The information published in this Undergraduate Calendar outlines the rules, regulations, curricula, programs and fees for the 2019-2020 academic year, including the Summer Semester 2019, the Fall Semester 2019 and the Winter Semester 2020.

For your convenience the Undergraduate Calendar is available in PDF format.

If you wish to link to the Undergraduate Calendar please refer to the Linking Guidelines.

The University is a full member of:

• Universities Canada

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    Guelph, Ontario, Canada
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    https://www.uoguelph.ca

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The University reserves the right to change without notice any information contained in this calendar, including fees, any rule or regulation pertaining to the standards for admission to, the requirements for the continuation of study in, and the requirements for the granting of degrees or diplomas in any or all of its programs. The publication of information in this calendar does not bind the University to the provision of courses, programs, schedules of studies, or facilities as listed herein.

The University will not be liable for any interruption in, or cancellation of, any academic activities as set forth in this calendar and related information where such interruption is caused by fire, strike, lock-out, inability to procure materials or trades, restrictive laws or governmental regulations, actions taken by faculty, staff or students of the University or by others, civil unrest or disobedience, public health emergencies, or any other cause of any kind beyond the reasonable control of the University.

In the event of a discrepancy between a print version (downloaded) and the Web version, the Web version will apply,

Published by: Enrolment Services
Introduction

Collection, Use and Disclosure of Personal Information

Personal information is collected under the authority of the University of Guelph Act (1964), and in accordance with Ontario's Freedom of Information and Protection of Privacy Act (FIPPA) http://www.e-laws.gov.on.ca/index.html. This information is used by University officials in order to carry out their authorized academic and administrative responsibilities and also to establish a relationship for alumni and development purposes. Certain personal information is disclosed to external agencies, including the Ontario Universities Application Centre, the Ministry of Training, Colleges and Universities, and Statistics Canada, for statistical and planning purposes, and is disclosed to other individuals or organizations in accordance with the Office of Registrarial Services Departmental Policy on the Release of Student Information. For details on the use and disclosure of this information call the Office of Registrarial Services at the University at (519) 824-4120 or see http://www.uoguelph.ca/registrar/registrar/index.cfm?index.

Disclosure of Personal Information to the Ontario Ministry of Training, Colleges and Universities

The University of Guelph is required to disclose personal information such as characteristics and educational outcomes to the Ministry of Training, Colleges and Universities under s. 15 of the Ministry of Training, Colleges and Universities Act, R.S.O. 1990, Chapter M.19, as amended. The Ministry collects this data for purposes including but not limited to planning, allocating and administering public funding to colleges, universities and other post-secondary educational and training institutions.

Amendments made to the Ministry of Training, Colleges and Universities Act, authorizing the collection and use of personal information from colleges and universities by the Minister which were set out in Schedule 5 of the Childcare Modernization Act, 2014, came into force on March 31, 2015.

The amendments strengthen the ability of the Minister to directly or indirectly collect and use personal information about students as required to conduct research and analysis, including longitudinal studies, and statistical activities conducted by or on behalf of the Ministry for purposes that relate to post-secondary education and training, including:

i. understanding the transition of students from secondary school to post-secondary education and training,

ii. understanding student participation and progress, mobility and learning and employment outcomes,

iii. understanding linkages among universities, colleges, secondary schools and other educational and training institutions prescribed by regulation,

iv. understanding trends in post-secondary education or training program choices made by students,

v. understanding sources and patterns of student financial resources, including financial assistance and supports provided by government and post-secondary educational and training institutions,

vi. planning to enhance the affordability and accessibility of post-secondary education and training and the quality and effectiveness of the post-secondary sector,

vii. identifying conditions or barriers that inhibit student participation, progress, completion and transition to employment or future post-secondary educational or training opportunities, and

viii. developing key performance indicators.

Information that the University is required to provide includes but is not limited to: first, middle and last name, Ontario Educational Number, citizenship, date of birth, gender, first three digits of a student’s postal code, mother tongue, degree program and major(s) in which the student is enrolled, year of study and whether the student has transferred from another institution.

Further information on the collection and use of student-level enrolment-related data can be obtained from the Ministry of Training, Colleges and Universities website: https://www.ontario.ca/page/ministry-advanced-education-and-skills-development or https://www.ontario.ca/fr/page/ministere-de-lenseignement-supieur-et-de-la-formation-professionnelle. (French) or by writing to the Director, Postsecondary Finance and Information Management Branch, Postsecondary Education Division, 7th Floor, Mowat Block, 900 Bay Street, Toronto, ON M7A 1L2.

An update on Institutional and Ministry of Training, Colleges and Universities Act Notice of Disclosure Activities is posted at https://www.ontario.ca/page/ministry-advanced-education-and-skills-development

Frequently Asked Questions related to the Ministry’s enrolment and OEN data activities are also posted at: http://www.tcu.gov.on.ca/pepa/publications/NoticeOfCollection.pdf

Authority to Disclose Personal Information to Statistics Canada

The Ministry of Training, Colleges and Universities discloses student-level enrolment-related data it collects from the colleges and universities as required by Statistics Canada in accordance with Section 13 of the Federal Statistics Act. This gives the Ministry authority to disclose personal information in accordance with s. 42(1) (e) of FIPPA

Notification of Disclosure of Personal Information to Statistics Canada

For further information, please see the Statistics Canada's web site at http://www.statcan.ca and Section XIV Statistics Canada.

Address for University Communication

Depending on the nature and timing of the communication, the University may use one of these addresses to communicate with students. Students are, therefore, responsible for checking all of the following on a regular basis:

Email Address

The University issued email address is considered an official means of communication with the student and will be used for correspondence from the University. Students are responsible for monitoring their University-issued email account regularly. See Section I--Statement of Students' Academic Responsibilities for more information.

Home Address

Students are responsible for maintaining a current mailing address with the University. Address changes can be made, in writing, through Enrolment Services.

Name Changes

The University of Guelph is committed to the integrity of its student records, therefore, each student is required to provide either on application for admission or on personal data forms required for registration, his/her complete, legal name. Any requests to change a name, by means of alteration, deletion, substitution or addition, must be accompanied by appropriate supporting documentation.

Student Confidentiality and Release of Student Information Policy Excerpt

The University undertakes to protect the privacy of each student and the confidentiality of his or her record. To this end the University shall refuse to disclose personal information to any person other than the individual to whom the information relates where disclosure would constitute an unjustified invasion of the personal privacy of that person or of any other individual. All members of the University community must respect the confidential nature of the student information which they acquire in the course of their work.

Learning Outcomes

On December 5, 2012, the University of Guelph Senate approved five University-wide Learning Outcomes as the basis from which to guide the development of undergraduate degree programs, specializations and courses:

1. Critical and Creative Thinking
2. Literacy
3. Global Understanding
4. Communicating
5. Professional and Ethical Behaviour

These learning outcomes are also intended to serve as a framework through which our educational expectations are clear to students and the broader public; and to inform the process of outcomes assessment through the quality assurance process (regular reviews) of programs and departments.

An on-line guide to the learning outcomes, links to the associated skills, and detailed rubrics designed to support the development and assessment of additional program and discipline-specific outcomes, are available for reference on the Learning Outcomes website.

1. Critical and Creative Thinking

Critical and creative thinking is a concept in which one applies logical principles, after much inquiry and analysis, to solve problems with a high degree of innovation, divergent thinking and risk taking. Those mastering this outcome show evidence of integrating knowledge and applying this knowledge across disciplinary boundaries. Depth and breadth of understanding of disciplines is essential to this outcome.

In addition, Critical and Creative Thinking includes, but is not limited to, the following outcomes: Inquiry and Analysis; Problem Solving; Creativity; and Depth and Breadth of Understanding.

2. Literacy

Literacy is the ability to extract information from a variety of resources, assess the quality and validity of the material, and use it to discover new knowledge. The comfort in using quantitative literacy also exists in this definition, as does using technology effectively and developing visual literacy.

In addition, Literacy includes, but is not limited to, the following outcomes: Information Literacy, Quantitative Literacy, Technological Literacy, and Visual Literacy.

3. Global Understanding:

Global understanding encompasses the knowledge of cultural similarities and differences, the context (historical, geographical, political and environmental) from which these arise, and how they are manifest in modern society. Global understanding is exercised as civic engagement, intercultural competence and the ability to understand an academic discipline outside of the domestic context.

In addition, Global Understanding includes, but is not limited to, the following outcomes: Global Understanding, Sense of Historical Development, Civic Knowledge and Engagement, and Intercultural Competence.

4. Communicating

Communicating is the ability to interact effectively with a variety of individuals and groups, and convey information successfully in a variety of formats including oral and written communication. Communicating also comprises attentiveness and listening, as well as reading comprehension. It includes the ability to communicate and synthesize information, arguments, and analyses accurately and reliably.

In addition, Communicating includes, but is not limited to, the following outcomes: Oral Communication, Written Communication, Reading Comprehension, and Integrative Communication.

5. Professional and Ethical Behaviour

Professional and ethical behaviour requires the ability to accomplish the tasks at hand with proficient skills in teamwork and leadership, while remembering ethical reasoning behind all decisions. The ability for organizational and time management skills is essential in bringing together all aspects of managing self and others. Academic integrity is central to mastery in this outcome.

In addition, Professional and Ethical Behaviour includes, but is not limited to, the following outcomes: Teamwork, Ethical Reasoning, Leadership, and Personal Organization and Time Management.
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Bachelor of Science (B.Sc.)

The University of Guelph offers general and honours programs leading to the B.Sc. degree. The general program consists of a minimum of 15.00 credits (usually 30 semester courses) involving normally 6 semesters of study. The requirements for the honours program is a minimum of 20.00 credits (usually 40 semester courses) which may be obtained over 8 semesters of study. Some majors may require more than 20.00 credits.

The Three Semester System

Most of the B.Sc. programs operate on the three semester system. In this system each of the Fall, Winter and Summer semesters is of 12 weeks duration. Two semesters are equivalent to 1 academic year at a university on the traditional system. In the three semester system, students may vary their rate of progress towards graduation. However, since many science courses must be taken in a certain sequence and not all courses are offered each semester, most science students are required to proceed from semester to semester in restricted patterns. Furthermore, the majority of courses of the honours programs are offered only in the regular fall and winter semesters.

Additional information may be obtained from Admissions Services, Office of Registrarial Services. The three-semester system and the pass-by-course method of advancement allow considerable flexibility of program arrangement. In addition, a variety of program contents is available which the student may modify to meet individual requirements.

Transfer from One B.Sc. Program to Another

On entrance to the B.Sc. program, the student may elect to follow an intended area of specialization or to postpone this decision until a later semester. The choice of a particular program of study may be most effectively made at the end of Semester 3 or 4. Judicious selection of courses in each and every semester will allow the easiest transfer between programs without incurring the need for additional semesters of study. The program counsellor of the particular college from which it is anticipated that the majority of science courses will be taken should be consulted for advice.

Program Information

B.Sc. Program Requirements

Regulations 1-9 apply to all B.Sc. students.

1. Entry Credits

In general, the 4U /grade 12 credit or its equivalent is required in a subject area to allow entrance to the initial university course. Students who lack this requirement can remedy the deficiency by successful completion of:

- BIOL*1020 for students lacking biology
- CHEM*1060 for students lacking chemistry

If more than one of the above courses is taken, students are required to complete additional credits beyond the minimum total required for the degree.

2. 1st Year Science Core

All majors within the B.Sc. degree are required to complete the first year core as outlined within their major. The core consists of courses in biology, chemistry, physics and mathematical science.

3. 1000 Level Credits

If more than 7.00 credits at the 1000 level are completed, students are required to complete additional credits beyond the minimum total required for the degree.

4. 3000 and 4000 Level Credits

There is a requirement for a minimum of 6.00 science credits at the 3000- and 4000-levels with a minimum of 2.00 credits at the 4000 level.

5. Science Credits

A minimum of 16.00 science credits (usually 32 courses) is required for the honours major program. The inclusion of a minor in a non-science area reduces the requirement to 14.00 science credits. A minimum of 12.00 science credits is required for the three year general B.Sc. degree. Acceptable science courses means "acceptable to the B.Sc. Program Committee". Lists of acceptable science courses are available at: https://www.uoguelph.ca/bsc/Approved_electives.

6. Liberal Education Requirement

All majors within the B.Sc. degree require a specified number of liberal education credits.

The goal of the liberal education requirement is to increase breadth by requiring credits that are outside the disciplines of science with a focus in at least one of the following areas:

- Policy, operational and management practices pertaining to a practical activity, or influence of social, cultural and economic environments on such activities.
- Personal or professional growth including ethical responsibility, leadership and communication.
- Development of historical, cultural, global, artistic, social, and language competencies.

A complete listing of acceptable courses can be found at: https://www.uoguelph.ca/bsc/.

7. Free Electives

All majors within the B.Sc. degree have a specified number of free electives. The free elective requirement can be fulfilled by any course on the B.Sc. approved science or liberal education elective list. Courses that are restricted from B.Sc. students are not eligible to fulfill the free elective requirement. This restriction is stated in the course description.

8. Double-Counting of Credits

A maximum of 2.50 credits required in a major program may be applied to meet the requirements of a minor or an additional major.

For a completed minor in a non-B.Sc. area, students can apply up to 1.00 credits at the 3000/4000 level from their minor towards the 6.00 credits at the 3000/4000 level required for the degree.

Students cannot declare a major or minor in the three year general B.Sc. degree.

9. Continuation of Study

Students are advised to consult the regulations for continuation of study outlined in detail in Section VIII--Undergraduate Degree & Regulations.

General Program Requirements

The general B.Sc. degree requires the successful completion of 15.00 credits. Normally 2.50 credits (usually 5 courses) are taken in each semester so that the degree may be completed in 6 semesters. The general science program is designed to give a broad general training in biological science, chemistry, physics and mathematical science. This is achieved by requiring each student to take a minimum of 1.00 credits in each of the above areas and an additional 0.50 credits in three of the four above areas. The courses to be taken in semesters 4 to 6 may be selected to allow a broad study of the sciences from the list of approved electives for B.Sc. students.

Honours Program Requirements

In order to graduate from the honours program, students must fulfill all program requirements for the program and have achieved a 60%, or higher, cumulative average over all course attempts. Normally 2.50 credits (usually 5 courses) are taken in each semester so that the degree may be completed in generally 8 semesters. The following types of honours programs are offered:

Honours Major Programs

Major in a subject
Major in a subject with a minor or a second major

Honours Major

Majors permit a student to study science in greater depth than is permitted by the general program. The student is required to take a minimum of 1.00 credits (usually 2 courses) in each of biological science, chemistry, physics and mathematical science. In each of semesters 3 to 8, students select science credits so that the total program provides a broad science training with concentration in an area of physical science or biological science. A major normally consists of certain prescribed courses (minimum of 8.00 credits) and a number of elective courses to complete the requirements for the degree. The composition of science courses selected must contain a sufficient number (minimum of 6.00 credits) of 3000 and 4000 level courses including a grouping (minimum of 2.00 credits) at the 4000 level. A major program may be studied in conjunction with a minor in an area of science, humanities or social science.

