



Faculty of Science

Biological Science

**Major Program Modification
New specialization in Environmental Biology**

September 29th, 2017

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Motion: That CPRC recommend to Academic Council the approval of a new specialization in Environmental Biology through the B.Sc. (Honours) Biological Science program.

PROPOSAL BRIEF

1. SUMMARY OF PROPOSED CHANGE

The Faculty of Science proposes to offer a new specialization in Environmental Biology through the B.Sc. (Honours) Biological Science program. This specialization would also include the Bachelor of Science and Management, and Co-operative Education program options.

2. BACKGROUND

The Faculty of Science proposes to offer a new specialization in Biological Science called *Environmental Biology*. Environmental Biology encompasses the diversity and function of life on the planet within the context of human impacts on the environment. This specialization complements the Faculty of Science mission, which is committed to excellence and innovation in interdisciplinary teaching and research relevant to the needs of society and the environment. It also supports UOIT's mandate for offering "market driven" programs that are relevant and reflective of the new green economy. In keeping with the university's mission to prepare students for careers, the program emphasizes the development of leadership skills, and includes the opportunity for experiential learning. The Co-operative education (or co-op) option provides up to five semesters of career-related experience, making the academic learning richer and more meaningful. Co-op not only develops intellectual growth through the application of theoretical principles learned in the classroom to real world problems, but it also enhances personal growth by helping students to develop the knowledge, perspective, and confidence to transform their lives.

Biological Sciences, like all other science programs at UOIT, is an Honours program. The program is supported by state-of-the art laboratories and classrooms, which include a leading-edge aquatics facility and advanced high-performance computing infrastructure. Unlike other universities in the region, UOIT students are exposed to new and innovative laboratory equipment that students from other universities sometimes do not get to use until the graduate-level. As students proceed through the Biological Science program, they develop a background in cell biology, genetics, physiology, and microbiology. Senior-level courses provide an opportunity to focus on advanced material in a diverse range of subjects from bioethics to genomics. All UOIT Science programs provide basic foundational knowledge in the core science disciplines. This prepares graduates for the future evolution of both their discipline and their scientific workplace.

Similar to other Faculty of Science programs, Biological Science offers several "specializations", which typically incorporate collections of at least six courses in the upper years emphasizing an application area of the discipline. Biological Science currently has three such specializations: *Life Sciences*, *Environmental Toxicology*, and *Pharmaceutical Biotechnology*. Students interested in the three primary specializations (*Life Sciences*, *Environmental Toxicology*, and *Pharmaceutical Biotechnology*) follow specified program maps prescribing the sequence of required courses.

Students also have the option to enroll in the Honours Biological Science program (no specialization) and work with the Science Academic Advisor to customize a program to match their interests and career plans. There is also the opportunity to earn a Bachelor of Science and Management (Honours) degree in Biological Science. This five-year degree provides students with an opportunity to combine their interests in science with business management skills. Students also have the option to participate in the Cooperative Education program, and earn a Bachelor of Science and Cooperative Education (Honours) degree in Biological Science following the successful completion of at least three work terms and all B.Sc. degree requirements.

As an interdisciplinary specialization, the Environmental Biology program map has been designed to make extensive use of courses that already exist in Biological Science, Chemistry and other Science programs. The proposed specialization does not require any new courses, and only requires one course modification (i.e., a new course title and description for BIOL 4020). This new specialization includes more electives in the upper years of the program to allow flexibility for those students wishing to take advantage of new minors that come on-line in the Faculty of Science. Finally, a new Environmental Biology specialization will build on a strong faculty cohort in environmental science, including two teaching-focused faculty members with backgrounds in ecology (A. Tavares) and environmental science (M. Olaveson), as well as tenured faculty with research interests and backgrounds in ecology (Sean Forrester and Andrea Kirkwood) and environmental toxicology (Tier I Canada Research Chair D. Holdway).

