UNIVERSITY OF TORONTO SCARBOROUGH

OFFICE OF THE CAMPUS COUNCIL

FOR APPROVAL **PUBLIC** **OPEN SESSION**

TO: UTSC Academic Affairs Committee

SPONSOR: Prof. William Gough, Interim Vice-Principal Academic and Dean
CONTACT INFO: 416-208-7027, vpdean@utsc.utoronto.ca

PRESENTER: Prof. Mark Schmuckler, Vice-Dean, Undergraduate,
CONTACT INFO: 416-208-2978, vicedean@utsc.utoronto.ca

DATE: Wednesday, January 27, 2016

AGENDA ITEM: 3a

ITEM IDENTIFICATION:

Major modification to introduce a new Major in Plant Biology (BSc)

JURISDICTIONAL INFORMATION:

University of Toronto Scarborough Academic Affairs Committee (AAC) "is concerned with matters affecting the teaching, learning and research functions of the Campus" (*AAC Terms of Reference, Section 4*). Under section 5.6 of its terms of reference, the Committee is responsible for approval of "Major and minor modifications to existing degree programs." The AAC has responsibility for the approval of Major and Minor modifications to existing programs as defined by the University of Toronto Quality Assurance Process (*UTQAP, Section 3.1*).

GOVERNANCE PATH:

1. **UTSC Academic Affairs Committee [For Approval] (January 27, 2016)**

PREVIOUS ACTION TAKEN:

No previous action in governance has been taken on this item.

HIGHLIGHTS:

The Department of Biological Sciences is proposing to introduce a new Major in Plant Biology (BSc), where there is an existing Specialist in Integrative Biology (BSc).

The proposed Major will provide students with an explicit opportunity to study plant biology, more readily connect students with experiential learning opportunities related to the botanical research being conducted by faculty in Biological Sciences, and fully leverage UTSC's location on a major ravine system at the doorsteps of the Rouge National Urban Park. In addition, the proposed Major will help the UTSC campus realize synergisms with other Major programs and green initiatives, and it will afford students greater flexibility (versus the Specialist) to pursue interests in other areas.

The primary goal of the existing Specialist program in Integrative Biology, which includes a specialized route option in Plant and Microbial Biology, is to provide students with a solid knowledge base in key foundational areas of biology while also providing breadth of knowledge to support more specialized studies and focused training in a range of sub-disciplines. The Specialist has a dual focus in plant and microbial biology that provides a relatively narrow view of both areas, and the program does not fully leverage the significant expertise in plant biology now existent in the Department of Biological Sciences.

The curricular requirements of the proposed Major are a subset of those of the existing Specialist, and it retains the Specialist program's unique, integrative, and multidisciplinary goal of studying organisms at multiple levels (cells, organisms, supra-organismal) while allowing this to be done in a way that permits a better understanding of plants specifically. In the proposed Major students will focus on plant biology throughout their program, and the required courses will provide a solid foundation in aspects of plant physiology, ecology, biochemistry, development and genetics. For this reason, the program is titled 'Plant Biology' to signify a focus on fundamental aspects and distinctive features of the botanical world. Research experiences will be encouraged, thus ensuring graduates of the proposed Major are well prepared to pursue both graduate educational opportunities and fulfilling careers.

The proposal is driven in part by the presence of a strong faculty research focus on plant biology within Biological Sciences at UTSC; the breadth of this plant expertise will allow them to provide a compelling educational opportunity for students. It is also driven by a growing student interest in this area of study; in fact, a 2015 survey of students in our Introductory Biology courses revealed significant interest in a program in Plant Biology. The proposed Major will provide more explicit opportunities for students to study plants, and will connect undergraduate education more explicitly with the Department's plant biology researchers, thus enriching the student's ability to connect with plant research.

This proposal has been approved by the Biological Sciences Departmental Curriculum Committee. There has been extensive consultation within Biological Sciences, and with the Departments of Computer & Mathematical Sciences and Psychology since courses

from these academic units are requirements in the program. Externally, there has been consultation with the UTM Department of Biology, and the St. George Departments of Cell and Systems Biology, and Ecology and Evolutionary Biology. Finally, the proposal has been reviewed by the Dean's Office, the Decanal Undergraduate Curriculum Committee and the Provost's Office.

FINANCIAL IMPLICATIONS:

There are no net financial implications to the campus' operating budget.

RECOMMENDATION:

Be It Resolved,

THAT the new Major in Plant Biology (BSc), as described in the proposal dated December 7, 2015 and recommended by the Interim Vice-Principal Academic and Dean, Professor William Gough, be approved effective April 1, 2016 for the academic year 2016-17.

DOCUMENTATION PROVIDED:

1. Major Modification B to introduce a new Major in Plant Biology (BSc), where there is an existing Specialist in Integrative Biology (BSc) dated December 7, 2015.

UNIVERSITY OF TORONTO

University of Toronto
Major Modification Proposal – Type B: Specialist or Major where there is an Existing Major or Specialist

What is being proposed:	A new Major in Plant Biology (BSc) where there is an existing Specialist in Integrative Biology (BSc)
Department / Unit where the program will be housed:	Biological Sciences
Start date of the program:	April 1, 2016
Faculty / Academic Division:	University of Toronto Scarborough
Faculty / Academic Division Contact:	Annette Knott, Academic Programs Officer aknott@utsc.utoronto.ca
Department/Unit Contact:	Dan Riggs/Clare Hasenkampf/Lucy Pickering
Date of this version of the proposal:	December 7, 2015

1 Executive Summary

This is a proposal to introduce a new Major in Plant Biology (BSc), where there is an existing Specialist in Integrative Biology (BSc). The program will be housed in the Department of Biological Sciences at the University of Toronto Scarborough (UTSC).

The proposed Major will provide students with an explicit opportunity to study plant biology, more readily connect students with experiential learning opportunities related to the botanical research being conducted by faculty in Biological Sciences, and fully leverage our location on a major ravine system at the doorsteps of the Rouge National Urban Park. In addition, we believe the proposed Major will help the campus realize synergisms with other Major programs and green initiatives, and it will afford students greater flexibility (versus the Specialist) to pursue interests in other areas.

The primary goal of the existing Specialist program in Integrative Biology is to provide students with a solid knowledge base in key foundational areas of biology while also providing breadth of knowledge to support more specialized studies and focused training in a range of sub-disciplines. One of the specialized route options of the Specialist program is Plant and Microbial Biology. This option recommends several courses within Biological Sciences (Plant Development and Biotechnology, Biology of Plant Stress, and Seminars in Microbiology), and also an Environmental Science course in Biogeochemistry. As such, there is a dual focus in plant and microbial biology that provides a relatively narrow view of both areas, and the program does not fully leverage the significant expertise that we now possess in the Department of Biological Sciences (see section 8 below).

The curricular requirements of the proposed Major are a subset of those of the existing Specialist, and the differences in course requirements and program learning outcomes between the proposed Major and the existing Specialist reflect the differences between what can be achieved in a Major program and what can be achieved in a Specialist program. The proposed Major retains the Specialist program's unique, integrative, and multidisciplinary goal of studying organisms at multiple levels (cells, organisms, supra-organismal) while allowing this to be done in a way that permits a better understanding of plants specifically. In the proposed Major students will focus on plant biology throughout their program, and the required courses will provide a solid foundation in aspects of plant physiology, ecology, biochemistry, development and genetics. For this reason, we feel that the program title 'Plant Biology' is most appropriate, signifying a focus on fundamental aspects and distinctive features of the botanical world. In addition, research experiences will be encouraged, thus ensuring graduates of the proposed Major are well prepared to pursue both graduate educational opportunities and fulfilling careers.