Honours Minor

A minor is a group of courses which provides for exposure to and mastery of the fundamental principles of a subject. A minor consists of a minimum of 5.00 credits (normally 10 courses). It may also require courses from other areas to be taken along with the specified courses of the minor. A minor is taken in conjunction with a major.

Students should seek advice from the program counsellor of either the College of Biological Science or the College of Engineering and Physical Sciences dependent upon their primary area(s) of interest. Refer to B.Sc. Program Requirements: Regulation 6 Double-Counting of Credits.

Special Study Options

Study at Other Universities

Students contemplating study at another university for credit towards a Bachelor of Science degree at the University of Guelph should refer to the general regulations governing Letters of Permission in Section VIII--Degree Regulations & Procedures in this calendar. Students must obtain approval for the Letter of Permission prior to undertaking studies at another institution.

Study Abroad

The University of Guelph offers Study Abroad and Exchange opportunities for students to enrich their learning experience. Bachelor of Science students are encouraged to participate in any of the diverse options available. Courses taken while on exchange or study abroad may be used as electives or core requirements pending appropriate approvals. For further information on the programs available, please refer to Section V - International Study. Students are advised to meet with the Centre for International Programs and B.Sc. Program Counsellor to discuss the feasibility of participating in an exchange or semester abroad.
Doctor of Veterinary Medicine

Students in the B.Sc. program who intend to apply for admission to the Doctor of Veterinary Medicine program should register for the Major Biological Science or Major Physical Science program, or the major of their choice. Prospective candidates for the D.V.M. program should consult the admission requirements for the program. Students may obtain assistance in selecting a program that will meet the requirements for the Doctor of Veterinary Program and for continuation in biological or physical science programs by consulting the appropriate Program Counsellor.

General Program (BSCG)

Continuation of Study

Students are advised to consult the regulations for continuation of study within the program which are outlined in detail in Section VIII—Undergraduate Degree Regulations & Procedures.

Conditions for Graduation

In order to qualify for graduation from the general program the student is required to attain a passing grade in a minimum of 15.00 required credits as outlined in the Total Course Requirements for all students in the General Science Program and have achieved a minimum cumulative average of 50%.

Total Course Requirements for all Students in the General Science Program

Total of 15.00 credits as follows:

1. 4.00 credits from the first year science core - 1.00 credits beyond the 4U/grade 12 level in each of biological science, chemistry, mathematical science, physics. Note: A maximum of 7.00 credits at the 1000 level may be used towards the degree requirements.
2. An additional 0.50 credits from at least 3 of the following subject areas: biological science, biochemistry/chemistry, mathematical science, physics.
3. 6.50 additional credits selected from the list of approved sciences electives for the B.Sc. degree program of which 2.50 credits must be at the 3000 or 4000 level. Note: One of BIOS*1020, CHEM*1060 may be counted towards the degree requirements, counting as 0.50 credits in science.
4. 2.00 credits - Liberal Education electives selected from the B.Sc. list of Liberal Education electives.
5. 1.00 credits in electives.

Recommended Schedule for Students in Biological Science Areas

Semester 1

BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology *
CHEM*1040 [0.50] General Chemistry I
MATH*1080 [0.50] Elements of Calculus I
PHYS*1080 [0.50] Physics for Life Sciences
0.50 Liberal Education electives

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at http://www.bsc.uoguelph.ca/revisedss

Semester 2

BIOL*1070 [0.50] Discovering Biodiversity *
CHEM*1050 [0.50] General Chemistry II
PHYS*1070 [0.50] Physics for Life Sciences II
One of:
CIS*1000 [0.50] Introduction to Computer Applications
CIS*1200 [0.50] Introduction to Computing
CIS*1500 [0.50] Introduction to Programming
STAT*2040 [0.50] Statistics I
MATH*1090 [0.50] Elements of Calculus II
0.50 Liberal Education electives

* BIOL*1080 is a prerequisite for some courses in the biological sciences. Students are strongly recommended to also complete this course by the end of the third semester.

Semester 3 to 6

A minimum of 2.50 credits in each semester, including at least 2.00 acceptable science credits per semester. For details consult 'Total Course Requirements'.

Recommended Schedule for Students in Physical Science Areas

Semester 1

CHEM*1040 [0.50] General Chemistry I
IPS*1500 [1.00] Integrated Mathematics and Physics I
One of:
BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1080 [0.50] Biological Concepts of Health
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
0.50 Liberal Education electives

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at http://www.bsc.uoguelph.ca/revisedss

Semester 2

CHEM*1050 [0.50] General Chemistry II
IPS*1510 [1.00] Integrated Mathematics and Physics II
One of:
BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1080 [0.50] Biological Concepts of Health
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
0.50 Liberal Education electives

Semester 3 to 6

A minimum of 2.50 credits in each semester, including 2.00 acceptable science courses per semester. For details consult 'Total Course Requirements'.

Honours Programs (BSCH)

Honours Program Majors

The following honours majors are available:

Biological Sciences:
20.00 credits - Animal Biology (ABIO)
20.00 credits - Biochemistry (BIOC)
20.00 credits - Biodiversity (BODI)
20.00 credits - Biological Science (BIOS)
20.00 credits - Bio-Medical Science (BIOM)
20.00 credits - Biomedical Toxicology (BITOX)
20.00 credits - Environmental Biology (ENVB)
20.00 credits - Food Science (FOOD)
20.00 credits - Human Genetics (HK)
20.00 credits - Marine and Freshwater Biology (MFB)
20.00 credits - Microbiology (MICR)
20.00 credits - Molecular Biology and Genetics (MBG)
20.00 credits - Neuroscience (NEUR)
20.00 credits - Nutritional and Nutraceutical Sciences (NANS)
20.00 credits - Plant Science (PLSC)
20.00 credits - Wildlife Biology and Conservation (WBC)

Physical Sciences:
20.00 credits - Biological and Medical Physics (BMPH)
20.00 credits - Biological and Pharmaceutical Chemistry (BPCH)
20.00 credits - Chemical Physics (CHPY)
20.00 credits - Chemistry (CHEM)
20.00 credits - Environmental Geomatics (EG)
20.00 credits - Mathematical Science (MSCI)
20.00 credits - Nanoscience (NANO)
20.00 credits - Physical Science (PSCI)
20.00 credits - Physics (PHYS)
20.00 credits - Theoretical Physics (THPY)

Co-operative Educational Programs:
21.50 credits - Biochemistry (Co-op) (BIOC)
22.00 credits - Biological and Medical Physics (Co-op) (BMPH)
21.50 credits - Biological and Pharmaceutical Chemistry (Co-op) (BPCH)
22.00 credits - Marine and Freshwater Biology (Co-op) (MFB)
21.50 credits - Biomedical Toxicology (Co-op) (BITOX)
22.00 credits - Chemical Physics (Co-op) (CHPY)
21.50 credits - Chemistry (Co-op) (CHEM)
21.50 credits - Environmental Geomatics (Co-op) (EG)
21.50 credits - Food Science (Co-op) (FOOD)
22.00 credits - Nanoscience (NANO)
21.50 credits - Microbiology (Co-op) (MICR)
22.00 credits - Physics (Co-op) (PHYS)

Honours Program Minors

Minors are available in the following science areas with the particular credit requirements being given (additional minors are available from the College of Arts and the College of Social and Applied Human Sciences). A minor may include additional prerequisites - consult with the appropriate faculty advisor.

Biological Sciences:
5.00 credits - Biology (BIOL)
5.00 credits - Biochemistry (BIOC)
5.00 credits - Biotechnology (BIOT)
5.00 credits - Microbiology (MICR)
5.00 credits - Molecular Biology and Genetics (MBG)
5.00 credits - Neuroscience (NEUR)
5.00 credits - Nutritional and Nutraceutical Sciences (NANS)
5.00 credits - Plant Science (PLSC)
5.00 credits - Zoology (ZOO)
**Physical Sciences:**
5.00 credits - Chemistry (CHEM)
5.00 credits - Physics (PHYS)

**Environmental Sciences:**
5.00 credits - Ecology (ECOL)
5.00 credits - Geographic Information Systems (GIS) and Environmental Analysis

**Mathematical Sciences:**
5.00 credits - Computing and Information Science (CIS)
5.00 credits - Mathematical Science (MSCI)
5.00 credits - Mathematics (MATH)
5.00 credits - Statistics (STAT)

**Additional Disciplines:**
5.00 credits - Business Economics (BECN)

**Continuation of Study**
Students are advised to consult the regulations for continuation of study within the program which are outlined in detail in Section VIII--Undergraduate Degree Regulations & Procedures.

**Conditions for Graduation**

**Schedules 1 and 2**
In order to qualify for graduation from the honours program, the student must fulfill all program requirements and have achieved 60%, or higher, cumulative average in all course attempts.

**Note:** A student registered in an honours program who has successfully completed all required courses and the specified total number of credits for the program but does not have a cumulative average of 60%, or higher, may apply to graduate from the general program.

**Co-operative Education Program**
Admission to the Co-operative Education program may be granted on entry to the University or by application normally before the conclusion of Semester 1. Application forms can be obtained from the Coop Education and Career Services website: https://www.recruituoguelph.ca/cce/

**Conditions for Graduation from the B.Sc. Co-operative Education Program**
Conditions for graduation are the same as the corresponding regular B.Sc. program. In addition, all work reports and work performance evaluations must have a grade of satisfactory or better.

**Animal Biology (ABIO)**

**Department of Animal Biosciences, Ontario Agricultural College**

**Major (Honours Program)**
Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor.

**Semester 1**
BIOL*1050 [0.50] Biology of Plants & Animals in Managed Ecosystems
CHEM*1040 [0.50] General Chemistry I
MATH*1080 [0.50] Elements of Calculus I
PHYS*1080 [0.50] Physics for Life Sciences

0.50 Liberal Education electives

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at: https://www.uoguelph.ca/bsc/revised_SS

**Semester 2**
ANSC*1210 [1.00] Principles of Animal Care and Welfare
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
CHEM*1050 [0.50] General Chemistry II
PHYS*1070 [0.50] Physics for Life Sciences II

**Semester 3**
AGR*2350 [0.50] Animal Production Systems, Health and Industry
BIOL*2580 [0.50] Introduction to Biochemistry
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
MBG*2400 [0.50] Fundamentals of Plant and Animal Genetics

0.50 electives or restricted electives

Students are encouraged to consider CIS*1000 as an elective if they wish to enhance their computer literacy.

**Semester 4**
ANSC*2340 [0.50] Structure of Farm Animals
MBC*2050 [0.50] Molecular Biology of the Cell
NUTR*3210 [0.50] Fundamentals of Nutrition
STAT*2040 [0.50] Statistics I

0.50 electives or restricted electives

**Semester 5**
ANSC*3080 [0.50] Agricultural Animal Physiology
ANSC*3120 [0.50] Introduction to Animal Nutrition

1.50 electives or restricted electives

**Semester 6**
ANSC*3040 [0.50] Animal Reproduction
ANSC*3270 [0.50] Animal Disorders
MBG*3060 [0.50] Quantitative Genetics

1.00 electives or restricted electives

**Semester 7**
2.50 electives or restricted electives

**Semester 8**
2.50 electives or restricted electives

**Restricted Electives**
1. Students must complete 2.00 credits of Liberal Education electives ANSC*1210 is a Liberal Education course, 1.00 credit. 1.00 additional credits from Liberal Education courses are required. The list of liberal education electives for B.Sc. students can be found at: http://www.uoguelph.ca/bsc
2. 0.50 credits is required from each of the following areas: Animal Nutrition, Animal Breeding & Genetics, and Animal Physiology & Behaviour. Students are encouraged to consult with the Faculty Advisor for help in tailoring their selection to meet personal and career interests.

**Animal Breeding & Genetics [0.50] Required**
ANSC*4050 [0.50] Biotechnology in Animal Science
MBG*4020 [0.50] Genetics of Companion Animals
MBG*4030 [0.50] Animal Breeding Methods and Applications

**Animal Nutrition [0.50] Required**
ANSC*4317 [0.50] Nutrition of Fish and Crustacea
ANSC*3180 [0.50] Wildlife Nutrition
ANSC*4260 [0.50] Beef Cattle Nutrition
ANSC*4270 [0.50] Dairy Cattle Nutrition
ANSC*4280 [0.50] Poultry Nutrition
ANSC*4290 [0.50] Swine Nutrition
ANSC*4560 [0.50] Pet Nutrition
ENQ*4020 [0.50] Advanced Equine Nutrition

**Animal Physiology & Behaviour [0.50] Required**
ANSC*3900 [0.50] Vertebrate Ethology
ANSC*4090 [0.50] Applied Animal Behaviour
ANSC*4100 [0.50] Applied Environmental Physiology and Animal Housing
ANSC*4350 [0.50] Experiments in Animal Biology
ANSC*4470 [0.50] Animal Metabolism
ANSC*4490 [0.50] Applied Endocrinology

3. An additional 3.00 credits must be obtained by selecting courses from the above lists and from the following:
ANSC*3050 [0.50] Aquaculture: Advanced Issues
ANSC*4610 [0.50] Critical Analysis in Animal Science
ANSC*4650 [0.50] Comparative Immunology
ANSC*4700 [0.50] Research in Animal Biology I
ANSC*4710 [0.50] Research in Animal Biology II
BIOC*3560 [0.50] Structure and Function in Biochemistry
ENQ*3050 [0.50] Equine Exercise Physiology
MICR*3230 [0.50] Immunology
PATH*3610 [0.50] Principles of Disease
POPM*3240 [0.50] Epidemiology
POPM*4230 [0.50] Animal Health

**Credit Summary (20.00 Total Credits)**
3.50 - First year science credits
6.50 - Required science courses semesters 3 - 8
4.50 - Restricted electives (#2 and #3)
1.50 - Approved Science electives
1.00 - Required Arts and/or Social Science course (ANSC 1210)
1.00 – Liberal Education electives
2.00 - Free electives - any approved elective for B.Sc. students.

Of the total credits required, students are required to complete 16.00 credits in science of which 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

**Biochemistry (BIOC)**

**Department of Molecular and Cellular Biology, College of Biological Science**

A B.Sc. in Biochemistry offers a multidisciplinary curriculum that gives students broad exposure to the life sciences with specific attention paid to the physical and chemical nature of biomolecular systems. The lab-intensive experience in this program prepares students to pursue post-graduate research opportunities in many different life science related fields. Graduates are also positioned to be successful in obtaining entrance to a number of professional programs, as well as employment in industry and government.

