understanding of the knowledge, methodologies, and skills students will have acquired by the time they complete the program (i.e. the program learning outcomes), including the appropriateness of the program learning outcomes and how they will be supported and demonstrated. With that in mind, and with explicit reference to the relevant degree level expectations, it would be useful to focus on what students in the program will know and/or be able to do by the end of a defined period of time and how that knowledge, methodology and/or skill will be supported and demonstrated.

5.1 Provide a detailed description of the program learning outcomes and indicate how the program learning outcomes are appropriate and align with the relevant degree level expectations.

In keeping with the university level framework for B.Sc degree, this program incorporates all elements to insure it is in alignment with the degree requirements and degree level expectations.

Graduates in Mathematical Biology will be able to demonstrate:

- an understanding of the scientific method, experience in laboratory practices in Mathematics and the Biological Sciences
- a developed knowledge of and facility with mathematics, and computational methods and tools
- a developed knowledge of the breadth and depth of Mathematics and its uses
- a developed knowledge of the breadth and depth of Science, from Biology, Chemistry, Computer Science and Physics
- skills in critical thinking, reasoning, problem solving and reflection
- an ability to communicate orally, in writing, and through graphical methods
- an awareness of the needs and changing needs in the broad field of Mathematical Biology, and limitations of one's knowledge within it
- an awareness of current intellectual and ethical issues and challenges within the field of Mathematical Biology

A number of the standards and educational goals are shared with existing Mathematics and Statistics Programs. These standards and goals are:

- independent and critical reading, problem solving, and selecting appropriate problem solving techniques; (1200, 2030, 32xx, 42xx)
- conjecturing, reasoning and proving mathematical statements; (1200, 2030, 2270, 32xx, 42xx)
- reflecting on and monitoring their processes; (1200, 32xx, 42xx)
- selecting tools and computational strategies to solve problems and aid conceptual understanding; (1131, 2030, 32xx, 42xx)
- making connections among mathematical concepts; (1200, 2030, 2270, 32xx, 42xx)
- representing and modelling mathematical ideas in multiple forms: concrete, graphical, numerical, algebraic, and with technology; (1200, 2030, 2270, 32xx, 42xx)
- communicating conjectures, reasoning, connections, and problem solutions in clear and effective ways, orally, in writing, with visuals, and with models and technology. (1200, 32xx, 42xx)

With respect to learning objectives, upon completion of Mathematical Biology Degree, students should be able to:

Program learning outcomes

Degree Level Expectation	Program Learning Outcome The graduate of this program will:	Course Requirement that Fulfills Outcome
Breadth and depth of knowledge	Integrate relevant knowledge and pose questions across a wide range of basic mathematics, applied mathematics and statistics;	1st and 2nd year core, 32xx, 42xx, and additional course at 3000 and 4000 levels
	A sense of interdisciplinary perspective, an understanding of how these disciplines interact;	1st and 2nd year core, 2270, 3090, 3271, 32xx, 4090, 42xx
	Breadth and depth in the application of mathematics to Biology	32xx, 42xx
	Developed critical thinking and analytical skills	All required courses
Knowledge of Methodologies	Make connections among mathematical concepts	1st and 2nd year core, 32xx, 42xx and additional courses at 3000 and 4000 levels
	Make connections among mathematical concepts in areas of biological applications	32xx, 42xx

	Identify and construct appropriate models when solutions are needed 'as soon as possible' versus 'a future deadline' (simple vs complex and refined models) Identify appropriate methods for analyzing various types of data sets Learn new mathematical concepts, methods and tools from the literature, and texts and be able to apply them appropriately in biological contexts;	1300, 1310, 2030, 2270, 2310, 3090, 3171, 3172, 3241, 32xx, 4090, 4170, 4271, 42xx, 4431 1131, 2030, 32xx, 42xx 32xx, 42xx
Applications of Knowledge, Skills, and Tools	Apply a range of techniques effectively to solve problems in mathematics and statistics and in the applications of mathematics and statistics, including theory, deduction, approximation, and simulation, and present multiple pathways for a given problem; Construct, analyze, and interpret mathematical models for a variety of real-life problems, drawing on a wide range of areas of mathematics and a wide range of tools Use computer programs and algorithms: both numerical and graphical, to obtain useful approximate solutions to mathematical problems and to present and visualize numerical results and reasoning appropriately Collect, organize, analyze, and interpret results, involving mathematical patterns and structures Analyze data using appropriate concepts and techniques from statistics and mathematics Employ technology effectively, including computer software, to investigate open-ended problems and to illustrate mathematical and statistical concepts and solutions to these problems; Critically analyze a proposed argument in	1200, 2030, 32xx, 42xx 1300, 2310, 3090, 3170, 32xx, 4090, 4170, 42xx 1131, 2041, 3090, 3171, 3172, 3241, 32xx, 4090, 4170, 42xx 1200, 2030, 3090, 3171, 3172, 32xx, 4090, 42xx, 4170, 4271, 4431 1131, 2030, 32xx, 42xx 1131, 2041, 3090, 3171, 3172, 3241, 32xx, 4090, 4170, 42xx and LE/EECS 1560

	mathematics, provide counter examples, and develop a supporting argument for a statement at the appropriate level designed for an appropriate audience	1200, 2030, 32xx, 42xx, 4431
Communication Skills	Present conjectures and results Communicate mathematical and statistical concepts, models, reasoning, explanation, interpretation and solutions clearly and effectively in multiple ways and to audiences inside and outside of mathematics: oral presentations, written reports, visually and with physical models, and present explanations for selecting these methods	1200, 2030, 32xx, 42xx 1200, 2030, 3010, 3090, 3171, 3172, 32xx, 4090, 4170, 42xx
Limits of Knowledge	Awareness of limitations of mathematical models, and the inherent error in models dependent on the underlying assumptions made Awareness of the limitations and computational complexity of various numerical algorithms and applications, and uncertainty in computational methods Awareness of the limitations imposed by computer hardware restrictions and computational costs When discussing mathematics and its applications, the speaker should be aware of the inherent limitations and differences in knowledge between the speaker and the audience Aware that there are many important problems in Mathematical Biology that are unsolved, and may be unsolvable, but could be approximated	All required courses incorporate discussions here 1131, 2041, 3090, 3171, 3172, 3241, 32xx, 4090, 4170, 42xx and LE/EECS 1560 2041, 3090, 3241, 32xx, 42xx and LE/EECS 1560 3090, 3170, 3172, 32xx, 4090, 4170, 42xx 32xx, 42xx
Autonomy and Professional Capacity	Identify and describe some of the current intellectual and ethical issues and challenges within the fields of mathematics and statistics, the applications of mathematics and statistics and the learning of mathematics Identify and describe some of the current intellectual and ethical issues and challenges within the field of Mathematical Biology	All courses 32xx, 42xx

	Demonstrate professionalism, and be able to work independently and in groups	All courses
	Ability to manage personal challenges in learning and identify areas for growth	All courses
	Behaviour consistent with academic integrity and social responsibility	All courses

Proposed BSc Mathematical Biology degree structure and degree level of expectations

Year 1

Credit value	BSc specified requirements (applies to Honours and Specialized Honours)		Course relevance to program requirements
3.0	SC/MATH 1021	Linear Algebra I	Math & Stats core
3.0	SC/MATH 1131	Introduction to Statistics I	Math & Stats core
3.0	SC/MATH 1200	Problems, Conjectures and Proofs	Math & Stats core
3.0	SC/MATH 1300	Differential Calculus with Applications	Math & Stats core
3.0	SC/MATH 1310	Integral Calculus with Applications	Math & Stats core
3.0	SC/CHEM 1000	Chemical Structure and Chemical Dynamics	Required Laboratory requirement General Education
3.0	SC/CHEM 1001	Chemical Dynamics	Required Laboratory requirement General Education
3.0	SC/BIOL 1000	Biology I – Cells, Molecular Biology and Genetics	Required Laboratory requirement General Education
3.0	SC/BIOL 1001	Biology II – Evolution, Ecology, Biodiversity and Conservation Biology	Required Laboratory requirement General Education
3.0	LE/EECS 1560	Computer science	Required General Education

BSc degree level expectations at the end of year one:

Breadth and depth of knowledge: Students will acquire skills in the basic foundation of which mathematical modelling builds on: statistics, calculus, algebra, and mathematical reasoning. They will learn through their work that knowledge in one area of mathematics will aid in others.

Students will have begun to pose questions within their specific areas of course coverage, and expand to questions which are related to more than one. Through studies in mathematics and other disciplines, students will have begun to get a sense of how different science disciplines interact.

Knowledge of Methodologies: Students will be exposed to a range of mathematical and statistical tools and techniques which build the foundational tools for Mathematical Biology. Students will have experience determining appropriate methods for solving mathematical problems and 'word problems'.

Applications of Knowledge, Skills, and Tools: Students will apply mathematical tools and techniques to solve mathematical problems and 'word problems'. This includes written work, and work aided by computer programs.

Communication Skills: Students will have experience developing written and oral presentations of their solutions.

Limits of Knowledge: Students will discuss 'error' in mathematics and statistics. They will be exposed to methods of approximation, and discuss approximate versus exact solutions.

Autonomy and Professional Capacity: Students will be capable of carrying out individual work, and working in groups. Students will perform their studies in line with York's policy on academic integrity and social responsibility.

Year 2

Credit value	BSc specified requirements (applies to Honours and Specialized Honours)		Course relevance to program requirements
3.0	SC/MATH 2030	Elementary Probability	Math & Stats core
3.0	SC/MATH 2022	Linear Algebra II	Math & Stats core
3.0	SC/MATH 2270	Differential Equations	Math & Stats core
3.0	SC/MATH 2310	Calculus of Several Variables with Applications	Math & Stats core
3.0	SC/MATH 2041	Symbolic Computational Lab I	Required
6.0	SC/BIOL at 2000 level or higher		Required
6.0	Electives at 1000 level or higher	SC/CHEM 2020 6.0 or HH/KINE 2011 3.0 + HH/KINE 2031 3.0 or SC/PHYS 1010 6.0 or SC/PHYS 1410 6.0 or ENVS 1000 6.0	Electives

		*Note that CHEM 2020 6.0 is required for some 3000 and 4000 level courses in BIOL.	
PLUS			
3.0	Electives at 1000 level or higher		Elective for Honours Major
3.0	SC/MATH 2001	Real Analysis I	Required for Specialized Honours Major

BSc degree level expectations at the end of year 2:

Breadth and depth of knowledge: Students continue to build breadth and depth in knowledge in mathematics and statistics. Students continue to get a sense of the interdisciplinary nature of mathematics and how it can be applied to other fields in science. Students are further developing analytical skills and critical thinking through experiences in course work.

Knowledge of Methodologies: Students have a better understanding of mathematical methods and tools that can be used to model certain phenomenon in nature. Students have an understanding the methods of approximation, and why approximations are useful. Students have begun to learn how to pose questions in mathematics and how to assess the appropriateness of different mathematical tools to answer such questions.

Applications of Knowledge, Skills, and Tools: Students have had experience applying a range of mathematical tools, techniques and approximations to solve mathematical problems, and apply their skills to some real-world problems. Students have become familiar with some computational tools and have used them to investigate problems in mathematics and statistics, inspired by real-world problems.

Communication Skills: Students will have experience developing written and oral presentations of their solutions.

Limits of Knowledge: Students have experience with error calculations and have learned about approximations and when they are useful. Students have discussed limitations in mathematics linked to computational restrictions.

Autonomy and Professional Capacity: Students will be capable of carrying out individual work, and working in groups. Students will being to have the ability to manage their own learning in changing circumstances. Students will perform their studies in line with York's policy on academic integrity and social responsibility.

Year 3

Credit value	BSc specified requirements (applies to Honours and Specialized Honours)		Course relevance to program requirements
9.0	SC/BIOL at 3000 level or higher		Required
6.0	Electives at 2000 level or higher	SC/CHEM 2020 6.0 , or HH/KINE 2011 3.0 + HH/KINE 2031 3.0 recommended	Electives
3.0	SC/MATH 32xx	Mathematical Biology	Required
PLUS			
3.0	SC/MATH 3090 or SC/MATH 3171 or SC/MATH 3172 or SC/MATH 3241 or SC/MATH 3260 or SC/MATH 3271	Computational Mathematics Linear Optimization Combinatorial Optimization Numerical Methods I Introduction to Graph Theory Partial Differential Equations	Required for Honours Major
9.0	Electives at 2000 level or higher		Electives for Honours Major
3.0	SC/MATH 3010	Vector Integral Calculus	Required for Specialized Honours Major
3.0	SC/MATH 3241	Numerical Methods I	Required for Specialized Honours Major
3.0	SC/MATH 3410	Complex Variables	Required for Specialized Honours Major
3.0	SC/MATH 3050 or SC/MATH 3090 or SC/MATH 3170 or SC/MATH 3172 or SC/MATH 3242 or SC/MATH 3260 or SC/MATH 3271	Introduction to Geometries Computational Mathematics Linear Optimization Combinatorial Optimization Numerical Methods II Introduction to Graph Theory Partial Differential Equaitons	Required for Specialized Honours Major

BSc degree level expectations at the end of year 3:

Breadth and depth of knowledge: Students have acquired more knowledge in mathematics and their field of application. Student will have focus on Mathematical Biology in this year. Critical thinking and analytical skills are further tuned.

Knowledge of Methodologies: Students have learned methods within the mathematical and computational sciences that are commonly used in mathematical modelling. They will be able to associate certain methods with real-world problems.

Applications of Knowledge, Skills, and Tools: Students have developed the ability to collect, organize, analyze and interpret results. They have learned how to dissect a real-world problem, identify appropriate mathematical and computational methods, apply these methods correctly, and interpret the results.

Communication Skills: Students will have experience developing written and oral presentations of their solutions. They will have also have experience interpreting mathematical results to a scientific language that can be understood by scientists in other fields. Students will also have the opportunity to write reflections on issues within Mathematical Biology, and discuss their thoughts with their peers.

Limits of Knowledge: Students have discussed the limitations of mathematical models with respect to complexity in an underlying biological system, interpretation of biological problems to simple versus complex mathematical models, and error in results.

Autonomy and Professional Capacity: Students have the ability to manage their own learning in changing circumstances. Students are capable of carrying out individual work, and work in groups. Students have shown some initiative and ownership of their learning. Students will perform their studies in line with York's policy on academic integrity and social responsibility.

Year 4

Credit value	**BSc specified requirements** (applies to Honours and Specialized Honours)		**Course relevance to program requirements**
6.0	SC/MATH 42xx	Practicum in Mathematical Biology (SC/MATH 4000 may substitute)	Required
6.0	SC/MATH 4090 SC/MATH 4170 SC/MATH 4271 SC/MATH 4430 SC/MATH 4431	Mathematical Modelling Operations Research II Dynamical Systems Stochastic Processes Probability models	Required
18.0	Electives at 2000 level or higher such that total number of credits at 3000 level or higher is at least 42		Electives

BSc degree level expectations at the end of year 4:

Breadth and depth of knowledge: Students have developed detailed knowledge in mathematics and their field of application. Students will have developed critical thinking and analytical skills inside and outside their focus in Mathematical Biology. Students have the ability to learn in areas outside their discipline.

Knowledge of Methodologies: Students have learned methods within the mathematical and computational sciences that are commonly used in mathematical modelling. They are able to determine appropriate mathematical and computational methods for different biological problems. Students are able to comment on the particular aspects of current research and discuss areas for development.

Applications of Knowledge, Skills, and Tools: Students can properly identify appropriate mathematical and computational tools to apply to a problem of interest. Students can apply these methods correctly, interpret results in their fields of application, identify areas for further investigation, and critically evaluate their own solution, as well as, studies in the Mathematical Biology literature.

Communication Skills: Students have the ability to communicate their work and results to individuals inside and outside their field of study, using a variety of communication tools/media.

Limits of Knowledge: Students have gained an understanding of the limits to their knowledge. Students have an understanding of error and approximations, and are able to appreciate uncertainty and limits that these issues pose in Mathematical Biology. Students are able to identify limitations in their work, and in the Mathematical Biology literature.

Autonomy and Professional Capacity: Students have the necessary knowledge and skills to move on their field of study. Students have the ability to manage their own learning within and outside their field of study. Students are capable of carrying out individual work, and work in groups. Students have shown some initiative and ownership of their learning. Students have demonstrated academic integrity and honesty.

5.2 Address how the program curriculum and structure supports achievement of the program learning outcomes. For research-focused graduate programs, comment on the nature and suitability of the major research requirement(s) for degree completion. For undergraduate programs, comment on the nature and suitability of students' final-year academic achievement in the program.

See above

5.3 Address how the methods and criteria for assessing student achievement are appropriate and effective relative to the program learning outcomes and Degree Level Expectations.

Program courses are structured with varying modes of assessment i.e. assignments, tests, presentations, participation, computer demonstrations, reflection papers, projects. Students will

work as individuals and in teams. Upon program completion, Mathematical Biology students will have demonstrated that they are successful in individual and team work, when solutions are needed 'as soon as possible' versus 'a future deadline' (simple vs complex and refined models) .

5.4 For graduate programs, indicate the normal full-time program length (i.e. the length of time in terms in which full-time students are expected to complete the program) including a description of how students' time-to-completion will be supported and managed to ensure that the program requirements can be reasonably completed within the proposed time period. Indicate if the program will be available on a part-time basis, and, if applicable, explain how students' time-to-completion will be supported and managed to ensure that program requirements can be reasonably completed on a part-time basis.

NA

5.5 Describe the proposed mode(s) of delivery, including how it/they are appropriate to and effective in supporting the program learning outcomes.

The mode of delivery of the required and suggested courses include lecture formats, hands on computer labs, interactive tutorials, internet-based discussion forums, and laboratory/discovery modules. The variety in course delivery is important for this program. Students graduating from this program will need to interact with individuals in other fields, perhaps perform some field work, employ computer techniques and programs, read the literature, learn from colleagues, give presentations, and complete a final year research project (see UUDLES). An effective Mathematical Biologist will be able to perform these effectively (these are included in the assessment tools of the program courses), and will benefit from the experience of these delivery methods in their education. Breadth and depth of program requirements will be met by the variety in course delivery.

6. Admission Requirements

6.1 Describe the program admission requirements, including how these requirements are appropriately aligned with the program learning outcomes.

Applicants from Ontario Secondary Schools

- Ontario Secondary School Diploma
- MHF4U Advanced Functions, MCV4U Calculus and Vectors, SCH4U Chemistry and SBI4U Biology, with SPH4U Physics recommended

The admission requirements reflect the interdisciplinary nature of the Mathematical Biology program.

6.2 Explain any alternative requirements, if any, for admission into an undergraduate, graduate or second-entry program, such as minimum grade point average, additional languages or portfolios, along with how the program recognizes prior work or learning experience.

Students from alternate backgrounds and pathways are also encouraged to apply:

Applicants from Secondary School (not Ontario)

- Subject to meeting equilvalents to Ontario Secondary School admission requirements

Transfer with Other Mathematics Programs

The proposal includes the new core of all mathematics major programs, matching the revised B.Sc. Programs at York University. Students already pursuing a degree in mathematics as well as with a biological science may choose to switch their major to Mathematical Biology. Depending on their choices in the fourth semester they can still transfer in and out of other major programs in mathematics. During their third year, students can switch in, or out, of this program from/to Applied Mathematics with a minimum of additional courses.

7. Resources

7.1 Comment on the areas of strength and expertise of the faculty who will actively participate in delivering the program, focusing on its current status, as well as any plans in place to provide the resources necessary to implement and/or sustain the program.

The Department of Mathematics & Statistics has many faculty members with active research in Mathematical Biology and related areas. Table 1 (below) outlines the research and teaching areas of these individuals. Faculty members in Biology, Chemistry and Kinesiology and Health Science have been consulted and, apart from teaching courses in these subject areas, can participate in supervisory and collaborative roles on final year projects. Faculty within the Mathematics & Statistics Department already have collaborative projects with many faculty in these units, and thus, final year projects in the Mathematical Biology program can facilitate these projects.

Faculty members in the Department of Mathematics & Statistics are active supervisors of undergraduate research assistants within the Research at York, and NSERC undergraduate research award programs. As such, Mathematical Biology undergraduates will have opportunities to conduct research beyond the required fourth year thesis project.

7.2 Comment on the anticipated role of retired faculty and contract instructors in the delivery of the program, as appropriate.

Retired faculty and contract faculty teach courses within the Mathematical Biology curriculum. This is common practice of Mathematics & Statistics, Biology, Chemistry and Kinesiology and Health Sciences. The majority of courses will be taught by fulltime faculty, however. MATH 32xx will be taught by fulltime faculty with primary research area in Mathematical Biology.

7.3 As appropriate, identify major laboratory facilities/equipment that will be available for use by undergraduate and/or graduate students and to support faculty research, recent acquisitions, and commitments/plans (if any) for the next five years.

The majority of the courses in the program do not require laboratory space. Students have access to labs in Biology, Chemistry and Kinesiology and Health Sciences as part of their courses. No extra lab space is required. Within the Mathematics & Statistics offerings computer labs are utilized and available. The new course MATH 32xx will use computing facilities within the Mathematics & Statistics Department.

7.4 As appropriate, provide information on the office, laboratory and general research space available that will be available for faculty, undergraduate and/or graduate students; the availability of common rooms for faculty and graduate students; administrative space; as well as any commitments/plans (if any) for the next five years.

The program has no new requirements for space. Students will have access to laboratories and research space as part of their courses. Computing needs are well supported within the Mathematics & Statistics Department in the Gauss Lab located in Ross S110. This lab is maintained by IT technicians within the department. Students also have access to computer labs on campus, and can login to computing facilities remotely (http://computing.yorku.ca)

Administration of the program falls within the current structure of the Applied Mathematics section within the Mathematics & Statistics Department. Coordination of the program will require administrative release time once enrolments are confirmed into the fourth year level, and a program coordinator will be appointed. A new curriculum committee will be required immediately to continue development of the program. Individual faculty members in Mathematical Biology will need to offer additional advising for this pool of students.