Since the creation of the Specialist program, the number of faculty at UTSC with a strong interest in plant biology has grown, and as a result the Department of Biological Sciences offers more courses with significant plant biology content. We now have the intellectual resources to sustain enrolment in a formal major that uses the integrative approach of the existing Specialist and builds on one of its existing, optional, informal areas of specialization (Plant and Microbial Biology).

The proposed Major is an important component of the Department's Academic Plan, and is consistent with both our research and teaching strategic initiatives. We wish to expand undergraduate enrolment in areas where we have significant expertise and capacity and in this regard, recent hires have given us this critical mass. Finally, we anticipate that the approved Rouge Park initiative will come to fruition in the next few years, and partnering opportunities will allow us to contribute to this unique endeavour and will provide a variety of experiences for our students. These themes are part of the larger UofT strategic plan that focuses in part on spatial identity and experiential learning.

2 Program Rationale

This is a proposal to introduce a new Major in Plant Biology (BSc), where there is an existing Specialist in Integrative Biology (BSc). The program will be housed in the Department of Biological Sciences at the University of Toronto Scarborough (UTSC).

The proposed Major will provide students with an explicit opportunity to study plant biology, more readily connect students with experiential learning opportunities related to the botanical research being conducted by faculty in Biological Sciences, and fully leverage our location on a major ravine system at the doorsteps of the Rouge National Urban Park. It is quite likely that our students within Biology will choose to pair the proposed Major with another program in the Department (e.g. Human Biology, Molecular Biology & Biotechnology). For example, plant biotechnology is poised to significantly contribute to many issues that face humanity, including pollution, environmental degradation and remediation, carbon capture technologies, malnutrition and food security. Double majors in these two areas will allow students to realize the complementarity of offerings in both programs and to build competence in areas that will be needed to address global issues of the twenty first century. We also believe the proposed Major will help the campus realize synergisms with other Major programs, as well as "Green" initiatives; for example, students might combine the proposed Major with Majors or Minors in Health Studies, Environmental Science, or Environmental Studies.

The primary goal of the existing Specialist program in Integrative Biology is to provide students with a solid knowledge base in key foundational areas of biology (ecology and evolution, cell and molecular biology, physiology and biochemistry) while also providing breadth of knowledge to support more specialized studies and focused training in a range of sub-disciplines. One of the specialized route options of the Specialist program is Plant and Microbial Biology, in which four courses are recommended to students: two in Plant Biology, a Microbiology Seminar course and an Environmental Science course in Biogeochemistry. These offerings highlight a few distinct areas within several (sub) disciplines, but the dual focus on plant and microbial biology provides a relatively narrow view of both areas of study.

The curricular requirements of the proposed Major are a subset of those of the existing Specialist; the differences in course requirements and program learning outcomes between the proposed Major and the existing Specialist reflect the differences between what can be achieved in a Major program and what can be achieved in a Specialist program.

In general, the Specialist program surveys the kingdoms of life and affords a broad education, giving students significant flexibility to focus their studies (e.g. the specialization in Plant and

Microbial Biology). In the proposed Major, students will focus on plant biology throughout their program, and the required courses will provide a solid foundation in aspects of plant physiology, ecology, biochemistry, physiology, development and genetics. In order to clearly signify the program's focus on fundamental aspects and distinctive features of the botanical world, we have entitled the proposed Major 'Plant Biology' rather than Integrative Biology. In addition, research experiences will be encouraged, thus ensuring graduates of the proposed Major are well prepared to pursue both graduate educational opportunities and fulfilling careers.

The proposal is driven in part by the presence of a strong faculty research focus on Plant Biology within Biological Sciences at UTSC; the breadth of this plant expertise will allow us to provide a compelling educational opportunity for students. It is also driven by a growing student interest in this area of study; in fact, a 2015 survey of students in our Introductory Biology courses revealed significant interest in a program in Plant Biology (see section 3 below).

The proposed Major will provide more explicit opportunities for students to study plants, and will connect undergraduate education more explicitly with our plant biology researchers, thus enriching the student's ability to connect with plant research.

The intention to introduce this Major is included in the Department's Academic Plan (April 2015), and it is consistent with Biological Sciences' research, teaching and complement planning. The proposed program is distinctive at the University of Toronto, but other universities do offer various types of plant biology programs. For example, the University of British Columbia has a Plant Biology Major that features course offerings and options similar to our proposed Major; thus, there is alignment with existing programs at other universities. There are also other universities in Canada and North America that are more agriculturally oriented and often have more applied educational streams (e.g. Plant Pathology). The proposed program is a particularly good fit for UTSC, which also has initiatives in Environmental Science and Conservation Biology, and is the home of the Canadian Centre for World Hunger Research.

One new course is associated with this program: BIOD30H3 Plant Research and Biotechnology-Addressing Global Problems. BIOD30H3 is intended as a capstone experience course in which students will engage with guest speakers who are established plant scientists, and who present their own research to assist students in understanding global problems and how plants can be used to address them.

3 Need and Demand

There are compelling reasons for developing a Major program in Plant Biology. Plants will be key in facing major global challenges – feeding the increasing world population, countering the rising CO_2 levels of the earth and mitigating habitat destruction. We will need citizens who recognize the value of plants as more than just a food source, and we will need scientists trained in Plant Biology. It is our aim to more effectively educate students in Plant Biology, help them see the niche of plants within the natural world, and teach them skills that will help them use plants to address local and global challenges.

We conducted a survey (March, 2015) of students in our Introductory Biology courses, which revealed significant interest in a program in Plant Biology: 12% of respondents (94 of 777)

indicated they were strongly interested, and 59.9% (465 respondents) expressed a moderate interest. We believe the interest expressed by our first year biology students is indicative of similar interests of graduating high school students.

It is possible that there will be some lateral movement of biology students from other Major programs in the Biological Sciences; but we anticipate it will be very small since the most popular Major program is currently the very different, Major in Human Biology. We believe that the proposed Major in Plant Biology (BSc) will attract a new group of students to UTSC, thus enhancing overall enrolment at UTSC. Furthermore it will be an attractive double Major for students in Health or Environmental Studies or Environmental Science. It may also prove attractive to students in Social Sciences programs such as International Development or City Studies. In addition, there may be attractive combinations of Plant Biology paired with Minor programs (e.g. Geography, Anthropology).

Employment opportunities exist within local, national and multinational businesses (e.g. Performance Plants, Syngenta), non-governmental organizations (e.g. Nature Conservancy), as well as governmental agencies that promote plant biology and biotechnology (Agriculture and Agri-Food Canada, Genome Canada) and we expected continued growth in these areas will drive demand for qualified graduates.

Table 1: Undergraduate Enrolment Projections

Level of study	Academic year 2016	Academic year 2017	Academic year 2018	Academic year 2019	Academic year 2020	Academic year 2021	Academic year 2022
1st year	#	#	#	#	#	#	#
2nd year	30	35	40	45	50	50	50
3rd year	0	25	30	35	40	42	43
4th year	0	0	20	25	30	35	40
Total enrolment	30	60	90	115	120	127	133

We assume that the program will reach steady state status in 4-5 years.

4 Admission / Eligibility Requirements

Consistent with all Major programs in Biological Sciences, admission to the proposed Major in Plant Biology requires the completion of 4.0 credits, including 1.0 credit in Biology, 1.0 credit in Chemistry, and 0.5 credit in Mathematics or Statistics; and a cumulative grade point average (CGPA) of at least 1.85.