Last Revision: July 4, 2019
Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. The major will require the completion of at least 20.00 credits as indicated below:

**Major (Honours Program)**

**Semester 1**
- BIOC*1090 [0.50] Introduction to Molecular and Cellular Biology
- CHEM*1040 [0.50] General Chemistry I
- MATH*1080 [0.50] Elements of Calculus I
- PHYS*1080 [0.50] Physics for Life Sciences
- 0.50 Liberal Education electives

**Semester 2**
- BIOC*1070 [0.50] Discovering Biodiversity
- BIOL*1080 [0.50] Biological Concepts of Health
- CHEM*1050 [0.50] General Chemistry II
- MATH*1090 [0.50] Elements of Calculus II
- PHYS*1070 [0.50] Physics for Life Sciences II
- 0.50 Liberal Education electives

**Semester 3**
- BIOC*2580 [0.50] Introduction to Biochemistry
- MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
- MICR*2420 [0.50] Introduction to Microbiology
- STAT*2040 [0.50] Statistics I
- 0.50 Liberal Education electives

**Semester 4**
- BIOC*3560 [0.50] Structure and Function in Biochemistry
- CHEM*2480 [0.50] Physical Chemistry
- CHEM*2700 [0.50] Organic Chemistry I
- MCB*2050 [0.50] Molecular Biology of the Cell
- MICR*2430 [0.50] Methods in Microbial Culture and Physiology

**Semester 5**
- BIOC*3570 [0.75] Analytical Biochemistry
- CHEM*2880 [0.50] Physical Chemistry
- CHEM*3750 [0.50] Organic Chemistry II
- 0.50 electives or restricted electives to a maximum of 2.75 total credits

**Semester 6**
- MBG*3350 [0.75] Laboratory Methods in Molecular Biology
- 0.50 electives or restricted electives to a maximum of 2.75 total credits

**Semester 7**
- 2.50 electives or restricted electives

**Semester 8**
- BIOC*4540 [0.75] Enzymology
- 0.50 electives or restricted electives to a maximum of 2.75 total credits

**Restricted Electives**

1. Students must take as part of their program: 4.00 credits from the following list, with at least 1.00 of these credits from BIOC*4520, BIOC*4580, MCB*4050.

   - BIOC*4520 [0.50] Metabolic Processes
   - BIOC*4580 [0.50] Membrane Biochemistry
   - BIOL*3300 [0.50] Applied Bioinformatics
   - BIOM*3200 [1.00] Biomedical Physiology
   - MBG*3040 [0.50] Molecular Biology of the Gene
   - MBG*3080 [0.50] Genetic Engineering of Plants
   - MCB*3010 [0.50] Dynamics of Cell Function and Signaling
   - MCB*4010 [0.50] Advanced Cell Biology
   - MCB*4050 [0.50] Protein and Nucleic Acid Structure
   - MCB*4500 [1.00] Research Project in Molecular & Cellular Biology I
   - MCB*4510 [1.00] Research Project in Molecular & Cellular Biology II
   - MCB*4600 [0.50] Topics in Molecular and Cellular Biology
   - MICR*3230 [0.50] Immunology
   - MICR*3330 [0.50] World of Viruses
   - MICR*4330 [0.50] Molecular Virology
   - MICR*4530 [0.50] Immunology II
   - PBSI*3110 [0.50] Crop Physiology
   - PBSI*4750 [0.50] Genetic Engineering of Plants
   - STAT*2050 [0.50] Statistics I
   - TOX*4590 [0.50] Biochemical Toxicology

2. Students must take as part of their program: 0.50 credits from the following list:

   - PHYS*2030 [0.50] Biophysics of Excitable Cells
   - PHYS*2240 [0.50] Thermal Physics
   - PHYS*2330 [0.50] Electricity and Magnetism I
   - PHYS*2600 [0.50] General Astronomy
   - PHYS*3080 [0.50] Energy

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**Credit Summary (20.00 Total Credits)**

- 4.50 - First year science credits
- 7.75 - Required science courses semesters 3 - 8
- 4.50 - Restricted elective (#1 and #2 in restricted elective list)
- 1.00 - Liberal Education electives
- 2.25 - Free electives – any approved electives for B.Sc. students

Of the total credits required, students are required to complete 16.00 credits in science of which a minimum of 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

**Minor (Honours Program)**

A minor in Biochemistry consists of at least 5.00 course credits. The following courses are required:

- BIOC*3560 [0.50] Structure and Function in Biochemistry
- BIOC*3570 [0.75] Analytical Biochemistry
- BIOC*4540 [0.75] Enzymology
- CHEM*2480 [0.50] Analytical Chemistry I
- CHEM*2700 [0.50] Organic Chemistry I

One of:
- MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
- MICR*2420 [0.50] Introduction to Microbiology

In addition, at least 1.50 credits must be chosen from the following courses, with at least 1.00 credits from the first three courses listed:

- BIOC*4520 [0.50] Metabolic Processes
- BIOC*4580 [0.50] Membrane Biochemistry
- MBG*3350 [0.75] Laboratory Methods in Molecular Biology
- MCB*4050 [0.50] Protein and Nucleic Acid Structure
- MICR*3230 [0.50] Immunology
- MICR*3330 [0.50] World of Viruses
- TOX*4590 [0.50] Biochemical Toxicology

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**Biochemistry (Co-op) (BIOC:C)**

Department of Molecular and Cellular Biology, College of Biological Science

A B.Sc. in Biochemistry offers a multidisciplinary curriculum that gives students broad exposure to the life sciences with specific attention paid to the physical and chemical nature of biomolecular systems. The lab-intensive experience in this program prepares students to pursue post-graduate research opportunities in many different life science related fields. Graduates are also positioned to be successful in obtaining entrance to a number of professional programs, as well as employment in industry and government.

**Program Requirements**

The Co-op program in Biochemistry is a four and a half year program, including four work terms. Students must complete a Fall (Sequence B only), Winter and Summer work term, and must follow the academic work schedule as outlined below (also found on the Co-operative Education website: https://www.uoguelph.ca/ccse/). Please refer to the Co-operative Education program policy with respect to adjusting this schedule.

**Biochemistry Academic and Co-op Work Term Schedule – Sequence A**

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Winter</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Academic Semester 1</td>
<td>Academic Semester 2</td>
<td>COOP*1100</td>
</tr>
<tr>
<td>2</td>
<td>Academic Semester 3</td>
<td>COOP*1000 Work Term I</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Academic Semester 5</td>
<td>COOP*2000 Work Term II</td>
<td>COOP*3000 Work Term III</td>
</tr>
<tr>
<td>4</td>
<td>Academic Semester 6</td>
<td>Academic Semester 7</td>
<td>COOP*4000 Work Term IV</td>
</tr>
<tr>
<td>5</td>
<td>Academic Semester 8</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**Biochemistry Academic and Co-op Work Term Schedule – Sequence B**

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Winter</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Academic Semester 1</td>
<td>Academic Semester 2</td>
<td>COOP*1100</td>
</tr>
<tr>
<td>2</td>
<td>Academic Semester 3</td>
<td>COOP*1000 Work Term I</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>COOP*2000 Work Term II</td>
<td>Academic Semester 5</td>
<td>COOP*3000 Work Term III</td>
</tr>
<tr>
<td>4</td>
<td>Academic Semester 6</td>
<td>Academic Semester 7</td>
<td>COOP*4000 Work Term IV</td>
</tr>
<tr>
<td>5</td>
<td>Academic Semester 8</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
To be eligible to continue in the Co-op program, students must meet a minimum 70% cumulative average requirement after second semester, as well as meet all work term requirements. Please refer to the Co-operative Education program policy with respect to work term performance grading, work term report grading and program completion requirements.

For additional program information students should consult with their Co-op Co-ordinator and Co-op Faculty Advisor, listed on the Co-operative Education web site.

**Credit Summary (21.50 Total Credits)***

<table>
<thead>
<tr>
<th>Semester 1 - Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1090 [0.50]  Introduction to Molecular and Cellular Biology</td>
</tr>
<tr>
<td>CHEM*1040 [0.50]  General Chemistry I</td>
</tr>
<tr>
<td>MATH*1080 [0.50]  Elements of Calculus I</td>
</tr>
<tr>
<td>PHYS*1080 [0.50]  Physics for Life Sciences</td>
</tr>
<tr>
<td>0.50 Liberal Education electives</td>
</tr>
<tr>
<td>Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at <a href="https://www.uoguelph.ca/bsc/revised_SS">https://www.uoguelph.ca/bsc/revised_SS</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 2 - Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1070 [0.50]  Discovering Biodiversity</td>
</tr>
<tr>
<td>BIOL*1080 [0.50]  Biological Concepts of Health</td>
</tr>
<tr>
<td>CHEM*1050 [0.50]  General Chemistry II</td>
</tr>
<tr>
<td>COOP*1100 [0.00]  Introduction to Co-operative Education</td>
</tr>
<tr>
<td>MATH*1090 [0.50]  Elements of Calculus II</td>
</tr>
<tr>
<td>PHYS*1070 [0.50]  Physics for Life Sciences II</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Summer Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>No academic semester or work term</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 3 - Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*2580 [0.50]  Introduction to Biochemistry</td>
</tr>
<tr>
<td>CHEM*2480 [0.50]  Analytical Chemistry I</td>
</tr>
<tr>
<td>CHEM*2880 [0.50]  Physical Chemistry</td>
</tr>
<tr>
<td>MBG*2040 [0.50]  Foundations in Molecular Biology and Genetics</td>
</tr>
<tr>
<td>0.50 Liberal Education electives</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Winter Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*1000 [0.50]  Co-op Work Term I</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 4 - Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*3570 [0.75]  Analytical Biochemistry</td>
</tr>
<tr>
<td>CHEM*2700 [0.50]  Organic Chemistry I</td>
</tr>
<tr>
<td>MICR*2420 [0.50]  Introduction to Microbiology</td>
</tr>
<tr>
<td>STAT*2040 [0.50]  Statistics I</td>
</tr>
<tr>
<td>electives or restricted electives to a maximum of 2.75 total credits</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 5 - Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*3560 [0.50]  Structure and Function in Biochemistry</td>
</tr>
<tr>
<td>CHEM*3750 [0.50]  Organic Chemistry II</td>
</tr>
<tr>
<td>MCB*2050 [0.50]  Molecular Biology of the Cell</td>
</tr>
<tr>
<td>MICR*2430 [0.50]  Methods in Microbial Culture and Physiology</td>
</tr>
<tr>
<td>0.50 electives or restricted electives</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Winter Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*2000 [0.50]  Co-op Work Term II</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 6 - Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBG*3350 [0.75]  Laboratory Methods in Molecular Biology</td>
</tr>
<tr>
<td>BIOL*4540 [0.75]  Enzymology</td>
</tr>
<tr>
<td>electives or restricted electives to a maximum of 2.75 total credits</td>
</tr>
</tbody>
</table>

### Summer Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*4000</td>
<td>[0.50]</td>
<td>Co-op Work Term IV</td>
</tr>
</tbody>
</table>

### Semester 8 - Fall

2.50 electives or restricted electives

### Restricted Electives

1. Students must take as part of their program: 4.00 credits from the following list, with at least 1.00 of these credits from BIOL*4520, BIOL*4580, MCB*4050.  

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*4520</td>
<td>[0.50]</td>
<td>Metabolic Processes</td>
</tr>
<tr>
<td>BIOL*4580</td>
<td>[0.50]</td>
<td>Membrane Biochemistry</td>
</tr>
<tr>
<td>BIOL*3300</td>
<td>[0.50]</td>
<td>Applied Bioinformatics</td>
</tr>
<tr>
<td>BIOM*3200</td>
<td>[0.50]</td>
<td>Biomedical Physiology</td>
</tr>
<tr>
<td>MBG*3040</td>
<td>[0.50]</td>
<td>Molecular Biology of the Gene</td>
</tr>
<tr>
<td>MBG*3080</td>
<td>[0.50]</td>
<td>Bacterial Genetics</td>
</tr>
<tr>
<td>MCB*3010</td>
<td>[0.50]</td>
<td>Dynamics of Cell Function and Signaling</td>
</tr>
<tr>
<td>MCB*4010</td>
<td>[0.50]</td>
<td>Advanced Cell Biology</td>
</tr>
<tr>
<td>MCB*4050</td>
<td>[0.50]</td>
<td>Protein and Nucleic Acid Structure</td>
</tr>
<tr>
<td>MCB*4500</td>
<td>[1.00]</td>
<td>Research Project in Molecular &amp; Cellular Biology I</td>
</tr>
<tr>
<td>MCB*4510</td>
<td>[1.00]</td>
<td>Research Project in Molecular &amp; Cellular Biology II</td>
</tr>
<tr>
<td>MCB*4600</td>
<td>[0.50]</td>
<td>Topics in Molecular and Cellular Biology</td>
</tr>
<tr>
<td>MICR*3230</td>
<td>[0.50]</td>
<td>Immunology</td>
</tr>
<tr>
<td>MICR*3330</td>
<td>[0.50]</td>
<td>World of Viruses</td>
</tr>
<tr>
<td>MICR*4330</td>
<td>[0.50]</td>
<td>Molecular Virology</td>
</tr>
<tr>
<td>MICR*4530</td>
<td>[0.50]</td>
<td>Immunology II</td>
</tr>
<tr>
<td>PBIO*3110</td>
<td>[0.50]</td>
<td>Crop Physiology</td>
</tr>
<tr>
<td>PBIO*4750</td>
<td>[0.50]</td>
<td>Genetic Engineering of Plants</td>
</tr>
<tr>
<td>STAT*2050</td>
<td>[0.50]</td>
<td>Statistics II</td>
</tr>
<tr>
<td>TOX*4590</td>
<td>[0.50]</td>
<td>Biochemical Toxicology</td>
</tr>
</tbody>
</table>

2. Students must take as part of their program: 0.50 credits from the following list:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHY*2030</td>
<td>[0.50]</td>
<td>Biophysics of Excitable Cells</td>
</tr>
<tr>
<td>PHY*2240</td>
<td>[0.50]</td>
<td>Thermal Physics</td>
</tr>
<tr>
<td>PHY*2330</td>
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<td>Electricity and Magnetism I</td>
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### Sequence A

#### Semester 1 - Fall

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>BIOL*1090</td>
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<td>Introduction to Molecular and Cellular Biology</td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>[0.50]</td>
<td>General Chemistry I</td>
</tr>
<tr>
<td>MATH*1080</td>
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<td>Elements of Calculus I</td>
</tr>
<tr>
<td>PHYS*1080</td>
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#### Semester 2 - Winter

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<tr>
<td>BIOL*1070</td>
<td>[0.50]</td>
<td>Discovering Biodiversity</td>
</tr>
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<td>BIOL*1080</td>
<td>[0.50]</td>
<td>Biological Concepts of Health</td>
</tr>
<tr>
<td>CHEM*1050</td>
<td>[0.50]</td>
<td>General Chemistry II</td>
</tr>
<tr>
<td>COOP*1100</td>
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</tr>
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<td>MATH*1090</td>
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<td>Elements of Calculus II</td>
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### Sequence B

#### Semester 1 - Fall

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<tr>
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<td>Introduction to Molecular and Cellular Biology</td>
</tr>
<tr>
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</tr>
<tr>
<td>MATH*1080</td>
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#### Semester 2 - Winter

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1070</td>
<td>[0.50]</td>
<td>Discovering Biodiversity</td>
</tr>
<tr>
<td>BIOL*1080</td>
<td>[0.50]</td>
<td>Biological Concepts of Health</td>
</tr>
<tr>
<td>CHEM*1050</td>
<td>[0.50]</td>
<td>General Chemistry II</td>
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<tr>
<td>COOP*1100</td>
<td>[0.00]</td>
<td>Introduction to Co-operative Education</td>
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<tr>
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<td>[0.50]</td>
<td>Elements of Calculus II</td>
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<tr>
<td>PHYS*1070</td>
<td>[0.50]</td>
<td>Physics for Life Sciences II</td>
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2019-2020 Undergraduate Calendar
**Biodiversity (BIOD)**

Department of Integrative Biology, College of Biological Science

The Major in Biodiversity offers a broad education in the diversity and evolution of life while providing a more specialized understanding of biology at the level of the organism. It is the most flexible of the majors offered by the Department of Integrative Biology and as such, it allows students the opportunity to design a customized program around their interests. The major qualifies students for postgraduate work in biodiversity, botany, ecology, and should plan their programs accordingly.