The project course MATH 42xx 6.0 will require a course coordinator. Coordinating MATH 42xx 6.0 will count towards the teaching load. 15 to 25 students are projected for the final year of the Mathematical Biology program (see Section 8). This is similar to final year thesis courses in other science subjects (i.e. Biology, Chemistry, Biochemistry) that have a course coordinator. Note that MATH 4000 does not have a course coordinator. MATH 4000 is not a required course for any Mathematics & Statistics program. Therefore, it has a very small enrolment.

7.5 As appropriate, comment on academic supports and services, including information technology, that directly contribute to the academic quality of the program proposed.

Academic supports and services are available in the Mathematics & Statistics Department and the Faculty of Science. Students will be advised by the program coordinator and instructors and advisors at the Faculty level. To facilitate the program, a program website will be developed and

maintained. Course instructors may employ Moodle or other technological aids to facilitate course instruction and student engagement.

7.6 For graduate programs, indicate financial support that will be provided to master's and/or PhD students, including how this support will be sufficient to ensure adequate quality and numbers of students. Comment on how supervisory loads will be distributed, as appropriate. Special attention should be paid to supervisory capacity for new PhD programs.
N/A

7.7 For undergraduate programs, indicate anticipated class sizes and capacity for supervision of experiential learning opportunities, as appropriate.

Class sizes will vary from year 1 to year 4. It is expected that MATH 32xx and MATH 42xx will include the entire class cohort in that year of study (see Section 8). In situations where the course is also offered for other degree programs, the class size may be larger, ranging from 30–150 students, with the larger class sizes experienced in the first and second year of study, and smaller sizes in third and fourth year.

Students will be partnered with supervisors in the Department of Mathematics & Statistics in their final year project course MATH 42xx. Students will have one or more collaborators in their field of application, within the university or industry. A list of the faculty from Mathematics & Statistics whom will aid in delivery of the program is found in Table 1 (below). Collaborators in other departments, schools and industry are not listed as this list is continuously evolving.

Table 1 - Listing of Faculty

Mathematics & Statistics

Name	Rank	Home Unit	Area(s) of Specialization
Michael Chen	Associate Professor	Applied Mathematics	Operations Research Teaching: MATH 1021, MATH 3170, MATH 4170, MATH 42xx
Jorg Grigull	Associate Professor	Applied Mathematics	Bioinformatics, Computational Biology Teaching: MATH 2030, MATH 3090, MATH 4090, MATH 42xx, MATH 4431
Michael Haslam	Associate Professor	Applied Mathematics	Numerical Analysis, Scientific Computing, Computational Electromagnetics, Computational Fluid Dynamics, Special Functions Teaching: MATH 3090, MATH 42xx
Jane Heffernan	Associate Professor	Applied Mathematics	Mathematical Biology, Disease Modelling, Stochastic Simulation Teaching: MATH 32xx, MATH 4090, MATH 42xx

Huaxiong Huang	Professor	Applied Mathematics	Operations Research, Financial Mathematics, Mathematical Biology, Disease Modelling, Computational Biology Teaching: MATH 3090, MATH 3170, MATH 4090, MATH 4170, MATH 42xx
Dong Liang	Professor	Applied Mathematics	Computational Mathematics, Computational Biology Teaching: MATH 3241, MATH 3242, MATH 42xx
Neal Madras	Professor	Applied Mathematics	Probability, Mathematical Biology, Disease Modelling Teaching: MATH 2030, MATH 32xx, MATH 4090, MATH 4170, MATH 42xx
Seyed Moghadas	Assistant Professor	Applied Mathematics	Mathematical Biology, Disease Modelling, Agent Based Simulations Teaching: MATH 3090, MATH 32xx, MATH 4090, MATH 42xx
Tom Salisbury	Professor	Applied Mathematics	Probability, Brownian motion, Markov processes, Super Brownian motion, Actuarial finance` Teaching: MATH 1300, MATH 2310, MATH 42xx
EJ Janse Van Rensburg	Professor	Applied Mathematics	Bioinformatics, Monte Carlo simulations, Discrete Mathematics, Combinatorics, Statistical Mechanics Teaching: MATH 2022, MATH 2041, MATH 3242, MATH 42xx
Walter Whitely	Professor	Applied Mathematics	Geometry, Mathematical Modelling of Biological structures Teaching: MATH 3050, MATH 42xx
Man Wah Wong	Professor	Applied Mathematics	Analysis, Medical Imaging, Partial Differential Equations Teaching: MATH 3271, MATH 42xx
Jianhong Wu	Professor	Applied Mathematics	Dynamical System, Delay Differential Equations, Mathematical Biology, Disease Modelling, Mathematical Ecology Teaching: MATH 32xx, MATH 42xx
Hongmei Zhu	Associate Professor	Applied Mathematics	Analysis, Medical Imaging Teaching: MATH 3410, MATH 42xx
Huaiping Zhu	Associate Professor	Applied Mathematics	Dynamical Systems, Mathematical Biology, Disease Modelling, Modelling Environment and Ecology Teaching: MATH 2270, MATH 32xx,

			MATH 4090, MATH 42xx
Cindy Fu	Associate Professor	Statistics	Mixture Models, Statistical Genetics, Empirical Likelihood Teaching: MATH 1131, MATH 42xx
Xin Gao	Associate Professor	Statistics	Biostatistics, statistical genetics, bioinformatics, biostatistics, nonparametrics, large sample theory, statistical computing Teaching: MATH 1131, MATH 42xx
Hanna Jankowski	Associate Professor	Statistics	Medical Imaging, Bird migration Teaching: MATH 1131, MATH 42xx, MATH 4430
Wei Lui	Associate Professor	Statistics	Biostatistics Teaching: MATH 1131, MATH 42xx
Helene Massam	Professor	Statistics	Biostatistics Teaching: MATH 1131, MATH 42xx
Peggy Ng	Associate Professor	Statistics	Biostatistics Teaching: MATH 1131, MATH 42xx
Steven Wang	Associate Professor	Statistics	Cluster analysis, Bioinformatics Teaching: MATH 1131, MATH 42xx

8. Enrolment Projections

8.1 Indicate the anticipated implementation date (i.e. year and term of initial in-take), and provide details regarding the anticipated yearly in-take and projected steady-state enrolment target, including when steady-state will be achieved.

5 year enrolment projection

The anticipated implementation date of this program is FW 2015-2016. We anticipate some immediate transfers into the program, as soon as it is available, as it meets the needs of some students currently in other mathematics, biology, chemistry, and kinesiology programs. We also anticipate an increase in applications to York University when this program is initiated. This program will attract students who may not have considered York as a potential place for their university studies.

	Level I	Level II	Level III	Level IV	Total
Year 1	15	10*			25
Year 2	25	10	5		40
Year 3	29	15	7	2	52
Year 4	35	18	10	3	67

Year 5	38	22	13	5	77

*Based on the York University Fact Book and a query for number of Applied Mathematics majors and Applied Mathematics or Mathematics majors combined with a major or minor in Biology, Chemistry or Kinesiology and Health Science.

All other numbers are projections and are based on applied mathematics enrolments in Level I at York University, major/minor and double major combinations of applied mathematics or mathematics with Biology, Chemistry or Kinesiology and Health Science, retention rates in the Applied Mathematics program, and a small augmentation to these numbers based on the recruitment campaign planned for this program once it is approved.

Recruitment Campaign - Literature on the new program will be distributed at University recruitment fairs and Science fairs (i.e., Science Rendezvous), and faculty members involved in the program will be available to talk to potential students. Visits to secondary schools to give talks on Mathematical Biology, with topics chosen that relate to current and popular real world issues for these age groups will be conducted through the York University Science Speakers Bureau. Mathematical Biology will also be given a focus in the new Faculty of Science enrichment program for secondary school students, including one or more weeks of introductory courses on Mathematical Biology. A new website will also be professionally developed that will provide information to current and future students of the Mathematical Biology program, including possible streams of focus, career opportunities and research interests.

Student Life– When a critical mass of 3rd and final year students are in the program a York Mathematical Biology Club (MBC@York) may be developed. This club will be student run similar to other undergraduate clubs and it may have close ties to the CDM. Suggestions for club events include: every year, MBC@York and CDM will organize at least two events: MB Orientation (Introduction of Program requirements and Introduction to Graduate Study: this will have a senior student talking about their experience, MB Program coordinator talking about program requirement, Graduate Program talking about Graduate Admission, and a Guest speaker from neighbouring university); MB Excitation (Senior Undergraduate Students talking about their projects and internships, Faculty or their Postdoctoral fellows talking about current and future research opportunities; MB Program coordinator introducing national and international MB events for the coming summer; CDM distinguished lecture, followed by a general reception).

9. Support Statements

Attachments

- Statement of support from the dean
- Comment on resource implications from VP academic
- Statement from University Librarian

- Statement from the University Registrar
- Confirmations from interested programs that their comments have been solicited
    - We have approached Biology, Chemistry, The Faculty of Kinesiology and Health Science, and the Centre for Disease Modelling
- Estimate of demand for the program from the office of Admissions
- Supporting documentation from the consultative process

Appendix A

Mathematical Biology programs

(see references [14-16])

University	Location	Level
University of Leeds	UK	UG
University of Dundee	UK	UG, MSc http://www.dundee.ac.uk/undergraduate/courses/mathematical_biology.htm
University of Essex	UK	UG
University of Southampton	UK	UG
University of Nottingham	UK	G
University of Hertfordshire	UK	UG
Harvey Mudd	USA	UG
University of Michigan	USA	UG
Rutgers University	USA	UG
University of Delaware	USA	UG
Beloit College	USA	UG
Carnegie Mellon	USA	UG, G
SUNY Buffalo	USA	UG
SUNY Brockport	USA	UG
Case Western Reserve University	USA	UG
New Jersey Institute of Technology	USA	UG
Florida State University	USA	UG
University of Scranton	USA	UG
UC Davis	USA	UG
Loyola College in Maryland	USA	UG
University of Alberta	Canada	G
McGill	Canada	UG, G biology.mcgill.ca/undergrad/jointmajor_biolmath.html
UBC	Canada	G
University of Waterloo	Canada	UG, BMath App Math degree/Biol Option
McMaster	Canada	UG, Interdisciplinary program Hon BSc Biology and Mathematics
Western University	Canada	UG, Math and Biology Major
Wilfrid Laurier	Canada	UG, Hon BSc Biology and Mathematics

Quantitative Structure of the BSc Degree

Degree Option/Requirement	Minimum Credit Requirement
Minimum Number of Major or Minor Credits *(including, where applicable, iBSc options):*	
BSc Major	30 credits; including 12 credits at the 3000 or 4000 level
Specialized Honours Major Bsc	54 credits; including 18 credits at the 3000 or 4000 level, with at least 12 credits at the 4000 level
Honours BSc Major	42 credits; including 18 credits at the 3000 or 4000 level, with at least 12 credits at the 4000 level
Honours Double Major BSc	42 credits; including 18 credits at the 3000 or 4000 level, with at least 12 credits at the 4000 level
Honours Major/Minor Bsc	42 credits, including 12 credits at the 4000 level in the major and 30 credits, normally including 6 credits at the 4000 level, in the minor
Laboratory Requirement	
	6 credits from courses with laboratories at the 1000-level in any of the following areas: biology, chemistry and physics (Biology, Chemistry and Physics programs require 6 additional credits outside the major)
Upper Level Requirements	
90 credit BSc	18 credits at the 3000 or 4000 level including 12 credits in the major.
120 credit Specialized Honours BSc and Honours BSc degrees	42 credits at the 3000 or 4000-level. This includes the 18 credits at 3000 and 4000 level in the major and minor listed above.
General Education Requirements	
	27 credits in total as follows: • 12 credits in human enquiry outside of science disciplines. • 6 credits in math at the 1000 level (excluding remedial courses); • 3 credits in computer science at the 1000 level; and • 6 credits from courses with laboratories at the 1000-level in any of the following areas: biology, chemistry and physics.
Science Requirement Outside the Major Program	
90 Credit BSc	24 credits in science disciplines outside the major, of which 3 credits must be at the 2000 level or above, which may include: -science credits in the General Education requirements that are not in the major; and -science credits required by the major that are not in the major discipline.
120 credit Specialized Honours BSc and Honours BSc degrees *Not applicable to double major and major/minor programs.*	24 credits in science disciplines outside the major, of which 3 credits must be at the 2000 level or above, which may include: -the science credits in the General Education requirements that are not in the major; and -science credits required by the major that are not in the major discipline.
Residency Requirement	
	A minimum of 30 course credits and at least half (50 per-cent) of the course credits required in each undergraduate degree program major/minor must be taken at York University.

Appendix C

Course Descriptions

MATH 1021 3.00 FW
Linear Algebra I
Linear equations, matrices, Gaussian elimination, determinants and vector spaces. This course covers material similar to that in SC/MATH 2221 3.00 but at a more advanced level. Required in Specialized Honours statistics and in all applied mathematics, mathematics and mathematics for commerce programs except the BA Program in Mathematics for Commerce. Prerequisite: One 12U or OAC mathematics course or equivalent. Course credit exclusions: SC/MATH 1025 3.00, SC/MATH 2021 3.00, SC/MATH 2221 3.00, GL/MATH/MODR 2650 3.00.

MATH 1131 3.00 FW
Introduction to Statistics I
Displaying and describing distributions; relations in categorical data; Simpson's paradox and the need for design; experimental design and sampling design; randomization; probability laws and models; central limit theorem; statistical inference including confidence intervals and tests of significance; matched pairs; simulation. Prerequisite: At least one 12U mathematics course or OAC in mathematics is recommended. Course credit exclusion: SC/MATH 2560 3.00, GL/MATH/MODR 1610 3.00, SC/BIOL 2060 3.00. Prior to Fall 2009: Course credit exclusion: AK/AS/SC/MATH 2560 3.00.

MATH 1200 3.00 Y
Problems, Conjectures and Proofs
Extended exploration of elementary problems leading to conjectures, partial solutions, revisions, and convincing reasoning, and hence to proofs. Emphasis on problem solving, reasoning, and proving. Regular participation is required. Prerequisite: 12U Advanced Functions (MHF4U) or Advanced Functions and Introductory Calculus (MCB4U). NCR note: Not open to any student who is taking or has passed a MATH course at the 3000 level or higher.

MATH 1300 3.00 FW
Differential Calculus with Applications
Limits, derivatives with applications, antiderivatives, fundamental theorem of calculus, beginnings of integral calculus. Prerequisite: SC/MATH 1515 3.00 SC/MATH 1520 3.00 or SC/MATH 1710 6.00 or a high school calculus course. Course credit exclusions: SC/MATH 1000 3.00, SC/MATH 1013 3.00, SC/MATH 1505 6.00, SC/MATH 1513 6.00, SC/MATH 1530 3.00, SC/MATH 1550 6.00, GL/MATH/MODR 1930 3.00, AP/ECON 1530 3.00.

MATH 1310 3.00 FW
Integral Calculus with Applications
Transcendental functions, differential equations, techniques of integration, improper integrals, infinite series. Prerequisite(s): One of SC/MATH 1000 3.00, SC/MATH 1013 3.00, SC/MATH 1300 3.00, or SC/MATH 1513 6.00; or, for non-science students only, six credits from SC/MATH 1530 3.00 and SC/MATH 1540 3.00, SC/MATH 1550 6.00, AP/ECON 1530 3.00 and AP/ECON 1540 3.00. Course credit exclusions: SC/MATH 1010 3.00, SC/MATH 1014 3.00, SC/MATH 1505 6.00, GL/MATH/MODR 1940 3.00.

MATH 2022 3.00 W
Linear Algebra II
Inner product spaces, linear transformations, eigenvalues, diagonalization, least squares, quadratic forms and Markov chains. Similar to MATH 2222 3.00 but at a more advanced level. Required in Specialized Honours applied mathematics, Specialized Honours statistics and in all mathematics and mathematics for commerce programs except the BA program in mathematics for commerce. Prerequisite: one of SC/MATH 1021 3.00, SC/MATH 2021 3.00, GL/MATH/MODR 2650 3.00 or permission of the course coordinator. Course credit exclusions: SC/MATH 2222 3.00, GL/MATH/MODR 2660 3.00.

MATH 2030 3.00 FW
Elementary Probability
Introduction to the theory of probability as preparation for further study in either mathematical or applied probability and statistics. Topics include probability spaces, conditional probability, independence, random variables, distribution functions, expectation, Chebyshev's inequality, common distributions, moment-generating functions and limit theorems. Prerequisite: One of SC/MATH 1010 3.00, SC/MATH 1014 3.00, SC/MATH 1310 3.00.

MATH 2310 3.00 F
Calculus of Several Variables with Applications
Vector functions, partial derivatives, gradient, multiple integrals, line integrals, optimization, applications. Prerequisite: SC/MATH 1010 3.00 or SC/MATH 1014 3.00 or SC/MATH 1310 3.00. Students should have a knowledge of vector algebra in two and three dimensions. Course credit exclusions: SC/MATH 2010 3.00, SC/MATH 2015 3.00, GL/MATH/MODR 2670 3.00, GL/MATH 3200 3.00.

MATH 2001 3.00 F
Real Analysis I
Axioms for, and properties of, the real numbers; sequences; functions of a real variable, continuity, and differentiation. Rigorous definitions of convergence and limit underpin a proof-based treatment of the subject material. Intended for Honours students in Mathematics. Prerequisites: SC/MATH 1200 3.00, SC/MATH 1300 3.00. Course credit exclusion: SC/MATH 3110 3.00. NCR note: MATH 2001 3.00 is not open to any student who has passed MATH 1010 3.00

MATH 2041 3.00 F
Symbolic Computation Laboratory I
An introduction to symbolic computing in the Maple environment. Topics from single-variable differential and integral calculus, including simple ordinary differential equations, are covered. Both mathematical understanding and applications are emphasized. Three lecture hours, open laboratory hours. One term. Three credits. Prerequisites: SC/CSE 1540 3.00 (formerly COSC) or equivalent computing experience; SC/MATH 1010 3.00 or SC/MATH 1014 3.00 or SC/MATH 1310 3.00.

MATH 2270 3.00 W
Differential Equations
Introduction to differential equations, including a discussion of the formation of mathematical models for real phenomena; solution by special techniques; applications; linear equations; solutions in series; other topics if time permits. Prerequisites: One of SC/MATH 2010 3.00, SC/MATH 2015 3.00 or SC/MATH 2310 3.00; one of SC/MATH 1021 3.00, SC/MATH 1025 3.00, or SC/MATH 2221 3.00. Course credit exclusion: SC/MATH 2271 3.00, GL/MATH 3400 3.00

MATH 3010 3.00 F
Vector Integral Calculus
Integrability of continuous functions over suitable domains, iterated integrals and Fubini's theorem, counterexamples, change of variables, Jacobian determinants, polar and spherical coordinates, volumes, vector fields, divergence, curl, line and surface integrals, Green's and Stokes's theorems, differential forms, general Stokes's theorem. Prerequisite: SC/MATH 2010 3.00, or SC/MATH 2310 3.00; or SC/MATH 2015 3.00 and written permission of the mathematics undergraduate director (normally granted only to students proceeding in Honours programs in mathematics or in the Specialized Honours program in statistics). Prerequisite or corequisite: SC/MATH 2022 3.00 or SC/MATH 2222 3.00.

MATH 3050 6.00 Y
Introduction to Geometries
Analytic geometry over a field with vector and barycentric coordinate methods, affine and projective transformations, inversive geometry, foundations of Euclidean and non-Euclidean geometry, applications throughout to Euclidean geometry. Prerequisite: SC/MATH 2022 3.00 or SC/MATH 2222 3.00 or permission of the course coordinator.

MATH 3090 3.00 F
Computational Mathematics
Modelling (discrete and continuous, deterministic and stochastic) and practical solutions to general categories of applied problems. Case studies of solutions through modelling and representation of data. Implementation, numerical considerations, efficiency, and application of numerical algorithms. Three lecture hours per week. Prerequisites: SC/MATH 2022 3.00; SC/MATH 2030 3.00; LE/EECS 1560 3.00, or LE/EECS 2031 3.00 and SC/MATH 2041 3.00, or LE/EECS 1540 3.00 and SC/MATH 2041 3.00. Prior to Summer 2013: Prerequisites: SC/MATH 2022 3.00; SC/MATH 2030 3.00; SC/CSE 1560 3.00, or SC/CSE 2031 3.00 and SC/MATH 2041 3.00, or SC/CSE 1540 3.00 and SC/MATH 2041 3.00.Prior to Fall 2009: Prerequisites: AK/AS/SC/CSE 2031 3.00 or AK/AS/SC/CSE 1540 3.00 (formerly COSC), AK/AS/SC/MATH 2022 3.00, AK/AS/SC/MATH 2030 3.00, AK/AS/SC/MATH 2041 3.00.

MATH 3170 6.00 Y
Operations Research I
A study of linear programming; transportation problems, including network flows, assignment problems and critical path analysis; integer programming; dynamic programming and an introduction to stochastic models. Application to a set of problems representative of the field of operations research. Prerequisites: SC/MATH 1021 3.00 or SC/MATH 1025 3.00 or SC/MATH 2221 3.00; one of SC/CSE 1520 3.00, SC/CSE 1540 3.00 or SC/CSE 1020 3.00 or equivalent. Course credit exclusions: SC/MATH 2751 3.00, AP/ECON 3120 3.00, AP/ADMS 3331 3.00, AP/ADMS 3351 3.00, GL/MATH 3660 6.00.

MATH 3171 3.00 F
Linear Optimization
This course introduces students to linear optimization (linear programming), including the problem formulation, simplex method, LP-duality theory, sensitivity analysis, and its business and industrial applications. Three lecture hours per week. Prerequisites: SC/MATH 1021 3.00 or SC/MATH 1025 3.00 or SC/MATH 2221 3.00. Course credit exclusions: SC/MATH 2751 3.00, AP/ECON 3120 3.00, AP/ADMS 3331 3.00, AP/ADMS 3351 3.00, GL/MATH 3660 6.00, SC/MATH 3170 6.00.