5 Program Requirements

Notes regarding color codes below:

1. Courses highlighted in yellow are also required in the Specialist in Integrative Biology.
2. Courses highlighted in green are options in the Specialist in Integrative Biology.
3. Courses highlighted in purple are options in the Specialist in Integrative Biology, that are also recommended to students pursuing the specialization in Plant and Microbial Biology.
4. The complete Calendar description for the Major in Plant Biology (Bsc) is given in Appendix A below.
5. The complete Calendar description for the Specialist in Integrative Biology (BSc) is given in Appendix B below.

MAJOR PROGRAM IN PLANT BIOLOGY (SCIENCE)
Supervisor: Dan Riggs (riggs@utsc.utoronto.ca)

The Major in Plant Biology provides a broad education in all areas of contemporary biology, and affords students an opportunity to concentrate on courses in upper years that are focused on plant biology. This program is suitable for students with an interest in the biochemistry, biotechnology, cell biology, ecology, evolution, genetics, physiology, and/or development of plants.

Program Requirements:

Students are required to complete a total of 8.5 credits.

Required Courses and Suggested Course Sequence:

First Year
1.0 Credit of Introductory Biology Courses
BIOA01H3 Life on Earth: Unifying Principles
BIOA02H3 Life on Earth: Form, Function and Interactions

1.0 Credit in Introductory Chemistry Courses
CHMA10H3 Introductory Chemistry I: Structure and Bonding
CHMA11H3 Introductory Chemistry II: Reactions and Mechanisms

0.5 Credit in Statistics
Choose From:
STAB22H3 Statistics I
PSYB07H3 Data Analysis in Psychology

Second Year
2.5 Credits of Biology Core Courses
BIOB10H3 Cell Biology
BIOB11H3 Molecular Aspects of Cellular and Genetic Processes
BIOB38H3 Plants and Society
BIOB50H3 Ecology
BIOB51H3 Evolutionary Biology

Second Year
0.5 Credit of Biology Core Labs
Choose from:
BIOB12H3 Cell and Molecular Biology Laboratory
BIOB52H3 Ecology and Evolutionary Biology Laboratory

Third Year
2.0 Credits
BIOC31H3 Plant Development and Biotechnology
BIOC37H3 Plants: Life on the Edge
BIOC40H3 Plant Physiology
[BIOC15H3 Genetics or BIOC17H3 Microbiology or BIOC50H3 Macroevolution]

Third/ Fourth Year
0.5 Credits; choose from:
BIOC61H3 Community Ecology and Environmental Biology
BIOD21H3 Advanced Molecular Biology Laboratory
BIOD37H3 Biology of Plant Stress
BIOD62H3 Species and Speciation
BIOD26H3 Fungal Biology and Pathogenesis

Fourth Year
0.5 Credit
Choose from:
[BIOD30H3 Plant Research and Biotechnology: Addressing Global Problems or [any of the following research-based courses if the research utilizes plants: BIOC99H3, BIOD95H3, BIOD98Y3 or BIOD99Y3]]

Complete List of Courses Associated With the Program:

BIOA01H3 Life on Earth: Unifying Principles
A lecture and laboratory course providing an overview of the origins and cellular basis of life, genetics and molecular biology, evolution and the diversity of microorganisms. **Note:** that both BIOA01H3 and BIOA02H3 **must** be completed prior to taking any other Biology course.
Prerequisite: Grade 12 Biology and Grade 12 Advanced Functions
Exclusion: BIO120H, BIO130H, (BIO150Y), (BGYA01H3)
Breadth Requirement: Natural Sciences

BIOA02H3 Life on Earth: Form, Function and Interactions
A lecture and laboratory course providing an overview of the anatomy and physiology of plants and animals, population biology, ecology and biodiversity. **Note:** that both BIOA01H3 and BIOA02H3 **must** be completed prior to taking any other Biology course.
Prerequisite: Grade 12 Biology and Grade 12 Advanced Functions
Exclusion: BIO120H, BIO130H, (BIO150Y), (BGYA02H3)
Breadth Requirement: Natural Sciences

BIOB10H3 Cell Biology
This course is designed to introduce theory and modern experimental techniques in cell biology. Emphasis will be on eukaryotic cells. Structure and function of major animal and plant organelles will be covered. Subsequent topics include the role of the cytoskeleton. Plasma membrane and extracellular matrix will also be detailed in the context of cell interactions with the environment.
Prerequisite: BIOA01H3 & BIOA02H3 & CHMA10H3 & CHMA11H3
Exclusion: (BGYB10H3), BIOB10Y3, (BGYB10Y3), BIO241H, (BIO250Y)
Breadth Requirement: Natural Sciences

BIOB11H3 Molecular Aspects of Cellular and Genetic Processes
A course focusing on the central dogma of genetics and how molecular techniques are used to investigate cellular processes. Topics include structure and function of the nucleus, DNA replication and cell cycle control, transcription and translation, gene regulation and signal transduction.
Prerequisite: BIOB10H3
Exclusion: BIOB10Y3, (BGYB10Y3), (BGYB11H3), BIO230H, (BIO250Y)
Breadth Requirement: Natural Sciences

BIOB12H3 Cell and Molecular Biology Laboratory
A practical introduction to experimentation in cell and molecular biology. Lab modules will introduce students to concepts and techniques in the general preparation of solutions and buffers, microbiology, molecular biology, biochemistry, microscopy and data manipulation and communication skills. This core laboratory course is the gateway for Cell & Molecular biology specialists to upper level laboratory offerings.
Prerequisite: CHMA10H3 & CHMA11H3
Corequisite: BIOB11H3 or BIOB10Y3
Exclusion: BIO215H, (BGYB12H3)
Breadth Requirement: Natural Sciences

BIOB38H3 Plants and Society
How do plants feed humans? What are agricultural origins and what plant traits changed in domesticated plants? Human population is at 7 billion, but will climb to 10 billion in 2050. This will tax our planet's ability to sustain life and environmentally sustainable food production will become more integral.
Prerequisite: BIOA01H3 and BIOA02H3
Exclusion: (BIOC38H3), EEB202H, EESB16H3
Breadth Requirement: Natural Sciences

BIOB50H3 Ecology
An introduction to the main principles of ecology, the science of the interactions of organisms with each other and with their environment. The course covers community and population ecology, and provides an emphasis on how ecology relates to other areas of biology, and to contemporary human and environmental issues.
Prerequisite: BIOA01H3 & BIOA02H3
Exclusion: (BGYB50H3)

Breadth Requirement: Natural Sciences

BIOB51H3 Evolutionary Biology
Students learn about development of evolutionary theory, maintenance of genetic variation, mechanisms of evolutionary change, adaptation, and current research topics in evolution.
Prerequisite: BIOA01H3 & BIOA02H3
Exclusion: (BGYB51H3)
Breadth Requirement: Natural Sciences

BIOB52H3 Ecology and Evolutionary Biology Laboratory
An introduction to field, lab and computational approaches to ecology and evolution. Laboratories will explore a variety of topics, ranging from population genetics to community ecology and biodiversity. Some lab
exercises will involve outdoor field work.
Prerequisite: BIOA01H3 and BIOA02H3
Corequisite: BIOB50H3 or BIOB51H3
Exclusion: (BGYB52H3)
Breadth Requirement: Natural Sciences

BIOC15H3 Genetics
Topics for this lecture and laboratory (or project) course include: a brief
review of DNA structure, transcription, and translation; inheritance and its chromosomal basis; gene interactions; sources and types of mutations and the relationship of mutation to genetic disease and evolution; genetic dissection of biological processes; genetic technologies and genomic approaches.
Prerequisite: [[BIOB10H3 & BIOB11H3] or BIOB10Y3] & [(MATA21H3)
or MATA35H3 or MATA36H3 or MATA37H3 or PSYB07H3 or STAB22H3]
Exclusion: (BGYC15H3), BIO260H, HMB265H
Breadth Requirement: Natural Sciences