Biodiversity impacts every aspect of our planet. To maximize a student’s exposure to biodiversity we strongly encourage students to consider an international exchange in their fifth semester. An increase in global awareness of the diverse issues facing biodiversity from different economic, social, environmental and biological landscapes will help students to critically think, analyze and recognize the inherent complexities within the field.

**Major (Honours Program)**

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. A minimum total of 20.00 credits required to complete the major.

**Semester 1**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BIOL*1070</td>
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<td>0.50</td>
</tr>
<tr>
<td>MATH*1080</td>
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<tr>
<td>PHYS*1080</td>
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<tr>
<td>BIOL*4410</td>
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<tr>
<td>BIOL*4610</td>
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<td>BIOL*4800</td>
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<td>IBIO*452/2</td>
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<tr>
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**Semester 2**

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<td>PHYS*1080</td>
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<tr>
<td>BIOL*4410</td>
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<td>BIOL*4610</td>
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<td>BIOL*4710</td>
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<td>ZOO*4170</td>
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</tr>
<tr>
<td>ZOO*4300</td>
<td>0.75</td>
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</table>

**Credit Summary (20.00 Total Credits)**

- 4.00 - First year science credits
- 6.50 - Required science courses semesters 3 - 8
- 1.50 - Restricted elective (# 2, 3 and 4 in restricted elective list)
- 4.00 - Approved Science electives
- 1.00 - Liberal Education (#1 in restricted electives)
3.00 - Free electives - any approved elective for B.Sc. students.

*Of the total credits required, students are required to complete 16.00 credits in science of which a minimum of 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

**Department of Physics, College of Engineering and Physical Sciences

**Major (Honours Program)**

The program emphasizes the application of physics to biology and medicine. It provides an excellent background for careers in the expanding interdisciplinary research laboratories of government and industry, as well as a starting point for a career in medical physics. Completion of the program at an appropriate level will qualify a student to pursue post-graduate studies in biophysics, medical physics and related areas of physics.

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. This major requires the completion of 20.00 credits as follows:

**Semester 1**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1090</td>
<td>[0.50]</td>
<td>Introduction to Molecular and Cellular Biology</td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>[0.50]</td>
<td>General Chemistry I</td>
</tr>
<tr>
<td>CIS*1300</td>
<td>[0.50]</td>
<td>Programming</td>
</tr>
<tr>
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<td></td>
<td>1.00 credits from: IPS<em>1500, or (MATH</em>1080, PHYS<em>1080) or (MATH</em>1200, PHYS*1080)</td>
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<tr>
<td>* IPS*1500</td>
<td>[0.50]</td>
<td>* IPS*1500 is recommended</td>
</tr>
</tbody>
</table>
| Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at: [https://www.uoguelph.ca/bsc/revised_SX](https://www.uoguelph.ca/bsc/revised_SX)

**Semester 2**

<table>
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<td>Biological Concepts of Health</td>
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<td>General Chemistry II</td>
</tr>
<tr>
<td>MATH*1160</td>
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<td>Linear Algebra I</td>
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<td></td>
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<td>* IPS*1510</td>
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<td>* IPS*1510 is recommended</td>
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**Semester 3**

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</tr>
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<td>Thermal Physics</td>
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<td>[0.50]</td>
<td>Electricity and Magnetism I</td>
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**Semester 4**

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<td>Introduction to Biochemistry</td>
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<td>Biophysics of Excitable Cells</td>
</tr>
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<td>PHYS*2180</td>
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<td>Experimental Techniques in Physics</td>
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<td>PHYS*2310</td>
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<td>Mechanics</td>
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<td>[0.50]</td>
<td>Electricity and Magnetism I</td>
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<td>1.00 electives **</td>
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**Semester 5**

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**Semester 6**

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<td>PHYS*3510</td>
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<td>Intermediate Laboratory</td>
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<td>PHYS*4040</td>
<td>[0.50]</td>
<td>Quantum Mechanics II</td>
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<td>PHYS*4540</td>
<td>[0.50]</td>
<td>Molecular Biophysics</td>
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**Semester 7**

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<td>Advanced Physics Laboratory</td>
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<tr>
<td>1.00 electives **</td>
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**Semester 8**

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<tbody>
<tr>
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<td>PHYS*4002</td>
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</tr>
<tr>
<td>1.50 electives **</td>
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Note: PHYS*4001/2 will be projects in biological or medical physics, some of which may be in areas outside the Department of Physics.

**List A: Biological Physics stream**

<table>
<thead>
<tr>
<th>Course Code</th>
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</thead>
<tbody>
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<td>Structure and Function in Biochemistry</td>
</tr>
<tr>
<td>BIOC*4580</td>
<td>[0.50]</td>
<td>Membrane Biochemistry</td>
</tr>
<tr>
<td>MBG*2040</td>
<td>[0.50]</td>
<td>Foundations in Molecular Biology and Genetics</td>
</tr>
<tr>
<td>MCB*2050</td>
<td>[0.50]</td>
<td>Molecular Biology of the Cell</td>
</tr>
<tr>
<td>MCB*4050</td>
<td>[0.50]</td>
<td>Protein and Nucleic Acid Structure</td>
</tr>
<tr>
<td>NANO*4100</td>
<td>[0.50]</td>
<td>Biological Nanomaterials</td>
</tr>
<tr>
<td>PHYS*3000</td>
<td>[0.50]</td>
<td>Optics: Fundamentals and Applications</td>
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</table>

**List B: Medical Physics stream**

<table>
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<td>Concepts in Human Physiology</td>
</tr>
<tr>
<td>ENGG*4040</td>
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<td>Medical Imaging Modalities</td>
</tr>
<tr>
<td>MBG*2040</td>
<td>[0.50]</td>
<td>Foundations in Molecular Biology and Genetics</td>
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<tr>
<td>PATH*3610</td>
<td>[0.50]</td>
<td>Principles of Disease</td>
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<td>[0.50]</td>
<td>Optics: Fundamentals and Applications</td>
</tr>
<tr>
<td>PHYS*4130</td>
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<td>Subatomic Physics</td>
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**Credit Summary (20.00 Total Credits)**

5.00 - First year science credits

9.50 - Required science courses semesters 3 – 8

1.50 - Restricted electives (from List A OR List B)

1.00 - Liberal Education electives

3.00 - Free electives - any approved elective for B.Sc. students.

Of the total credits required, students are required to complete 16.00 credits in science of which 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

**Department of Physics, College of Engineering and Physical Sciences**

**Program Requirements**

The Co-op program in Biological and Medical Physics is a five year program, including five work terms. Students must complete a Fall, Winter and Summer work term and must follow the academic work schedule as outlined below (also found on the Co-operative Education website: [https://www.recruituoguelph.ca/ceca/](https://www.recruituoguelph.ca/ceca/)). Please refer to the Co-operative Education program policy with respect to adjusting this schedule.

**Biological and Medical Physics Academic and Co-op Work Term Schedule**

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Winter</th>
<th>Summer</th>
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<tbody>
<tr>
<td>1</td>
<td>Academic Semester 1</td>
<td>Academic Semester 2</td>
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</tr>
<tr>
<td>2</td>
<td>Academic Semester 3</td>
<td>COOP*1100</td>
<td>COOP*1000 Work Term I</td>
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<td>Academic Semester 5</td>
<td>COOP*2000 Work Term II</td>
<td>COOP*3000 Work Term III</td>
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<td>Academic Semester 7</td>
<td>COOP*4000 Work Term IV</td>
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<td>COOP*5000 Work Term V</td>
<td>Academic Semester 8</td>
<td>N/A</td>
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</table>

To be eligible to continue in the Co-op program, students must meet a minimum 70% cumulative average requirement after second semester, as well as meet all work term requirements. Please refer to the Co-operative Education program policy with respect to work term performance grading, work term report grading and program completion requirements.

For additional program information students should consult with their Co-op Co-ordinator and Co-op Faculty Advisor, listed on the Co-operative Education web site.

**Credit Summary (22.00 Total Credits)**

5.00 - First year science credits

9.50 - Required science courses semesters 3 – 8

1.50 - Restricted electives (from List A OR List B)

1.00 - Liberal Education electives

3.00 - Free electives - any approved elective for B.Sc. students.

2.00 - Co-op Work Terms

Of the total credits required, students are required to complete 16.00 credits in science of which 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Note: A minimum of four Co-op work terms including a Summer, Fall, and Winter are necessary to complete the Co-op requirement. *A fifth Co-op work term is optional and if completed, the total number of credits will equal 22.50.*

The recommended program sequence is outlined below.
### Major (Honours Program)

#### Semester 1 - Fall
- **BIOL*1090** [0.50] Introduction to Molecular and Cellular Biology
- **CHEM*1040** [0.50] General Chemistry I
- **CIS*1300** [0.50] Programming

1.00 credits from: **IPS*1500**, or (**MATH*1080, PHYS*1080**) or (**MATH*1200, PHYS*1080**)

* **IPS*1500** is recommended

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at: [https://www.uoguelph.ca/bsc/revised_SS](https://www.uoguelph.ca/bsc/revised_SS)

#### Semester 2 - Winter
- **BIOL*1080** [0.50] Biological Concepts of Health
- **CHEM*1050** [0.50] General Chemistry II
- **MATH*1160** [0.50] Linear Algebra I

1.00 credits from: **IPS*1510**, or (**MATH*1090, PHYS*1070**) or (**MATH*1210, PHYS*1010**)

* **IPS*1510** is recommended

#### Semester 3 - Fall
- **COOP*1100** [0.00] Introduction to Co-operative Education
- **MATH*2200** [0.50] Advanced Calculus I
- **MATH*2270** [0.50] Applied Differential Equations
- **PHYS*2230** [0.50] Thermal Physics
- **PHYS*2330** [0.50] Electricity and Magnetism I

0.50 Liberal Education electives

#### Semester 4 - Winter
- **BIOC*2580** [0.50] Introduction to Biochemistry
- **PHYS*2030** [0.50] Biophysics of Excitable Cells
- **PHYS*2180** [0.50] Experimental Techniques in Physics
- **PHYS*2310** [0.50] Mechanics
- **PHYS*2340** [0.50] Electricity and Magnetism II

#### Summer Semester
- **COOP*1000** [0.50] Co-op Work Term I

#### Semester 5 - Fall
- **PHYS*3130** [0.50] Mathematical Physics
- **PHYS*3230** [0.50] Quantum Mechanics I

1.50 electives ***

#### Winter Semester
- **COOP*2000** [0.50] Co-op Work Term II

(8-month work term in conjunction with **COOP*3000**)

- **COOP*3000** [0.50] Co-op Work Term III

(8-month work term in conjunction with **COOP*2000**)

#### Semester 6 - Fall
- **IPS*3000** [0.50] Science Communication
- **PHYS*3170** [0.50] Radioactivity and Radiation Interactions

1.50 electives ***

#### Semester 7 - Winter
- **NANO*3600** [0.50] Computational Methods in Materials Science
- **PHYS*3510** [0.50] Intermediate Laboratory
- **PHYS*4040** [0.50] Quantum Mechanics II
- **PHYS*4540** [0.50] Molecular Biophysics

0.50 electives ***

#### Summer Semester
- **COOP*4000** [0.50] Co-op Work Term IV

#### Fall Semester
- **COOP*5000** [0.50] Co-op Work Term V

#### Semester 8 - Winter
- **PHYS*4070** [0.50] Clinical Applications of Physics in Medicine
- **PHYS*4500** [0.50] Advanced Physics Laboratory

1.50 electives ***

Students are required to complete 1.50 credits from either List A or List B as follows:

#### List A: Biological Physics stream
- **BIOC*3560** [0.50] Structure and Function in Biochemistry
- **BIOC*4580** [0.50] Membrane Biochemistry
- **MBG*2040** [0.50] Foundations in Molecular Biology and Genetics
- **MCB*2050** [0.50] Molecular Biology of the Cell
- **MCB*4050** [0.50] Protein and Nucleic Acid Structure
- **NANO*4100** [0.50] Biological Nanomaterials
- **PHYS*3000** [0.50] Optics: Fundamentals and Applications

#### List B: Medical Physics stream
- **BIOM*2000** [0.50] Concepts in Human Physiology

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**ENGG*4040** [0.50] Medical Imaging Modalities
**MBG*2040** [0.50] Foundations in Molecular Biology and Genetics
**PATH*3610** [0.50] Principles of Disease
**PHYS*3000** [0.50] Optics: Fundamentals and Applications
**PHYS*4130** [0.50] Subatomic Physics

### Biological and Pharmaceutical Chemistry (BPCH)

**Department of Chemistry, College of Engineering and Physical Sciences**

**Major (Honours Program)**

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. This major will require the completion of 20.00 credits as indicated below:

#### Semester 1
- **BIOL*1090** [0.50] Introduction to Molecular and Cellular Biology
- **CHEM*1040** [0.50] General Chemistry I
- **IPS*1500** [1.00] Integrated Mathematics and Physics I

0.50 Liberal Education electives

Students who are lacking one 4U /grade 12 course in Biology, Chemistry or Physics must take the equivalent introductory course in first semester. The required first-year science courses in that subject should be completed according to the revised schedule of studies available at: [https://www.uoguelph.ca/bsc/revised_SS](https://www.uoguelph.ca/bsc/revised_SS)

#### Semester 2
- **CHEM*1050** [0.50] General Chemistry II
- **IPS*1510** [1.00] Integrated Mathematics and Physics II
- **COOP*1100** [0.00] Introduction to Co-operative Education
- **MATH*2200** [0.50] Advanced Calculus I
- **MATH*2270** [0.50] Applied Differential Equations

One of:
- **BIOL*1070** [0.50] Discovering Biodiversity
- **BIOL*1080** [0.50] Biological Concepts of Health

0.50 Liberal Education electives

#### Semester 3
- **BIOC*2580** [0.50] Introduction to Biochemistry
- **CHEM*2060** [0.50] Structure and Bonding
- **CHEM*2880** [0.50] Physical Chemistry

One of:
- **MBG*2040** [0.50] Foundations in Molecular Biology and Genetics
- **STAT*2040** [0.50] Statistics I

0.50 electives or restricted electives

#### Semester 4
- **CHEM*2070** [0.50] Structure and Spectroscopy
- **CHEM*2700** [0.50] Organic Chemistry I
- **CHEM*2400** [0.75] Analytical Chemistry I
- **MICR*2420** [0.50] Introduction to Microbiology

One of:
- **MBG*2040** [0.50] Foundations in Molecular Biology and Genetics
- **STAT*2040** [0.50] Statistics I

0.50 Liberal Education electives

#### Semester 5
- **BIOC*3570** [0.75] Analytical Biochemistry
- **CHEM*3750** [0.50] Organic Chemistry II

One of:
- **CHEM*3640** [0.50] Chemistry of the Elements I

0.50 electives or restricted electives *

One of:
- **TOX*3300** [0.50] Analytical Toxicology ***

0.50 electives or restricted electives *

Electives or restricted electives to a maximum of 2.75 total credits in this semester*

**CHEM*3640** is a prerequisite for **CHEM*3650**

**TOX*3300** is a substitute for **CHEM*3430** in Semester 6

#### Semester 6

Select either Option A or Option B

**Option A (at Guelph)**
- **BIOC*3560** [0.50] Structure and Function in Biochemistry
- **CHEM*3430** [0.50] Analytical Chemistry II: Instrumental Analysis
- **CHEM*3650** [0.50] Chemistry of the Elements II
- **CHEM*3760** [0.50] Organic Chemistry III

0.50 electives or restricted electives *

**Option B (at Seneca)**
- **XSEN*3030** [0.50] Pharmacology and Applied Toxicology
- **XSEN*3040** [0.50] Occupational Health and Chemistry
- **XSEN*3060** [0.50] Pharmaceutical Analysis - Advanced
- **XSEN*3070** [0.50] Pharmaceutical Product Formulations
- **XSEN*3090** [0.50] Biopharmaceuticals
- **XSEN*3200** [0.50] Pharmaceutical Organic Chemistry
- **XSEN*3210** [0.50] Introduction to Pharmaceutical Manufacturing

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[Last Revision: July 4, 2019]
Note: All XSEN courses are taught at the Seneca@York campus of Seneca College in Toronto.