Student Demand

Student enquiries related to the existence of UOIT programs in the general area of environmental science have regularly come up at Open House events and other recruitment events such as the Ontario University Fair. We believe that there is a significant cohort of students interested in this area of biological science, and that the proposed specialization would be very attractive to them. Specifically, having the option to specialize in Environmental Biology would be desirable to students in view of the many career opportunities in the growing environmental sector. These “green jobs” are believed to be an important area of growth and demand for highly skilled personnel with expertise related to environmental sustainability and management. Some career path examples include: environmental consulting, environmental policy development and regulation, conservation, environmental compliance/regulation, biofuels industry, environmental analytical labs, and natural resource management. The broad skills base acquired through the Environmental Biology specialization will permit a variety of complementary career paths in corporate sustainability, urban affairs, regional planning, communications (such as environmental journalism), environmental design, law, research and education.

Societal Need

There is widespread societal interest in incorporating environmental stewardship into today’s industrial economy. This specialization prescribes an integrated set of courses that provide a

fundamental scientific understanding of the diversity of life on the planet within the context of human environmental impacts and sustainability.

Duplication

The proposed specialization was not duplicated from any particular undergraduate program in Canada, but was designed from first principles. It is built on the core science and biology strengths of our current programs, and the research foci of faculty members in Biology. Many universities offer “Environmental Science” programs, but only 4 (Guelph, Nipissing, Toronto (St. George and Scarborough), Queens) offer majors or specializations in *Environmental Biology* (Table 1). The Environmental Biology specialization at UOIT would share some common elements with Environmental Biology programs at other universities, but would be particularly unique in that it prescribes a strong foundation in the natural sciences (biology, chemistry, physics and mathematics) over the first two years of study. In upper years, students will take a range of courses that reflect the diversity and adaptation of life on earth, as well as courses that cover human environmental impacts from genomes to ecosystems. Furthermore, courses such as *Bioethics*, *Conservation Biology* and *Economics and Politics of the Environment* will provide context for matters related to environmental decision-making. The Environmental Biology specialization also serves as a clear pathway to our *Applied Bioscience* graduate program, which includes a research theme in *Ecosystem Health*.

Table 1. Ontario universities with Environmental Biology majors or specializations.

University	Program Name
Nipissing University	Bachelor of Science (BSc) Honours specialization in Environmental Biology and Technology
Queens University	Honours B.Sc. Specialization in Environmental Biology
University of Guelph	Honours B.Sc. program in Environmental Biology
University of Toronto (St. George Campus)	Honours B.Sc. Major or Minor program in Environmental Biology
University of Toronto (Scarborough Campus)	Honours B.Sc. Specialist program in Environmental Biology

Differentiation from the Environmental Toxicology Specialization

A new specialization in Environmental Biology is not intended to divert students from enrolling in the Environmental Toxicology specialization. The Environmental Toxicology specialization has a highly prescribed program map designed to educate and prepare students in the niche discipline of *environmental toxicology*. Although unique and unrivalled across Ontario, the narrow focus of the Environmental Toxicology specialization may in part explain why it has not attracted a large number of students over the 14 years it has been offered at UOIT. To address this, Environmental Biology was born out of an aspiration to offer students more breadth and flexibility in an environmental specialization. In addition to providing a broad, but comprehensive environmental scope, the Environmental Biology program map also includes flexibility for students to acquire a degree minor. There are shared required courses between Environmental Biology and Environmental Toxicology, but this is not unlike other specializations in Biological Science.

3. DEGREE REQUIREMENTS

a) Program learning outcomes

Upon graduation, students of the Environmental Biology specialization will have particular abilities that are consistent with the provincial degree level expectations:

1. Depth and breadth of knowledge

The integrated approach of the Environmental Biology program exposes students to a variety of science disciplines, which provides them with the scientific basis necessary for understanding the physical, chemical, and biological nature of the environment. The “sustainability” theme inherent in the program provides a framework for the analysis of the human impacts on the environment, as well as an introduction to the socioeconomic, political, technological and cultural influences that govern choices we make about the environment. Specifically:

- Students will develop knowledge and critical understanding of the key concepts, major fields, methodologies, current advances, and theoretical approaches and assumptions in the environmental sciences through core courses in biology, chemistry, physics, mathematics and environmental science.
- Students will develop an interdisciplinary perspective through both core and elective courses offered in the Faculty of Science and other faculties.
- Students will develop the ability to gather, review, evaluate and interpret information, compare the merits of alternative hypotheses relevant to the major fields in environmental science through the Environmental Research Methods course, the core Environmental Biology specialization courses, and hands-on research (e.g., Directed Studies, Honours Undergraduate Thesis).
- Students will develop critical thinking and analytical skills throughout their program in both core and elective courses