BIOC17H3 Microbiology
This course presents an overview of the microbial world and introduces the students, in more detail, to the physiological, cellular and molecular aspects of bacteria. The laboratories illustrate principles and provide training in basic microbiological techniques essential to microbiology and to any field where recombinant DNA technology is used.
Prerequisite: [[BIOB10H3 and BIOB11H3] or BIOB10Y3]
Exclusion: (BGYC17H3), MGY377H, (MBY377H)
Breadth Requirement: Natural Sciences

BIOC31H3 Plant Development and Biotechnology
A central question of developmental biology is how does a single cell become a complex organism. This lecture course focuses on molecular and cellular mechanisms that control developmental processes in plants, including embryonic, vegetative, reproductive development; hormone signal transduction pathways; analysis of mutants, transgenic plants and their connection to biotechnology.
Prerequisite: [BIOB10H3 and BIOB11H3] or BIOB10Y3

Exclusion: CSB340H, (BOT340H), (BGYC31H3)
Breadth Requirement: Natural Sciences

BIOC37H3 Plants: Life on the Edge
Plants have evolved adaptations to maximize growth, survival and reproduction under various taxing environmental conditions. This course will study the great diversity of plant structures and function in relation to ecology, focusing mainly on the anatomy of flowering plants.
Prerequisite: BIOB38H3 or BIOB50H3 or BIOB51H3
Exclusion: EEB340H
Enrolment Limits: 48
Breadth Requirement: Natural Sciences

BIOC40H3 Plant Physiology
An introduction to plant biology. Topics include plant and cell structure, water balance, nutrition, transport processes at the cell and whole plant level, physiological and biochemical aspects of photosynthesis, and growth and development in response to hormonal and environmental cues.
Prerequisite: [[BIOB10H3 and BIOB11H3] or BIOB10Y3]] and BIOB38H3
Exclusion: (BIOB31H3), BIO251Y, (BOT251Y), (BGYB31H3)
Breadth Requirement: Natural Sciences

BIOC50H3 Macroevolution
An overview of recent developments in evolutionary biology that focus on large-scale patterns and processes of evolution. Areas of emphasis may include the evolutionary history of life on earth, phylogenetic reconstruction, patterns of diversification and extinction in the fossil record, the geography of evolution, the evolution of biodiversity, and the process of speciation.
Prerequisite: BIOB50H3 & BIOB51H3
Exclusion: EEB362H
Breadth Requirement: Natural Sciences

BIOC61H3 Community Ecology and Environmental Biology
An examination of the theory and methodology of community analysis, with an emphasis on the factors regulating the development of ecosystems. The application of ecological theory to environmental problems is emphasized. Topics include: succession, primary productivity, nutrient supply, predation, competition, trophic dynamics, stability and disturbance, and effects of global change.
Prerequisite: BIOB50H3
Exclusion: EEB321H, (BIO321H), (BGYC61H3)
Breadth Requirement: Natural Sciences

BIOC99H3 Biology Team Research
In this introduction to academic research, a group of 3-5 students work with a faculty supervisor and TA to develop a research proposal or implement a research project. Prior to registering, students must find a faculty supervisor, form a group, then submit a permission form to the department.
Prerequisite: (1) Enrolment in a UTSC Major or Specialist Subject POSt offered by Biological Sciences and (2) completion of all second year core program requirements and (3) have at least

10.0 full credits and (4) a cumulative GPA of at least 3.0 and (5) a commitment from a Biology faculty member to serve as supervisor and (6) formation of a group that includes at least 2 other students

BIOD21H3 Advanced Molecular Biology Laboratory
Applications of molecular technology continue to revolutionize our understanding of all areas of life sciences from biotechnology to human disease. This intensive laboratory, lecture / tutorial course provides students with essential information and practical experience in recombinant DNA technology, molecular biology and bio-informatics.
Prerequisite: BIOB12H3 & BIOC15H3 & [BIOC17H3 or [IMCB01H3 & IMCB02H3 (for Applied Microbiology students only)]]
Corequisite: BIOC12H3 (Note: Although listed as a corequisite, it is recommended that BIOC12H3 be taken in advance of BIOD21H3.)
Exclusion: (BGYD21H3)
Breadth Requirement: Natural Sciences

BIOD26H3 Fungal Biology and Pathogenesis
A lecture and tutorial based course designed to provide an overview of the fungal kingdom and the properties of major fungal pathogens that contribute to disease in animals (including humans) and plants. This course will address the mechanisms and clinical implications of fungal infections and host defence mechanisms. Topics include virulence factors and the treatment and diagnosis of infection.
Prerequisite: BIOC17H3 or BIOC39H3
Enrolment Limits: 50
Breadth Requirement: Natural Sciences

BIOD30H3 Plant Research and Biotechnology: Addressing Global Problems *(new)*
Plant scientists who are working to address some of today's most pressing challenges will give presentations. In advance of these talks, students will identify terminologies and methodologies needed to engage with the speaker, and will critique the research. Student teams will also develop their own related research questions/strategies.
Prerequisite: BIOB38H3 & [one of BIOC15H3, BIOC31H3, BIOC37H3 or BIOC40H3]
Enrolment Limits: 30 students
Breadth Requirement: Natural Sciences

BIOD37H3 Biology of Plant Stress
This course examines resistance mechanisms (anatomical, cellular, biochemical, molecular) allowing plants to avoid or tolerate diverse abiotic and biotic stresses. Topics include: pathogen defence; responses to temperature, light, water and nutrient availability, salinity, and oxygen deficit; stress perception and signal transduction; methods to study stress responses; and strategies to improve stress resistance.
Prerequisite: [[BIOB10H3 and BIOB11H3] or BIOB10Y3]] and [BIOC40H3 or (BIOB31H3)]
Exclusion: (BGYD37H3)
Breadth Requirement: Natural Sciences

BIOD62H3 Species and Speciation

A species is the basic unit of evolution and this course will focus on the process of how species evolve and what keeps established species apart. This course will thus provide the student with a deeper understanding of how Earth's biodiversity evolved and is maintained under natural conditions.
Prerequisite: BIOC50H3
Exclusion: EEB340H
Breadth Requirement: Natural Sciences

BIOD95H3 Supervised Study in Biology
This course is designed to permit intensive examination of the primary literature of a select topic. Frequent consultation with the supervisor is necessary and extensive library research is required. The project will culminate in a written report. Students must obtain a permission form from SW420B that is to be completed and signed by the intended supervisor, then returned to SW420B. At that time, the student will be provided with an outline of the schedule and general requirements for the course. 5 sessions of group instruction will form part of the coursework.
Prerequisite: Satisfactory completion of 12.5 full credits, of which at least four must be Biology B- or C-level courses. Students must have permission of the instructor. In order to be eligible for BIOD95H3, with the same instructor as for BIOD98Y3 or BIOD99Y3, the student and instructor must provide a plan that goes beyond the work of those courses.
Exclusion: (BGYD03H3), (BGYD95H3)

BIOD98Y3/BIOD99Y3 Directed Research in Biology
A course designed to permit laboratory or field research or intensive examination of a selected topic in biology. Supervision of the work is arranged by mutual agreement between student and instructor. Students must obtain a permission form from SW420B that is to be completed and signed by the intended supervisor, and returned SW420B. At that time, the student will be provided with an outline of the schedule and general requirements for the course. 10 sessions of group instruction will form part of the coursework.
Prerequisite: Satisfactory completion of 13.5 full credits, of which at least four must be Biology B- or C-level courses and permission of the instructor.
Exclusion: CSB498Y, EEB498Y, (BGYD01Y3), (BGYD98Y3), (BOT460Y), (ZOO498Y)

CHMA10H3 Introductory Chemistry I: Structure and Bonding
This course will introduce the study of chemical transformations of matter, from a macroscopic and microscopic perspective. It starts with a quantitative description of gases, solids and solutions and develops ideas of bonding and structure in chemical compounds with a particular emphasis on organic and biological molecules. This course includes a three hour laboratory every other week which alternates with a one hour mandatory tutorial.
Prerequisite: Grade 12 Chemistry and [Grade 12 Advanced Functions or Calculus]
Exclusion: CHM140Y, CHM151Y
Recommended Preparation: MATA30H3
Breadth Requirement: Natural Sciences
NOTE: MATA30H3 and [MATA35H3 or MATA36H3] are required for some higher level Physical and Environmental Sciences courses.