Semester 7
One of:
CHEM*4730 [0.50] Synthetic Organic Chemistry
CHEM*4740 [0.50] Topics in Bio-Organic Chemistry
2.00 electives or restricted electives *

Semester 8
2.50 electives or restricted electives *

* Restricted Electives
**Students are advised to pay particular attention to pre-requisite requirements when choosing individual courses, and seek advice as needed.

1. 0.50 credits from the following:
MCB*2050 [0.50] Molecular Biology of the Cell
TOX*2000 [0.50] Principles of Toxicology

2. A minimum of 1.50 credits at the 4000 level and 2.50 credits at the 3000/4000 level from the following list:
BIOC*3560 [0.50] Structure and Function in Biochemistry
BIOC*4520 [0.50] Metabolic Processes
BIOC*4540 [0.50] Enzymology **
BIOC*4580 [0.50] Membrane Biochemistry
BIOM*3090 [0.50] Principles of Pharmacology **
BIOM*3200 [1.00] Biomedical Physiology
BIOM*4090 [0.50] Pharmacology **
CHEM*3360 [0.50] Environmental Chemistry and Toxicology
CHEM*3440 [0.50] Analytical Chemistry III: Analytical Instrumentation
CHEM*3640 [0.50] Chemistry of the Elements I
CHEM*3650 [0.50] Chemistry of the Elements II **
CHEM*3760 [0.50] Organic Chemistry III
CHEM*4010 [0.50] Chemistry and Industry
CHEM*4400 [0.50] Advanced Topics in Analytical Chemistry
CHEM*4630 [0.50] Bioinorganic Chemistry **
CHEM*4720 [0.50] Organic Reactivity **
CHEM*4730 [0.50] Synthetic Organic Chemistry **
CHEM*4740 [0.50] Topics in Bio-Organic Chemistry
CHEM*4900 [1.00] Chemistry Research Project I **
CHEM*4910 [1.00] Chemistry Research Project II **
MBG*3040 [0.50] Molecular Biology of the Gene **
MBG*3350 [0.75] Laboratory Methods in Molecular Biology **
MCB*4050 [0.50] Protein and Nucleic Acid Structure **
MICR*3230 [0.50] Immunology
NUTR*3210 [0.50] Fundamentals of Nutrition
PATH*3610 [0.50] Principles of Disease
TOX*4590 [0.50] Biochemical Toxicology **
XSEN*3030 [0.50] Pharmacology and Applied Toxicology
XSEN*3040 [0.50] Occupational Health and Chemistry
XSEN*3060 [0.50] Pharmaceutical Analysis - Advanced
XSEN*3070 [0.50] Pharmaceutical Product Formulations
XSEN*3090 [0.50] Biopharmaceuticals
XSEN*3200 [0.50] Pharmaceutical Organic Chemistry
XSEN*3210 [0.50] Introduction to Pharmaceutical Manufacturing

Credit Summary (20.00 Total Credits)
4.00 - First year science credits
6.50 - Required science courses semesters 3 – 8
5.50 - Restricted electives (#1 and #2 in restricted electives list)
0.50 - Approved Science electives
1.00 - Liberal Education electives
3.00 - Free electives - any approved elective for B.Sc. students. (could be less if restricted electives do not count as science)

Of the total credits required, students are required to complete 16.00 credits in science of which 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Biological and Pharmaceutical Chemistry (Co-op) (BPCH:C)
Department of Chemistry, College of Engineering and Physical Sciences

Program Requirements
The Co-op program in Biological and Pharmaceutical Chemistry is a four and a half year program, including four work terms. Students must complete a Fall, Winter and Summer work term, and must follow the academic work schedule as outlined below (also found on the Co-operative Education website: https://www.recruitguelph.ca/cecs/). Please refer to the Co-operative Education program policy with respect to adjusting this schedule.

Biological and Pharmaceutical Chemistry Academic and Co-op Work Term Schedule

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Winter</th>
<th>Summer</th>
</tr>
</thead>
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<tr>
<td>1</td>
<td>Academic Semester 1</td>
<td>Academic Semester 2</td>
<td>COOP*1100</td>
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<td>2</td>
<td>Academic Semester 3</td>
<td>COOP*1000 Work Term I</td>
<td>Academic Semester 4</td>
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<td>Academic Semester 5</td>
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<td>4</td>
<td>COOP*3000 Work Term III</td>
<td>Academic Semester 7</td>
<td>COOP*4000 Work Term IV</td>
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<tr>
<td>5</td>
<td>Academic Semester 8</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

To be eligible to continue in the Co-op program, students must meet a minimum 70% cumulative average requirement after second semester, as well as meet all work term requirements. Please refer to the Co-operative Education program policy with respect to work term performance grading, work term report grading and program completion requirements.

For additional program information students should consult with their Co-op Co-ordinator and Co-op Faculty Advisor, listed on the Co-operative Education web site.

Credit Summary (21.50 Total Credits)*
1.00 - Liberal Education electives
3.00 - Free electives - any approved elective for B.Sc. students. (could be less if restricted electives do not count as science)
1.50 - Co-op Work Terms

Of the total credits required, students are required to complete 16.00 credits in science of which a minimum of 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Note: A minimum of three Co-op work terms including a Summer, Fall, and Winter are necessary to complete the Co-op requirement. *A fourth Co-op work term is optional and if completed, the total number of credits will equal 22.00.

The recommended program sequence is outlined below.

Major (Honours Program)

Semester 1 - Fall
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
CHEM*1040 [0.50] General Chemistry I
IPS*1500 [1.00] Integrated Mathematics and Physics I
0.50 Liberal Education electives

Students who are lacking one 4U /grade 12 course in Biology, Chemistry or Physics must take the equivalent introductory course in first semester. The required first-year science courses in that subject should be completed according to the revised schedule of studies available at: https://www.uoguelph.ca/bsc/revised_SS

Semester 2 - Winter
CHEM*1050 [0.50] General Chemistry II
COOP*1100 [0.00] Introduction to Co-operative Education
IPS*1510 [1.00] Integrated Mathematics and Physics II

One of:
BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1080 [0.50] Biological Concepts of Health
0.50 Liberal Education electives

Semester 3 - Fall
BIOL*2580 [0.50] Introduction to Biochemistry
CHEM*2060 [0.50] Structure and Bonding
CHEM*2400 [0.75] Analytical Chemistry I
CHEM*2880 [0.50] Physical Chemistry
5.00 electives or restricted electives to a maximum of 2.75 total credits in this semester*

Winter Semester
COOP*1000 [0.50] Co-op Work Term I

Semester 4 - Summer
CHEM*2070 [0.50] Structure and Spectroscopy
CHEM*2700 [0.50] Organic Chemistry I
CHEM*3430 [0.50] Analytical Chemistry II: Instrumental Analysis
STAT*2040 [0.50] Statistics I
0.50 electives or restricted electives *

Semester 5 - Fall
BIOC*3570 [0.75] Analytical Biochemistry
CHEM*3750 [0.50] Organic Chemistry II
One of:
CHEM*3640 [0.50] Chemistry of the Elements I **
0.50 electives or restricted electives *
electives or restricted electives to a maximum of 2.75 total credits in this semester*
** CHEM*3640 is a prerequisite for CHEM*3650

Semester 6 - Winter

Select either Option A or Option B

**Option A (at Guelph)**

BIOC*3560 [0.50] Structure and Function in Biochemistry
CHEM*3650 [0.50] Chemistry of the Elements II
CHEM*3760 [0.50] Organic Chemistry III
1.00 electives or restricted electives *

**Option B (at Seneca)**

XSEN*3030 [0.50] Pharmacology and Applied Toxicology
XSEN*3040 [0.50] Occupational Health and Chemistry
XSEN*3060 [0.50] Pharmaceutical Analysis - Advanced
XSEN*3070 [0.50] Pharmaceutical Product Formulations
XSEN*3090 [0.50] Biopharmaceuticals
XSEN*3200 [0.50] Pharmaceutical Organic Chemistry
XSEN*3210 [0.50] Introduction to Pharmaceutical Manufacturing

Note: All XSEN courses are taught at the Seneca@York campus of Seneca College in Toronto.

Summer Semester

COOP*2000 [0.50] Co-op Work Term II

Fall Semester

COOP*3000 [0.50] Co-op Work Term III

Semester 7 - Winter

2.50 electives or restricted electives *

Summer Semester

COOP*4000 [0.50] Co-op Work Term IV

Semester 8 - Fall

One of:
CHEM*4730 [0.50] Synthetic Organic Chemistry
CHEM*4740 [0.50] Topics in Bio-Organic Chemistry
2.00 electives or restricted electives *

* Restricted Electives

**Students are advised to pay particular attention to pre-requisite requirements when choosing individual courses, and seek advice as needed.

1. MICR*2420 [0.50] Introduction to Microbiology
2. 1.00 credits from the following:
   MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
   MCB*2050 [0.50] Molecular Biology of the Cell
   TOX*2000 [0.50] Principles of Toxicology
3. A minimum of 1.50 credits at the 4000 level and 2.50 credits at the 3000/4000 level from the following list:
   BIOC*3560 [0.50] Structure and Function in Biochemistry
   BIOC*4520 [0.50] Metabolic Processes
   BIOC*4540 [0.75] Enzymology **
   BIOC*4580 [0.50] Membrane Biochemistry
   BIOM*3090 [0.50] Principles of Pharmacology **
   BIOM*3200 [1.00] Biomedical Physiology
   BIOM*4090 [0.50] Pharmacology **
   CHEM*3360 [0.50] Environmental Chemistry and Toxicology
   CHEM*3440 [0.50] Analytical Chemistry III: Analytical Instrumentation
   CHEM*3640 [0.50] Chemistry of the Elements I
   CHEM*3650 [0.50] Chemistry of the Elements II **
   CHEM*3760 [0.50] Organic Chemistry III
   CHEM*4010 [0.50] Chemistry and Industry
   CHEM*4400 [0.50] Advanced Topics in Analytical Chemistry
   CHEM*4630 [0.50] Bioinorganic Chemistry **
   CHEM*4720 [0.50] Organic Reactivity **
   CHEM*4730 [0.50] Synthetic Organic Chemistry **
   CHEM*4740 [0.50] Topics in Bio-Organic Chemistry
   CHEM*4900 [1.00] Chemistry Research Project I **
   CHEM*4910 [1.00] Chemistry Research Project II **
   MBG*3040 [0.50] Molecular Biology of the Gene **
   MBG*3350 [0.75] Laboratory Methods in Molecular Biology **
   MCB*4050 [0.50] Protein and Nucleic Acid Structure **
   MICR*3210 [0.50] Immunology
   NUTR*3210 [0.50] Fundamentals of Nutrition
   PATH*3610 [0.50] Principles of Disease
   TOX*4590 [0.50] Biochemical Toxicology **
   XSEN*3030 [0.50] Pharmacology and Applied Toxicology

XSEN*3040 [0.50] Occupational Health and Chemistry
XSEN*3060 [0.50] Pharmaceutical Analysis - Advanced
XSEN*3070 [0.50] Pharmaceutical Product Formulations
XSEN*3090 [0.50] Biopharmaceuticals
XSEN*3200 [0.50] Pharmaceutical Organic Chemistry
XSEN*3210 [0.50] Introduction to Pharmaceutical Manufacturing

Biological Science (BIOS)

**Major (Honours Program)**

The Biological Science major offers the opportunity to study a wide range of topics within biological science. The major is one of the most flexible within the B.Sc. program. After the core sciences in first and second year, students can tailor the degree to create a major all their own. With the wide breadth of courses offered, students can choose to focus their studies in one area of biological science or create a unique skill set and combination of courses not currently offered in any one of our majors. Students can also add a minor in either an area of science, arts or social science.

With this flexibility, students in the Biological Science major are encouraged to seek out study abroad opportunities through the Centre for International Programs. With a high number of elective spaces within the major, students can incorporate a study abroad and still meet the degree requirements within four years. Students who wish to pursue this option should start researching and planning in semesters 3 and 4.

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. This major will require the completion of 20.00 credits as indicated below:

**Schedule of Studies**

**Semester 1**

BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
CHEM*1040 [0.50] General Chemistry I
MATH*1080 [0.50] Elements of Calculus I
PHYS*1080 [0.50] Physics for Life Sciences

0.50 Liberal Education electives

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at https://www.uoguelph.ca/bsc/2019-2020/undergraduate_calendar/

**Semester 2**

BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1080 [0.50] Biological Concepts of Health
CHEM*1050 [0.50] General Chemistry II
PHYS*1070 [0.50] Physics for Life Sciences II

0.50 Liberal Education electives

**Semester 3**

BIOL*2400 [0.50] Evolution

One of:
   BIOC*2580 [0.50] Introduction to Biochemistry
   MBG*2040 [0.50] Foundations in Molecular Biology and Genetics

1.00 electives or restricted electives *

0.50 Liberal Education elective

**Semester 4**

STAT*2040 [0.50] Statistics I

One of:
   BIOC*2580 [0.50] Introduction to Biochemistry
   MBG*2040 [0.50] Foundations in Molecular Biology and Genetics

1.00 electives or restricted electives *

0.50 Liberal Education elective

**Semester 5**

2.50 credits of electives or restricted electives *

Students are encouraged to consider study abroad options

**Semester 6**

2.50 credits of electives or restricted electives *

Students are encouraged to consider study abroad options

**Semester 7 and 8**

2.50 credits of electives or restricted electives *

Students interested in studying abroad need to apply in the year prior to going abroad. Students need to contact the Centre for International Programs to confirm admission requirements and to submit an application. Study abroad requires approval from the appropriate individuals and is pending available space at the host institution.