MATH 3172 3.00 W

Combinatorial Optimization
This course introduces students to combinatorial optimization (integer programming), including problem formulation, branch-and-bound method, cutting-plane method, implicit enumeration, and its business and industrial applications, including transportation problem, network flow optimization etc. Three lecture hours per week. Prerequisites: SC/MATH 3171 3.00, SC/MATH 1021 3.00 or SC/MATH 1025 3.00 or SC/MATH 2221 3.00. Course credit exclusions: AP/ECON 3120 3.00, AP/ADMS 3331 3.00, AP/ADMS 3351 3.00, GL/MATH 3660 6.00, SC/MATH 3170 6.00.

MATH 3241 3.00 F
Numerical Methods I
(same as LE/EECS 3121 3.00)
An introductory course in computational linear algebra. Topics include simple error analysis, linear systems of equations, non-linear equations, linear least squares and interpolation. Prerequisites: One of SC/MATH 1010 3.00, SC/MATH 1014 3.00, SC/MATH 1310 3.00; one of SC/MATH 1021 3.00, SC/MATH 1025 3.00, SC/MATH 2221 3.00; one of SC/CSE 1540 3.00, SC/CSE 2031 3.00, or SC/CSE 2501 1.00. Course credit exclusion: SC/COSC 3121 3.00. Prior to Fall 2009: Prerequisites: One of AS/SC/MATH 1010 3.00, AS/SC/MATH 1014 3.00, AK/AS/SC/MATH 1310 3.00; one of AK/AS/SC/MATH 1021 3.00, AS/SC/MATH 1025 3.00, AK/AS/SC/MATH 2221 3.00; one of AK/AS/SC/CSE 1540 3.00, AK/AS/SC/CSE 2031 3.00 (formerly COSC), or SC/CSE 2501 1.00. Course credit exclusion: AK/AS/SC/COSC 3121 3.00.

MATH 3242 3.00 W
Numerical Methods II
(same as LE/EECS 3122 3.00)
Algorithms and computer methods for solving problems of differentiation, integration, systems of nonlinear equations and matrix eigenvalues. Prerequisite: SC/MATH 3241 3.00 or SC/CSE 3121 3.00. Course credit exclusion: SC/COSC 3122 3.00. Prior to Fall 2009: Prerequisite: AS/SC/MATH 3241 3.00 or AK/AS/SC/CSE 3121 3.00 or AK/AS/SC/COSC 3121 3.00. Course credit exclusion: AK/AS/SC/COSC 3122 3.00.

MATH 3260 3.00 W
Introduction to Graph Theory
Introductory graph theory with applications. Graphs, digraphs. Eulerian and Hamiltonian graphs. The travelling salesman. Path algorithms; connectivity; trees; planarity; colourings; scheduling; minimal cost networks. Tree searches and sortings, minimal connectors and applications from physical and biological sciences. Prerequisite: At least six credits from 2000-level mathematics courses without second digit 5.

MATH 3271 3.00 F
Partial Differential Equations
Partial differential equations of mathematical physics and their solutions in various coordinates, separation of variables in Cartesian coordinates, application of boundary conditions; Fourier series and eigenfunction expansions; generalized curvilinear coordinates; separation of variables in spherical and polar coordinates. Prerequisites: SC/MATH 2270 3.00; SC/MATH 2010 3.00 or SC/MATH 2015 3.00 or SC/MATH 2310 3.00; SC/MATH 3010 3.00 is also desirable, though not essential, as prerequisite for students presenting SC/MATH 2010 3.00 or SC/MATH 2310 3.00.

MATH 3410 3.00 W

Complex Variables
Analytic functions, the Cauchy-Riemann equations, complex integrals, the Cauchy integral theorem, maximum modulus theorem. Calculations of residues and applications to definite integrals, two-dimensional potential problems and conformal mappings. Prerequisite: SC/MATH 2010 3.00 or SC/MATH 2015 3.00 or SC/MATH 2310 3.00. (SC/MATH 3010 3.00 is also recommended as a prerequisite for students who have taken SC/MATH 2010 3.00.) Course credit exclusion: GL/MATH 4230 3.00.

MATH 4000 3.00 FW and 6.00 Y
Individual Project
A project of a pure or applied nature in mathematics or statistics under the supervision of a faculty member. The project allows the student to apply mathematical or statistical knowledge to problems of current interest. A report is required at the conclusion of the project. Prerequisites: Open to all students in Honours programs in the Department of Mathematics and Statistics. Permission of the program director is required. Applied mathematics students can enrol only after they have completed the core program in applied mathematics.

MATH 4090 3.00 W
Mathematical Modelling
Discrete, continuous and probabilistic modelling of problems from industry, finance and the life and physical sciences. The ability to model complex problems is stressed. Three lecture hours. One term. Three credits. Note: Registration required in an Honours Program in Mathematics and Statistics, and the completion of all specified core courses in that program.

MATH 4170 6.00 Y
Operations Research II
(same as GS/MATH 6900 3.00 plus
GS/MATH 6901 3.00)
Selected topics from game theory, decision theory, simulation, reliability theory, queuing theory, nonlinear programming, classification, pattern-recognition and prediction. Each chapter contains an optimization problem and methods and algorithms for solving it. The course is rich in examples. Prerequisites: SC/MATH 2010 3.00 or SC/MATH 2015 3.00 or SC/MATH 2310 3.00; SC/MATH 2030 3.00; SC/MATH 3170 6.00; or permission of the course coordinator. Course credit exclusion: AS/MATH 4570 6.00.

MATH 4271 3.0 W
MATH 3270 3.0 - before 1998/99
Dynamical Systems
Iterations of maps and differential equations; phase portraits, flows; fixed points, periodic solutions and homoclinic orbits; stability, attraction, repulsion; Poincaré maps, transition to chaos. Applications: logistic maps, interacting populations, reaction kinetics, forced Van der Pol, damped Duffing, and Lorenz equations. Students who have not passed MATH 3210 must obtain permission of the instructor to enrol. Prerequisite:AS/SC/MATH 2021.03 or AS/SC/AK/MATH 2221.03 or AS/SC/MATH 1025.03; AS/SC/AK/MATH 2270.03. Exclusion:AS/SC/AK/MATH 3270 3.0

MATH 4430 3.0 W
Stochastic Processes
Basic stochastic processes, including Markov chains, Poisson processes, and birth-death processes. Topic from queues, renewal processes, stationary processes, Brownian motion.

Prerequisite:AS/SC/AK/ MATH 2030 3.0.

MATH 4431 3.0
Probability Models
This course introduces the theory and applications of several kinds of probabilistic models, including renewal theory, branching processes and martingales. Additional topics may include stationary processes, large deviations from the sciences. Prerequisite:AS/SC/AK/ MATH 2030 3.0.

Proposed new courses

MATH 32xx 3.0
Mathematical Biology I (see attached new course proposal)
This course will introduce the student to mathematical modelling with applications in biology in related fields such as chemistry, ecology and health. There is an emphasis on case studies and problem solving skills. Topics include discrete and continuous models describing population dynamics (i.e. logistic model, predator prey), population health, chemical reactions and biological structures. This course is required for the Honours Specialist, the Honours Major, Double Major and Major in a Major/Minor program. It is also listed as a course choice in the Honours Minor requirements. Prerequisites: Registration in an Honours Program in Mathematics and Statistics and the completion of all specified core courses in that program or permission of the instructor.

MATH 42xx 6.0
Practicum in Mathematical Biology
(MATH 4000 will suffice until there is a significant enrolment in the Mathematical Biology program. The MATH 4000 project must include application to biology to substitute for MATH 42xx. No new course proposal is attached here.)
Students in the Honours Specialist, the Honours Major, Double Major and Major in a Major/Minor program in the Mathematical Biology program are required to complete a practicum project in mathematics applied to an area in a biological science. This course is listed as a course choice in the Honours Minor requirements. The student works under the supervision of a faculty member in mathematics on a topic a field of application (Biology, Chemistry or Kinesiology and Health Science). These topics may be provided by faculty members in Biology, Chemistry or Kinesiology and Health Science. These faculty members will also have the opportunity to supervise the project if they are interested. A report is required at the conclusions of the project as well as a presentation. The amount of work expected of the student is approximately 10 hours per week. The supervisors are expected to spend about one or two hours per week with the student (together or individually) average over the duration of the project. In addition to the final report, a mid term progress report is required during the course. The final grade will be based upon the final report as well as the interim progress reports. Prerequisites: Open to all students majoring in a Mathematical Biology program who have completed the 3rd year requirements. This course is required for students in the Honours Specialist, the Honours Major, Double Major and Major in a Major/Minor program in Mathematical Biology. However, SC/MATH 4000 6.0 may be used as a substitute if SC/MATH 42xx is not offered.

Named Courses which are not MATH courses
LE/EECS 1560 3.0
Introduction to Computing for Mathematics and Statistics

An introduction to scientific computing using an integrated computing and visualization environment. The course presents computer-based problem-solving techniques through a series of applications rooted in Mathematics and Statistics. Two lecture hours per week and one weekly three hour laboratory session. Prerequisite: SC/MATH 1300 3.00: Corequisites: SC/MATH 1310 3.00; SC/MATH 1131 3.00. Prior to Fall 2009: Prerequisite: AK/AS/SC/MATH 1300 3.00; Corequisites: AK/AS/SC/MATH 1310 3.00; AK/AS/SC/MATH 1131 3.00. Course credit exclusion: LE/EECS 1541 3.00, LE/SC/CSE 1541 3.00, LE/EECS 1570 3.00, LE/SC/CSE 1570 3.00. NCR Note: This course is not open to any student who has passed or is taking SC/PHYS 2030 3.00.

SC/CHEM 1000 3.0
Chemical Structure
Introduction to chemistry with emphasis on physical and electronic structure of matter, including gases, liquids and solids. Topics include behaviour of gases; thermochemistry; atomic structure and periodic table; chemical bonding and architecture; structure of liquids and solids; frontiers of chemistry. Two and one-half lecture hours per week, one tutorial hour per week, six three-hour laboratory sessions. One term. Three credits. Prerequisites: OAC chemistry, 12U chemistry or SC/CHEM 1500 4.00 or equivalent. Course credit exclusions: SC/CHEM 1000 6.00, SC/CHEM 1010 6.00.

SC/CHEM 1001 3.0
Chemical Dynamics
This course complements SC/CHEM 1000 3.00 - with emphasis on chemical change and equilibrium. Topics include chemical kinetics; chemical equilibrium; entropy and free energy as driving forces for chemical change; electrochemistry; frontiers in chemistry. Two and one-half lecture hours per week, one tutorial hour per week, six three-hour laboratory sessions. One term. Three credits. Prerequisites: OAC chemistry, 12U chemistry or SC/CHEM 1500 4.00 or equivalent. Course credit exclusions: SC/CHEM 1000 6.00, SC/CHEM 1010 6.00.

SC/BIOL 1000 3.00
Biology I - Cells, Molecular Biology and Genetics
An introduction to major unifying concepts and fundamental principles of biology, including evolution and cell theory. Topics include cells, biological energetics, metabolism, cell division and genetics. The laboratory and lecture components must be passed independently to pass the course. Three lecture hours per week; three laboratory hours in alternate weeks. One term. Three credits. Prerequisite: OAC Biology or 12U Biology or SC/BIOL 1500 3.00; OAC Chemistry or 12U Chemistry or SC/CHEM 1500 4.00. Course credit exclusions: SC/BIOL 1010 6.00; SC/BIOL 1410 6.00.

SC/BIOL 1001 3.00
Biology II - Evolution, Ecology, Biodiversity and Conservation Biology
A continuation of Biology I, exploring major unifying concepts and fundamental principles of biology, building on earlier concepts. Topics include mechanisms of evolution, ecology, a survey of biodiversity and conservation biology. The laboratory and lecture components must be passed independently to pass the course. Three lecture hours per week; three laboratory hours in alternate weeks. One term. Three credits. Prerequisite: SC/BIOL 1000 3.00. Course credit exclusions: SC/BIOL 1010 6.00; SC/BIOL 1410 6.00.

SC/PHYS 1010 6.00
Physics
Topics include linear, rotational and oscillatory motion; Newtonian mechanics; gravitation; electrostatics; magnetostatics; electric current and induction; heat; geometrical and physical optics and sound.

Differential and integral calculus and vector algebra are used. This course covers fewer topics than SC/PHYS 1410 6.00, but covers them in greater depth. It should be taken by all those likely to enrol in 2000-level physics courses. Includes three hour laboratory component normally in alternating weeks. Prerequisite: OAC Physics or 12U Physics or SC/PHYS 1510 4.00. Corequisite(s): SC/MATH 1013 3.00 and SC/MATH 1014 3.00, or SC/MATH 1505 6.00, or equivalents. Course credit exclusions: SC/PHYS 1410 6.00 and SC/PHYS 1420 6.00. Prior to Fall 2009: Prerequisite: OAC Physics or 12U Physics or SC/PHYS 1510 4.00. Corequisite(s): AS/SC/MATH 1013 3.00 and AS/SC/MATH 1014 3.00, or AS/SC/MATH 1505 6.00, or equivalents. Course credit exclusions: SC/PHYS 1410 6.00 and SC/PHYS 1420 6.00.

SC/PHYS 1410 6.00
Physical Science
A survey of physics. Topics include kinematics, dynamics, momentum and energy for linear and rotational motion; elementary kinetic theory and thermodynamics; static and current electricity; waves and physical and geometrical optics; elements of modern physics. This is a calculus-based course recommended for students unlikely to take 2000-level Physics courses. It includes a three hour laboratory component, normally in alternating weeks. Prerequisites: 12U Physics or OAC Physics or SC/PHYS 1510 4.00; MHF4U Advanced Functions and MCV4U Calculus and Vectors, or 12U Advanced Functions and Introductory Calculus, or OAC Algebra and OAC Calculus, or SC/MATH 1505 6.00, or SC/MATH 1520 3.00. Course credit exclusions: SC/PHYS 1010 6.00, SC/PHYS 1420 6.00

SC/PHYS 1420 6.00
Physics with Applications to Life Sciences
A survey of physics in which many fundamental concepts are emphasized through applications to the life sciences. Topics include kinematics, dynamics, momentum and energy for linear and rotational motion; elementary kinetic theory and thermodynamics; static and current electricity; waves and physical and geometrical optics; elements of modern physics. This is a calculus-based course recommended for students unlikely to take 2000-level Physics courses. It includes a three-hour laboratory component, normally in alternating weeks. Prerequisites: 12U Physics or OAC Physics or SC/PHYS 1510 4.00; MHF4U Advanced Functions and MCV4U Calculus and Vectors, or 12U Advanced Functions and Introductory Calculus, or OAC Algebra and OAC Calculus, or SC/MATH 1505 6.00, or SC/MATH 1520 3.00. Course Credit Exclusions: SC/PHYS 1010 6.00, SC/PHYS 1410 6.00

HH/KINE 2011 3.00
Human Physiology I
The focus of this course is the cellular basis of human physiology. Basic principles of physiology are presented from the viewpoint of the simplest structural unit-the cell-in order to provide a sound basis for understanding complex multi-cellular organisms in subsequent courses. Course credit exclusions: AS/HH/SC/KINE 3011 3.00.

HH/KINE 2031 3.00
Human Anatomy
An overview of the organization and structure of the human body. Each of the following systems is examined with respect to cell morphology, cell and tissue arrangement and inter-systems organization: skeletal, muscular, nervous, circulatory, lymphatic, respiratory, urinary, reproductive and endocrine. Three lecture hours per week, two laboratory hours in alternate weeks. One term. Course credit exclusions: AS/SC/KINE 3070 3.00 (prior to Fall/Winter 1997-1998), AS/SC/PHED 2070 3.00 (prior to

Fall/Winter 1996-1997), SC/PHED 2070 4.00 (prior to Fall/Winter 1996-1997), AS/PHED 3070 3.00 (prior to Fall/Winter 1996-1997), SC/PHED 3070 4.00 (prior to Fall/Winter 1996-1997), SC/NATS 1650 6.00.

ES/ENVS 1000 6.00
Earth in Our Hands: Introduction to Environmental Studies
This course is designed to provide students with an introductory perspective or framework of understanding for environmental studies at the broadest level. The course introduces students to environmental issues, using the urgent, emerging prospect of the fate of the "Earth in our hands" as the main organizing ethical, scientific and practical theme throughout the year. Course credit exclusion: ES/ENVS 1000 6.00 (prior to 2009)

Appendix D

Calendar Copy for Mathematical Biology BSc

New Copy **Bachelor of Science Programs** The mathematics/statistics core is defined as: SC/MATH 1021 3.00; SC/MATH 1131 3.00; SC/MATH 1200 3.00; SC/MATH 1300 3.00; SC/MATH 1310 3.00; SC/MATH 2022 3.00; SC/MATH 2030 3.00; SC/MATH 2310 3.00	**New Copy** **Bachelor of Science Programs** The mathematics/statistics core is defined as: SC/MATH 1021 3.00; SC/MATH 1131 3.00; SC/MATH 1200 3.00; SC/MATH 1300 3.00; SC/MATH 1310 3.00; SC/MATH 2022 3.00; SC/MATH 2030 3.00; SC/MATH 2310 3.00
	Mathematical Biology This is a mathematics program focusing on the needs of students interested in pursuing careers in medicine, public health, ecology and environmental science. **Specialized Honours (BSc)** A. General Education: • Non-science requirement: 12 credits; • Mathematics: satisfied within the major requirements; • Computer science: LE/EECS 1560 3.00; • Foundational science: SC/CHEM 1000 3.00, SC/CHEM 1001 3.00. B. Major requirements: • SC/BIOL 1000 3.00, SC/BIOL 1001 3.00; • a minimum of 15 additional credits at the 2000 level or higher in Biology courses including at least 9 credits from the 3000 level or higher; • the mathematics/statistics core (24 credits); • SC/MATH 2001 3.00; SC/MATH 2041 3.00; SC/MATH 2270 3.00; • SC/MATH 3010 3.00; SC/MATH 3241 3.00; SC/MATH 32xx 3.00; SC/MATH 3410 3.00; • One of: MATH 3050 6.0 or MATH 3090 3.0 or MATH 3171 3.0 or MATH 3172 3.0 or MATH 3242 3.0 or MATH 3260 3.0 or MATH 3271 3.0 • MATH42xx 6.0 • 6 additional credits selected from MATH 4090 3.0, MATH 4170 6.0, MATH 4271 3.0, MATH 4430 3.0, MATH 4431 3.0, for an overall total of at least 60 credits from major mathematics courses;

	C. Science breadth: satisfied by the above requirements. D. Upper level: a minimum of 42 credits must be at the 3000 level or above. E. Additional elective credits, as required, for an overall total of 120 credits for the Honours program. F. Standing requirements: To proceed in the Specialized Honours program requires in addition to the overall cumulative GPA as established by Senate, a major cumulative GPA (defined to include all required Chemistry, Biology, and Mathematics courses) of at least 6.00 (B). To graduate in an Honours program requires successful completion of all Faculty requirements and departmental required courses, a major cumulative GPA (as defined above) of at least 6.00 (B) and a minimum cumulative credit-weighted GPA of 5.00 (C) over all courses completed. Students that do not satisfy these requirements will be transferred to a program in Applied Mathematics (if the program requirements are satisfied). **Honours Major (BSc)** A. General Education: • Non-science requirement: 12 credits; • Mathematics: satisfied within the major requirements; • Computer science: LE/EECS 1560 3.00; • Foundational science: SC/CHEM 1000 3.00, SC/CHEM 1001 3.00. B. Major requirements: • SC/BIOL 1000 3.00, SC/BIOL 1001 3.00; • a minimum of 15 additional credits at the 2000 level or higher in Biology courses including at least 9 credits from the 3000 level or higher; • the mathematics/statistics core (24 credits); • SC/MATH 2041 3.00; SC/MATH 2270 3.00; • SC/MATH 32xx 3.00; • One of: MATH 3090 3.0 or MATH 3171 3.0 or MATH 3172 3.0 or MATH 3241 3.0 or MATH 3260 3.0 or MATH 3271 3.0 • MATH42xx 6.0 • 6 additional credits selected from MATH

	4090 3.0, MATH 4170 6.0, MATH 4271 3.0, MATH 4430 3.0, MATH 4431 3.0, for an overall total of at least 48 credits from major mathematics courses; C. Science breadth: satisfied by the above requirements. D. Upper level: a minimum of 42 credits must be at the 3000 level or above. E. Additional elective credits, as required, for an overall total of 120 credits for the Honours program. F. Standing requirements: To proceed in the Honours program requires in addition to the overall cumulative GPA as established by Senate, a major cumulative GPA (defined to include all required Chemistry, Biology, and Mathematics courses) of at least 6.00 (B). To graduate in an Honours program requires successful completion of all Faculty requirements and departmental required courses, a major cumulative GPA (as defined above) of at least 6.00 (B) and a minimum cumulative credit-weighted GPA of 5.00 (C) over all courses completed. Students that do not satisfy these requirements will be transferred to a program in Applied Mathematics (if the program requirements are satisfied). **Honours Double Major and Major/Minor (BSc)** It is possible to combine an Honours Major with another Major or a Minor in another subject area. Examples include (but are not limited to): Biology, Chemistry, Physics, Kinesiology. Students considering an Honours Double Major or Honours Major/Minor program are encouraged to speak to academic advisor. A. General Education: • Non-science requirement: 12 credits; • Mathematics: satisfied within the major requirements; • Computer science: LE/EECS 1560 3.00; • Foundational science: SC/CHEM 1000 3.00, SC/CHEM 1001 3.00. B. Major requirements: When the second major or the minor is neither Biology nor Kinesiology: • SC/BIOL 1000 3.00, SC/BIOL 1001 3.00; • a minimum of 15 additional credits at the 2000 level or higher in Biology courses including at least 9 credits from

	the 3000 level or higher; • the requirements of the second major; • When the second major or the minor is either Biology or Kinesiology: • SC/BIOL 1000 3.00, SC/BIOL 1001 3.00; • the requirements of either the Biology or the Kinesiology major; • Plus • the mathematics/statistics core (24 credits); • SC/MATH 2041 3.00; SC/MATH 2270 3.00; • SC/MATH 32xx 3.00; • One of: MATH 3090 3.0 or MATH 3170 6.0 or MATH 3241 3.0 or MATH 3260 3.0 or MATH 3271 3.0; • MATH 42xx 6.0; • 6 additional credits selected from MATH 4090 3.0, MATH 4170 6.0, MATH 4271 3.0, MATH 4430 3.0, MATH 4431 3.0, for an overall total of at least 48 credits from major mathematics courses. C. Science breadth: satisfied by the above requirements. D. Upper level: a minimum of 42 credits must be at the 3000 level or above. E. Additional elective credits, as required, for an overall total of 120 credits for the Honours program. F. Standing requirements: Standing requirements: To proceed in the Honours program requires in addition to the overall cumulative GPA as established by Senate, a major cumulative GPA (defined to include all required Chemistry, Biology, and Mathematics courses) of at least 6.00 (B). To graduate in an Honours program requires successful completion of all Faculty requirements and departmental required courses, a major cumulative GPA (as defined above) of at least 6.00 (B) and a minimum cumulative credit-weighted GPA of 5.00 (C) over all courses completed. Students that do not satisfy these requirements will be transferred to a program in Applied Mathematics (if the program requirements are satisfied). **Honours Minor (BSc)** The Honours Minor may only be combined with a Biology major or a Kinesiology major. A. General Education:

	• Defined by the requirements of the Biology of Kinesiology major B. Major requirements: • MATH 1021 3.0; MATH 1300 3.0; MATH 1310 3.0; • MATH 2310 3.0; • MATH 32xx 3.0 • 6 additional credits from MATH 2022 3.0, MATH 2030 3.0, MATH 2041 3.0, MATH 2222 3.0, MATH 2270 3.0; • 3 additional credits from MATH 3090 3.0, MATH 3170 6.0, MATH 3241 3.0, MATH 3242 3.0, MATH; • 6 additional credits from MATH 4090 3.0, MATH 4170 3.0, MATH 4430 3.0, MATH 4431 3.0, MATH 42xx 6.0; • the requirements of the Biology or Kinesiology major; C. Science breadth: satisfied by the above requirements. D. Upper level: a minimum of 42 credits must be at the 3000 level or above. E. Additional elective credits, as required, for an overall total of 120 credits for the Honours program. F. Standing requirements: as specified by the major.