CHMA11H3 Introductory Chemistry II: Reactions and Mechanisms
In this course reactions and equilibria in chemical systems are explored through their thermodynamic properties and chemical kinetics. Acid/base and solubility equilibria will be discussed along with topics in electrochemistry. This course includes a three hour laboratory every other week which alternates with a one hour mandatory tutorial.
Prerequisite: CHMA10H3 Exclusion: CHM139H, CHM140Y, CHM151Y
Recommended Preparation: MATA30H3 and [MATA35H3 or MATA36H3].
Breadth Requirement: Natural Sciences
NOTE: MATA30H3 and [MATA35H3 or MATA36H3] are required for some higher level Physical and Environmental Sciences courses.

PSYB07H3 Data Analysis in Psychology
This course focuses on the fundamentals of the theory and the application of statistical procedures used in research in the field of psychology. Topics will range from descriptive statistics to simple tests of significance, such as Chi-Square, t-tests, and one-way Analysis-of-Variance. A working knowledge of algebra is assumed. Students in the Specialist programs in Psychology, Psycholinguistics or Neuroscience will be given priority for this course.
Exclusion: ANTC35H3, MGEB11H3/(ECMB11H3), MGEB12H3/(ECMB12H3), PSY201H, (SOCB06H3), STAB22H3, STA220H, STA221H, STA250H, STA257H
Breadth Requirement: Quantitative Reasoning

STAB22H3 Statistics I
This course is a basic introduction to statistical reasoning and methodology, with a minimal amount of mathematics and calculation. The course covers descriptive statistics, populations, sampling, confidence intervals, tests of significance, correlation, regression and experimental design. A computer package is used for calculations.
Exclusion: ANTC35H3, MGEB11H3/(ECMB11H3), (POLB11H3),PSYB07H3, (SOCB06H3), STAB52H3, STAB57H3, STA220H,STA250H
Breadth Requirement: Quantitative Reasoning

6 Program Structure, Learning Outcomes, and Degree Level Expectations

Degree Level Expectations	**Clearly describe how the Program Learning Outcomes will support the degree level expectations. Indicate how the learning outcomes for the proposed program differ from the learning outcomes for the existing program(s).**	**Clearly describe how the program design/structure will support the program learning outcomes.**
1. Depth and Breadth of	The core learning outcomes	Courses in first year provide core knowledge

Knowledge Depth of Knowledge: is attained through a progression of introductory, core and specialized courses. Specialized courses will normally be at the C and D levels. Breadth of Knowledge: students will gain an appreciation of the variety of modes of thinking, methods of inquiry and analysis, and ways of understanding the world that underpin different intellectual fields.	of the proposed Major are closely aligned to those of the existing Specialist in Integrative Biology. Specifically, as with the Specialist, students completing the proposed Major will receive training in all areas of contemporary biology, including: ecology, evolutionary biology, physiology, genetics, biochemistry, developmental and molecular biology. Students in the proposed Major will then develop a more specialized education in courses that focus on the fundamental principles of plants, from the molecular to the ecosystems level. Specifically, the proposed Major in Plant Biology will require some specific C- and D-level courses that will ensure a broad education in plant biology. These options include Genetics, Microbiology, Macroevolution, Community Ecology and Environmental biology, Plant Stress, Advanced Molecular Biology Laboratory and Species and Speciation, and Fungal Biology and Pathogenesis. It should be noted that the existing route to specialization in Plant and Microbial Biology does not require the suggested courses and thus the Major program will be a more prescribed and coherent education	in science, including biology (BIOA01H3 and BIOA02H3), chemistry (CHMA10H3 and CHMA11H3), and statistics (STAB22H3). In the second year students develop breadth of knowledge in biology based on courses in the biology "core", which is shared across our Major and Specialist programs and includes ecology, evolution, cell biology, and molecular genetics. In addition, students will take a plant specific course (BIOB38H3) that acquaints them with the importance of plants in addressing global problems. Second year students also receive practical training in a lab course (BIOB12H3 or BIOB52H3). In the third year, students deepen their knowledge of the physiology (BIOC40H3), development (BIOC31H3), ecology and reproductive strategies (BIOC37H3) of plants. Finally, in the fourth year, the new course BIOD30H3 is intended to be a capstone experience in which students engage with guest speakers whose research focuses on addressing a global issue (e.g. food security). This capstone course emphasizes many transferrable skills useful for the workplace or graduate studies. We also encourage students to engage in a research-based course.
2. Knowledge of Methodologies Students have a working knowledge of different	All Specialist and Major programs in the Biological Sciences give students the opportunity to gain valuable experiential training in	Courses that incorporate laboratories (BIOA01H3, BIOA02H3, CHMA10H3, and CHMA11H3) in first year will provide the foundation for students' understanding and practice of experimental research skills.

methodologies and approaches relevant to their area of study. They are able to evaluate the efficacy of different methodologies in addressing questions that arise in their area of study.	practical and general laboratory methodologies. The core learning outcomes of the proposed Major program are closely aligned to those of the related Specialist. Specifically, students will develop an understanding of the basic techniques and methodologies that are useful for investigating any area of biology Students in the proposed Major will then focus, in the third and fourth years, on a more extensive set of skills in plant science technologies and approaches. Students will also further develop their critical thinking skills and ability to evaluate plant science methodologies via seminars, presentations and research papers.	In the second year, students have a choice of a B-level core lab based on their particular area of interest (BIOB12H3 Cell and Molecular Biology Laboratory or BIOB52H3 Ecology and Evolutionary Biology Laboratory). Of the three credits of 'bin' courses specified for the third and fourth year of study, three courses have lab practicals (BIOC15H3, BIOC17H3 and BIOD21H3) and four have tutorials (BIOC31H3, BIOC50H3, BIOC61H3, & BIOD26H3), which use and assess different methodologies and approaches to answering questions in Biology. All of the fourth year (D-level) courses specified in this program provide students the ability to engage with the primary research literature. In addition, discussions, critiques, research papers and seminars provide opportunities to develop a deeper understanding of techniques and strategies for answering research questions.
3. Application of Knowledge Students are able to frame relevant questions for further inquiry. They are familiar with, or will be able to seek the tools with which, they can address such questions effectively.	Through exploration of the primary literature, students in the proposed Major will: • Develop an understanding of how to choose appropriate tools and methodologies for asking and answering scientific questions related to plant biology. Students in the existing Specialist stream take courses that provide a broad organismal survey of these facets, while the proposed new Major program essentially provides the same type of training, but will more effectively immerse students in a 'plant-rich' environment, in courses where specific strategies	The ability to frame questions and identify appropriate tools and methods for answering those questions is introduced and developed through the experiential learning laboratories in first year (BIOA01H3, BIOA02H3, CHMA10H3, and CHMA11H3) and second year (BIOB12H3 or BIOB52H3). In third and fourth years, students are directed to choose from among courses that include courses with labs (BIOC15H3, BIOC17H3 or that are laboratory intensive courses (e.g. BIOD21H3), or have tutorials that help students formulate and critique hypothesis and the methods chosen to test the hypotheses. We also have two courses that have a focus on translational research (BIOC31H3 and BIOD30H3). These two courses focus on understanding and solving plant science based problems, giving students practical experience in building critical thinking skills while focussing on issues of global importance.