* Restricted Electives

**Note:** Some courses may require additional prerequisites.

1. At least 2.00 credits of Liberal Education electives are required. The list of Liberal Education electives for B.Sc. students can be found at: https://www.uoguelph.ca/bsc/
2. A minimum of 0.50 credits in Ecology:
   BIOL*2060 [0.50] Ecology

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Last Revision: July 4, 2019  
2019-2020 Undergraduate Calendar
BOT*3050 [0.50] Plant Functional Ecology

3. A minimum of 0.50 credits in Mathematical or Computational Science:
   CIS*1000 [0.50] Introduction to Computer Applications
   CIS*1200 [0.50] Introduction to Computing
   MATH*1090 [0.50] Elements of Calculus II
   STAT*2050 [0.50] Statistics II

4. A minimum of 0.50 credits in Physiology:
   BIOM*3200 [1.00] Biomedical Physiology
   BOT*2100 [0.50] Life Strategies of Plants
   HK*2810 [0.50] Human Physiology I - Concepts and Principles
   ZOO*3600 [0.50] Comparative Animal Physiology I

5. 5.50 additional Biological Science credits of which 4.00 must be at the 3000 or 4000 level. The list of approved science electives is posted at http://www.bsc.uoguelph.ca/.

Credit Summary (20.00 Total Credits)

4.00 - First year science core
3.50 - Required science courses semesters 3 - 8 (# 2, 3 and 4 in restricted elective list)
5.50 - Approved Biological Science electives of which 4.00 must be 3000/4000 level (# in restricted elective list)
3.00 - Approved Science electives of which 2.00 credits must be 3000/4000 level* May include 1 of BIOL*1020, CHEM*1060
2.00 - Liberal Education electives
2.00 - Electives

* Of the total credits required, students are required to complete 16.00 credits in science of which a minimum of 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Biology (BIOL)

College of Biological Science

Minor (Honours Program)

A minor in Biology consists of a minimum of 5.00 credits including the following courses:

BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics

One of:
BIOL*2060 [0.50] Ecology
BOT*3050 [0.50] Plant Functional Ecology

Of the additional 3.00 credits of approved science electives, students must complete a minimum of 1.50 credits at the 3000 or 4000 level, from courses offered by the following departments: Human Health and Nutritional Sciences, Integrative Biology and Molecular and Cellular Biology. BIOL*1080 is a prerequisite for some CBS courses. This minor is restricted to students registered in B.Sc. majors in the Physical Sciences, B.A.S., and the B.A. degree programs.

Bio-Medical Science (BIOM)

Department of Biomedical Sciences and Department of Human Health and Nutritional Sciences

This joint program of the Department of Human Health and Nutritional Sciences and the Department of Biomedical Sciences provides students with a broad and integrated foundational overview of human and animal health through the study of function (biochemistry and physiology), structure (anatomy and histology), and paracrinical sciences (epidemiology and pharmacology). The program prepares students well for more advanced studies or applied training in many health-related fields including clinical practice, business, government, research and education. Through the use of electives, students may structure a program emphasizing aspects of health and disease. For more information on recommended electives contact the Faculty Advisor of the major.

In addition, this program is designed to partially meet the current requirements for entry into medical schools in Ontario (a student interested in meeting these requirements should check the present admission requirements for the medical schools); as well as entry into the DVM program of the Ontario Veterinary College.

Live animals and/or animal tissues are used for teaching purposes in some courses in the Bio-Medical Science Major. This must be accepted by students admitted to the program. All animals are protected under the Animals for Research Act of Ontario (1980), the Guidelines for the Care and Use of Experimental Animals (Canadian Council on Animal Care), and the Animal Care Policies of the University of Guelph.

Students who are admitted into the Bio-Medical Science major from high school must meet additional requirements to continue in the major. Continuation from first to second year is based on the cumulative average in the first two semesters (total of 5.00 credits), including the eight core courses as prescribed by the Schedule of Studies (see below). Students with a minimum average of 75% average will be guaranteed continuation in this major. For students with a 70-74.9% average, continuation will be competitive based on available spaces. Students with an average below 70% will be changed to the Biological Science major. Students may subsequently change to another B.Sc. major of their choice.

B.Sc. students who wish to declare the specialization at the end of or beyond first year must apply directly to the Department of Biomedical Sciences by the last day of classes in the winter semester and meet the same requirements specified above.

Admission to the major will be based on the cumulative average in the two semesters (total of 5.00 credits) preceding application to the major (normally fall and winter). Acceptance will be competitive based on available spaces. Students with an average below 70% will not be considered for admission to the major. All decisions will be made at the end of June.

Major (Honours Program)

A minimum of 20.00 credits is required.

Semester 1
BIOL*1080 [0.50] Biological Concepts of Health
CHEM*1040 [0.50] General Chemistry I
MATH*1080 [0.50] Elements of Calculus I
PHYS*1080 [0.50] Physics for Life Sciences
0.50 electives or restricted electives

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at: https://www.uoguelph.ca/bsc/revised_SS

Semester 2
BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
CHEM*1050 [0.50] General Chemistry II
PHYS*1070 [0.50] Physics for Life Sciences II
0.50 electives or restricted electives

Semester 3 (see admission statement above)
BIOC*2580 [0.50] Introduction to Biochemistry
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
STAT*2040 [0.50] Statistics I
1.00 electives or restricted electives

Semester 4
MCR*2050 [0.50] Molecular Biology of the Cell
NUTR*3210 [0.50] Fundamentals of Nutrition
One of:
BIOM*3200 [1.00] Biomedical Physiology
HK*2810 [0.50] Human Physiology I - Concepts and Principles
Electives or restricted electives to a maximum of 2.50 total credits in this semester.

Note: If HK*2810 is selected, then HK*3810 must be taken in Semester 5.

Semester 5
BIOC*3560 [0.50] Structure and Function in Biochemistry
Electives or restricted electives to a maximum of 2.75 total credits in this semester.

BIOM*3210 is recommended.

Note: As part of the electives or restricted electives, students must select HK*3810 in semester 5 if HK*2810 was selected in semester 4.

Semester 6
BIOM*3090 [0.50] Principles of Pharmacology
PATH*3610 [0.50] Principles of Disease
POMP*3240 [0.50] Epidemiology
Electives or restricted electives to a maximum of 2.75 total credits in this semester.

Semester 7
2.50 electives or restricted electives

Semester 8
2.50 electives or restricted electives

Restricted Electives

1. Anatomy Elective - [1 of (BIOM*3010, BIOM*3040), HK*3401/2, HK*3501/2]
2. Immunology Elective - ANSC*4650 or MIRC*3230
3. Advanced Study Electives - 2.00 credits from BIOM*4030, BIOM*4050, BIOM*4070, MBG*4090, BIOM*4110, BIOM*4150, BIOM*4180, BIOM*4300, BIOM*4500, BIOM*4510, BIOM*4521/2, HK*4070, HK*4230, HK*4340, HK*4360, HK*4371/2, HK*4441/2, HK*4460, NUTR*4320, NUTR*4360, NUTR*4510, TOX*4000
4. At least 2.00 credits of Liberal Education electives are required. The list of Liberal Education electives for B.Sc. students can be found at: https://www.uoguelph.ca/bsc/

Credit Summary (20.00 Total Credits)

4.00 - First year science credits
5.75 - Required science courses semesters 3 – 8 (with HK 2810,3810) or 5.50 (with BIOM 3200)
4.00 - Restricted elective (with HK 2810,3810) or 3.75 (with BIOM 3010, BIOM 3040)
5.75 - Required science courses semesters 3 – 8 (with HK 2810,3810) or 5.50 (with BIOM 3010, BIOM 3040)
5.50 - Approved Biological Science electives of which 4.00 must be at the 3000 or 4000 level. The list of approved science electives is posted at http://www.bsc.uoguelph.ca/.

Note that specified learning outcomes for programs and courses cannot be achieved through independent study. Students must apply directly to the Department of Biomedical Sciences by the last day of classes in the winter semester and meet the same requirements specified above.
Of the total credits required, students are required to complete 16.00 credits in science of which 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Biomedical Toxicology (BTOX)
Interdisciplinary Program, Departments of Biomedical Sciences, Chemistry, School of Environmental Sciences, Molecular and Cellular Biology

Major (Honours Program)
Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. A minimum of 20.00 credits are required for graduation.

Semester 1
Biol*1090 [0.50] Introduction to Molecular and Cellular Biology
Chem*1040 [0.50] General Chemistry I
Math*1080 [0.50] Elements of Calculus I
Phys*1080 [0.50] Physics for Life Sciences
0.50 Liberal Education electives

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at: https://www.uoguelph.ca/bsc/revised_SS

Semester 2
Biol*1080 [0.50] Biological Concepts of Health
Chem*1050 [0.50] General Chemistry II
Phys*1070 [0.50] Physics for Life Sciences II
Stat*2040 [0.50] Statistics I
0.50 Liberal Education electives

Semester 3
Bio*c2580 [0.50] Introduction to Biochemistry
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
TOX*2000 [0.50] Principles of Toxicology
1.00 elective or Liberal Education electives

Semester 4
Biom*3200 [1.00] Biomedical Physiology
Chem*2480 [0.50] Analytical Chemistry I
Chem*2700 [0.50] Organic Chemistry I
0.50 electives or restricted electives*

Semester 5
Bio*c3560 [0.50] Structure and Function in Biochemistry
MCB*2050 [0.50] Molecular Biology of the Cell
NUTR*3210 [0.50] Fundamentals of Nutrition
TOX*3300 [0.50] Analytical Toxicology
0.50 electives or restricted electives*

Semester 6
Bio*m3090 [0.50] Principles of Pharmacology
Path*3610 [0.50] Principles of Disease
TOX*3360 [0.50] Environmental Chemistry and Toxicology
One of:
Bio*m3040 [0.75] Medical Embryology
MBG*3350 [0.75] Laboratory Methods in Molecular Biology *
Electives or restricted electives to a maximum of 2.75 total credits in this semester

Semester 7
NUTR*4510 [0.50] Toxicology, Nutrition and Food
TOX*4000 [0.50] Medical Toxicology
TOX*4590 [0.50] Biochemical Toxicology
1.00 electives or restricted electives*

Semester 8
Bio*m4090 [0.50] Pharmacology
TOX*4100 [0.50] Toxicological Pathology
TOX*4200 [0.50] Topics in Toxicology
1.00 electives or restricted electives*

* Restricted Electives
At least 1.50 credits must be completed from the following list of allowable courses.
**Students are advised to pay particular attention to pre-requisite requirements when choosing individual courses, and seek advice as needed.

Agriculture and Environmental Science
Ansc*4650 [0.50] Comparative Immunology
Biom*3040 [0.75] Medical Embryology
Bio*m4050 [0.50] Biomedical Aspects of Aging
Bio*m4070 [0.50] Biomedical Histology
Bio*m4150 [0.50] Cancer Biology
Chem*3750 [0.50] Organic Chemistry II
Chem*3760 [0.50] Organic Chemistry III
Chem*4740 [0.50] Topics in Bio-Organic Chemistry
MBG*3040 [0.50] Molecular Biology of the Gene
MBG*3350 [0.75] Laboratory Methods in Molecular Biology
MBG*4270 [0.50] DNA Replication, Recombination and Repair

Credit Summary (20.00 Total Credits)

4.00 - First year science credits
10.75 - Required science courses semesters 3 – 8
1.50 - Restricted electives
1.50 - Liberal Education electives
2.25 - Free electives - any approved elective for B.Sc. students

Of the total credits required, students are required to complete 16.00 credits in science of which 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Biomedical Toxicology (Co-op) (BTOX: C)
Interdisciplinary Program, Departments of Biomedical Sciences, Chemistry, School of Environmental Sciences, Molecular and Cellular Biology

Program Requirements
The Co-op program in Biomedical Toxicology is a four and a half year program, including four work terms. Students must complete a Fall, Winter and Summer work term, and must follow the academic work schedule as outlined below (also found on the Co-operative Education website: https://www.recruitguelph.ca/cecs/). Please refer to the Co-operative Education program policy with respect to adjusting this schedule.

Biomedical Toxicology Academic and Co-op Work Term Schedule

Year  | Fall | Winter | Summer
---  | ---  | ---    | ---
1    | Academic Semester 1 | Academic Semester 2 | OFF
| COOP*1100 | Co-op 2000 Work Term I | Co-op*2000 Work Term II
2    | Academic Semester 3 | COOP*1000 Work Term | Co-op 3000 Work Term III
3    | Academic Semester 4 | Academic Semester 5 | Co-op*3000 Work Term III
4    | COOP*4000 Work Term IV | Academic Semester | OFF
5    | Academic Semester 7 | N/A | N/A

To be eligible to continue in the Co-op program, students must meet a minimum 70% cumulative average requirement after second semester, as well as meet all work term requirements. Please refer to the Co-operative Education program policy with respect to work term performance grading, work term report grading and program completion requirements.

For additional program information students should consult with their Co-op Co-ordinator and Co-op Faculty Advisor, listed on the Co-operative Education website web site.

Credit Summary (21.50 Total Credits)

4.00 - First year science credits
10.75 - Required science courses semesters 3 – 8
1.50 - Restricted electives
1.50 - Liberal Education electives
2.25 - Free electives - any approved elective for B.Sc. students
1.50 - Co-op Work Terms

Of the total credits required, students are required to complete 16.00 credits in science of which a minimum of 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Note: A minimum of three Co-op work terms including a Summer, Fall, and Winter are necessary to complete the Co-op requirement. *A fourth Co-op work term is optional and if completed, the total number of credits will equal 22.00.

The recommended program sequence is outlined below.