York University Quality Assurance Procedures (YUQAP)
New Program Appraisal

External Appraisal Report on the Proposed New Bachelor of Science in Mathematical Biology

Please provide feedback, as appropriate, on the evaluation criteria provided below.

External Reviewer(s) Gerda de Vries
Professor and Associate Chair (Undergraduate Studies)
Department of Mathematical & Statistical Sciences, University of Alberta
Past-President, Society for Mathematical Biology

1. Outline of the Visit

- Who was interviewed
    - Administration
        - Alice Pitt, Vice-Provost Academic
        - Don Hastie, Dean of Science
    - Department of Mathematics and Statistics
        - Faculty members
            - Stephen Chamberlin
            - Jorg Grigull
            - Jane Heffernan
            - Neil Madras (visit host)
            - Seyed Moghadas
            - Juris Steprans, Chair
            - Walter Whiteley
            - Man Wah Wong
            - Jianhong Wu
            - Huaipung Zhu
        - Support staff
            - Janice Grant (undergraduate office staff)
            - Robert Reynolds (computer support staff)
            - Madeline Salzarulo (undergraduate office staff)
        - Graduate students
            - Lorianne Donata, MSc student with Jianhong Wu
            - Rachel Milwid, MSc student with Jane Heffernan
    - Department of Biology
        - Tamara Kelly
    - School of Kinesiology and Health Sciences
        - Roger Kelton, Chair
    - Library
        - Catherine Davidson, Head of Collections
        - Sarah Shujah, interim Math & Stats Librarian

- What facilities were seen
    - Department of Mathematics and Statistics, Ross Building
        - N620 (Lounge)
        - N502 (Undergraduate Office)
        - Department computing facilities

- Any other activities relevant to the appraisal

  N/A

2. General Objectives of the Program

- Is/are the program name and degree designation(s) appropriate?

  The proposal is to offer Specialized Honours, Honours Major, and Honours Minor programs in Mathematical Biology.

  The program name is appropriate. Mathematical Biology is a well-recognized name for the field of study that lies at the interface of the mathematical and the biological/life sciences. In particular, there are learned societies that use this name (Society for Mathematical Biology; European Society for Mathematical and Theoretical Biology; Japanese Society for Mathematical Biology), journals (Bulletin of Mathematical Biology; Journal of Mathematical Biology), and centres and institutes (Centre for Mathematical Biology [Oxford University]; Centre for Mathematical Biology [University of Alberta]; Mathematical Biology Institute [Ohio State University]). In addition, there are at least two Canada Research Chairs in Mathematical Biology in Canada (Lindi Wahl at the University of Western Ontario; Mark Lewis at the University of Alberta).

  Within the context of degrees offered at York University, the degree designations are appropriate. The program fits well with existing programs in the Department of Mathematics & Statistics. The Specialized Honours and Honours Major programs use the same core first- and second-year course requirements that are required for existing programs. Further, there is a clear distinction in the course requirements for the Specialized Honours, Honours Major, and Honours Minor, not just in the number of courses, but also in the types of courses. For example, one would expect any Specialized Honours program in mathematics but not necessarily an Honours Major to include courses such as MATH 2001 Real Analysis and MATH 3410 Complex Analysis. These courses are indeed required courses for the proposed Specialized Honours in Mathematical Biology but not for the proposed Honours Major in Mathematical Biology.

- For graduate programs that wish to have a Quality Council endorsed field(s), are the fields indicated in the proposal appropriate?

  N/A

- Are the general objectives of the program clear and are they consistent with University and Faculty missions and academic plans?

  The general objectives of the program are clear. The program aims to provide students with foundational knowledge in mathematics and in the application of mathematics to biological processes. The primary field of study is mathematics and the secondary field of study is biology. Students can choose to obtain a broad knowledge of biology, or specialize in an area such as ecology, genetics, epidemiology, immunology, etc. The secondary field of study serves to provide students with sufficient foundation to practice building mathematical models of biological processes and interpreting results of mathematical analysis in terms of the biological questions at hand. In short, graduates of the program therefore will be Applied Mathematicians specialized in Mathematical Biology.

  The objectives of the program are consistent with University and Faculty missions and academic plans. York University is committed to interdisciplinary studies and research, in particular in the area of global health and sustainability, and is interested in expanding its teaching and research activities in the areas of medicine, health, and applied sciences. The field of Mathematical Biology is interdisciplinary and applied, and graduates from the proposed degree program will be well positioned to make contributions in the field of medicine, global health, and sustainability.

3. Need and Demand

- Is there sufficient explanation of need/demand for the program?

  The proposal explains nicely the desirability for a program in Mathematical Biology. Because of the abundance of quantitative data now becoming available in the biological sciences, there is a need to develop quantitative, descriptive mathematical models of biological processes to help in interpreting the data and making predictions. Applications can be found in all areas of biology, from applied research in medicine, public health, and environmental science to theoretical research in ecology and evolution. In general terms, research in Mathematical Biology is a growing endeavour. This is true in particular at York University. There currently is a large group of researchers in the Department of Mathematics & Statistics active in Mathematical Biology. It seems timely to capitalize on its research strength in Mathematical Biology to build an undergraduate program in Mathematical Biology.

  The proposal does not clearly explain the need/demand for the program, neither from the perspective of undergraduate students seeking to combine a study in mathematics and biology, nor from the perspective of employers or graduate programs seeking graduates trained in both mathematics and biology.

  - The proposal does not include information on the number of students currently pursuing a Major in Mathematics and a Minor in Biology or vice versa (or a Double Major in Mathematics and Biology), but anecdotal evidence (from conversations with faculty members and students) suggests that this number is quite small. It would have been nice to know why the number is small. Is it because there is no interest? Or is there interest, but the program requirements of a Major in one discipline and of a Minor in the other discipline are too demanding? Or is it because very few students are aware of the opportunities that lie at the interface of mathematics and the biological/life sciences? Even if there is interest or awareness, it is not clear how many students would pursue a program in Mathematical Biology. What is the uptake of undergraduate programs in Mathematical Biology at other institutions in Ontario? Do those institutions see a large demand for their programs?
  - The proposal does not present evidence that employers in industry and government are seeking graduates at the BSc level trained in Mathematical Biology. While the proposers can think of classes of employers who would benefit from individuals trained in Mathematical Biology, there are no concrete examples (names of companies or government agencies that have hired recent graduates with a background in Mathematical Biology, job ads, letters from prospective employers, etc.).
  - The proposal does not make a clear case that graduates in Mathematical Biology interested in graduate school have an advantage over graduates in Mathematics or Applied Mathematics. Most of the successful researchers in Mathematical Biology today are classically trained Mathematicians or Applied Mathematicians, and graduate students with a similar background still do very well in graduate programs in Mathematical Biology. There is an argument to be made for the desirability of the breadth and depth obtained through a classical training in Mathematics or Applied Mathematics. By its very nature, a program in Mathematical Biology makes a trade-off: it sacrifices some of the breadth and depth in mathematics in favour of obtaining a background in biology. Whether a student with a background in Mathematical Biology is more desirable than a student with a background in Mathematics or Applied Mathematics will depend very much on the potential supervisor and the research projects of that supervisor.

  It is not clear how many of the students enrolling in a program in Mathematical Biology will be new students and how many will be drawn from other programs. Ideally, the program will, over time, attract new students to York University. The remaining students presumably will be drawn from existing students. Since there is considerable enrolment pressure in programs in Biology and Kinesiology and those programs do not have sufficient resources to satisfy demand, drawing students from those programs can be viewed as desirable. There also is the potential to draw students from programs in Mathematics and Applied Mathematics, which is less desirable (possibly leading to smaller programs, spreading an already relatively small cohort over more programs and courses).

4. Program Content and Curriculum

- Does the curriculum reflect the current state of the discipline or area of study? If applicable, comment on the appropriateness of any unique curriculum or program innovations or creative components.

  The curriculum reflects the current state of the discipline. The curriculum has been chosen carefully to give students the essential foundational knowledge in both the mathematical and the biological sciences, with more emphasis on the former than the latter, as is appropriate for programs situated in the Department of Mathematics and Statistics. At the same time, there is enough flexibility to allow students to pursue their own interests within mathematics (from discrete mathematics to differential equations to stochastic models and beyond) and within biology (from genetics to epidemiology to immunology and beyond). The high level of flexibility within the proposed program is novel and a definite strength of the proposal; it provides opportunities for a large variety of students to participate in the program.

  Most of the courses that constitute the proposed degree program already exist at the university. The fact that the program is built primarily around existing courses and that only two new courses are required is another definite strength of the proposal. One new course is required immediately, namely a third-year course MATH 32xx Mathematical Biology. Since there are several faculty members in the Department of Mathematics & Statistics whose research area is Mathematical Biology, there is no shortage of expertise to develop and deliver this course. This course should appeal to students in other programs within the Department as well, most notably students in Applied Mathematics and students in Computational Mathematics. Provided that the prerequisites for this course are not too onerous, the course should attract students from outside the department as well, most notably students in Biology and Kinesiology with interests in mathematics, and may serve to attract these students into the proposed program. Another new course will be needed when the program has sufficient enrolment, namely a fourth-year course MATH 42xx Practicum in Mathematical Biology. For the time being, students can substitute with MATH 4000 Individual Project.

  The third-year Mathematical Biology course will serve to introduce students to the discipline. There is a lot of room for discussion of case studies and oral and/or written scientific presentations in this course (innovative and non-traditional in the context of classical training in mathematics). Although the instructor likely will choose most of the case studies, students will have the opportunity to drive some of their own learning through the requirement of a final paper. More student-driven, experiential learning will take place in the fourth-year Practicum course, in which students are expected to work on an independent research project, in partnership with a pair of supervisors, one from the Department of Mathematics & Statistics and one from the field of application.

- For undergraduate programs, comment on the appropriateness of the anticipated class sizes. For graduate programs, is there adequate evidence that each graduate student in the program will take a minimum of two-thirds of the course requirements from among graduate level courses?

  The class sizes of existing courses are appropriate. No significant increase in class sizes is expected when the proposed program comes on board.

  The anticipated class size of 15-25 students for the new course MATH 32xx is appropriate. Since the students will be expected to write a final paper, it would be undesirable to have a class size significantly larger than this.

  The anticipated class size of 15-25 students for the new course MATH 42xx seems high. This course asks a lot of faculty members in the department and outside. It is not clear that the Mathematical Biology group can handle the supervision of individual research projects of that many students in any one year. That said, the projected enrolment numbers presented in Section 8 of the proposal suggest that the class size for this course would be significantly smaller, something like 5-10. There is sufficient supervisory capacity in the department to handle this smaller number.

5. Program Structure, Learning Outcomes and Assessment

- Are the program requirements and learning outcomes clear, appropriate and in alignment with the relevant degree level expectations?

  The program requirements and learning outcomes are all of the above. There is an appropriate emphasis on content knowledge, critical thinking, reasoning, problem solving, and reflection, and an appropriate focus on the ability to communicate orally, in writing, and through graphical methods. The development of a broad range of communication skills is not always emphasized enough in traditional mathematics programs, but absolutely crucial in an applied discipline such as Mathematical Biology. The new courses MATH 32xx and MATH 42xx will be critical in the delivery of these learning outcomes.

- Comment on the appropriateness of the program curriculum and structure to support the program learning outcomes. For undergraduate programs, comment on the nature and suitability of students' final-year academic achievement in the program. For research-focused graduate programs, comment on the nature and suitability of the major research requirement(s).

  The structure of the proposed program supports the program learning outcomes. The courses are sequenced logically, and chosen to provide both depth and breadth in the discipline. Students are introduced to mathematical modelling in the area of biology in year 3 through MATH 32xx Mathematical Biology. Although it is possible to do some modelling in earlier years, students typically do not have enough breadth and depth in mathematics to do so independently, nor sufficient exposure to biological processes to make the models meaningful. Situating this cornerstone course in year 3 is very appropriate, and in line with the timing of similar courses at other universities. Inclusion of the capstone course MATH 42xx in year 4 is crucial in moving students towards demonstrating initiative and ownership of learning.

- Are the methods and criteria for assessing student achievement appropriate and effective relative to the program learning outcomes?

  The methods and criteria for assessing student achievement are standard. They are varied, ranging from assignments and exams to oral presentations and project papers, and include both individual and collaborative work. They are appropriate and effective relative to the program learning outcomes.

- For graduate programs, comment on the appropriateness of the program length, including on how students' time-to-completion will be supported and managed to ensure that the program requirements can be reasonably completed within the proposed time period.

  N/A

- Comment on the appropriateness of the proposed mode(s) of delivery to meet the program learning outcomes.

  The modes of delivery of the courses are standard. They include traditional face-to-face lectures, interactive tutorials, project work, and hands-on laboratories, requiring students to work both individually and in groups. Through the variety of delivery modes, all of the learning outcomes are addressed.

6. Admission Requirements

- Are the admission requirements appropriately aligned with the program learning outcomes?

  Admission requirements are exactly as they should be: they ensure that students are prepared for all of the courses required and recommended for the proposed program.

- Is there sufficient explanation of any alternative requirements, if any, for admission into an undergraduate, graduate or second-entry program, such as minimum grade point average, additional languages or portfolios, along with how the program recognizes prior work or learning experience?

Because there is sufficient overlap with existing programs in the Department of Mathematics & Statistics and because the proposed program has a high degree of flexibility, students can enter the program at various points during their undergraduate degree. Alternative requirements are not necessary.

7. Resources

For all programs

- Adequacy of the administrative unit's planned utilization of existing human, physical and financial resources, and any institutional commitment to supplement those resources, to support the program.

  The proposed program consists primarily of existing resources; additional resources required are relatively minor:

  - Two new courses, MATH 32xx Mathematical Biology and MATH 42xx Practicum in Mathematical Biology

    The Department of Mathematics & Statistics has a relatively large group of faculty members active in the area of Mathematical Biology who can handle the teaching needs associated with these two courses, therefore no new hires are required. One of the courses, MATH 32xx Mathematical Biology, is a course that will be attractive to students in other programs in the department as well as students in programs in other units on campus. The second course, MATH 42xx Practicum in Mathematical Biology, is a course that does not need to be offered until there is sufficient enrolment in the program; for the time being, an existing course, MATH 4000 Individual Project, can substitute for MATH 42xx. The Dean of the Faculty of Science has indicated strong support for the introduction of the two new courses.

  - Registration spaces for students enrolled in the proposed program in courses outside the department, most notably the highly subscribed courses in Biology and Kinesiology

    Students enrolled in the proposed program will be required to take prescribed courses in CSE, CHEM, and BIOL, as well as options in BIOL and KINE, many of which have restricted access due to high demand. Both the Department of Biology and the School of Kinesiology and Health Science have indicated strong support for the proposed program and have agreed to open their courses to students in Mathematical Biology.

  - Supervisory capacity for MATH 42xx Practicum in Mathematical Biology

    The new course MATH 42xx is a project-based course, requiring a supervisor from the Department of Mathematics & Statistics and a co-supervisor from an area of application. There is no shortage of projects; these can come from faculty members active in Mathematical Biology, faculty members associated with the Centre for Disease Modelling at York University, and faculty members in the Department of Biology and the School of Kinesiology and Health Science interested in quantitative research. The Mathematical Biology group is sufficiently large to be able to handle to additional supervisory capacity for the research projects. Building co-supervisory capacity from outside the department may be challenging initially (in particular if the pay-off of time invested by researchers is nebulous initially), but provides a real opportunity to build strong and long-lasting interdisciplinary collaborations between researchers from departments across campus. Department chairs and/or Deans may need to put incentives in place to ensure sufficient (co)supervisory capacity for the program until the benefits (in the form of research papers, new collaborations, access to well-trained graduate students, etc.) of the program are well established.

- Appropriateness of the collective faculty expertise to contribute substantively to the program.

  The Mathematical Biology group at York University is well established, with a broad range of teaching and research expertise (ranging from medical imaging to epidemiology to bioinformatics and beyond). The proposed program in Mathematical Biology capitalizes on the existing teaching and research strength of the group. All faculty members in the group can contribute substantively to the program.

- Participation of a sufficient number and quality of faculty who are competent to teach and/or supervise in the program, including qualifications, research, innovation and scholarly record.

  Twenty-two faculty members in the Department of Mathematics & Statistics list an interest in Mathematical Biology, to varying degrees, with several individuals in the group maintaining a consistently high-quality research program in the field, with good funding from NSERC, and active in the supervision of graduate students. Collectively, there are more than enough faculty members to develop and deliver a vigorous undergraduate program in Mathematical Biology. Because the group is relatively large, the shared burden of implementing the new program is manageable.

- Evidence that there are adequate resources (e.g. library, laboratory) to sustain the quality of scholarship produced by undergraduate students as well as graduate students' scholarship and research activities.

  The library already has the resources required to deliver teaching, learning, and research support for the proposed program. All of the standard reference texts in Mathematical Biology already are in its collections, and access to the leading journals in Mathematical Biology is in place as well. Further, the library has capacity to provide library research skills and information literacy workshops to students enrolled in the proposed program, in particular in conjunction with the two new courses MATH 32xx and MATH 42xx.

  No new laboratory resources are needed.

Additional criteria for undergraduate programs only

- Evidence of and planning for adequate numbers and quality of: (a) faculty and staff to achieve the goals of the program; or (b) of plans and the commitment to provide the necessary resources in step with the implementation of the program; (c) planned/anticipated class sizes; (d) provision of supervision of experiential learning opportunities (if required); and (e) the role of adjunct and contract faculty.

  a) The faculty and staff required to achieve the goals of the proposed program already are in place; no new hires are needed. See comments above.

  b) The Dean of Science has expressed strong support for the program, and promised the required resources to introduce the two new required courses, MATH 32xx and MATH 42xx. The Department of Biology and the School of Kinesiology and Health Science have pledged to open their courses to students registered in the proposed program. See comments above.

  c) There are no significant changes in class sizes. See comments above.

  d) Sufficient supervisory capacity for the new experiential learning experiences through MATH 32xx and MATH 42xx already exists in the Department of Mathematics & Statistics and across York University. See comments above.

  e) Although adjunct and contract faculty may participate in the delivery of the proposed program, there is sufficient teaching capacity and expertise in the Department of Mathematics & Statistics. Therefore there is no need to plan for the involvement of adjunct and contract faculty.

8. Quality of Student Experience

- Is there evidence of a program structure and faculty research that will ensure the intellectual quality of the student experience? *Note: Reviews are urged to avoid using references to individuals. Rather, they are asked to assess the ability of the faculty as a whole to deliver the program and to comment on the appropriateness of each of the areas/fields of the program that the university has chosen to emphasize, in view of the expertise and scholarly productivity of the faculty.*

  The program structure is clear. The focus of the program is on ensuring that students obtain a solid foundation in the tools of Applied Mathematics and the opportunity to specialize in a field of application, namely biology (in its broadest sense, from ecology to genetics to immunology and beyond).

  The Department of Mathematics & Statistics already has significant research expertise in Mathematical Biology, and is well positioned to develop and deliver the proposed educational program in Mathematical Biology.