2. Knowledge of Methodologies

As a multidiscipline specialization, Environmental Biology students will learn a variety of techniques that include laboratory protocols in biology and chemistry, quantitative analyses in mathematics and statistics, and a variety of computer software applications for writing, data analysis, and modeling. Specifically:

- Students will learn to evaluate the appropriateness of different approaches to solving problems using well-established ideas and techniques
- Students will learn to devise and sustain arguments or solve problems using these methods in their term papers and the more in-depth hands-on research courses (Environmental Research Methods, Directed Studies, Honours Undergraduate Thesis).
- Students will learn to describe and comment upon particular aspects of current research in their term papers and the more in-depth hands-on

research courses (Environmental Research Methods, Directed Studies, Honours Undergraduate Thesis).

3. Application of knowledge

The Environmental Biology specialization emphasizes adaptability by teaching a wide range of topics that will be periodically reviewed for their inclusion of important trends in the environmental sector. This is done to maintain program relevance with a rapidly changing job market. Students will learn how to design, research, analyze, and implement new approaches to environmental problems, in addition to gaining fundamental knowledge in the natural sciences. Important technical skills will be acquired from advanced lab and computer training, which only adds to their adaptability to a changing job market. Environmental Biology graduates will be prepared for employment in any area dealing with environmental issues, particularly in government and the environmental consulting industry. Through the integration of their multi-discipline knowledgebase, they will be able to apply their unique skills to solve environmental problems using sustainability as the guiding principle. Their undergraduate training will have provided a toolbox of techniques and ideas that can be applied to problems in ecology, environmental governance, energy, water, waste management, media, and environmental assessment. Specific applications of knowledge include:

- Students will be able to develop lines of argument, make sound judgments in accordance with major theories, concepts and methods of Environmental Biology, apply underlying concepts, principles, and techniques of analysis both within Environmental Biology and in other disciplines, and appropriately use this knowledge along their career path.
- Students will have the ability to use a range of established techniques to initiate and undertake critical evaluation of arguments, assumptions, abstract concepts and information, propose solutions, frame appropriate questions for the purpose of solving a problem, in their required courses. They will learn to solve a problem or create a new work in their hands-on research courses (in their term papers and in more in-depth hands-on research courses Environmental Research Methods, Directed Studies, Honours Undergraduate Thesis).
- Students will be able to make critical use of scholarly reviews and primary sources in their required courses, as well as electives and hands-on research courses (in which they are required to write reports describing/explaining their research).

4. Communication skills

Due to the vast array of career opportunities in the environmental sector, an important deliverable of the Environmental Biology specialization will be effective

science communication, particularly since the exchange of information and knowledge across disciplines will be essential for solving environmental problems. Students will attain the ability to communicate information, arguments, and analyses accurately and reliably, both orally and in writing. Most courses in the Environmental Biology program map provide students with the opportunity to learn effective communication strategies, either through written reports and assignments or via oral presentations. Most of the upper-year courses include communication assessments such as group projects and presentations. Group work not only offers experience with group dynamics, but also emphasizes management skills in workload delegation.

5. Awareness of limits of knowledge

Students will learn the limits of their own knowledge and ability, and gain an appreciation of the complexity, uncertainty, and limits to knowledge in core Environmental Biology courses. They will also learn about limits and uncertainty in courses that highlight environmental research such as Ecology, Environmental Toxicology, Conservation Biology, and Environmental Research Methods.

6. Autonomy and professional capacity

An integrated theme in all Faculty of Science programs emphasizes the importance of personal responsibility and accountability in both individual and group contexts. Students will learn to exhibit the behaviour consistent with academic integrity and social responsibility through their coursework and progressively more responsible activities, such as independent research (Directed Studies or Honours Undergraduate Thesis). Students will gain the:

- capacity to make decisions in complex scenarios through a graduated progression in core coursework, as well as hands-on work in research-related courses.
- qualities and transferable skills necessary for further study, employment, and community involvement.
- ability to manage their own learning in changing circumstances, both within and outside the discipline.
- awareness to exhibit behaviour consistent with academic integrity and social responsibility

b) Admission Requirements

Admission requirements are in line with existing Faculty of Science and UOIT practices.