Major (Honours Program)

Semester 1 - Fall
Biol*1090 [0.50] Introduction to Molecular and Cellular Biology
Chem*1040 [0.50] General Chemistry I
Math*1080 [0.50] Elements of Calculus I
Phys*1080 [0.50] Physics for Life Sciences
0.50 Liberal Education electives

MCB*4010 [0.50] Advanced Cell Biology
MICR*3230 [0.50] Immunology
NUTR*4090 [0.50] Functional Foods and Nutraceuticals
NUTR*4320 [0.50] Nutrition and Metabolic Control of Disease
PATH*3040 [0.50] Principles of Parasitology
POPM*3240 [0.50] Epidemiology
POPM*4040 [0.50] Epidemiology of Food-borne Diseases
Stat*2050 [0.50] Statistics II
Stat*3510 [0.50] Environmental Risk Assessment
TOX*4900 [1.00] Toxicology Research Project I
TOX*4910 [1.00] Toxicology Research Project II

Last Revision: July 4, 2019

2019-2020 Undergraduate Calendar
Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at: https://www.uoguelph.ca/bsc/revised_SS

Semester 2 - Winter
Biol*1080 [0.50] Biological Concepts of Health
Chem*1050 [0.50] General Chemistry II
Coop*1100 [0.00] Introduction to Co-operative Education
Phys*1070 [0.50] Physics for Life Sciences II
Stat*2040 [0.50] Statistics I
0.50 Liberal Education electives

Semester 3 - Fall
Bio*2580 [0.50] Introduction to Biochemistry
Chem*2480 [0.50] Analytical Chemistry I
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
Tox*2000 [0.50] Principles of Toxicology
0.50 Liberal Education electives

Semester 4 - Fall
Bio*3350 [0.50] Structure and Function in Biochemistry
MBG*2050 [0.50] Molecular Biology of the Cell
Nutr*3210 [0.50] Fundamentals of Nutrition
Tox*3300 [0.50] Analytical Toxicology
0.50 electives or restricted electives

Semester 5 - Winter
Chem*2700 [0.50] Organic Chemistry I
Biom*3200 [1.00] Biomedical Physiology
Tox*3360 [0.50] Environmental Chemistry and Toxicology
0.50 electives or restricted electives*

Summer Semester
Coop*3000 [0.50] Co-op Work Term III

Fall Semester
Coop*4000 [0.50] Co-op Work Term IV

Semester 6 - Winter
Biom*3090 [0.50] Principles of Pharmacology
Path*3610 [0.50] Principles of Disease
One of:
Biom*3040 [0.75] Medical Embryology
MBG*3350 [0.75] Laboratory Methods in Molecular Biology *
Electives or restricted electives to a maximum of 2.75 total credits in this semester

Semester 7 - Fall
Nutr*4510 [0.50] Toxicology, Nutrition and Food
Tox*4000 [0.50] Medical Toxicology
Tox*4590 [0.50] Biochemical Toxicology
One of:
Biom*4090 [0.50] Pharmacology
Tox*4900 [1.00] Toxicology Research Project I
1.00 electives or restricted electives*

Semester 8 - Winter
Biom*4090 [0.50] Pharmacology (if not taken in Semester 7)
Tox*4100 [0.50] Toxicological Pathology
Tox*4200 [0.50] Topics in Toxicology
Electives or restricted electives to a maximum of 2.50 total credits

* Restricted Electives
At least 1.50 credits must be completed from the following list of allowable courses.

** Students are advised to pay particular attention to pre-requisite requirements when choosing individual courses, and seek advice as needed.

Biotechnology (BIOT)

Department of Molecular and Cellular Biology, College of Biological Science

Minor (Honours Program)
A minimum of 5.00 credits is required including:

Bio*3560 [0.50] Structure and Function in Biochemistry
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
MBG*2420 [0.50] Introduction to Microbiology
MBG*2430 [0.50] Methods in Microbial Culture and Physiology
0.50 credits from:

Econ*2660 [0.50] Biological Engineering Systems I
Econ*3830 [0.50] Bio-Process Engineering
Food*2410 [0.50] Introduction to Food Processing
Food*2420 [0.50] Introduction to Food Microbiology
Food*2620 [0.50] Food Engineering Principles

1.00 credits from:

Econ*1050 [0.50] Introductory Microeconomics
Econ*1100 [0.50] Introductory Macroeconomics
Econ*2100 [0.50] Economic Growth and Environmental Quality
Econ*2310 [0.50] Intermediate Microeconomics
Econ*2410 [0.50] Intermediate Macroeconomics
MCS*1000 [0.50] Introductory Marketing

A minimum of 1.50 credits from:

Ansc*4050 [0.50] Biotechnology in Animal Science
BioC*4540 [0.75] Enzymology
BioI*3300 [0.50] Applied Bioinformatics
Food*3270 [0.50] Industrial Microbiology
MBG*3660 [0.50] Genomics
MBG*4240 [0.50] Applied Molecular Genetics in Medicine and Biotechnology
MCB*4050 [0.50] Protein and Nucleic Acid Structure
MBG*3230 [0.50] Immunology
PBIO*3750 [0.50] Plant Tissue Culture
PBIO*4750 [0.50] Genetic Engineering of Plants

Business Economics (BECN)

Department of Economics and Finance, Gordon S. Lang School of Business and Economics

Interdisciplinary study in Business Economics is offered as a minor in the honours program. Students in this program will be counselled by the Department of Economics and Finance. It is possible for students to pursue a more intensive program in the area of business and economics; see the heading Economics (ECON) or Mathematical Economics (MAEC) in the B.A. degree and the heading Management Economics (MEF) in the B.Comm. degree.

Minor (Honours Program)
A minimum of 5.00 credits is required, including:

AccC*1220 [0.50] Introductory Financial Accounting
AccC*2230 [0.50] Management Accounting
Econ*1050 [0.50] Introductory Microeconomics
Econ*1100 [0.50] Introductory Macroeconomics
Econ*2310 [0.50] Intermediate Microeconomics
Econ*2410 [0.50] Intermediate Macroeconomics
Econ*2560 [0.50] Introduction to Finance

One of:

Ips*1500 [1.00] Integrated Mathematics and Physics I
Math*1030 [0.50] Business Mathematics
Math*1080 [0.50] Elements of Calculus I
Math*1200 [0.50] Calculus I

One of:

Econ*2740 [0.50] Economic Statistics
Psyc*1010 [0.50] Making Sense of Data in Psychological Research
Soc*2120 [0.50] Introductory Methods
Stat*2040 [0.50] Statistics I
Stat*2060 [0.50] Statistics for Business Decisions
Stat*2080 [0.50] Introductory Applied Statistics I
Stat*2120 [0.50] Probability and Statistics for Engineers

One of:

Econ*3660 [0.50] Investments
Econ*4400 [0.50] Managerial Economics

PBIO*3750 [0.50] Plant Tissue Culture
PBIO*4750 [0.50] Genetic Engineering of Plants

Last Revision: July 4, 2019
### Chemical Physics (CHPY)

Administered by the Office of the Dean, College of Engineering and Physical Sciences on behalf of the Department of Chemistry and the Department of Physics

#### Major (Honours Program)

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. A minimum of 20.00 credits is required. At least 1.00 credits must be from Liberal Education electives.

**Semester 1**

- **CHEM*1040** [0.50] General Chemistry I
- **CIS*1300** [0.50] Programming
- **IPS*1500** [1.00] Integrated Mathematics and Physics I

One of:
- **BIOL*1070** [0.50] Discovering Biodiversity
- **BIOL*1080** [0.50] Biological Concepts of Health
- **BIOL*1090** [0.50] Introduction to Molecular and Cellular Biology

Students who are lacking one 4U / grade 12 course in Biology, Chemistry or Physics must take the equivalent introductory course in first semester. The required first-year science courses in that subject should be completed according to the revised schedule of studies available at: [https://www.uoguelph.ca/bsc/revised_SS](https://www.uoguelph.ca/bsc/revised_SS)

**Semester 2**

- **CHEM*1050** [0.50] General Chemistry II
- **IPS*1510** [1.00] Integrated Mathematics and Physics II
- **MATH*1160** [0.50] Linear Algebra I

One of:
- **BIOL*1070** [0.50] Discovering Biodiversity
- **BIOL*1080** [0.50] Biological Concepts of Health
- **BIOL*1090** [0.50] Introduction to Molecular and Cellular Biology

**Semester 3**

- **CHEM*2060** [0.50] Structure and Bonding
- **MATH*2200** [0.50] Advanced Calculus I
- **MATH*2270** [0.50] Applied Differential Equations
- **PHYS*2330** [0.50] Electricity and Magnetism I
- **0.50 Liberal Education electives**

**Semester 4**

- **CHEM*2070** [0.50] Structure and Spectroscopy
- **CHEM*2480** [0.50] Analytical Chemistry I
- **PHYS*2180** [0.50] Experimental Techniques in Physics
- **PHYS*2310** [0.50] Mechanics
- **PHYS*2340** [0.50] Electricity and Magnetism II

**Semester 5**

- **CHEM*3860** [0.50] Quantum Chemistry
- **PHYS*3130** [0.50] Mathematical Physics
- **PHYS*3230** [0.50] Quantum Mechanics I

One of:
- **CHEM*2820** [0.50] Thermodynamics and Kinetics
- **PHYS*2240** [0.50] Thermal Physics

One of:
- **IPS*3000** [0.50] Science Communication
- **0.50 Liberal Education electives**

**Semester 6**

- **CHEM*3430** [0.50] Analytical Chemistry II: Instrumental Analysis
- **NANO*3600** [0.50] Computational Methods in Materials Science
- **PHYS*3000** [0.50] Optics: Fundamentals and Applications
- **PHYS*4040** [0.50] Quantum Mechanics II

One of:
- **CHEM*3870** [0.50] Molecular Spectroscopy
- **CHEM*4880** [0.50] Topics in Advanced Physical Chemistry

**Semester 7**

- **CHEM*3440** [0.50] Analytical Chemistry III: Analytical Instrumentation
- **PHYS*4120** [0.50] Atomic and Molecular Physics
- **PHYS*4240** [0.50] Statistical Physics II

One of:
- **PHYS*4001** [0.50] Research in Physics +
- **0.50 Liberal Education electives**

**Semester 8**

One of:
- **CHEM*3870** [0.50] Molecular Spectroscopy
- **CHEM*4880** [0.50] Topics in Advanced Physical Chemistry

One of:
- **CHEM*4900** [1.00] Chemistry Research Project I +
- **PHYS*4002** and 0.50 electives

One of:
- **IPS*3000** [0.50] Science Communication
- **0.50 Liberal Education electives**
- **0.50 electives**

Students must complete either (PHYS*4001, PHYS*4002 in semester 7 and 8) or (CHEM*4900 in semester 8).

+ One of CHEM*3870 or CHEM*4880 is required for graduation.

A minimum of 1.00 credits of Liberal Education electives is required for completion of this program. The list of Liberal Education electives for B.Sc. students can be found at: [https://www.uoguelph.ca/bsc/](https://www.uoguelph.ca/bsc/)

### Credit Summary (20.00 Total Credits)

- 5.00 - First year science credits
- 11.50 - Required science courses semesters 3 – 8
- 1.00 - Liberal Education electives

2.50 - Free electives - any approved elective for B.Sc. students

Of the total credits required, students are required to complete 16.00 credits in science of which 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

### Chemical Physics (Co-op) (CHPY:C)

Administered by the Office of the Dean, College of Engineering and Physical Sciences on behalf of the Department of Chemistry and the Department of Physics

Program Requirements

The Co-op program in Chemical Physics is a five year program, including five work terms. Students must complete a Fall, Winter and Summer work term and must follow the academic work schedule as outlined below (also found on the Co-operative Education website: [https://www.recruituoguelph.ca/eces/](https://www.recruituoguelph.ca/eces/)). Please refer to the Co-operative Education program policy with respect to adjusting this schedule.

Chemical Physics Academic and Co-op Work Term Schedule

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<th>Year</th>
<th>Fall</th>
<th>Winter</th>
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<td>1</td>
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<td>Academic Semester 4</td>
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<td>COOP*4000 Work Term IV</td>
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<td>Academic Semester 7</td>
<td>Academic Semester 8</td>
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</tr>
</tbody>
</table>

To be eligible to continue in the Co-op program, students must meet a minimum 70% cumulative average requirement after second semester, as well as meet all work term requirements. Please refer to the Co-operative Education program policy with respect to work term performance grading, work term report grading and program completion requirements.

For additional program information students should consult with their Co-op Co-ordinator and Co-op Faculty Advisor, listed on the Co-operative Education web site.

### Credit Summary (22.00 Total Credits)*

- 5.00 - First year science credits
- 10.50 - Required science courses semesters 3 – 8
- 0.50 - Approved science electives
- 1.00 - Liberal Education electives
- 3.00 - Free electives - any approved elective for B.Sc. students.
- 2.00 - Co-op Work Terms

Of the total credits required, students are required to complete 16.00 credits in science of which 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

**Note:** A minimum of four Co-op work terms including a Summer, Fall, and Winter are necessary to complete the Co-op requirement. *A fifth Co-op work term is optional and if completed, the total number of credits will equal 22.50.

The recommended program sequence is outlined below.

#### Major (Honours Program)

**Semester 1 - Fall**

- **CHEM*1040** [0.50] General Chemistry I
- **CIS*1300** [0.50] Programming
Students who are lacking one 4U /grade 12 course in Biology, Chemistry or Physics must take the equivalent introductory course in first semester. The required first-year science courses in that subject should be completed according to the revised schedule of studies available at: https://www.uoguelph.ca/bsc/revised_SS

Semester 2 - Winter
CHEM*1050 [0.50] General Chemistry II
IPS*1510 [1.00] Integrated Mathematics and Physics II
MATH*1160 [0.50] Linear Algebra I
One of:
BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1080 [0.50] Biological Concepts of Health
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology

Semester 3 - Fall
CHEM*2060 [0.50] Structure and Bonding
COOP*1100 [0.00] Introduction to Co-operative Education
MATH*2200 [0.50] Advanced Calculus I
MATH*2270 [0.50] Applied Differential Equations
PHYS*2330 [0.50] Electricity and Magnetism I

Summer Semester
COOP*1000 [0.50] Co-op Work Term I

Fall Semester
COOP*2000 [0.50] Co-op Work Term II

Semester 6 - Fall
CHEM*3430 [0.50] Analytical Chemistry II: Instrumental Analysis
One of:
CHEM*3870 [0.50] Molecular Spectroscopy +
0.50 electives *
One of:
CIS*2500 [0.50] Intermediate Programming
0.50 electives *
1.00 electives*

Summer Semester
COOP*3000 [0.50] Co-op Work Term III

Semester 7** - Fall
CHEM*3860 [0.50] Quantum Chemistry
IPS*3000 [0.50] Science Communication
PHYS*3130 [0.50] Mathematical Physics
PHYS*3230 [0.50] Quantum Mechanics I
One of:
CHEM*2820 [0.50] Thermodynamics and Kinetics
PHYS*2240 [0.50] Thermal Physics

Winter Semester
COOP*4000 [0.50] Co-op Work Term IV
(8-month work term in conjunction with COOP*5000)

Summer Semester
COOP*5000 [0.50] Co-op Work Term V
(8-month work term in conjunction with COOP*4000)

Semester 8** - Fall
CHEM*3440 [0.50] Analytical Chemistry III: Analytical Instrumentation
PHYS*4240 [0.50] Statistical Physics II
One of:
CHEM*3640 [0.50] Chemistry of the Elements I
CHEM*3750 [0.50] Organic Chemistry II
0.50 electives *
1.00 electives *

Semester 8** - Winter
NANO*3600 [0.50] Computational Methods in Materials Science
PHYS*3000 [0.50] Optics: Fundamentals and Applications
PHYS*4040 [0.50] Quantum Mechanics II
One of:
CHEM*3870 [0.50] Molecular Spectroscopy +
CHEM*4880 [0.50] Topics in Advanced Physical Chemistry +
0.50 electives *
0.50 electives *

* A minimum of 1.00 credits of Liberal Education electives is required for completion of this program. The list of Liberal Education electives for B.Sc. students can be found at: https://www.uoguelph.ca/bsc/
** A minimum of 2.00 credits in science courses at the 4000 level is required for graduation.
+ One of CHEM*3870 or CHEM*4880 is required for graduation.