  The proposed program is very flexible in that students can tailor the program to their own interests, within both the mathematics component of the program and the biology component of the program. By its very nature, the program will challenge the students to bridge two very different disciplines, each with its own intellectual culture. The mathematics requirements in the program are fewer than in traditional programs in mathematics alone. That said, the intellectually challenging courses such MATH 1200 Problems, Conjectures and Proofs, MATH 2001 Real Analysis, and MATH 3410 Complex Variables are not avoided. Beyond these classic foundational courses in mathematics, emphasis is on courses in Applied Mathematics. The requirements in biology and the requirements of the cornerstone course MATH 32xx Mathematical Biology and especially the capstone course MATH 42xx Practicum in Mathematical Biology then enrich the program. These two courses will provide experiential learning experiences with a focus on research that will surely challenge the students intellectually while socializing them into the field of Mathematical Biology. Several of the faculty members active in Mathematical Biology have a great deal of experience supervising undergraduate summer research students and project-based summer schools aimed at senior undergraduate and beginning graduate students. This experience will translate well to the teaching and supervisory needs in both MATH 32xx and MATH 42xx, promising a high quality educational experience for students.

9. Other Issues

Because of the flexibility of the mathematics component of the proposed program, the staff in the Undergraduate Office will be burdened with additional complexity in their role as advisors. It is extremely important to have clear, structured information in the form of webpages and/or handouts (charts, checklists, etc.) to facilitate advising of students. Advising on the requirements of the biology component of the proposed program should lie with the program coordinator.

A previous draft of the proposal included examples of coherent combinations of courses to fulfill the requirements of the biology component of the program (for example combinations in Biochemistry, Molecular Biology, Immunology and Virology, Animal Physiology, etc.). The information is missing from the final proposal, but should be included on the program webpage. The information would be extremely useful for students already in the program to help them choose their courses wisely, but also for recruitment efforts if only to advertise the richness of possibilities and the flexibility in the program.

10. Summary and Recommendations (*Note: The responsibility for arriving at a recommendation on the final classification of the program belongs to the Appraisal Committee. Individual reviewers are asked to refrain from making recommendations in this respect.*)

N/A

External Reviewer(s) Gerda de Vries
Professor and Associate Chair (Undergraduate Studies)
Department of Mathematical & Statistical Sciences, University of Alberta
Past-President, Society for Mathematical Biology

We would like to thank Dr. Gerda de Vries for the time and expertise she has invested in reviewing the proposal for an undergraduate degree program in Mathematical Biology at York University. Dr. de Vries is an expert in Mathematical Biology, is a past president of the Society for Mathematical Biology, and conducts some research in Mathematical Biology education. Dr. de Vries is also a lead researcher in the Centre for Mathematical Biology at the University of Alberta.

We have noted that the review of the proposed program is very positive. In a few areas where more information or detail has been requested we have revised the proposal accordingly and we provide replies to these comments below.

1. Outline of the Visit

☐☐ Who was interviewed

o Administration
- -Alice Pitt, Vice-Provost Academic
- -Don Hastie, Dean of Science

o Department of Mathematics and Statistics

o Faculty members
- Stephen Chamberlin
- Jorg Grigull
- Jane Heffernan
- Neil Madras (visit host)
- Seyed Moghadas
- Juris Steprans, Chair
- Walter Whiteley
- Man Wah Wong
- Jianhong Wu
- Huaipung Zhu

o Support staff
- Janice Grant (undergraduate office staff)
- Robert Reynolds (computer support staff)
- Madeline Salzarulo (undergraduate office staff)

o Graduate students
- Lorianne Donata, MSc student with Jianhong Wu
- Rachel Milwid, MSc student with Jane Heffernan

o Department of Biology
- Tamara Kelly

o School of Kinesiology and Health Sciences
- Roger Kelton, Chair

o Library
- Catherine Davidson, Head of Collections

- Sarah Shujah, interim Math & Stats Librarian

□□ What facilities were seen
o Department of Mathematics and Statistics, Ross Building
o N620 (Lounge)
o N502 (Undergraduate Office)
o Department computing facilities

□□ Any other activities relevant to the appraisal
N/A

2. General Objectives of the Program
□□ Is/are the program name and degree designation(s) appropriate?

The proposal is to offer Specialized Honours, Honours Major, and Honours Minor programs in Mathematical Biology.

The program name is appropriate. Mathematical Biology is a well-recognized name for the field of study that lies at the interface of the mathematical and the biological/life sciences. In particular, there are learned societies that use this name (Society for Mathematical Biology; European Society for Mathematical and Theoretical Biology; Japanese Society for Mathematical Biology), journals (Bulletin of Mathematical Biology; Journal of Mathematical Biology), and centres and institutes (Centre for Mathematical Biology [Oxford University]; Centre for Mathematical Biology [University of Alberta]; Mathematical Biology Institute [Ohio State University]). In addition, there are at least two Canada Research Chairs in Mathematical Biology in Canada (Lindi Wahl at the University of Western Ontario; Mark Lewis at the University of Alberta).

Within the context of degrees offered at York University, the degree designations are appropriate. The program fits well with existing programs in the Department of Mathematics & Statistics. The Specialized Honours and Honours Major programs use the same core first- and second-year course requirements that are required for existing programs. Further, there is a clear distinction in the course requirements for the Specialized Honours, Honours Major, and Honours Minor, not just in the number of courses, but also in the types of courses. For example, one would expect any Specialized Honours program in mathematics but not necessarily an Honours Major to include courses such as MATH 2001 Real Analysis and MATH 3410 Complex Analysis. These courses are indeed required courses for the proposed Specialized Honours in Mathematical Biology but not for the proposed Honours Major in Mathematical Biology.

We agree, we have taken great care in determining courses that should be incorporated in the Honours and Specialized Honours programs.

□□For graduate programs that wish to have a Quality Council endorsed field(s), are the fields indicated in the proposal appropriate?

N/A

☐☐ Are the general objectives of the program clear and are they consistent with University and Faculty missions and academic plans?

The general objectives of the program are clear. The program aims to provide students with foundational knowledge in mathematics and in the application of mathematics to biological processes. The primary field of study is mathematics and the secondary field of study is biology. Students can choose to obtain a broad knowledge of biology, or specialize in an area such as ecology, genetics, epidemiology, immunology, etc.

The secondary field of study serves to provide students with sufficient foundation to practice building mathematical models of biological processes and interpreting results of mathematical analysis in terms of the biological questions at hand. In short, graduates of the program therefore will be Applied Mathematicians specialized in Mathematical Biology.

The objectives of the program are consistent with University and Faculty missions and academic plans. York University is committed to interdisciplinary studies and research, in particular in the area of global health and sustainability, and is interested in expanding its teaching and research activities in the areas of medicine, health, and applied sciences. The field of Mathematical Biology is interdisciplinary and applied, and graduates from the proposed degree program will be well positioned to make contributions in the field of medicine, global health, and sustainability.

We thank Dr. de Vries for the very thorough and thoughtful review.

3. Need and Demand

☐☐ Is there sufficient explanation of need/demand for the program?

The proposal explains nicely the desirability for a program in Mathematical Biology. Because of the abundance of quantitative data now becoming available in the biological sciences, there is a need to develop quantitative, descriptive mathematical models of biological processes to help in interpreting the data and making predictions. Applications can be found in all areas of biology, from applied research in medicine, public health, and environmental science to theoretical research in ecology and evolution. In general terms, research in Mathematical Biology is a growing endeavour. This is true in particular at York University. There currently is a large group of researchers in the Department of Mathematics & Statistics active in Mathematical Biology. It seems timely to capitalize on its research strength in Mathematical Biology to build an undergraduate program in Mathematical Biology.

The proposal does not clearly explain the need/demand for the program, neither from the perspective of undergraduate students seeking to combine a study in mathematics and biology, nor from the perspective of employers or graduate programs seeking graduates trained in both mathematics and biology.

o The proposal does not include information on the number of students currently pursuing a Major in Mathematics and a Minor in Biology or vice versa (or a Double Major in Mathematics and Biology), but

anecdotal evidence (from conversations with faculty members and students) suggests that this number is quite small. It would have been nice to know why the number is small. Is it because there is no interest? Or is there interest, but the program requirements of a Major in one discipline and of a Minor in the other discipline are too demanding? Or is it because very few students are aware of the opportunities that lie at the interface of mathematics and the biological/life sciences? Even if there is interest or awareness, it is not clear how many students would pursue a program in Mathematical Biology. What is the uptake of undergraduate programs in Mathematical Biology at other institutions in Ontario? Do those institutions see a large demand for their programs?

Table 1 – BSC degrees that include a mathematics degree program as a major or a minor

	Total	Single Major	Double Major	Major/ Minor	Combine Mathematics with Biology, Chemistry or Kinesiology
Applied Mathematics (APMA)	79	71	4	4	1 – Major APMA, Minor BIOL
Computational Mathematics (COMP)	10	10			
Math for Education (MAED)	43	29	5	9	1 – Major MAED, Major KINE 1 – Major MAED, Minor BIOL 1 – Major MAED, Minor CHEM
Mathematics (MATH)	53	47	5	1	1 – Major MATH, major BIOL 2 – Major MATH, major CHEM 1 – Major MATH, Minor CHEM
Statistics (STAT)	24	22	1	1	
Biology (BIOL)				1	1 – Major BIOL, Minor MAED
Chemistry (CHEM)					
Computer Science (COSC)				1	
Kinesiology (KINE)				1	1 – Major KINE, Minor APMA
Physics and Astronomy (PHAS)				1	
Psychology (PSYC)				1	

There are currently 223 students at York University declaring a BSc major in a mathematics discipline APMA, COMP, MAED, MATH and STAT. Of these, 179 declare a single major in a mathematics discipline, 15 declare a double major with a mathematics discipline, 15 declare a Major/Minor with a mathematics discipline as a major, and 5 declare a Major/Minor with a mathematics discipline as a minor. Of the 33 students combining a mathematics discipline with another subject area there are 10 students pursuing a BSc that combines a mathematics discipline with Biology, Chemistry or Kinesiology, representing approximately one third of all students pursuing degrees combining mathematics with another discipline. From these numbers it is clear that a substantial minority of students choose to formally declare a Major/Major or Major/Minor with a mathematics discipline. However, of these students declaring such a combination, approximately one third combine mathematics

with Biology, Chemistry or Kinesiology. This indicates that where there is interest in pursuing interdisciplinary studies with mathematics, the combined degree lies within the field of Mathematical Biology.

Major/major and major/minor degree programs are relatively inflexible since students must meet individual requirements in both subject areas. This challenge alone might account for the low number of students who choose combined degree programs. The Mathematical Biology degree program is designed to balance targeted education with enhanced flexibility. Similar cross disciplinary programs like Biochemistry demonstrate that student interest increases when a formalized program combining two disciplines exists, compared to combined degree major/major and major/minor. It is anticipated that a formalized degree program in Mathematical Biology will attract students that do not normally pursue a major/major or major/minor.

We are in complete agreement that there is limited awareness of applications at the interface of Mathematics and Biology presently. It is the experience of many Mathematical Biologists that they did not know that this field existed until they were in their final one or two years of undergraduate mathematics. Modelling as a curriculum focus in secondary schools and undergraduate programs is increasing awareness of the linkages with mathematics with applications; however, there is still a lack of understanding that mathematics and biology are intimately connected. We expect that the introduction of this new program will serve to alleviate this deficit. Literature describing the linkages between Mathematics and Biology and the new Mathematical Biology program at York will be sent to secondary school guidance offices, and will be distributed at University fairs and Science demonstrations such as Science Rendezvous. Word about a possible formalized program in Mathematical Biology has already reached students applying to university, and the topic has been raised at recruitment fairs. Last year, three secondary school students attending a red carpet recruitment event at York University listed mathematics and biology as their top choices for degree study and were very interested in learning more about the field of Mathematical Biology.

A small survey of undergraduate programs at other Ontario Universities was conducted. Of the universities contacted, only two were able to share information regarding students pursuing degrees that combine Mathematics with Biology, Chemistry or Kinesiology. Data from these two respondents show that at least 25 students are currently pursuing double degrees combining these disciplines. Combining this information with that in Table 1 shows that at least 35 students at three Ontario universities are pursuing degrees that lie in the field of Mathematical Biology. This limited sample speaks to a broad interest in Mathematical Biology in Ontario.

o The proposal does not present evidence that employers in industry and government are seeking graduates at the BSc level trained in Mathematical Biology. While the proposers can think of classes of employers who would benefit from individuals trained in Mathematical Biology, there are no concrete examples (names of companies or government agencies that have hired recent graduates with a background in Mathematical Biology, job ads, letters from prospective employers, etc.).

A study of careers that combine Mathematics and Biology (by Maria Kielmas, Demand Media - work.chron.com/careers-combine-biology-mathematics-10664.html) reports that Biomathematicians currently work in research and development services in human genetics, health care, pharmaceuticals and conservation. The study also reports that the May 2011 median salary of mathematicians, including

biomathematicians, in research and development services was $117,970, (U.S. Bureau of Labor Statistics (BLS)), and that the BLS forecasts employment growth of 16% for all mathematicians, including biomathematicians, between 2012 and 2020.

Many private companies hire individuals with a mathematical background and a set of skills they find valuable. Therefore, companies that hire Mathematics and Applied Mathematics majors are also likely to hire majors in Mathematical Biology. An advantage that a Mathematical Biology degree holder from York University will have over individuals with other Mathematics degrees, however, is that this individual will have had: training in interpreting the real world to mathematics and vice versa; hands on experiences with data; experience writing reports and giving presentations to individuals with mathematics, biology and other backgrounds; experience conducting their own mathematical modelling study on a current issue in the real world from start to finish.

It is hard to say what companies hire BSc degree holders in Mathematical Biology. Communication with the Society of Mathematical Biology on this has stemmed interest in conducting a formal survey of BSc Mathematical Biology alumni. A survey of Mathematical Biology programs in the United States of America shows close links and collaborations with zoos and aquariums; National Parks services; Departments of transportation, land management and water treatment; research institutes; oil and gas companies; scientific consulting companies; cyber-security and security companies; electronics companies; and space and aeronautics research companies. Specific examples include: Mitre, NASA, Boeing, Metron and Philips. [math.arizona.edu/academics/undergrads/employment/external, www.sru.edu/academics/enrollment/career/Pages/CTHBioChemMathPhys.aspx]. Current researchers in Mathematical Biology at York University have connections with industry, scientific consulting companies, government agencies and research institutes. Also, over time the program will attract other companies and government agencies. It is expected that these connections will lead to job prospects for graduates with a BSc in Mathematical Biology.

Mathematical Biology researchers at York are continuous participants in undergraduate research programs (Research at York, NSERC Undergraduate Student Research Awards, MITACS Globallink). Past Mathematics and Applied Mathematics undergraduate students that have completed summer research programs in Mathematical Biology have been successful in obtaining jobs as dentists, doctors, computer programmers, graduate students, research assistants and statistical consultants.

It must be acknowledged that many students that pursue undergraduate degrees in Science disciplines will also move on to professional schools and obtain jobs in teaching, medicine, law, business, dentistry, optometry, etc. Even in cases where Mathematical Biology is not related to the current career of the individual, the undergraduate degree experience still influences and informs their professional practice.

o The proposal does not make a clear case that graduates in Mathematical Biology interested in graduate school have an advantage over graduates in Mathematics or Applied Mathematics. Most of the successful researchers in Mathematical Biology today are classically trained Mathematicians or Applied Mathematicians, and graduate students with a similar background still do very well in graduate programs in Mathematical Biology. There is an argument to be made for the desirability of the breadth and depth obtained through a classical training in Mathematics or Applied Mathematics. By its very nature, a program in Mathematical Biology makes a trade-off: it sacrifices some of the breadth and depth in mathematics in favour of obtaining a background in biology. Whether a student with a

background in Mathematical Biology is more desirable than a student with a background in Mathematics or Applied Mathematics will depend very much on the potential supervisor and the research projects of that supervisor.

We are in agreement with the reviewer, in that, it will depend very much on the potential supervisor and the research projects of that supervisor whether an Applied Mathematics of a Mathematical Biology graduate will be desirable for graduate research. We have developed a degree program in Mathematical Biology that tries to minimize the differences between an Applied Mathematics major and Mathematical Biology while augmenting knowledge and experience in an area of application. The courses MATH 32xx and 42xx have been designed to minimize this sacrifice so that some mathematical subjects that may be covered in depth in an Applied Mathematics program (i.e., partial differential equations) will be introduced and taught in relation to an area of application. The MATH 32xx and 42xx however, will also include mathematical tools and techniques that are currently used in Mathematical Biology that are not common in Applied Mathematics (i.e., discrete Leslie Matrices). In developing the Mathematical Biology program we have also ensured that students in Mathematical Biology will acquire skills that are not necessarily obtained through Applied Mathematics degrees. For example, all students graduating from the Mathematical Biology degree program will have had experience handling real data, writing reports and giving presentations, communicating across disciplines, and completing a research project that is current to the real world. These are skills that are also sought after by potential supervisors of graduate students.

It is not clear how many of the students enrolling in a program in Mathematical Biology will be new students and how many will be drawn from other programs. Ideally, the program will, over time, attract new students to York University. The remaining students presumably will be drawn from existing students. Since there is considerable enrolment pressure in programs in Biology and Kinesiology and those programs do not have sufficient resources to satisfy demand, drawing students from those programs can be viewed as desirable. There also is the potential to draw students from programs in Mathematics and Applied Mathematics, which is less desirable (possibly leading to smaller programs, spreading an already relatively small cohort over more programs and courses).

It is expected that some students currently enrolled in other mathematics programs at York University will want to transfer to the degree Program in Mathematical Biology. However, it is expected that this number will be small as evidenced in Table 1 – BSc degrees that include a mathematics degree program as a major or a minor.

It is anticipated that a new program in Mathematical Biology will attract applications from students wanting a degree program which involve Biology, Chemistry or Kinesiology. It is also anticipated that the new program will attract applications from secondary school students that may not normally have considered applying to York University. Literature on the new degree program will be sent to secondary schools and mathematics departments at Canadian universities. Literature on the new program will also be distributed at University recruitment fairs and Science fairs, and faculty members involved in the program will be available to talk to potential students. Visits to secondary schools to give talks on Mathematical Biology, with topics chosen that relate to current and popular real world issues for these age groups will be conducted through the York University Science Speakers Bureau. Mathematical

Biology will also be given a focus in the new Faculty of Science enrichment program for secondary school students, including one or more weeks of introductory courses on Mathematical Biology.

4. Program Content and Curriculum

☐☐ Does the curriculum reflect the current state of the discipline or area of study? If applicable, comment on the appropriateness of any unique curriculum or program innovations or creative components.

The curriculum reflects the current state of the discipline. The curriculum has been chosen carefully to give students the essential foundational knowledge in both the mathematical and the biological sciences, with more emphasis on the former than the latter, as is appropriate for programs situated in the Department of Mathematics and Statistics. At the same time, there is enough flexibility to allow students to pursue their own interests within mathematics (from discrete mathematics to differential equations to stochastic models and beyond) and within biology (from genetics to epidemiology to immunology and beyond). The high level of flexibility within the proposed program is novel and a definite strength of the proposal; it provides opportunities for a large variety of students to participate in the program.

Most of the courses that constitute the proposed degree program already exist at the university. The fact that the program is built primarily around existing courses and that only two new courses are required is another definite strength of the proposal. One new course is required immediately, namely a third-year course MATH 32xx Mathematical Biology. Since there are several faculty members in the Department of Mathematics & Statistics whose research area is Mathematical Biology, there is no shortage of expertise to develop and deliver this course. This course should appeal to students in other programs within the Department as well, most notably students in Applied Mathematics and students in Computational Mathematics. Provided that the prerequisites for this course are not too onerous, the course should attract students from outside the department as well, most notably students in Biology and Kinesiology with interests in mathematics, and may serve to attract these students into the proposed program. Another new course will be needed when the program has sufficient enrolment, namely a fourth-year course MATH 42xx Practicum in Mathematical Biology. For the time being, students can substitute with MATH 4000 Individual Project.

The third-year Mathematical Biology course will serve to introduce students to the discipline. There is a lot of room for discussion of case studies and oral and/or written scientific presentations in this course (innovative and non-traditional in the context of classical training in mathematics). Although the instructor likely will choose most of the case studies, students will have the opportunity to drive some of their own learning through the requirement of a final paper. More student-driven, experiential learning will take place in the fourth-year Practicum course, in which students are expected to work on an independent research project, in partnership with a pair of supervisors, one from the Department of Mathematics & Statistics and one from the field of application.

We thank Dr. de Vries for her comments. We have taken much time to ensure that the degree program will provides flexibility to students so that they can mould the degree program to their specific interests or opt to generalize, taking courses in different areas. MATH 32xx has been developed to introduce students to the field of Mathematical Biology, but also to provide knowledge in areas of mathematics

that are not included as specific course requirements. MATH 42xx (or MATH 4000) will provide students with a great opportunity to conduct research on a real world problem, but this course will also aid Mathematical Biology students in developing skills that will benefit them when looking for jobs after they graduate (i.e., communication skills, interdisciplinary collaboration experience).

☐☐ For undergraduate programs, comment on the appropriateness of the anticipated class sizes. For graduate programs, is there adequate evidence that each graduate student in the program will take a minimum of two-thirds of the course requirements from among graduate level courses?

The class sizes of existing courses are appropriate. No significant increase in class sizes is expected when the proposed program comes on board.

The anticipated class size of 15-25 students for the new course MATH 32xx is appropriate. Since the students will be expected to write a final paper, it would be undesirable to have a class size significantly larger than this.

The anticipated class size of 15-25 students for the new course MATH 42xx seems high. This course asks a lot of faculty members in the department and outside. It is not clear that the Mathematical Biology group can handle the supervision of individual research projects of that many students in any one year. That said, the projected enrolment numbers presented in Section 8 of the proposal suggest that the class size for this course would be significantly smaller, something like 5-10. There is sufficient supervisory capacity in the department to handle this smaller number.

We have revised the ranges to reflect the projected enrolment numbers from Section 8.