	are employed. • Develop an appreciation for translational research opportunities (e.g. through the new course BIOD30). Students will be exposed to local and internationally recognized plant scientists, who will assist in developing students' understanding of research in the field.	
4. Awareness of Limits of Knowledge Students gain an understanding of the limits of their own knowledge and an appreciation of the uncertainty, ambiguity, and limits to our collective knowledge and how these might influence analyses and interpretations.	Students in the proposed Major will: • Develop an understanding of the scientific principles of hypothesis-testing, as well as uncertainty and statistics. • Develop a strong understanding of plant biology as the curriculum provides an intensive study of how plants operate, from the molecular to the ecosystems level. This breadth of formal education is offered in the existing Specialist program, but the courses are not required; in the proposed Major, a required set of courses that spans multiple levels of organization will assist students in recognizing limitations and will fuel curiosity for exploring these apparent boundaries particularly in the context of plant biology.	Core courses, shared among all degree-seeking Biological Sciences students, provide an awareness of knowledge limits as students gain a deeper understanding of biology. Discussion of limits of knowledge begins in first year when students are introduced to sources of error and statistical approaches (BIOA01H3, BIOA02H3). Knowledge of statistics is extended by the statistics requirement (STAB22H3 or PSYB07H3). This understanding is refined in second year, particularly in lab-based courses (BIOB12H3, BIOB52H3). As many of our courses delve into the primary literature, there are numerous opportunities for students to become acquainted with specific approaches and examples, where they will be exposed to constraints that define boundaries in plant sciences. As students move to the third and fourth years, they are more frequently exposed to original research (e.g. the primary literature), which familiarizes them with the limitations of systems and instrumentation. The new capstone course BIOD30H3 will explore the interpretation of data in the context of particular hypotheses, and students will be challenged to solve new problems.
5. Communication Skills Students are able to communicate information, arguments, and analyses	Students in the proposed Major will: • Develop a strong skill set in critical thinking and	The development of communication and learning skills begins in first year when students write laboratory and experimental reports (BIOA01H3, BIOA02H3, CHMA10H3, and CHMA11H3).

accurately and reliably, both orally and in writing. They learn to read and to listen critically.	knowledge transfer. • Develop strong oral and written communication skills. Some courses within the existing Specialist program provide opportunities to enhance these skills, while the new Major program requires courses that will extend the number of opportunities that exist for student projects, seminars, and problem based inquiry. As such, it refines the type of student experience to emphasize plant science.	Communication skills are reinforced in second year laboratories (BIOB12H3 and BIOB52H3), where oral presentations/laboratory reports are required. In third and fourth year courses, numerous assignments will require written or oral communication, and thus afford opportunities for students to hone their skills. Our new capstone course BIOD30H3 requires team work and group presentations, which further enhances soft skills.
6. Autonomy and Professional Capacity The education students receive achieves the following broad goals: • It gives students the skills and knowledge they need to become informed, independent and creative thinkers • It instils the awareness that knowledge and its applications are influenced by, and contribute to, society • It lays the foundation for learning as a life-long endeavour	Graduates of the proposed Major will: • Have developed the skillsets they need to critically analyze experimental designs and research data. • Have developed the foundational skills they need to enter the work force or move into higher education. Neither of these two points are new to the proposed Major program, but rather are proven core components of the Specialist program that will be retained in the proposed Major program. • Understand the relevance of their education for societal needs, and in particular, how plants play important roles in many facets of our lives.	As students progress through the program, they will be taught different methods of knowledge acquisition, including traditional independent reading and study (e.g., the core second year courses of the program), the use of experiential learning in laboratories (BIOA01H3, BIOA02H3, BIOB12H3, BIOB52H3, BIOC15H3, BIOC17H3, BIOD21H3), the societal focus of BIOB38H3, and group learning in both lab and seminar-based coursework at the third and fourth year. Advanced fourth year courses (and BIOB38H3) will highlight the importance of knowledge and research in plant biology to meet societal needs.

7 Consultation

As there are requirements for courses in other departments (CHMA10H3, CHMA11H3,

PSYB07H3, and STAB22H3), we have advised Chairs/Associate Chairs in the Departments of Computer & Mathematical Sciences, Physical and Environmental Sciences, and Psychology. To date, all responses are positive.

We have also consulted with other divisions across the wider University of Toronto, including the UTM Department of Biology, and the St. George Departments of Cell and Systems Biology, and Ecology and Evolutionary Biology. None of these departments offer such a program, although UTM is discussing one. There are no reports of issues of duplication of training, though all of these departments offer some courses that are similar to ours, as a consequence of broad coverage of topics in every Biology Department.

Within UTSC Biological Sciences, we found colleagues encouraging and it must be restated that Plant Biology is both a strength of the Department and aligned with our Academic Plan. We envision the undergraduate program as a feeder program for future graduate programs within the Department and at UTSC in general (e.g. the graduate Environmental Sciences streams within DPES).

8 Resources

8.1 Faculty requirements

The proposed Major largely takes advantage of courses that are currently taught, and it is anticipated that students interested in it will put little or no pressure on existing resources, either within or external to our department.

At UTSC, we have 7 research stream plant biologists and 2 teaching stream faculty members whose expertise involves plants and fungi. All research stream faculty hold external grants and maintain active research programmes. Collectively, the plant biology faculty has extensive expertise in many areas of plant sciences, from ecology to genomics, and numerous volunteer, work-study, and for credit opportunities exist for students within our laboratories. All nine of these faculty members currently contribute to offerings of the Specialist program, and will contribute to both it and the Majors program by regularly offering courses that either focus specifically on plants and/or employ plant science where appropriate.

Table 2: Detailed List of Committed Faculty

Faculty name and rank	Home Unit	Area(s) of Specialization
Herbert Kronzucker, Professor	Biological Sciences	Ion Transport/Physiological Ecology
Greg Vanlerberghe, Professor	Biological Sciences	Plant Metabolism/Biotic and Abiotic Stress
Marc Cadotte, Associate Professor	Biological Sciences	Conservation Biology/Ecology and Evolution
Sonia Gazzarrini, Associate Professor	Biological Sciences	Developmental Biology/Seed Biology/Plant Stress
Clare Hasenkampf, Associate Professor	Biological Sciences	Cytogenetics/ Meiosis
Dan Riggs, Associate	Biological Sciences	Meristem Biology/Meiosis

Professor		
Rongmin Zhao, Associate Professor	Biological Sciences	Protein Folding/Molecular Chaperones
Shelley Brunt, Associate Professor, Teaching Stream	Biological Sciences	Fungal and Microbiology
Ivana Stehlik, Associate Professor, Teaching Stream	Biological Sciences	Conservation/environmental biology/ecology

In addition, although delivery of the program does not require any new or additional faculty resources, nor does it require contractual faculty beyond that normally required to replace faculty on cyclical research leaves, we anticipate that, once the Rouge Valley Urban Park is fully realized, botanists there could obtain adjunct status. We will certainly be cognizant of new plant scientists at the Rouge or other local entities (e.g. Toronto Zoo), for ways in which we could extend our research breadth and depth, and it is likely that these individuals would also wish to seek cross appointments in our Department. These scientists/entities could be expected to provide additional research opportunities for our students. All required courses are currently taught or are proposed to be taught by our current faculty complement.
The proposed Major in Plant Biology will enhance the supervision of experiential learning by improving the linkage between students and plant research, making it easier for students to identify plant research opportunities. Additionally, the program has a new capstone course BIOD30H3 that will provide an opportunity for students to engage with plant research scientists and develop their research skills.
Only one new course BIOD30H3 is associated with this proposal, and no new faculty will be required to teach it. New TA support, consistent with current support for D-level courses of 35 hours will be requested to support BIOD30H3.