Current Ontario secondary school students must complete the Ontario Secondary School Diploma (OSSD) with six 4U or 4M credits including English (ENG4U), Advanced Functions (MHF4U), and two of Biology (SBI4U), Calculus and Vectors (MCV4U), Chemistry (SCH4U) or Physics (SPH4U). In addition, a combined minimum of 70 per cent average in

prerequisite math and science courses is required. It is recommended that all four of MCV4U, SBI4U, SCH4U and SPH4U be taken.

c) Program Structure

Overview

The Environmental Biology specialization curriculum can be divided into the following subcategories:

Core Science Courses

Environmental Biology majors will take all of the first-year and most of the second year courses required of all Biological Science students, which include courses in biology, chemistry, physics, mathematics, and computer programming.

Core Biological Science Courses

Since Environmental Biology is a specialization within Biological Science, students must acquire knowledge of the core areas of Biology. Accordingly, students are required to take one course in each core area in the first two years of the program. These core areas include courses in Cell Biology, Physiology, Genetics and Molecular Biology, Microbiology and Immunology, and Biochemistry. These courses are completed by the end of the second year so that the students are well-grounded in biology and have achieved the necessary pre-requisites for specialized courses in years three and four of the program. All of these core Biological Sciences courses are currently in the University Calendar.

Core Environmental Biology Specialization Courses

Years three and four of the program map include the specialized courses that make Environmental Biology unique and innovative. These courses are designed to reflect timely topics and issues related to the environment including courses in biology, chemistry, statistics, and environmental science. Biology courses covering aspects of life in the environment include Ecology, Plant Biology, Comparative Zoology, Conservation Biology, Environmental Toxicology, Aquatic Ecology, and Environmental Research Methods. Remaining required Science courses that contribute to the environmental theme include Environmental Science, Environmental Chemistry, and Economics and Politics of the Environment. In the fourth year of the program, students have the option of an honours undergraduate thesis project, directed studies project, or senior science elective.

Electives

Due to the breadth and interdisciplinary nature of Environmental Biology, there is an increased opportunity for students to take elective courses in science to allow for a minor in a complementary discipline (e.g. Data Science). As such, there is a minimum of 24 credit hours allocated for elective courses, with an additional 6 credit hours of senior biology

electives in the 4th year for students not enrolled in Directed Studies or Honours Thesis courses. It is proposed that 12 of the elective credit hours be applied to courses outside of the Faculty of Science, which keeps in line with the breadth requirements of other Biological Science specializations.

Applied Learning Opportunities

As noted in the learning objectives above and consistent with UOIT's orientation, this program puts a high priority on practical application of academic knowledge. All students are required to take the Environmental Research Methods course in the fourth year of the program, which provides an opportunity to apply the comprehensive scientific knowledge acquired during their undergraduate program. This includes an understanding of ecological/environmental concepts and principals, as well statistical theory and applications. Students are then expected to apply this knowledge to environmental problems using various research tools and lines of enquiry. As an option, students may enroll in a Directed Studies or Honours Undergraduate Thesis course, both of which may include one-on-one faculty directed research on an environment-related problem. Currently a new third-year laboratory experience course is undergoing curriculum review, and if accepted, would offer another opportunity for practical training and experience in a laboratory environment for students. Such experiences are highly valued by graduate departments and future employers as examples of independent work. The co-operative education program described earlier is also another option for applied, experiential learning in Environmental Biology.

Calendar Copy and/or Program Maps

Biological Science – Environmental Biology specialization

General information

As students proceed through the Biological Science program, they will obtain a background in cell biology, genetics and molecular biology, physiology, biochemistry and developmental biology. Senior level courses such as Bioethics, Neuroscience, Functional Genomics and Proteomics, along with access to modern laboratories, computational tools, sophisticated equipment and state-of-the-art facilities will enable advanced research work and skills training in industry best practice and in research.

Students can study through the Honours Biological Science program, or choose to specialize in either Life Sciences, Environmental Biology, Environmental Toxicology, or Pharmaceutical Biotechnology.

Environmental Biology specialization

The Environmental Biology specialization at UOIT prepares students for leadership roles in the environmental sector. The Environmental Biology specialization combines disciplinary study in the natural sciences in the first two years of the program, followed by focused study in the last two years on the diversity of life from genomes to ecosystems in natural and human impacted environments.