5. Program Structure, Learning Outcomes and Assessment

☐☐ Are the program requirements and learning outcomes clear, appropriate and in alignment with the relevant degree level expectations?

The program requirements and learning outcomes are all of the above. There is an appropriate emphasis on content knowledge, critical thinking, reasoning, problem solving, and reflection, and an appropriate focus on the ability to communicate orally, in writing, and through graphical methods. The development of a broad range of communication skills is not always emphasized enough in traditional mathematics programs, but absolutely crucial in an applied discipline such as Mathematical Biology. The new courses MATH 32xx and MATH 42xx will be critical in the delivery of these learning outcomes.

Thank you. MATH 32xx and 42xx have been designed to ensure student development in communication.

☐☐ Comment on the appropriateness of the program curriculum and structure to support the program learning outcomes. For undergraduate programs, comment on the nature and suitability of students' final-year academic achievement in the program. For research-focused graduate programs, comment on the nature and suitability of the major research requirement(s).

The structure of the proposed program supports the program learning outcomes. The courses are sequenced logically, and chosen to provide both depth and breadth in the discipline. Students are introduced to mathematical modelling in the area of biology in year 3 through MATH 32xx Mathematical Biology. Although it is possible to do some modelling in earlier years, students typically do not have enough breadth and depth in mathematics to do so independently, nor sufficient exposure to biological processes to make the models meaningful. Situating this cornerstone course in year 3 is very appropriate, and in line with the timing of similar courses at other universities. Inclusion of the capstone course MATH 42xx in year 4 is crucial in moving students towards demonstrating initiative and ownership of learning.

We agree with Dr. de Vries. We have taken great care in ensuring that the proposed program supports program learning outcomes, and to ensure that the learning steps that students must take in the program occur in a logical fashion.

☐☐ Are the methods and criteria for assessing student achievement appropriate and effective relative to the program learning outcomes?

The methods and criteria for assessing student achievement are standard. They are varied, ranging from assignments and exams to oral presentations and project papers, and include both individual and collaborative work. They are appropriate and effective relative to the program learning outcomes.

We agree with Dr. de Vries' comments entirely.

☐☐ For graduate programs, comment on the appropriateness of the program length, including on how students' time-to-completion will be supported and managed to ensure that the program requirements can be reasonably completed within the proposed time period.
N/A

☐☐ Comment on the appropriateness of the proposed mode(s) of delivery to meet the program learning outcomes.

The modes of delivery of the courses are standard. They include traditional face-to-face lectures, interactive tutorials, project work, and hands-on laboratories, requiring students to work both individually and in groups. Through the variety of delivery modes, all of the learning outcomes are addressed.

We thank Dr. de Vries for her thorough review.

6. Admission Requirements

☐☐ Are the admission requirements appropriately aligned with the program learning outcomes?

Admission requirements are exactly as they should be: they ensure that students are prepared for all of the courses required and recommended for the proposed program.

We agree with Dr. de Vries' assessment here.

☐☐ Is there sufficient explanation of any alternative requirements, if any, for admission into an undergraduate, graduate or second-entry program, such as minimum grade point average, additional languages or portfolios, along with how the program recognizes prior work or learning experience?

Because there is sufficient overlap with existing programs in the Department of Mathematics & Statistics and because the proposed program has a high degree of flexibility, students can enter the program at various points during their undergraduate degree. Alternative requirements are not necessary.

Thank you. We have taken much time to ensure that the proposed degree program will allow transfers from other programs.

7. Resources

For all programs

☐☐ Adequacy of the administrative unit's planned utilization of existing human, physical and financial resources, and any institutional commitment to supplement those resources, to support the program. The proposed program consists primarily of existing resources; additional resources required are relatively minor:

o Two new courses, MATH 32xx Mathematical Biology and MATH 42xx Practicum in Mathematical Biology

The Department of Mathematics & Statistics has a relatively large group of faculty members active in the area of Mathematical Biology who can handle the teaching needs associated with these two courses, therefore no new hires are required. One of the courses, MATH 32xx Mathematical Biology, is a course that will be attractive to students in other programs in the department as well as students in programs in other units on campus. The second course, MATH 42xx Practicum in Mathematical Biology, is a course that does not need to be offered until there is sufficient enrolment in the program; for the time being, an existing course, MATH 4000 Individual Project, can substitute for MATH 42xx. The Dean of the Faculty of Science has indicated strong support for the introduction of the two new courses.

Advising on the requirements of the Mathematical Biology program will be available from the program coordinator. A website for the program will be developed, and this website will include examples of research streams that the students can tailor their degrees towards. The website will be professionally developed so that it is appealing and can be used to advertise the program.

o Registration spaces for students enrolled in the proposed program in courses outside the department, most notably the highly subscribed courses in Biology and Kinesiology

Students enrolled in the proposed program will be required to take prescribed courses in CSE, CHEM, and BIOL, as well as options in BIOL and KINE, many of which have restricted access due to high demand. Both the Department of Biology and the School of Kinesiology and Health Science have indicated strong support for the proposed program and have agreed to open their courses to students in Mathematical Biology.

In developing the proposed program we have solicited feedback from the Department of Biology, the Department of Chemistry and the Faculty of Health. We are very happy to have the support of these programs.

o Supervisory capacity for MATH 42xx Practicum in Mathematical Biology

The new course MATH 42xx is a project-based course, requiring a supervisor from the Department of Mathematics & Statistics and a co-supervisor from an area of application. There is no shortage of projects; these can come from faculty members active in Mathematical Biology, faculty members associated with the Centre for Disease Modelling at York University, and faculty members in the Department of Biology and the School of Kinesiology and Health Science interested in quantitative research. The Mathematical Biology group is sufficiently large to be able to handle to additional supervisory capacity for the research projects. Building co-supervisory capacity from outside the department may be challenging initially (in particular if the pay-off of time invested by researchers is nebulous initially), but provides a real opportunity to build strong and long-lasting interdisciplinary collaborations between researchers from departments across campus. Department chairs and/or Deans may need to put incentives in place to ensure sufficient (co)supervisory capacity for the program until the benefits (in the form of research papers, new collaborations, access to well-trained graduate students, etc.) of the program are well established.

The Mathematical Biology group has existing collaborations across department and faculties already. We see the undergraduate program as a real opportunity to build long-lasting interdisciplinary collaborations between researchers at York University as well. The Dean of Science is very supportive of the program. The Office of the Dean can facilitate linkages between departments when/if necessary.

□□ Appropriateness of the collective faculty expertise to contribute substantively to the program.

The Mathematical Biology group at York University is well established, with a broad range of teaching and research expertise (ranging from medical imaging to epidemiology to bioinformatics and beyond). The proposed program in Mathematical Biology capitalizes on the existing teaching and research strength of the group. All faculty members in the group can contribute substantively to the program.

We agree entirely.

□□ Participation of a sufficient number and quality of faculty who are competent to teach and/or supervise in the program, including qualifications, research, innovation and scholarly record.

Twenty-two faculty members in the Department of Mathematics & Statistics list an interest in Mathematical Biology, to varying degrees, with several individuals in the group maintaining a consistently high-quality research program in the field, with good funding from NSERC, and active in the supervision of graduate students. Collectively, there are more than enough faculty members to develop and deliver a vigorous undergraduate program in Mathematical Biology. Because the group is relatively large, the shared burden of implementing the new program is manageable.

We agree with Dr. de Vries assessment here. We have chosen to propose an undergraduate program in Mathematical Biology as this field has strong ties to many individuals in the department.

☐☐ Evidence that there are adequate resources (e.g. library, laboratory) to sustain the quality of scholarship produced by undergraduate students as well as graduate students' scholarship and research activities.

The library already has the resources required to deliver teaching, learning, and research support for the proposed program. All of the standard reference texts in Mathematical Biology already are in its collections, and access to the leading journals in Mathematical Biology is in place as well. Further, the library has capacity to provide library research skills and information literacy workshops to students enrolled in the proposed program, in particular in conjunction with the two new courses MATH 32xx and MATH 42xx.

No new laboratory resources are needed.

We thank Dr. de Vries for her thorough review.

Additional criteria for undergraduate programs only

☐☐ Evidence of and planning for adequate numbers and quality of: (a) faculty and staff to achieve the goals of the program; or (b) of plans and the commitment to provide the necessary resources in step with the implementation of the program; (c) planned/anticipated class sizes; (d) provision of supervision of experiential learning opportunities (if required); and (e) the role of adjunct and contract faculty.

a) The faculty and staff required to achieve the goals of the proposed program already are in place; no new hires are needed. See comments above.

b) The Dean of Science has expressed strong support for the program, and promised the required resources to introduce the two new required courses, MATH 32xx and MATH 42xx. The Department of Biology and the School of Kinesiology and Health Science have pledged to open their courses to students registered in the proposed program. See comments above.

c) There are no significant changes in class sizes. See comments above.

d) Sufficient supervisory capacity for the new experiential learning experiences through MATH 32xx and MATH 42xx already exists in the Department of Mathematics & Statistics and across York University. See comments above.

e) Although adjunct and contract faculty may participate in the delivery of the proposed program, there is sufficient teaching capacity and expertise in the Department of Mathematics & Statistics. Therefore there is no need to plan for the involvement of adjunct and contract faculty.

We thank Dr. de Vries for her time an expertise in preparing this thorough review.

8. Quality of Student Experience

☐☐ Is there evidence of a program structure and faculty research that will ensure the intellectual quality of the student experience? *Note: Reviews are urged to avoid using references to individuals. Rather, they are asked to assess the ability of the faculty as a whole to deliver the program and to comment on*

the appropriateness of each of the areas/fields of the program that the university has chosen to emphasize, in view of the expertise and scholarly productivity of the faculty.

The program structure is clear. The focus of the program is on ensuring that students obtain a solid foundation in the tools of Applied Mathematics and the opportunity to specialize in a field of application, namely biology (in its broadest sense, from ecology to genetics to immunology and beyond).

The Department of Mathematics & Statistics already has significant research expertise in Mathematical Biology, and is well positioned to develop and deliver the proposed educational program in Mathematical Biology.

The proposed program is very flexible in that students can tailor the program to their own interests, within both the mathematics component of the program and the biology component of the program. By its very nature, the program will challenge the students to bridge two very different disciplines, each with its own intellectual culture. The mathematics requirements in the program are fewer than in traditional programs in mathematics alone. That said, the intellectually challenging courses such MATH 1200 Problems, Conjectures and Proofs, MATH 2001 Real Analysis, and MATH 3410 Complex Variables are not avoided.

Beyond these classic foundational courses in mathematics, emphasis is on courses in Applied Mathematics. The requirements in biology and the requirements of the cornerstone course MATH 32xx Mathematical Biology and especially the capstone course MATH 42xx Practicum in Mathematical Biology then enrich the program. These two courses will provide experiential learning experiences with a focus on research that will surely challenge the students intellectually while socializing them into the field of Mathematical Biology. Several of the faculty members active in Mathematical Biology have a great deal of experience supervising undergraduate summer research students and project-based summer schools aimed at senior undergraduate and beginning graduate students. This experience will translate well to the teaching and supervisory needs in both MATH 32xx and MATH 42xx, promising a high quality educational experience for students.

The program structure has been chosen to provide flexibility to students. Students can choose an area of biology of interest or can opt to generalize. This is an attractive structure as it can accommodate students pursuing careers in many different areas and interests in biology. We have also ensured that academic advising will be available to students to discuss Mathematics and Biology course options (meetings with program and course directors). It is expected that this program will attract a wide range of students considering careers in Mathematical, Medical, Biological or Environmental research, academia, teaching, public health, public health policy, ecology (animal and plant), and practical medicine.

9. Other Issues

Because of the flexibility of the mathematics component of the proposed program, the staff in the Undergraduate Office will be burdened with additional complexity in their role as advisors. It is extremely important to have clear, structured information in the form of webpages and/or handouts

(charts, checklists, etc.) to facilitate advising of students. Advising on the requirements of the biology component of the proposed program should lie with the program coordinator.

A previous draft of the proposal included examples of coherent combinations of courses to fulfill the requirements of the biology component of the program (for example combinations in Biochemistry, Molecular Biology, Immunology and Virology, Animal Physiology, etc.). The information is missing from the final proposal, but should be included on the program webpage. The information would be extremely useful for students already in the program to help them choose their courses wisely, but also for recruitment efforts if only to advertise the richness of possibilities and the flexibility in the program.

Advising on the requirements of the Mathematical Biology program will be available from the program coordinator. A website for the program will be developed, and this website will include examples of research streams that the students can tailor their degrees towards. The website will be professionally developed so that it is appealing and can be used to advertise the program effectively.

10. Summary and Recommendations (*Note: The responsibility for arriving at a recommendation on the final classification of the program belongs to the Appraisal Committee. Individual reviewers are asked to refrain from making recommendations in this respect.*)
N/A

YORK UNIVERSITY

FACULTY OF SCIENCE

Office of the Dean

MEMORANDUM

TO: Rhonda Lenton, Vice-Provost Academic

FROM: Donald Hastie, Dean

DATE: September 11, 2013

SUBJECT: Mathematical Biology – Letter of Support

It is my pleasure to support the proposal for a B.Sc. in Mathematical Biology offered by the Department of Mathematics and Statistics, Faculty of Science and Engineering.

While the curricular additions to the Departments offerings are small (two courses: one 3 credit the other 6 credits) it is the focus of the program that gives it value. The application of advanced mathematical methods in the physical sciences is well established. However, this has not been as true for the life sciences. Recently, with the more quantitative nature of life sciences and the increasing availability of computing power, the need to apply rigorous mathematical methods in this area have increased markedly; bioinformatics, and applying modelling and statistics to health science data are obvious examples. It is this growing area that this proposal seeks to address. The program has collected existing relevant courses into a program with additional courses to produce a coherent program of mathematics applied to biological and health sciences, although I would be surprised if it did not also meet the needs of physical science students.

This program meets the Department's plans to expand in the University priority areas of applied science and health science. The Department is well positioned to run this program immediately as the bulk of the courses already exist and there is a plan to bring the additional courses online. There is faculty strength in this area, particularly from those members of the Centre for Disease Modelling.

The students who graduate from this program will be well positioned for careers in a number of applied areas described in the proposal (general need), or move into mathematics or interdisciplinary graduate programs.

The development of the program will have small resource requirements with the two courses coming online as student numbers demand, and the administration could be covered by existing undergraduate support.

I am excited to see this program come forward from the Department and look forward to supporting its implementation.

DH/ss

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Ray Jayawardhana
Dean

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MEMORANDUM

To: Rhonda Lenton, Vice President, Academic and Provost

From: Ray Jayawardhana, Dean

Date: September 30, 2014

Subject: Proposal for a BSc program in Mathematical Biology

I am pleased to add my strong support for the proposed BSc program in Mathematical Biology, to be offered in the Department of Mathematics and Statistics within the Faculty of Science.

This compelling proposal brings together relevant existing courses (that have additional capacity) with two new course offerings to create a coherent, exciting, interdisciplinary program. Furthermore, it aims to leverage the world-class research strength at York in this area, particularly in the Centre for Disease Modelling, to attract and benefit high-performing undergraduates. The graduates of the program would be well positioned for a wide range of careers and graduate/professional schools. The proposal also advances the Faculty's goals of raising the profile of sciences at York and of recruiting top students, through innovative curricular offerings and experiential learning opportunities.

One concern, also noted by the external reviewer, is the difficulty of assessing student demand. My sense is that it will be possible to reach the anticipated enrollment levels through vigorous promotion of the program, for example, by offering a week-long module in the Faculty-run Helix summer science institute for high school students and workshops on related topics for teachers on campus or as part of professional association meetings (e.g., Science Teachers Association of Ontario annual conference). Elucidating the varied opportunities for graduates of the program, perhaps with data/insights from the Society for Mathematical Biology, may also help.

I appreciate the initiative taken by faculty members in Mathematics and Statistics in developing this excellent program proposal, and look forward to its successful implementation.

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Memorandum

To: Paul Axelrod, Chair, Senate APPRC

From: Rhonda Lenton, Provost

Date: October 8, 2013

Subject: Proposal for a BSc Program in Mathematical Biology

I have reviewed the proposal from the Faculty of Science to introduce a BSc program (Specialized Honours, Honours Major, Honours Minor) in Mathematical Biology, to be housed in the Department of Mathematics & Statistics. This proposal provides an excellent example of how existing resources can be drawn together in innovative ways in order to create programs that address both institutional priorities and demand. The program will expand York's programming and increase our profile in the applied sciences and health, thereby enhancing our comprehensiveness. York is already well known for contributions to research and policy development in this area, primarily through the Centre for Disease Modelling. The program is expected to attract new constituencies of students and respond to demand for mathematical modelling approaches to health sciences in hospitals, universities, industry and government agencies, for example.

Building on the program's mathematics core, students will have flexibility to choose additional courses from the sciences (e.g. biology, chemistry) and health (e.g., kinesiology) to meet their interests. The programs whose courses will be available have indicated that students can be accommodated in those courses. Initial new enrolments of 15 (plus about 10 transfers from other programs) are anticipated, growing to close to 80 after five years. Only two new courses will be required – a 3000-level course specifically on mathematical biology and a 4000-level project course, to be added to the curriculum as enrolments warrant.

Dean Hastie has confirmed that faculty and administrative resources are in place to support this program, as are plans to introduce the new courses in future years.

I am pleased to record my support for this proposal.

Cc: Dean D. Hastie
C. Underhill for ASCP

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Memorandum

To: Rebecca Pillai Riddell, Chair, Senate APPRC

From: Rhonda Lenton, Provost

Date: November 24, 2014

Subject: Proposal for a BSc Program in Mathematical Biology

I have reviewed the proposal from the Faculty of Science to introduce a BSc program (Specialized Honours, Honours Major, Honours Minor) in Mathematical Biology, as well as the reviewer's report on the proposal, the Mathematics & Statistics Department's response, and Dean Jayawardhana's letter of support. As I indicated in my earlier letter, this program effectively draws together two existing fields – and the resources associated with those fields – in innovative ways to highlight York strengths and offer an attractive new program. The reviewer has commented very positively on the design, flexibility and capacity of the program. The issues raised have to do with evidence of demand for the program - from students and as preparation for careers or graduate studies. I believe the Department and the Dean have provided fully satisfactory responses in relation to the anticipated sources of student interest in the program (including from new constituencies) and the steps that will be undertaken to present the program to student audiences. They have also indicated how the program's design will prepare students for a range of careers in the sciences and beyond, as well as for graduate study.

Given this program's importance in relation to York's objectives around increasing its comprehensiveness and growing the sciences, as well as the relatively modest resources associated with its introduction (two new courses), I am happy to record my continued support for this initiative.

Cc: Dean R. Jayawardhana
C. Underhill for ASCP

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OFFICE OF THE UNIVERSITY REGISTRAR

Bennett Centre for Student Services
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Memorandum

To: Jane Heffernan, Mathematics and Statistics
Cheryl Underhill, Secretary, Senate ASCP

Date: December 5, 2014

From: Don Hunt, University Registrar

Subject: **Proposal for a Bachelor of Science Degree in Mathematical Biology**

I am writing in response to the proposal as noted above. Following the submission of the December 2014 revised copy, the Registrar's Office supports a Bachelor of Science Degree in Mathematical Biology.

At this time, there may still be some operational challenges to be addressed; however we look forward to working collaboratively through any implementation issues not foreseen in the review of this proposal.

Thank you for the opportunity to review and comment.

Don Hunt
York University
University Registrar
phone: 416-736-2100 ext 70704
fax: 416-650-8124
Partners in Student Success

Major Modification
Establishment of a Co-Op Option for BEng and BSc Programs

1. **Programs:**
   Civil Engineering
   Computer Engineering
   Electrical Engineering
   Geomatics Engineering
   Mechanical Engineering
   Software Engineering
   Space Engineering
   Computer Engineering
   Earth Science (BSc)
   Atmospheric Science (BSc)

2. **Degree Designation:** BEng or BSc/BSc (specialized honours)

3. **Type of Modification:** Introduction of a Co-Op Option

4. **Effective Date:** Summer 2015

5. **Provide a general description of the proposed changes to the program.**

This proposal is for the creation of a Co-Op option that can be associated with any of York University's BEng programs and the selected science (BSc) programs listed in (1). It provides the framework for students to complete a co-op program which:

- includes at least twelve months of employment, normally paid;
- comprises at least two periods of work, interspersed with study;
- begins and ends with academic study periods at the University.

The Lassonde School of Engineering will offer the program together with the Career Centre, building on the successful Technology Internship Program (TIP) used by Lassonde students and others over the last decade.

The co-op program is proposed as an Option so that a single structure can be implemented for all associated programs, while allowing a student's participation in the program to be recorded on their transcript.

6. **Provide the rationale for the proposed changes.**

In co-operative education, students alternate their academic studies with periods of paid work experience.

Co-operative Education gives students an opportunity to test skills learned in the classroom, and to expand their knowledge through related work experience.
(Canadian Association for Co-operative Education, http://www.cafce.ca/en/about-us-benefits retrieved 11Sep2013)

Additionally, employers benefit from early access to tomorrow's highly talented individuals, and universities receive essential feedback on the quality of their academic programs.

Co-op is in high demand from students and their parents, with availability of co-op being one of the most frequently asked questions at recruiting and information events.

Lassonde co-op will combine the best of both co-op and internship style experiential education. From more than a decade's experience of operating a highly successful internship program, we recognize the value of a longer work period to both students and employers, in particular the greater responsibility the student can be assigned. We also recognize the value of more than one period of work experience, integrated across the academic curriculum. Born of this understanding, Lassonde's co-op program will offer the advantages of both multiple periods of work and the longer duration. It will comprise at least 4 months of work before 3rd year, and a continuous period of at least 8 months after 3rd year, for a total of 12-16 months of work experience.

Students will receive career skills workshops in preparation for their jobs, on-the-job evaluation and workplace monitoring by work managers and university staff, and assessment of work reports by academic staff.