8.2 Space/Infrastructure

There are no resources implications for space or infrastructure related to this proposal.

9 Governance Process:

Levels of Approval Required	Dates
Departmental Curriculum Committee	June 24, 2015
Decanal Sign Off	November 18, 2015
DUCC (Undergraduate)	December 21, 2015
UTSC Academic Affairs Committee	January 27, 2016
Submission to Provost's Office	
Report to AP&P	
Report to Ontario Quality Council	

Appendix A: Final Calendar Copy Major in Plant Biology (BSc)

MAJOR PROGRAM IN PLANT BIOLOGY (SCIENCE)
Supervisor: Dan Riggs (riggs@utsc.utoronto.ca)

The Major in Plant Biology provides a broad education in all areas of contemporary biology, and affords students an opportunity to concentrate on courses in upper years that are focused on plant biology. This program is suitable for students with an interest in the biochemistry, biotechnology, cell biology, ecology, evolution, genetics, physiology, and/or development of plants.

Program Requirements:

Students are required to complete a total of 8.5 credits.

Required Courses and Suggested Course Sequence:

First Year
1.0 Credit of Introductory Biology Courses
BIOA01H3 Life on Earth: Unifying Principles
BIOA02H3 Life on Earth: Form, Function and Interactions

1.0 Credit in Introductory Chemistry Courses
CHMA10H3 Introductory Chemistry I: Structure and Bonding
CHMA11H3 Introductory Chemistry II: Reactions and Mechanisms

0.5 Credit in Statistics
Choose From:
STAB22H3 Statistics I
PSYB07H3 Data Analysis in Psychology

Second Year
2.5 Credits of Biology Core Courses
BIOB10H3 Cell Biology
BIOB11H3 Molecular Aspects of Cellular and Genetic Processes
BIOB38H3 Plants and Society
BIOB50H3 Ecology
BIOB51H3 Evolutionary Biology

Second Year
0.5 Credit of Biology Core Labs
Choose from:
BIOB12H3 Cell and Molecular Biology Laboratory
BIOB52H3 Ecology and Evolutionary Biology Laboratory

Third Year
2.0 Credits
BIOC31H3 Plant Development and Biotechnology
BIOC37H3 Plants: Life on the Edge
BIOC40H3 Plant Physiology
[BIOC15H3 Genetics or BIOC17H3 Microbiology or BIOC50H3 Macroevolution]

Third/ Fourth Year
0.5 Credits; choose from:
BIOC61H3 Community Ecology and Environmental Biology
BIOD21H3 Advanced Molecular Biology Laboratory
BIOD37H3 Biology of Plant Stress
BIOD62H3 Species and Speciation
BIOD26H3 Fungal Biology and Pathogenesis

Fourth Year
0.5 Credit
Choose from:
[BIOD30H3 Plant Research and Biotechnology: Addressing Global Problems or [any of the following research-based courses if the research utilizes plants: BIOC99H3, BIOD95H3, BIOD98Y3 or BIOD99Y3]]

Appendix B: Calendar Copy Specialist in Integrative Biology (BSc)

SPECIALIST PROGRAM IN INTEGRATIVE BIOLOGY (SCIENCE)

Supervisor: M. Andrade *Email*: integrative-biology@utsc.utoronto.ca
In today's rapidly changing world, the development of solutions to combat some of the most pressing global challenges such as climate change, emerging diseases, hunger and species extinction, requires an integrative approach in which expertise is drawn from disparate biological and other disciplines. The specialist program in Integrative Biology provides the student with a solid knowledge base in key core and foundational areas of biology while also providing a breadth of knowledge to support more specialized studies and focused training in a range of disciplines (for examples, see below under "Routes to Specialization"). Students who complete this program will be well positioned for a career in many aspects of the biological sciences or to undertake further studies at the professional or graduate level.

Program Requirements
This program consists of 14.5 required credits including at least 4.0 credits at the C- or D-level of which at least 1.0 must be at the D-level.

A. Required Courses

First Year
1.0 Credit of Introductory Biology Courses
BIOA01H3 Life on Earth: Unifying Principles
BIOA02H3 Life on Earth: Form, Function and Interactions

1.0 Credit of Introductory Chemistry Courses
CHMA10H3 Introductory Chemistry I: Structure and Bonding
CHMA11H3 Introductory Chemistry II: Reactions and Mechanisms

1.0 Credit in Mathematics
MATA30H3 Calculus I for Biological and Physical Sciences
MATA35H3 Calculus II for Biological Sciences

0.5 Credit in Physics
Choose from:
PHYA10H3 Introduction to Physics IA
PHYA11H3 Introduction to Physics IB

0.5 Credit in Computer Science
Choose from:
CSCA08H3 Introduction to Computer Science I (most appropriate course for computer science students)
CSCA20H3 Introduction to Programming (most appropriate course for non-computer science

students)
PSCB57H3 Introduction to Scientific Computing (this course could also be taken in second year)

Second Year
3.0 Credits of Biology Core Courses
BIOB10H3 Cell Biology
BIOB11H3 Molecular Aspects of Cellular and Genetic Processes
[BIOB34H3 Animal Physiology or (BIOB30H3) Mammalian Physiology I]
[BIOB38H3 Plants and Society or (BIOB31H3) Plant Physiology]
BIOB50H3 Ecology
BIOB51H3 Evolutionary Biology

0.5 Credit of Biology Core Labs
Choose from:
BIOB12H3 Cell and Molecular Biology Laboratory
BIOB32H3 Animal Physiology Laboratory
BIOB33H3 Human Development and Anatomy Laboratory
BIOB52H3 Ecology and Evolutionary Biology Laboratory

0.5 Credit in Statistics
Choose from:
STAB22H3 Statistics I
PSYB07H3 Data Analysis in Psychology

Third Year
1.5 Credits of Biology Foundation Courses
BIOC15H3 Genetics
BIOC17H3 Microbiology
BIOC54H3 Animal Behaviour

Third/Fourth Year
0.5 Credit of Advanced Courses in Physiology, Biochemistry and Neurobiology
Choose from:
BIOC12H3 Biochemistry I: Proteins and Enzymes
BIOC13H3 Biochemistry II: Bioenergetics and Metabolism
BIOC23H3 Practical Approaches to Biochemistry
BIOC32H3 Human Physiology I
BIOC33H3 Human Physiology II: Lecture and Laboratory
BIOC34H3 Human Physiology II: Lecture
BIOC39H3 Immunology
BIOC40H3 Plant Physiology
BIOC65H3 Environmental Toxicology
ANTC67H3 Foundations in Epidemiology
NROC34H3 Neuroethology
NROC61H3 Learning and Motivation
NROC64H3 Sensorimotor Systems

PSYC31H3 Clinical Neuropsychology
BIOD08H3 Theoretical Neuroscience
BIOD27H3 Molecular Endocrinology
BIOD29H3 Pathobiology of Human Disease
BIOD43H3 Animal Movement and Exercise
BIOD65H3 Pathologies of the Nervous System
NROD67H3 Psychobiology of Aging