In addition to the regular program, a co-op program is also available. Students in Environmental Biology interested in the co-op program, should contact the Faculty of Science Co-op Coordinator as early as the fall of their second year.

Admission requirements

Admission is competitive. The specific average or standing required for admission varies from year to year. Students are selected by taking into consideration a wide range of criteria including school marks, distribution of subjects taken, and performance in subjects relevant to the academic program. Possession of the minimum requirements does not guarantee acceptance. Preference will be given to applicants with the best qualifications.

Current Ontario secondary school students must complete the Ontario Secondary School Diploma (OSSD) with six 4U or 4M credits including English (ENG4U), Advanced Functions (MHF4U), and two of Biology (SBI4U), Calculus and Vectors (MCV4U), Chemistry (SCH4U), or Physics (SPH4U). In addition, a combined minimum 70 per cent average in math and science courses is required. It is recommended that all four MCV4U, SBI4U, SCH4U and SPH4U be taken. All other applicants should refer to admissions for the requirements for their specific category of admission.

Program details and degree requirements

Although reasonable efforts will be made to adhere to the following program map, course requirements and term offerings may change.

Year 1

Semester 1 (15 credit hours)

- BIOL 1000U – Foundations in Bioscience
- BIOL 1010U – Biology I: Molecular and Cellular Systems
- CHEM 1010U – Chemistry I
- MATH 1015U – Mathematics for Bioscience ++
- PHY 1030U – Introductory Physics +

Semester 2 (15 credit hours)

- Elective**
- BIOL 1020U – Biology II: Diversity of Life and Principles of Ecology

- CHEM 1020U – Chemistry II
- CSCI 1040U – Introduction to Programming for Scientists
- PHY 1040U – Physics for Biosciences ++

+All students who have completed Grade 12 Advanced Functions (MHF4U) and Calculus and Vectors (MCV4U) should take PHY 1010U. Students without one of these high school courses or equivalent are directed to take PHY 1030U

++Students who wish to take upper-year physics courses must take MATH 1000U or MATH 1010U, MATH 1020U, PHY 1010U or PHY 1030U, and PHY 1020U. However, students who achieve a B standing or higher in PHY 1040U will be permitted to proceed to higher-level physics courses. Students who wish to take upper-year mathematics courses must take MATH 1000U or MATH 1010U, and MATH 1020U.

Year 2

Semester 1 (15 credit hours)

- BIOL 2010U – Human Physiology
- BIOL 2030U – Cell Biology
- CHEM 2020U – Introduction to Organic Chemistry
- CHEM 2130U – Analytical Chemistry for Biosciences
- STAT 2020U – Statistics and Probability for Biological Science

Semester 2 (15 credit hours)

- Elective**
- BIOL 2020U – Genetics and Molecular Biology
- BIOL 2060U – Introduction to Microbiology and Immunology
- BIOL 2080U – Biochemistry I
- ENVS 1000 – Introduction to Environmental Science

Year 3

Semester 1 (15 credit hours)

- Elective**
- BIOL 3020U – Principles of Pharmacology and Toxicology
- BIOL 3640U – Plant Biology
- BIOL 3610U – Comparative Zoology
- BIOL 3660U – Ecology

Semester 2 (15 credit hours)

- Two electives**
- BIOL 3620U – Conservation Biology
- ENVS 3110U – Economics and Politics of the Environment
- STAT 3010U – Biostatistics

Year 4

Semester 1 (15 credit hours)

- Elective**
- BIOL 4010U – Introduction to Environmental Research Methods
- BIOL 4020U – Introduction to Environmental Toxicology (*change in course title*)
- CHEM 3050U – Environmental Chemistry

One of:

- BIOL 4410U – Biology Thesis Project I *** or
- Senior Biology Elective**

Semester 2 (15 credit hours)

- Two Electives**
- BIOL 4080U – Bioethics
- BIOL 4660U – Aquatic Ecology

One of:

- BIOL 4420U – Biology Thesis Project II *** or
- Senior Biology elective**

Notes:

No more than 42 credit hours may be taken at the first-year level.