Most other co-op programs do not provide a strong link back to the academic curriculum. In Lassonde’s case, participants will complete two online two-credit courses based on the preparation and evaluation of an electronic professional portfolio (e-Portfolio) in order to maximize the learning benefits achieved by interleaving work and study.

A feature of Lassonde co-op will be its focus on small, entrepreneurial employers. In keeping with Lassonde's focus on entrepreneurship, student entrepreneurs will have the opportunity to do co-op at their own start-up companies. More than 40% of Ontario's economic activity is generated by SMEs (with < 500 employees) and 47% of all Ontario's SMEs are located in the Greater Toronto Area. The region around York University is therefore a hub for entrepreneurial businesses. These businesses provide a wealth of business and engineering opportunities for our students, and we will work with community business partners to facilitate co-op employment in this vital but untapped sector.

A key characteristic of the Renaissance Engineer™ is an understanding of the social context of his or her work. In this regard, the Lassonde School of Engineering shares York University's commitment to social responsibility and celebrates the important contributions engineers make to social, development, environmental, and other not-for-profit agencies. We seek to establish a fund to compensate engineering students who wish to complete some or all of their co-op experience at such organizations, and to cover WSIB contributions.

For those students contemplating graduate school, working as paid research assistants in professors’ research laboratories is also possible. Working abroad will also be encouraged.

While the academic programs include many opportunities to students to gain practical experience through laboratories, projects and extracurricular competitions, it is widely acknowledged that the incorporation of work experience into the curriculum benefits students, employers and society.

However, the multiple periods of work featured in co-op programs allow students to integrate their work experience and academic knowledge on an ongoing basis, rather then in one period. Co-op also encourages students to broaden their experience by working with more than one employer. On a practical side, the earlier work opportunity provided by co-op employment allows students to spread their earnings more evenly throughout their studies.

The popularity and impact of co-op/internships are revealed by surveys of university graduates:

- 48% of students have some sort of work experience as part of their program
- 73% said the experience contributed very much to their personal development.[1]

A Lassonde co-op program provides an excellent vehicle for promoting and developing some of our core initiatives, such as entrepreneurship and practical experience. It also provides an opportunity to distinguish ourselves from other local engineering programs. Ryerson University offers co-op for only one engineering program while the University of Toronto focuses on their Professional Experience Year and summer internships. Other universities (Waterloo, Guelph, McMaster) offer well-developed co-op engineering programs.

Surveys of all first-year students show that 32% chose a university program primarily because of the availability of co-op or internship. This figure rises for engineering students, of whom 58% deem co-op or internships very important for their choice of university.[2]

7. Comment on the alignment between the program changes with Faculty and/or University academic plans.

Within the York University context, experiential education, and co-op in particular, has been identified as a key strategic goal:

- *Expanding experiential learning opportunities available to students at all levels (including co-op, internships, community-based learning, problem-based learning, etc.) [York University Academic Plan 2010-2015];*
- *Over the next decade, there will be a significant increase in opportunities for students to participate in an experiential education activity, both domestically and internationally, as a component of their degree program. [Priority 7, 2009 Provostial White Paper].*

This proposal to establish a co-op option therefore aligns well with both the internal and external contexts for engineering education.

By partnering with reputable organizations in Canada and around the world, and by integrating high-quality work experiences into an internationally and entrepreneurial focused program, Co-op will meet several of York's objectives, outlined in the Strategic Directions for York University 2010-2020, for building a more engaged community:

- Promoting Quality in the Student Learning Experience- understanding that "students learn and succeed in different ways" and helping them develop "fundamental and

1 Canadian University Survey Consortium 2012 Graduating Student Survey

2 Both statistics from the Canadian University Survey Consortium 2013 First Year Student Survey

transferable skills including effective communication, critical thinking, research and information literacy, and collaboration"
- Promoting Quality through Internationalization- "Ensure that all York students have opportunities to gain a genuine international experience and enhanced global understanding" (p 67)
- Promoting Quality through Community Engagement

8. **Provide a detailed outline of the changes to the program and the associated learning outcomes, including how the proposed requirements will support the achievement of program learning objectives (i.e., the mapping of the requirements to the program learning outcomes).**

Because co-op is presented as an optional add-on to the core degrees, there are no changes to the UUDLES for the programs. The co-op option has its own learning outcomes: the following are adapted from the National Commission for Cooperative Education[3]: On completion of the co-op option, students will be able to:

Academic Outcomes
- Demonstrate the ability to integrate classroom knowledge with workplace practice;
- Develop greater clarity about their academic goals;
- Articulate how university study is applicable in practice;
- Improve their technical competence by learning from their practical experience;
- Demonstrate how they meet the graduate attribute requirements of the Canadian Engineering Accreditation Board.

Professional Outcomes
- Develop greater clarity about their career goals;
- Be productive members of the workplace;
- Demonstrate improved workplace competencies;
- Learn and apply new or advanced workplace skills;
- Display a knowledge of the professional of engineering end its regulation.

Personal Outcomes
- Exhibit an increased sense of personal responsibility and maturity;
- Determine their own strengths and weaknesses;
- Demonstrate enhanced interpersonal and communication skills;
- Develop citizenship and lifelong learning skills.

9. Summarize the consultation undertaken with relevant academic units, including commentary on the impact of the proposed changes on other programs. Provide individual statements from the relevant program(s) confirming consultation and their support.

The proposed co-op option has a direct impact only on the Career Centre, in its role of administering the existing Technology Internship Program. Staff from the Career Centre have been involved, consulted and informed throughout the Co-Op proposal development.

3 Quoted in *Learning Outcomes: the educational value of cooperative education*, C. Cates & P. Jones 1999, p.54.

Detailed consultations and approvals are as follows:

Approvals:

- Framework endorsed by the Engineering Management and Planning Committee, 7 March 2012
- Information at Council of Lassonde School of Engineering, 10 September 2013
- Department of Earth and Space Science and Engineering approval 24 September 2013
- Department of Electrical Engineering and Computer Science, 10 October 2013
- Lassonde Learning, Curriculum and Students Committee, 30 October 2013
- Lassonde Committee on Policy, Academic Resources and Research, 14 November 2013
- Lassonde Faculty Council

Consultations:

- Career Centre and Technology Internship Program staff
- Experiential Education Working Group
- Faculty of Science

10. Are changes to the program's admission requirements being proposed coincident with the program change(s)? If so, outline the admission changes, and comment on the appropriateness of the revised requirements to the achievement of the program learning outcomes.

No changes to the program admissions requirements are proposed.

11. Describe any resource implications and how they are being addressed (e.g., through a reallocation of existing resources). If new/additional resources are required, provide a statement from the relevant Dean(s)/Principal confirming resources will be in place to implement the changes.

The Co-Op Option is designed to operate in cost-recovery mode, in which expenses (primarily staff salaries) are offset by (i) an associated course fee for zero-credit COOP X109 work-term courses in which students enroll while they are working (as is currently the case for the Technology Internship Program) and (ii) tuition from the two-credit professional development courses, COOP 2100, 3100. Academic and advising staff will be recruited as necessary to serve enrolment. Hence while there may be a significant cash *flow* associated with the Option, the underlying resource requirement will be relatively limited.

12. Is the mode of delivery of the program changing? If so, comment on the appropriateness of the revised mode(s) of delivery to the achievement of the program learning outcomes.

No changes are proposed to the mode of delivery of the existing degrees. However, the Co-Op Option does include two professional development courses (COOP 2100, 3100) designed to integrate work experience and academic study and provide the opportunity for structured reflection. These courses will be offered entirely online.

13. Is the assessment of teaching and learning within the program changing? If so, comment on the appropriateness of the revised forms of assessment to the achievement of the program learning outcomes.

The co-op option is intended to be available to all students in good standing (5.0 GPA) in the relevant programs, but is not a mandatory requirement. This reflects feedback from students who, for example, do not wish to interrupt long-standing relationships with existing employers to participate in co-op, while others seek to complete their degrees and enter the workforce in the shortest possible time.

Once a student satisfies the requirements for enrolment in the work-term portion of the Option, s/he will attend a series of preparatory workshops focusing on resume preparation, interviews and other job-finding skills. Upon completion of these workshops, students will gain access to the online job-posting site and can apply for positions. Employers carry out interviews to determine which co-op students they will employ.

Co-op terms will be recorded by the zero-credit LE COOP 2109/3109/4109 sequence. The course framework provides a mechanism for recording work-terms on a student's transcript as well as for collecting associated course fees. The courses are taken on a pass/fail basis, with the student's performance based on feedback from the employer and an assessment by academic staff of a report written by the student. Students can enroll in each of these courses multiple times according to their year level and the number of work-terms. Students must pass three of them (e.g., 2109 + 3109 twice, or 2109, 3109, and 4109) to complete the Co-op option. Failure in COOP X109 would result in that work term not counting towards completion of the Co-op Option. If this is for academic reasons (e.g., inadequate report) the requirements can be repeated; failure due to non-completion of the work period itself will be assessed on a case-by-case basis to determine the circumstances (performance related, employer related, illness, etc).

An additional requirement for co-op students will be the successful completion of two 2-credit online professional development courses to be taken during their first and last work-terms. The goal of these courses is to achieve an improved integration of the work experience with the academic curriculum.

- LE/COOP 2100 2.0 (WT1): Transition to the workplace; preparing an e-Portfolio
- LE/COOP 3100 2.0 (last WT): evaluation of e-Portfolio; reflection topics based on graduate attributes (answered with reference to e-Portfolio)

Note: Qualifying work-terms after second year count towards experience requirements for licensure as a Professional Engineer.

14. Provide a summary of how students currently enrolled in the program will be accommodated.

Students currently in year 1 or Year 2 of the programs will have the opportunity to enroll in the Co-op Option. Students in later years will not be able to complete all requirements of the Option and will be offered the opportunity for work experience through an internship program.

15. Provide as an appendix a side-by-side comparison of the existing and proposed program requirements as they will appear in the Undergraduate or Graduate Calendar.

The Co-op Stream is an add-on option to the existing undergraduate Engineering programs. Please refer to academic calendar for undergraduate engineering programs.

A student's progress through the Co-op Option is summarized below (for an engineering student):

Milestone	Comments
72 credits for engineering and 60 credits for science of academic study	Co-op students will effectively have finished 2nd year
Meeting co-op requirements and enrolment	Good standing (a GPA of 5.0) in an engineering/science program
Preparatory workshops	Resume preparation, interview skills offered by the Career Centre.
Finding and securing the position	Positions posted on job site, interviews conducted by employers
First work period (typically 4 months)	Telephone follow-ups, employer and employee evaluations, graded work-term report
	Online professional development course, COOP 2100 2.0 Professional Development for Co-Op Students
At least 30 credits of academic study	A co-op program requires at least two periods of work, separated by study
Second work period (at least 8 months)	A co-op program requires at least 12 months' of work experience
	Online professional development course, COOP 3100 2.0 Critical Reflection on Work Experience using Professional Portfolios
Final academic study period, at least 9 credits	A co-op program requires a period of study after the last work period
	In-person de-brief to share experiences with faculty, staff & incoming co-op students
Graduation from the Engineering / Science program with co-op option	Completion of co-op experience noted on transcript, and letter of recognition issued by the School.

Richard Hornsey, 11 December 2014

Responses to questions concerning Lassonde's Co-op Option raised by ASCP at its 10 December 2014 meeting.

Note: Many of these issues were addressed in the original co-op option proposal presented at ASCP back in January (22 January 2014). However in adhering to the major modification template, some sections of that proposal were omitted. Below, quotes from that proposal are italicized.

With respect to the possibility that students will have the opportunity to fulfill the co-op placement at their "own start-up companies", how would the potential conflict of interest be managed, and who would provide the oversight/assessment function in such scenarios?

From the original proposal: *"The evaluation of co-op students who form their own companies must differ slightly from those working with arms-length employers. In particular the elements of feedback normally completed by a student's direct manager will need to be performed by representatives of the co-op program and will include feedback from clients of the company. It is envisioned that these entrepreneurial students will be receiving support and advice from the Lassonde School of Engineering (including adherence to appropriate regulations), and so feedback from those advisors can take the place of the normal manager's report."*

Student-led companies will have mentors, either from the entrepreneurship staff in Lassonde or through other new venture organizations such as MaRS, Next 36, Venturelab, or InnovationYork. These mentors will verify that the co-op formalities are observed.

How many students are projected to pursue the Co-op option; what are the initial and steady-state numbers?

We have modelled scenarios ranging from 50 students to 400. The operation is fully scalable to adjust to the actual enrolment. Our expectation is 40 students in the Summer 2015 pilot phase, increasing to a steady state of 100 – 150 (out of a projected 450 eligible students).

Are all of the possible work placement options paid positions?

Yes. This is expected for engineering and science co-op programs and is the practice for the current Technology Internship Program.

Fuller information on how the work placements will be supported.

From the original proposal: *"administrative staff … are allocated at a staff-to-student ratio of 1:100, in two categories:*

- *to provide services (follow-up, monitoring, etc) to students already out on work assignments*
- *to administer the program (recruit new employers, post positions, run workshops, assist prospective students)."*

Support of students while on work terms is modelled after the TIP program. Staff members follow up with the student and his/her manager on several occasions in each four-month work term. At the end of each four-month period, both student and manager are asked to complete an evaluation, which is also implemented by members of staff. Students also complete a brief work

term report for the zero-credit COOP2109/3109/4109 courses which are used to determine a pass/fail grade and are assessed by an academic work term coordinator.

Pre-employment resume and interviewing workshops are being offered by the Career Centre.

The Summer 2015 pilot phase will be run by Marvin James, Lassonde's co-op coordinator and industry liaison. As enrolments grow, staff requirements will also increase proportionally. The program is designed to reach cost recovery after approximately four years.

With respect to the scheduling of curriculum in the engineering programs, will students completing a four-month work placement be out of sync with the course offerings when they return to studies? If so, how would that affect their degree progress and what options exist for them?

From the original proposal: "*We recognize that students progress through the academic program at different rates, and therefore will meet the various co-op milestones at different times, and with different courses completed (although still meeting the appropriate gatekeeping requirements).*

This has two main consequences. Firstly, students will need to enter the co-op program each term, so preparatory workshops and work-terms must be offered every September, January and May. Secondly, because students also return to the University at various times of the year, there will be no fixed cohort around which to base course timetabling. Hence the timing of course offerings cannot be adjusted specifically to fit around co-op (although multiple offerings of key courses throughout the year are likely once engineering student enrolments reach targets). The current TIP program operates successfully in this way."

So in practice, a student may take work terms whenever they like, subject to the basic gatekeeping requirements of the program (appropriate numbers of credits, GPA, two periods of work, etc). There is therefore plenty of flexibility for students to start when they choose and to pursue work periods (4, 8 , 12, 16 months) that fit with their course schedule. This will be part of their academic advising.

liberal arts & professional studies | YORK UNIVERSITÉ UNIVERSITY

Bachelor of Arts - Department of Languages, Literatures and Linguistics: Portuguese Studies

Effective session of change: Fall 2015

Portuguese Studies is proposing to **Change the Name of the Program of Portuguese Studies to *Portuguese and Luso-Brazilian Studies***

Rationale

Courses in Portuguese language have been taught in the Department of Languages, Literatures and Linguistics since 1986. In 1993, the *Instituto Camões* began funding Visiting Lecturers in Portuguese Language to teach courses in Portuguese in the Department. These visiting instructors and their courses were overseen by the Director of Undergraduate Programs (Languages and Literatures). When a memorandum of agreement to establish a program in Portuguese Studies was signed between the *Instituto* and the University in 2005, the University for its part authorized a Contractually Limited Appointment. It's incumbent, Maria João Dodman (now a tenured associate professor), created courses in Lusophone literature and culture, taught both in Portuguese and English, building a base of students to enrol in the Portuguese Studies Honours Minor and Three-Year B.A. Programs, inaugurated on July 1, 2008. The first majors graduated in June, 2009.

Program Mission:

The Portuguese Studies program's mission statement is to educate students about the Lusophone world, including its language, its cultures and literary expressions. We prepare students for advanced study in those disciplines, as well as for practical application of their acquired skills and knowledge in a wide variety of fields, such as education, business, and international studies. We seek to achieve these goals through diverse course offerings that engage students in innovative and relevant research methodologies and critical thinking skills. Students gain socio-cultural and intercultural competence, allowing them to connect with and acquire a deeper understanding of, the historical, literary, cultural and linguistic perspectives that inform the richly varied nature of the entire Lusophone world.

For all these reasons, the program's current title does not reflect its courses' breadth and its truly Lusophone character. With the exception of Portugal, Portuguese-speaking countries do not culturally identify themselves as Portuguese, but rather as Lusophone, a term more widely accepted.

Proposed Name Change and Consultations:

Upon careful consideration of all proposals, the program decided that the terms **Portuguese**, **Luso** or **Lusophone** and **Brazilian** must be included in the new name. Thus, the proposed new name for the program is ***Portuguese and Luso-Brazilian Studies***. The reasons for this choice are explained as follows:

• ***Portuguese:*** expresses the program's appreciation of the unifying language of eight countries in their shared historical and foundational linguistic backgrounds. It supports our commitment to our international Portuguese Partner (the *Instituto Camões*), to our communities (the large Portuguese community in Canada and especially in the GTA), and to our Portuguese-speaking heritage students.

• ***Luso:*** meaning Lusophone, names the program's commitment to interdisciplinary and internationalization which includes course offerings representative of the entire Portuguese-speaking world beyond Portugal.

• ***Brazilian:*** specifies (1) the program's strategic development towards strengthening our ties with the growing Brazilian communities in the GTA; (2) our commitment to Brazilian studies through course offerings and research in the area; (3) our participation in LACS and in the Brazil Studies Seminars.

Degrees, Certificates and Diplomas Offered by York University

Degrees

Faculty of Liberal Arts & Professional Studies
Bachelor of Administrative Studies
Bachelor of Administrative Studies (Honours)
Bachelor of Arts
Bachelor of Arts (Honours)
International Bachelor of Arts (Honours)
Bachelor of Disaster & Emergency Management
Bachelor of Disaster & Emergency Management (Honours)
Bachelor of Human Resources Management
Bachelor of Human Resources Management (Honours)
Bachelor of Public Administration (Honours)
Bachelor of Social Work (Honours)

Faculty of Education
Bachelor of Education
Bachelor of Education, Indigenous Teacher Education Program (ITEP)
Bachelor of Education (Technological Education)

Faculty of Environmental Studies
Bachelor in Environmental Studies
Bachelor in Environmental Studies (Honours)

School of the Arts, Media, Performance & Design+
Bachelor of Arts
Bachelor of Arts (Honours)
Bachelor of Fine Arts (Honours)
Bachelor of Design (Honours)

Glendon College / Collège universitaire Glendon
Bachelor of Arts
Bachelor of Arts (Honours)
International Bachelor of Arts (Honours)
Baccalauréat ès arts
Baccalauréat ès arts (Spécialisé)
Baccalauréat international ès arts (Spécialisé)

Faculty of Graduate Studies*
Doctor of Philosophy
Master of Accounting
Master of Applied Science
Master of Arts
Master of Business Administration
Master of Business Analytics+
Executive Master of Business Administration
International Master of Business Administration
Master of Conference Interpreting
Master of Design
Master of Disaster and Emergency Management Degree
Master in Environmental Studies
Master of Education
Master of Fine Arts
Master of Finance
Master of Financial Accountability
Master of Fitness Science
Master of Human Resources Management
Master of Kinesiology
Master of Laws
Master of Public Administration
Master of Public and International Affairs
Master of Public Policy, Administration & Law
Master of Science
Master of Science in Nursing
Master of Social Work

Faculty of Health
Bachelor of Arts
Bachelor of Arts (Honours)
Bachelor of Science
Bachelor of Science (Honours)
Bachelor of Health Studies
Bachelor of Health Studies (Honours)
Bachelor of Science in Nursing (Honours)

Lassonde School of Engineering
Bachelor of Engineering
Bachelor of Applied Science (Honours)
Bachelor of Arts
Bachelor of Arts (Honours)
International Bachelor of Arts
International Bachelor of Arts (Honours)
Bachelor of Science
Bachelor of Science (Honours)
International Bachelor of Science (Honours)

Faculty of Science
Bachelor of Arts
Bachelor of Arts (Honours)
Bachelor of Science
Bachelor of Science (Honours)
Bachelor of Science (Technology)
International Bachelor of Arts
International Bachelor of Arts (Honours)
International Bachelor of Science (Honours)

Osgoode Hall Law School
Bachelor of Laws/*Juris Doctor*

Schulich School of Business
Bachelor of Business Administration (Honours)
International Bachelor of Business Administration (Honours)

**Master or Magisteriate / Doctor or Doctorate*

Certificates and Diplomas

Faculty of Liberal Arts and Professional Studies

Advanced Certificate in Hebrew and Jewish Studies
Advanced Certificate in Professional Accounting
Advanced Certificate in Gender and Women's Studies
Certificate in Geographic Information Systems (GIS) and Remote Sensing
Certificate in Non-Profit Management
Certificate in Professional Ethics
Certificate in the Teaching of English to Speakers of Other Languages
Certificate of French Language Proficiency (Basic, Intermediate and Advanced)
Certificate of French Language Proficiency in Business (Basic, Intermediate and Advanced)
Certificate of Language Proficiency in Modern Greek
Certificate of Language Proficiency in Portuguese
Certificate of Language Proficiency in Spanish Language
Certificate of Proficiency in Chinese Language
Certificate of Proficiency in German Language
Certificate of Proficiency in Italian Language (Beginner, Intermediate and Advanced)
Certificate of Proficiency in Japanese Language
Certificate of Proficiency in Modern Hebrew Language+
Cross-Disciplinary Certificate in Anti-Racist Research and Practice
Cross-Disciplinary Certificate in Indigenous Studies
Cross-Disciplinary Certificate in Sexuality Studies
Cross-Disciplinary Certificate in South Asian Studies
General Certificate in Law and Society
General Certificate in Practical Ethics
General Certificate in Refugee and Migration Studies
General Certificate in Gender and Women's Studies
General Certificate in Urban Studies
Professional Certificate in Accounting
Professional Certificate in Emergency Management
Professional Certificate in Financial Planning
Professional Certificate in Health Services Financial Management
Professional Certificate in Human Resources Management
Professional Certificate in Human Resources Management for Internationally Educated Professionals
Professional Certificate in Information Technology Auditing and Assurance
Professional Certificate in Investment Management
Professional Certificate in Logistics
Professional Certificate in Management
Professional Certificate in Marketing
Professional Certificate in Public Administration & Law
Professional Certificate in Public Policy Analysis
Professional Certificate in Real Estate