0.5 Credit of Advanced Courses in Ecology and Conservation
Choose from:
BIOC50H3 Macroevolution
BIOC51H3 Tropical Biodiversity Field Course
BIOC52H3 Ecology Field Course
BIOC58H3 Biological Consequences of Global Change
BIOC59H3 Advanced Population Ecology
BIOC61H3 Community Ecology and Environmental Biology
BIOC62H3 Role of Zoos in Conservation
BIOC63H3 Conservation Biology
(BIOC67H3) Inter-University Biology Field Course
EESC04H3 Biodiversity and Biogeography
BIOD52H3 Special Topics in Biodiversity and Systematics
BIOD54H3 Applied Conservation Biology
BIOD60H3 Spatial Ecology
BIOD62H3 Species and Speciation
BIOD66H3 Causes and Consequences of Diversity
BIOD67H3 Inter-University Biology Field Course

0.5 Credit of Advanced Courses in Genes and Development
Choose from:
BIOC10H3 Cell Biology: Proteins from Life to Death
BIOC14H3 Genes, Environment and Behaviour
BIOC16H3 Evolutionary Genetics and Genomics
BIOC19H3 Animal Developmental Biology
BIOC31H3 Plant Development and Biotechnology
BIOD19H3 Epigenetics in Health and Disease
BIOD21H3 Advanced Molecular Biology Laboratory
BIOD22H3 Molecular Biology of the Stress Response
BIOD23H3 Special Topics in Cell Biology
BIOD25H3 Genomics

0.5 Credit of Advanced Courses in Organismal Biology
Choose from:
BIOC21H3 Vertebrate Histology: Cells and Tissues
(BGYC22H3) Vertebrate Histology: Organs
ANTD22H3 Theory and Methodology of Primatology
ANTC68H3 Deconstructing Epidemics

EESC30H3 Microbial Biogeochemistry
BIOC37H3 Plants: Life on the Edge
(BIOC38H3) Plants and Society
BIOC60H3 Winter Ecology
BIOD17H3 Seminars in Cellular Microbiology
BIOD26H3 Fungal Biology and Pathogenesis
BIOD29H3 Pathobiology of Human Disease
BIOD33H3 Comparative Animal Physiology
BIOD37H3 Biology of Plant Stress
BIOD45H3 Animal Communication
BIOD48H3 Ornithology and Herpetology
BIOD53H3 Special Topics in Behavioural Ecology

3.0 Credits of Additional C- or D-Level Biology Courses
Choose from:
Any BIO (or formerly BGY) C- or D-level courses offered by the department.
Note: this includes the Biology Team Research, Supervised Studies and Directed Research courses (BIOC99H3, BIOD95H3, BIOD98Y3 and BIOD99Y3).
Note: NROC34H3 (Neuroethology), EESC04H3 (Biodiversity and Biogeography) and EESC30H3 (Microbial Biogeochemistry) may also be used toward fulfilling this requirement, if not already used toward fulfilling one of the other requirements above.

B. Routes to Specialization (optional)
A key advantage of the specialist program in Integrative Biology is the ability for students to readily specialize in areas of particular interest. Please note that students are not required to follow any of these suggested routes. They are provided for guidance only.

- For students with a particular interest in "The Impact of Environment and Climate Change on the Biology of Ecosystems", you should consider including some or all of the following courses in your program: BIOB52H3 (Ecology and Evolutionary Biology Lab), BIOC52H3 (Ecology Field Course), BIOC58H3 (Biological Consequences of Global Change), BIOC59H3 (Advanced Population Ecology), BIOC60H3 (Winter Ecology), BIOC61H3 (Community Ecology and Environmental Biology) and (BIOC67H3) (Inter-University Biology Field Course).
- For students with a particular interest in "The Conservation and Biodiversity of Organisms", you should consider including some or all of the following courses in your program: BIOC51H3 (Tropical Biodiversity Field Course), BIOC62H3 (Role of Zoos in Conservation), BIOC63H3 (Conservation Biology), BIOD48H3 (Ornithology and Herpetology), BIOD52H3 (Special Topics in Biodiversity and Systematics), BIOD54H3 (Applied Conservation Ecology), BIOD60H3 (Spatial Ecology) & BIOD66H3 (Causes and Consequences of Biodiversity).
- For students with a particular interest in "Animal Physiology", you should consider including some or all of the following courses in your program: BIOB32H3 (Animal Physiology Laboratory), BIOC32H3 (Human Physiology I), BIOC33H3 or BIOC34H3 (Human Physiology II), BIOD29H3 (Pathobiology of Human Disease), BIOD33H3 (Comparative Animal Physiology), & BIOD43H3 (Animal Movement and Exercise).

- For students with a particular interest in "Ecophysiology", you should consider including some or all of the following courses in your program: BIOC65H3 (Environmental Toxicology), EESC30H3 (Microbial Biogeochemistry), BIOD33H3 (Comparative Animal Physiology) & BIOD37H3 (Biology of Plant Stress).
- For students with a particular interest in "Infection and Disease" or "clinically-oriented topics", you should consider including some or all of the following courses in your program: ANTC67H3 (Foundations in Epidemiology) or ANTC68H3 (Deconstructing Epidemics), BIOB33H3 (Human Development and Anatomy), BIOC21H3 (Vertebrate Histology: Cells and Tissues), BIOC33H3 or BIOC34H3 (Human Physiology II), BIOC39H3 (Immunology), BIOD17H3 (Seminars in Cellular Microbiology), BIOD25H3 (Genomics), BIOD26H3 (Fungal Biology and Pathogenesis), BIOD29H3 (Pathobiology of Human Disease) & BIOD65H3 (Pathologies of the Nervous System).
- For students with a particular interest in "Plant and Microbial Biology", you should consider including some or all of the following courses in your program: BIOC31H3 (Plant Development and Biotechnology), EESC30H3 (Microbial Biogeochemistry), BIOD17H3 (Seminars in Cellular Microbiology) and BIOD37H3 (Biology of Plant Stress).
- For students with a particular interest in "Behavioural Biology" you should consider including some or all of the following courses in your program: NROC34H3 (Neuroethology), BIOD45H3 (Animal Communication), BIOD53H3 (Special Topics in Behavioural Ecology) & NROC61H3 (Learning and Motivation).
- For students with a particular interest in "Behavioural Genetics", you should consider including some or all of the following courses in your program: BIOC16H3 (Evolutionary Genetics and Genomics), NROC34H3 (Neuroethology), BIOD21H3 (Advanced Molecular Biology Laboratory), BIOD22H3 (Molecular Biology of the Stress Response), BIOD23H3 (Special Topics in Cell Biology), BIOD25H3 (Genomics), BIOD45H3 (Animal Communication), and BIOD53H3 (Special Topics in Behavioural Ecology).
- For students with a particular interest in "The Evolution of Development" (a.k.a. "evo/devo"), you should consider including some or all of the following courses in your program: BIOC12H3 (Biochemistry I: Proteins and Enzymes), BIOC13H3 (Biochemistry II: Bioenergetics and Metabolism), BIOC16H3 (Evolutionary Genetics and Genomics), BIOC19H3 (Animal Developmental Biology), BIOC23H3 (Practical Approaches to Biochemistry), BIOC31H3 (Plant Development and Biotechnology), BIOC33H3 (Human Physiology II: Lecture and Laboratory) or BIOC34H3 (Human Physiology II: Lecture), BIOD21H3 (Advanced Molecular Biology Laboratory), BIOD22H3 (Molecular Biology of the Stress Response), BIOD23H3 (Special Topics in Cell Biology), & BIOD25H3 (Genomics).