**Electives and breadth requirements

All students must complete 24 elective credit hours including at least one senior science elective. Students not accepted to take BIOL 4410U and BIOL 4420U must take an additional two senior biology electives for a total of 30 elective credit hours. A senior biology elective is defined as any 4000-level biology course not specified in the course map. At least 12 elective credit hours must be in courses offered by the Faculty of Science including the 3 credit hours in a senior science elective; the additional two senior Biology electives required for students who are not enrolled in thesis cannot be used to meet this requirement.

***Thesis Project or Senior Biology electives

Students in clear academic standing who have completed 90 credit hours of their BIOL program and six third-year required courses may optionally apply to take a two-course sequence consisting of BIOL 4410U – Biology Thesis Project I and BIOL 4420U – Biology Thesis Project II. Students not accepted to take the thesis courses must complete two additional senior biology electives instead. A senior biology elective is defined as any 4000-level biology course not specified in the course map. A student meeting the above requirements who does not take BIOL 4410U and BIOL 4420U may optionally apply to

take BIOL 4430U – Directed Studies in Biology as one of the required senior biology electives. Opportunities for the Thesis Project and Directed Studies options are limited; for either of these options, students must apply through Science Advising by March 30 following completion of the first three years of the program.

d) Program Content

No new courses are being proposed with this specialization. Only one minor course change to BIOL 4020U is being proposed (documentation attached).

4. RESOURCE REQUIREMENT

a) Faculty members

Currently, the main faculty members who would support the program consist of five biologists with expertise in a broad range of subject areas related to Environmental Biology. These core faculty members meet the breadth requirements of the specialization, and will teach most of the required specialization courses in years three and four. Their qualifications are summarized in the following table (Table 2).

Table 2. List of core faculty members supporting the Environmental Biology specialization.

Faculty Member	Highest Degree Earned	Rank	No. of courses in the Env. Bio. Specialization	Areas of expertise
Mary Olaveson	M.Sc.	Senior Lecturer	5	Botany, ecotoxicology, environmental microbiology
Annette Tavares	M.Sc.	Senior Lecturer	3	Ecology, zoology, taxonomy
Sean Forrester	Ph.D.	Associate Professor	2	Ecology, toxicology, parasitology
Douglas Holdway	Ph.D.	Full Professor (CRC in Aquatic Toxicology)	2	Fish biology, aquatic toxicology
Andrea Kirkwood	Ph.D.	Associate Professor	4	Aquatic ecology, microbial ecology

b) Additional academic and non-academic human resources

No additional academic and non-academic human resources are expected with regards to the implementation and running of this specialization. Environmental Biology will be an additional option to the existing complement of Biological Science specializations. While the hope is the addition of this new specialization will increase interest and enrollment in the Biological Science program, we do not anticipate that this increase would be above normal overall enrollment projections for the discipline, and thereby should not draw any additional resources.

c) Physical resource requirements

Similar to all Faculty of Science undergraduate programs, new space requirements may be needed in the future to keep pace with increasing enrolments. No additional space requirements are anticipated over the next three years based on the current Strategic Mandate Agreement with the Province of Ontario. Additionally, no significant increases in resource requirements are anticipated in terms of library holdings, information technology support and student services, and special equipment.

5. BUSINESS PLAN

a) Statement of funding requirements

Since no additional academic and non-academic human resources are required for the implementation and running of this specialization, there are no additional costs anticipated. Although the goal for this new specialization is to increase interest and enrollment in the Biological Science program, we do not anticipate that this increase would be above normal overall enrollment projections for the discipline, and thereby should not draw any additional resources.

b) Statements of resource availability

As previously mentioned, no new hires or courses are needed for this proposed specialization. Since enrollments are expected to be within the earmarked projections for the Biological Science program as a whole, the appropriate resources in the Faculty of

Science and external to the Faculty of Science are already in place. As such, no amendments or changes to resource allocations are required.

6. TIMELINE OF IMPLEMENTATION & TRANSITION PLAN (Include semester of implementation)

As this specialization requires no new courses or resources, it can be made available in Fall 2018. Students currently in the Biological Science program would have the option to switch into this specialization, under consultation with the Science Academic Advisors.

APPROVAL DATES

Curriculum Committee Approval	October 18 th , 2017
Faculty Council Approval	November 1 st , 2017
CPRC or GSC Approval	19 January 2018
Academic Council Approval	