Faculty of Education

Certificate in Educational Studies
Diploma in Teacher Preparation in the Education of Deaf and Hard-of-Hearing Students

Faculty of Environmental Studies

Certificate in Geographic Information Systems and Remote Sensing
Certificate in Sustainable Energy
Cross-Disciplinary Certificate in Community Arts Practice
Cross-Disciplinary Certificate in Urban Ecologies
General Certificate in Refugee & Migration Studies

School of the Arts, Media, Performance & Design

Professional Certificate in Digital Design
Cross-Disciplinary Certificate in Community Arts Practice
Cross-Disciplinary Certificate in Digital Media
Disciplinary Certificate in Dance Science

Glendon College / Collège universitaire Glendon

Bilingual Certificate in Public Administration and Public Policy
Certificat en rédaction professionelle
Certificate in Bilingualism, French & English
Certificate in English/Spanish, Spanish/ English Translation
Certificate in Law and Social Thought
Certificate in the Discipline of Teaching English as an International Language
Certificate of Bilingual Excellence
Certificate of Trilingual Excellence
Cross-Disciplinary Certificate in Sexuality Studies
General Certificate in Refugee & Migration Studies
Proficiency Certificate in Technical & Professional Communication

Faculty of Graduate Studies

Diploma in Advanced Hebrew and Jewish Studies (Type 2)
Diploma in Arts and Media Administration (Type 2)
Diploma in Asian Studies (Type 2)
Diploma in Business and the Environment (Type 2)
Diploma in Comparative Literature (Type 2)+
Diploma in Curatorial Studies in Visual Culture (Type 2)
Diploma in Democratic Administration (Type 2)
Diploma in Early Childhood Education (Type 2&3)
Diploma in Education in Urban Environments (2&3)

Diploma in Environmental/Sustainability Education (Type 2 & 3)
Diploma in Financial Engineering (Type 2 and 3)
Diploma in Interpreting (Type 1)
Diploma in German and European Studies (Type 2)
Diploma in Health Industry Management (Type 2)
Diploma in Health Psychology (Type 2)
Diploma in International & Security Studies (Type 2)
Diploma in Jewish Studies (Type 3)
Diploma in Justice System Administration (Type 2)
Diploma in Language, Literacy and Education (Type 2 & 3)
Diploma in Latin American and Caribbean Studies (2)
Diploma in Mathematics Education (Type 2 and 3)
Diploma in Neuroscience (Type 2)
Diploma in Non-Profit Management (Type 2)
Diploma in Post-Secondary Education: Community, Culture and Policy (Type 2 & 3)
Diploma in Real Estate and Infrastructure (Type 2)
Diploma in Refugee and Migration Studies (Type 2)
Diploma in Theatre Studies (Type 3)
Diploma in Value Theory and Applied Ethics (Type 2)
Diploma in Voice Teaching (Type 2 and Type 3)
Diploma in World Literature (Type 2)+
Post-M.B.A. Graduate Diploma in Advanced Management (Type 3)

Faculty of Health
Cross-Disciplinary Certificate in Health Informatics
Certificate in Psychometrics
Professional Certificate in Athletic Therapy
Professional Certificate in Fitness Assessment and Exercise Counselling
York-Seneca Rehabilitation Services Programme Certificate

Lassonde School of Engineering
Certificate in Geographic Information Systems (GIS) and Remote Sensing
Certificate in Meteorology

Schulich School of Business
Certificate in Managing International Trade and Investment

Access/Bridging Programs
Transition Year Program Certificate of Completion
Certificate of Completion in Educational Studies
College - University Accounting Bridge Program Certificate of Completion

+New for 2014-2015
Updated: September 2014

University Program Approval Process

Senate

22 January 2015

Updates to University Program Approval Process

The Deans were provided with the copies of documents sent by the Ministry in October and November 2014.

Who needs to know?

- Deans and Associate Deans,
- Administrative Officers/Assistants involved with Curriculum Planning
- ASCP and APPR Senate committees
- Joint Sub-committee on Quality Assurance
- OIPA
- Vice-President Finance & Administration
- OSAP office

Updates - overview

1. Evaluation Criteria and Information
2. Review Process
3. Review Timelines
4. Program Development Reports
5. Future Program Growth Discussion
6. Programs offered at New Locations
7. Areas of Ongoing Review
8. Collaborative or Joint Programs (PSECE)
9. Invitation to comment on submission – criteria
10. Accredited Programs

1. Evaluation Criteria and Information

- SMA alignment;
- Proposed tuition fee (including institutional and sector comparators);
- Costs (including program financing consideration and capital cost implications);
- Justifiable duplication;
- Societal need and labour market demand;
- Student demand;
- Enrolment planning and graduate allocations;
- Experiential learning; and
- Program prioritization/ program transformation initiatives

2. Review Process

- Expedited Review
- Secondary Review

3. Review Timelines

The Ministry is establishing a cycle with the following submission deadlines:

Submission Deadline	Target Dates for Decisions for Expedited Submissions
November 3, 2014	March 2, 2015
January 12, 2015	May 11, 2015
April 13, 2015	August 10, 2015
July 13, 2015	November 9, 2015
November 2, 2015	March 7, 2016

4. Program Development Reports

Updated Program Development Report for 2014-15 includes both:

- Current report focuses on restructured, merged, and closed programs;
- **New:** Report requires a three year program development plan

5. Future Program Growth Discussion

Meetings with the Ministry to discuss future program growth plans.

6. Programs at New Locations

- Programs offered at new locations – the same or lower tuition fee as the original program

7. Areas of Ongoing Review (Ministry)

- Checking list of the core programs to ensure relevance
- Improving labour market information
- Clarifying types of changes that require approval (addition co-op, translation into French, undergraduate certificates)

8. New Collaborative or Joint Programs

Universities are reminded that in circumstances where a degree, certificate, and/or diploma program is jointly delivered, the college portion of the program must be submitted for the appropriate approval simultaneously with the university approval, if it was not previously approved.

9. Invitation to comment on submission – criteria

The Ministry releases a list of submitted programs and all publicly assisted colleges and universities are invited to comment, within 30 days, on possible duplication, demand, workplace opportunities.

10. Accreditation

The Ministry has to be notified about accreditation status for any approved program.

How to support the changes?

- Resource Binder/Website
  - ✓Communications from MTCU
  - ✓Schedules for core/ non core undergraduate programs
  - ✓MTCU check lists
  - ✓Revisions to YUQAP templates

What has to happen immediately?

- Deans to be advised about the invitation to comment on new program submission
- Deans to be advise on need to develop a 3 year-plan (include 2014-15 to end of SMA)
- Deans to use Notice of Intention when supporting a new initiative

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Q&A?

ACADEMIC POLICY, PLANNING & RESEARCH COMMITTEE

Report to Senate
at its meeting of January 22, 2015

1. Planning Cycle for January to June

With the advice of its Technical Sub-Committee, APPRC has finalized the planning cycle for the remainder of the academic year. The key milestones for the Committee and Senate in the months ahead are as follows:

- briefing on the new SHARP budget model (January / February)
- discussions with the Deans, Principal and University Librarian in February and early March (a copy of the invitation is attached as Appendix A)
- an open planning forum on April 23 – please save the date – on academic priorities at which a draft Institutional Strategic Direction document will be in scope
- in May, a recommendation to Senate to endorse or approve in principle the Institutional Strategic Directions document's academic components and the Provost's annual report on planning progress and initiatives
- submission of a summative report on the attainment of UAP objectives and the Vice-President Finance and Administration's spring budget update (June)

2. Institutional Strategic Directions Document and Senate

Faculties are in the process of preparing responses to recommendations of the Academic Task Force of AAPR or developing an agenda of concerns based on consultations. Responses from Faculties will form the basis of an Institutional Strategic Directions document which will, together with other discussions such as the annual engagement with Faculty planners, feed into the UAP renewal process. The document will be discussed at an April planning forum and in other forums, and will come to Senate for endorsement or approval in principal in the manner of the Provostial White Paper of 2010.

3. Recommendations of the AAPR Academic Task Force

In November APPRC reported to Senate that it would review recommendations 2-33 of the Academic Task Force report to determine if there were actionable matters raised (such as those referencing quality assurance, Organized Research Unit policy, and planning in general):

> "The Academic Task Force deeds thirty-three recommendations. The first of these has attracted the most attention and concern to date. However, there are others in which Senate has a direct stake or indirect interest. Some are explicitly grounded in the UAP or touch on Senate policies such as those governing ORUs or quality assurance. Some refer to matters that Senate committees have previously expressed themselves on or have flagged for action. APPRC plans to review the recommendations to see if and how

they might be framed for Senate consideration. (Excerpt from the APPRC report to Senate of December 2014)

Some of the recommendations appear to be ready-made for consideration by other Senate committees or sub-committees – such as those that apply to quality assurance or to ORUs – in conjunction with Vice-Presidents or their associates. Some would benefit from a response by the Provost and others prior to discussion by APPRC. As a result, APPRC is developing an action plan for the consideration of recommendations which it will share with Senate.

4. **Approval of Endowed Chair: James and Joanne Love Chair in Environmental Engineering**

APPRC has concurred with the Provost's recommendation to establish the James and Joanne Love Chair in Environmental Engineering. The Provost's correspondence is attached, along with details about the Chair provided by Lassonde. For greater certainty, the Provost emphasized that the donation agreement does not include any restrictions whatsoever, and will in no way undermine the academic freedom of incumbents or bar the creation of other chairs in the area of Environmental Engineering.

Endowed chairs and professorships are formally approved by the Board of Governors following action by APPRC. APPRC has advised the Board of its concurrence.

A priority for the Committee this year is to recommend amendments to the Board-Senate policy governing the establishment of chairs and professorships.

Documentation is attached as Appendix B.

5. **Referral the Full Committee re Briefing on the University Finances**

The Chair and Secretary received an analysis of the University's financial statements by two faculty members together with a suggestion from a Senator that APPRC should consider scheduling a briefing by these individuals on an alternative perspective on financial statements. This idea was referred to the Technical Sub-Committee, which advised against taking up the matter directly. APPRC's mandate focuses on academic resources matters and accountability for the allocation to academic activities rather than finances *per se*. YUFA and administration are continuing to discuss the University's finances through their own structures and processes (notably the Financial Information Sub-Committee). APPRC and Senate are open to questions and information sharing that bear on their mandates, and there are regular opportunities to explore aspects of the budget, especially in the context of the Vice-President Finance and Administration's report. Senate will also have an opportunity to discuss the impact of the SHARP model in the near future.

6. **Welcome to New Members**

The Committee was pleased to welcome its newest members at its meeting of January 8: Gayle McFadden, the YFS Senator; Sharon Murphy, Professor in the Faculty of Education; and Houman Tahmasebi, BSc Candidate in Biology.

Rebecca Pillai Riddell, Chair

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Memo

To: Deans, Principal and University Librarian

From: Rebecca Pillai Riddell, Secretary, Academic Policy, Planning and Research Committee of Senate

Date: January 9, 2015

Re: **APPRC Meetings with Academic Planners**

I am writing on behalf of APPRC to formally invite you to participate in a round of planning discussions that is, as you know, a prominent feature of Senate's annual planning cycle.

This year's discussions come at an especially important moment for academic planners throughout the University. They coincide with a variety of other internal initiatives related to research intensification, strategic enrolment management – critical to both recruitment and retention – and reputation-building. Of course they are also set against a backdrop that includes the following contexts:

- the release of the AAPR task force reports and the information that has been gathered and assessed during the process
- the advent and implementation of the SHARP budget model
- notable external factors such as marked shifts in program choices, a differentiation agenda propelled by governments, continuing resource challenges, and continuing attention to curriculum, teaching and learning, student success and the student experience
- preparation of new Integrated Resource Plans, and the pending renewal of the University Academic Plan.

As always, there are also more enduring factors for planners to consider, especially the need to pursue the overarching theme of quality in the current UAP.

In anticipation of your visit, we ask that you respond in writing to the following questions.:

As a University we are facing both pressures internally (e.g. enrollment, student satisfaction, limited funding) and externally (e.g. differentiation pressures, limited funding, competing universities). Thinking of current and future initiatives, and about planning priorities in the years ahead:

a) What collegial processes and strategies have you utilized that are helping you to pursue the quality imperatives of the current University Academic Plan?

b) What priorities should the next UAP articulate?

Given the press of other business that we are all managing, we would appreciate a *brief* written response to these questions of no more than five pages, in the format of your choosing, that can be shared with Senate as part of an APPRC report on academic planning. APPRC will co-sponsor a planning forum in early April on the question of academic priorities as informed by the Institutional Strategic Directions document, and it is proposed that our meetings be scheduled for February and early March. In this light we ask that you submit your response to the Committee's Secretary, Robert Everett, by February 2, 2015. Efforts are underway now to schedule each of you for individual sessions of one hour.

Please feel free to contact Bob or myself should you have any questions.

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Memorandum

To: Rebecca Pillai Riddell, Chair, APPRC

From: Rhonda Lenton, Provost

Date: December 18, 2014

Subject: **James and Joanne Love Chair in Environmental Engineering, LSE**

I am writing to seek the concurrence of APPRC for the establishment of an endowed Chair, the James and Joanne Love Chair in Environmental Engineering, in accordance with University Policy on Endowed Chairs and Professorships. The proposed Chair will support the development of engineering at York , consistent with institutional priorities, and will be located in the Department of Civil Engineering in the Lassonde School of Engineering. The Chair will be funded by an endowment from James Love (lawyer and long-time advocate on behalf of York and the environment) and his wife Joanne, supplemented by funds allocated by York University.

The establishment of this chair is consistent with LSE's vision of preparing Renaissance Engineers™ who not only have a solid understanding of scientific concepts but who also have a deep appreciation for environmental, cultural and societal issues and are equipped to provide leadership and to work creatively in diverse teams. The environment is a common theme in civil engineering education and research. Environmental engineers work to protect the future of land and water resources, develop clean energy, promote green infrastructure, and work to mitigate and prevent pollution. At York, several faculty members in the Department of Civil Engineering are already involved in research and teaching spanning these areas, which are reflected in the department's research focus areas, as well as in its curriculum.

The Chair supports a planned tenure stream appointment in the Faculty. In addition to normal teaching responsibilities, the Chair holder will lead a vigorous research program in the area of environmental engineering, thereby contributing to addressing urgent issues in the environment such as water security, urban pollution, the need for clean and safe resources, and the effects of climate change. Effectively dealing with these issues requires an interdisciplinary approach, and the Chair will lead and foster innovative research in

environmental engineering by forging interdisciplinary collaborations with other York departments and Faculties, particularly with the Faculty of Environmental Studies, to combine technical advancements in environmental engineering with development of effective policies and regulations. The Chair is also expected to attract external industrial research funding and enhance York's international reputation.

The York University Policy on Endowed Chairs and Professorships indicates that in such situations as this, where the proposed Chair is consistent with an existing Senate-approved teaching program and where the other terms and conditions set out in the policy are met, the Vice-President Academic & Provost may ask for the concurrence of APPRC so that the Board of Governors might consider the proposal. By this memorandum, I confirm that the proposed Chair satisfies the expectations of the University policy, and unless APPRC has questions about it, I will ask that this matter be placed on the agenda of the Board of Governors for consideration at its next meeting.

c.c. Dean J. Kozinski
Associate Dean R. Hornsey

The James and Joanne Love Chair in Environmental Engineering

Department of Civil Engineering, Lassonde School of Engineering, York University

Background

Water security and urban pollution continue to be of growing concern throughout the world. Billions of dollars are spent annually in Canada to protect our water resources and our environment from different pollutants, while current demands for clean and safe resources have been increasing. For example, it is predicted that human energy consumption will double by the year 2040. In parallel, climate change - mainly caused by anthropogenic activities - has become a national and an international issue that needs to be addressed urgently. These problems are all interconnected and require interdisciplinary solutions. Unfortunately most Canadian universities focus on independent disciplines, "siloing" research and in most cases, doubling the effort towards the same solution.

Chair in Environmental Engineering

The Department of Civil Engineering at the Lassonde School of Engineering, York University has a different vision. We aspire to graduate engineers who not only have a solid understanding of scientific concepts, but who also have deep appreciation for environmental, cultural and societal issues and are equipped to provide leadership and to work creatively in diverse teams. We call these engineers Renaissance Engineers™. We see the establishment of a Chair in Environmental Engineering in the Department of Civil Engineering as a significant step towards our achieving our aspirations. The Chair in Environmental Engineering will enrich our faculty and student research, broaden and enliven our teaching endeavor, and inculcate a deep sense of environmental stewardship in our graduates.

Interdisciplinary Collaboration

The Chair will also help lead innovative research in Environmental Engineering by forging inter-disciplinary collaborations with other York faculties, particularly with the Faculty of Environmental Studies (FES) in terms of combining technical advancements in the field of Environmental Engineering with development of effective policies and regulations. The Chair would also expand partnerships with other departments and enhance York's international reputation by attracting external industrial research funding to establish a thriving Environmental Engineering research program at York.

Current Activities

The environment is a common theme in Civil Engineering – both in terms of engineering education and research. Environmental engineers work to protect the future of our land and water resources, develop clean energy, promote green infrastructure, and work to mitigate and prevent pollution. At York, several faculty members in the Department of Civil Engineering are already involved in research spanning these areas. These areas are also represented in the Department's three main research focus areas: Infrastructure Lifecycle Assessment, Costing, and Rehabilitation; Designing for Climate-change-driven Extreme Loading Events; and Sustainable Development. As such, the role of the new Chair in Environmental Engineering would be to establish and lead a vigorous research program to push the boundaries of knowledge in these focus areas.

The Successful Candidate

The successful candidate will be a research leader in the field of environmental engineering, with an international reputation and commensurate track record. The term will be for an initial five-year period, renewable for a further five years subject to review.

Funding
This Chair will be supported under the *Externally Funded Regular Named Positions* program at York University.

According to the funding agreement between the University and James & Joanne Love: "$1,500,000 is designated to an endowment fund that will create a new Chair in Environmental Engineering at the Lassonde School of Engineering. The University will supplement the annual payout amount from the endowment such as to cover 100% of the salary and benefits of the Chairholder. University matching will take the form of the salary for a full-time professorial position already included in Lassonde's budget for our new and expanding Department of Civil Engineering.

In the case of an external recruitment for the position, the start up package available to the chairholder from the Faculty may include funds for research infrastructure to establish a laboratory as well as minor research grant to facilitate the development of the chair holders research program. The amounts will be determed according to the needs and experience of the chair holder.

The teaching duties, start-up package and other conditions of appointment will be the same as regularly appointed faculty members.

Chair in Environmental Engineering – Priorities
It is expected that the Chair in Environmental Engineering will help strengthen one or more of the following areas:

1. Water Security
Fresh water is by far the most important resource on our planet. It is needed for human life and well-being and for economic development. Yet, a number of factors, such as human population growth, industrial developments, extraction of natural resources, changing climate patterns, changing land use demographics, and pollution, are threatening the world's water resources. As such, it is imperative that we secure our water resources and manage them effectively. However, effective management of water resources requires interdisciplinary research, which requires deep understanding of the societal aspects of securing water resources, the anthropogenic factors affecting the environment, and the relationship and interplay between water systems, land and the atmosphere. There is an urgent need for multi-faceted research programs that integrate social, natural and health sciences, public policy and engineering for the development of science and technologies that will help effective management of world's water resources in the light of shifting climate patterns and increasing urbanization of human population. The Research Chair in Environmental Engineering will engage with key stakeholders in order to translate cutting-edge technological developments into effective policies and management strategies for the world's water resources.

2. Sustainable Groundwater Sources
A third of the world's fresh water supply comes from groundwater found in aquifers. Groundwater recharges lakes, wetlands, and streams, and is an important resource for agricultural and industrial activities. Therefore understanding and protecting this natural resource is of critical importance to the health of our country and for ensuring sustainable supply of fresh drinking water for future generations. Contaminated groundwater is difficult to clean up

because different compounds require different remediation technologies, and the pollution source, as well as, the extent of contamination is often hard to locate. Consequently, the development, pilot scale testing, and modelling of new and innovative remediation technologies is crucial in achieving clean-up goals at contaminated sites and to ensure a sustainable source of safe water for future generations of Canadians.

3. Smart Environmental Technologies for Climate Change Adaptation

One of the most important factors currently affecting water quality is the enrichment of nutrients (i.e. organic matter, nitrogen, and phosphorus) in water bodies leading to excessive eutrophication. Although conventional water and wastewater treatment and reuse processes have been used successfully to control various pollutants, their applications are currently uneconomical and challenged by increasingly stringent federal and provincial regulations. In addition, climate-change-driven extreme loading events may increase system nutrient loads, further promoting the need for economical and effective treatment technologies. Therefore, research into novel and smart technologies for water and wastewater treatments, along with an incorporation of reduced power consumption and carbon footprint, is essential.

4. Green Infrastructure

With the rise in gas prices and the increase in energy consumption, the need for clean energy and green infrastructure is on the rise. Although strides have been made in establishing building codes for energy-efficient buildings (LEED), research into smart cities, sustainable energy technologies such as geothermal heating, green roofs, and waste-to-bioenergy, brownfield redevelopment, as well as, sustainable building rehabilitation is imperative. Investing in these technologies could lead to substantial improvement in clean energy technologies and put York at the forefront of green building design.