Chemistry (CHEM)

Department of Chemistry, College of Engineering and Physical Sciences

Major (Honours Program)

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. The major will require the completion of 20.00 credits as indicated below:

Semester 1
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
CHEM*1040 [0.50] General Chemistry I
IPS*1500 [1.00] Integrated Mathematics and Physics I
0.50 Liberal Education electives

Semester 2
CHEM*1050 [0.50] General Chemistry II
IPS*1510 [1.00] Integrated Mathematics and Physics II
MATH*1160 [0.50] Linear Algebra I
One of:
BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1080 [0.50] Biological Concepts of Health
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology

Semester 3
CHEM*2070 [0.50] Structure and Spectroscopy
CHEM*2480 [0.50] Analytical Chemistry I
PHYS*2180 [0.50] Experimental Techniques in Physics
PHYS*2310 [0.50] Mechanics
PHYS*2340 [0.50] Electricity and Magnetism II

Semester 4 - Winter
COOP*1000 [0.50] Co-op Work Term I

Semester 5
CHEM*3430 [0.50] Analytical Chemistry II: Instrumental Analysis
One of:
CHEM*3870 [0.50] Molecular Spectroscopy +
0.50 electives *
One of:
CIS*2500 [0.50] Intermediate Programming
0.50 electives *
1.00 electives*

Semester 6 - Fall
CHEM*3860 [0.50] Quantum Chemistry
IPS*3000 [0.50] Science Communication
PHYS*3130 [0.50] Mathematical Physics
PHYS*3230 [0.50] Quantum Mechanics I
One of:
CHEM*2820 [0.50] Thermodynamics and Kinetics
PHYS*2240 [0.50] Thermal Physics

Winter Semester
COOP*4000 [0.50] Co-op Work Term IV
(8-month work term in conjunction with COOP*5000)

Semester 7
CHEM*3440 [0.50] Analytical Chemistry III: Analytical Instrumentation
3.00 Chemistry or Biochemistry**
1.50 electives*

Semester 7 and 8
CHEM*3440 [0.50] Analytical Chemistry III: Analytical Instrumentation
3.00 Chemistry or Biochemistry**
1.50 electives*

*selection of electives is subject to the following:
1. At least 1.00 credits of Liberal Education electives are required. The list of Liberal Education electives for B.Sc. students can be found at: https://www.uoguelph.ca/bsc/
2. Approval of the Faculty Advisor must be obtained for the selection of courses not listed as restrictive electives.
3. Options for an "Area of Focus" or a minor are available. Subject areas include Biochemistry, Computing and Information Science, Earth Sciences, Environmental Sciences, Mathematical Sciences, and Physics. Please consult with your Faculty Advisor for more detail.

**3.00 credits from the 3000/4000 level as follows:
1. 1.50 comprising of (CHEM*3870 or CHEM*4880), (CHEM*4620 or CHEM*4630), (CHEM*4720 or CHEM*4730)
2. 1.50 chosen from CHEM*3870, CHEM*4010, CHEM*4400, BIOC*4520, BIOC*4540,BIOC*4580, CHEM*4620, CHEM*4630, CHEM*4720, CHEM*4730, CHEM*4740, CHEM*4880, CHEM*4900, CHEM*4910, MCB*4050, MCB*4080, TOX*4590
Note:
1. Some of these courses may have to be taken in Semester 6.
2. Some of these courses are offered only in alternate years, and some have additional prerequisites for which the student must plan ahead, with the assistance of the faculty advisor.

Credit Summary (20.00 Total Credits)
4.50 - First year science credits
7.25 - Required science courses semesters 3 – 8
3.00 - Restricted electives (#1 and 2 in restricted electives list)
1.25 – Approved science electives
1.00 - Liberal Education electives
3.00 - Free electives - any approved elective for B.Sc. students.

Of the total credits required, students are required to complete 16.00 credits in science of which 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Minor (Honours Program)
A minor in Chemistry consists of at least 5.00 credits including the following courses:
CHEM*1040 [0.50] General Chemistry I
CHEM*1050 [0.50] General Chemistry II
Of the additional 4.00 credits, students will select Chemistry courses (CHEM) at the 2000 level or above including a minimum of 1.00 credits at the 3000 or 4000 level. BIOC*2580 can be counted towards this specialization.

Chemistry (Co-op) (CHEM:C)
Department of Chemistry, College of Engineering and Physical Sciences
Program Requirements
The Co-op program in Chemistry is a four and a half year program including four work terms. Students must complete a Fall, Winter and Summer work term, and must follow the academic work schedule as outlined below (also found on the Co-operative Education website: https://www.recruitguelph.ca/cecs/). Please refer to the Co-operative Education program policy with respect to adjusting this schedule.
Chemistry Academic and Co-op Work Term Schedule

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Winter</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Academic Semester 1</td>
<td>Academic Semester 2</td>
<td>Off</td>
</tr>
<tr>
<td></td>
<td>COOP*1100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Academic Semester 3</td>
<td>COOP*1000 Work Term I</td>
<td>Academic Semester 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>COOP*2000 Work Term II</td>
<td>Academic Semester 5</td>
<td>COOP*3000 Work Term III</td>
</tr>
<tr>
<td>4</td>
<td>Academic Semester 6</td>
<td>COOP*4000 Work Term IV</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Academic Semester 8</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

To be eligible to continue in the Co-op program, students must meet a minimum 70% cumulative average requirement after second semester, as well as meet all work term requirements. Please refer to the Co-operative Education program policy with respect to work term performance grading, work term report grading and program completion requirements.

For additional program information students should consult with their Co-op Co-ordinator and Co-op Faculty Advisor, listed on the Co-operative Education web site.

Credit Summary (21.50 Total Credits)*
4.50 - First year science credits
7.25 - Required science courses semesters 3 – 8
3.00 - Restricted electives (#1 and 2 in restricted electives list)
1.25 – Approved science electives
1.00 - Liberal Education electives
3.00 - Free electives - any approved elective for B.Sc. students.
1.50 - Co-op Work Terms

Note: A minimum of three Co-op work terms including a Summer, Fall, and Winter are necessary to complete the Co-op requirement. *A fourth Co-op work term is optional and if completed, the total number of credits will equal 22.00.
The recommended program sequence is outlined below.

Major (Honours Program)
Semester 1 - Fall
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
CHEM*1040 [0.50] General Chemistry I
IPS*1500 [1.00] Integrated Mathematics and Physics I
0.50 Liberal Education electives

Students who are lacking one 4U /grade 12 course in Biology, Chemistry or Physics must take the equivalent introductory course in first semester. The required first-year science courses in that subject should be completed according to the revised schedule of studies available at: https://www.uoguelph.ca/bsc/revised_SS

Semester 2 - Winter
CHEM*1050 [0.50] General Chemistry II
COOP*1100 [0.00] Introduction to Co-operative Education
IPS*1510 [1.00] Integrated Mathematics and Physics II
MATH*1160 [0.50] Linear Algebra I
One of
  BIOL*1070 [0.50] Discovering Biodiversity
  BIOL*1080 [0.50] Biological Concepts of Health

Semester 3 - Fall
BIOC*2580 [0.50] Introduction to Biochemistry
CHEM*2060 [0.50] Structure and Bonding
CHEM*2400 [0.75] Analytical Chemistry I
MATH*2270 [0.50] Applied Differential Equations

Electives to a maximum of 2.75 total credits in this semester *

Winter Semester
COOP*1000 [0.50] Co-op Work Term I

Semester 4 - Summer
CHEM*2070 [0.50] Structure and Spectroscopy
CHEM*2700 [0.50] Organic Chemistry I
CHEM*3430 [0.50] Analytical Chemistry II: Instrumental Analysis
1.00 electives *

Semester 5 - Fall
CHEM*2820 [0.50] Thermodinamics and Kinetics
CHEM*3640 [0.50] Chemistry of the Elements I
CHEM*3750 [0.50] Organic Chemistry II
CHEM*3860 [0.50] Quantum Chemistry
0.50 electives *

Semester 6 - Winter
CHEM*3650 [0.50] Chemistry of the Elements II
CHEM*3760 [0.50] Organic Chemistry III
1.50 electives* or restricted electives**

Summer Semester
COOP*2000 [0.50] Co-op Work Term II

Fall Semester
COOP*3000 [0.50] Co-op Work Term III

Semester 7 - Winter
2.50 electives* or restricted electives**

Summer Semester
COOP*4000 [0.50] Co-op Work Term IV

Semester 8 - Fall
CHEM*3440 [0.50] Analytical Chemistry III: Analytical Instrumentation
2.00 electives* or restricted electives**

* selection of electives is subject to the following:
1. At least 1.00 credits of Liberal Education electives are required. The list of Liberal Education electives for B.Sc. students can be found at: https://www.uoguelph.ca/bsc/
2. Approval of the Faculty Advisor must be obtained for the selection of courses not listed as restrictive electives.
3. Options for an “Area of Focus” or a minor are available. Subject areas include Biochemistry, Computing and Information Science, Earth Sciences, Environmental Sciences, Mathematical Sciences, and Physics. Please consult with your Faculty Advisor for more details.

** 3.00 credits from the 3000/4000 level as follows:
1. 1.50 comprising of (CHEM*3870 or CHEM*4880), (CHEM*4620 or CHEM*4630), (CHEM*4720 or CHEM*4730)
2. 1.50 chosen from CHEM*3870, CHEM*4010, CHEM*4400, BIOC*4520, BIOC*4540, BIOC*4580, CHEM*4620, CHEM*4630, CHEM*4720, CHEM*4730, CHEM*4740, CHEM*4880, CHEM*4900, CHEM*4910, MCB*4050, MCB*4080, TOX*4590

Note:
Some of these courses are offered only in alternate years, and some have additional prerequisites for which the student must plan ahead, with the assistance of the faculty advisor.

Computing and Information Science (CIS)
School of Computer Science, College of Engineering and Physical Sciences
A knowledge of Computing is a complement to most areas of study. The Minor in Computing and Information Science is directed towards students who wish to supplement their studies in another area with some experience in Computing. Students interested in pursuing a Major in Computing can do so through the Bachelor of Computing Degree Program.

Minor (Honours Program)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIS*1300</td>
<td>Introduction to Computing</td>
<td>0.50</td>
</tr>
<tr>
<td>CIS*1910</td>
<td>Computer Organization and Design</td>
<td>0.50</td>
</tr>
<tr>
<td>CIS*2170</td>
<td>User Interface Design</td>
<td>0.50</td>
</tr>
<tr>
<td>CIS*2430</td>
<td>Object Oriented Programming</td>
<td>0.50</td>
</tr>
<tr>
<td>CIS*2500</td>
<td>Intermediate Programming</td>
<td>0.50</td>
</tr>
<tr>
<td>CIS*2520</td>
<td>Data Structures</td>
<td>0.50</td>
</tr>
<tr>
<td>CIS*2750</td>
<td>Software Systems Development and Integration</td>
<td>0.50</td>
</tr>
</tbody>
</table>

**Ecology (ECOL)**

**Department of Integrative Biology, College of Biological Science**

This minor provides a foundation in the principles and methods of ecology. It introduces the knowledge and skills necessary for work in conservation, environmental science, education, resource management, ecological consulting, or nature interpretation.

Minor (Honours Program)

A minimum of 5.00 credits is required to complete the minor, which must include:

- BIOL*2060 Ecology [0.50]
- BIOL*3010 Laboratory and Field Work in Ecology [0.50]
- BIOL*3050 Populations, Communities & Ecosystems [0.50]
- BIOL*4110 Ecological Methods [1.00]
- BIOL*4120 Evolutionary Ecology [0.50]

At least one of:

- ENVS*1210 Human Impact on the Environment [0.50]
- ENVS*1220 Introduction to the Biophysical Environment [0.50]

**Environmental Biology (ENVB)**

**School of Environmental Sciences, Ontario Agricultural College**

The Honours B.Sc. program in Environmental Biology combines a broad education in the life sciences with a more specialized understanding of the biological consequences of interactions between humans and the environment. This major prepares students for post-graduate work in environmental biology and related life sciences and provides a strong foundation for students wishing to pursue careers in teaching, government service or the private sector.

**Major (Honours Program)**

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. This major requires the completion of 20.00 credits. A minimum of 16.00 of these 20.00 must be science credits.

**Semester 1**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1070</td>
<td>Introduction to Biodiversity</td>
<td>0.50</td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>General Chemistry I</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*1100</td>
<td>Fundamentals of Environmental Sciences</td>
<td>0.50</td>
</tr>
<tr>
<td>MATH*1080</td>
<td>Elements of Calculus I</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*1080</td>
<td>Physics for Life Sciences</td>
<td>0.50</td>
</tr>
<tr>
<td>STAT*2040</td>
<td>Statistics I</td>
<td>0.50</td>
</tr>
</tbody>
</table>

**Semester 2**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1090</td>
<td>Introduction to Molecular and Cellular Biology</td>
<td>0.50</td>
</tr>
<tr>
<td>CHEM*1050</td>
<td>General Chemistry II</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*1070</td>
<td>Physics for Life Sciences II</td>
<td>0.50</td>
</tr>
<tr>
<td>CIS*1200</td>
<td>Introduction to Computing</td>
<td>0.50</td>
</tr>
<tr>
<td>CIS*1500</td>
<td>Introduction to Programming</td>
<td>0.50</td>
</tr>
<tr>
<td>MATH*1090</td>
<td>Elements of Calculus II</td>
<td>0.50</td>
</tr>
<tr>
<td>STAT*2040</td>
<td>Statistics I</td>
<td>0.50</td>
</tr>
</tbody>
</table>

**Semester 3**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*2580</td>
<td>Introduction to Biochemistry</td>
<td>0.50</td>
</tr>
<tr>
<td>STAT*2040</td>
<td>Statistics I (if not taken in semester 2)</td>
<td>0.50</td>
</tr>
<tr>
<td>TOX*2000</td>
<td>Principles of Toxicology</td>
<td>0.50</td>
</tr>
</tbody>
</table>

1.00 electives or restricted electives chosen from lists A, B, C and/or D or Liberal Education elective (or 1.50 if STAT*2040 was taken in semester 2).

**Semester 4**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*2060</td>
<td>Introduction to Biodiversity</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*2000</td>
<td>Fundamentals of Environmental Biology</td>
<td>0.50</td>
</tr>
<tr>
<td>MATH*2040</td>
<td>Foundations in Molecular Biology and Genetics</td>
<td>0.50</td>
</tr>
</tbody>
</table>

1.00 electives or restricted electives chosen from lists A, B, C and/or D.

**Semester 5**

2.50 electives or restricted electives chosen from lists A, B, C and/or D.

**Semester 6**

2.50 electives or restricted electives chosen from lists A, B, C and/or D.

**Semester 7**

ENVS*4001 Project in Environmental Sciences [0.50]
2.00 electives or restricted electives chosen from lists A, B, C and/or D

Students contemplating graduate studies are encouraged to take ENVS*4410 in semester 7 and ENVS*4420 or ENVS*4430 in 8.

**Semester 8**

ENVS*4000 Toxological Risk Assessment [0.50]

Project in Environmental Sciences [0.50]

Restricted Electives

1. A minimum of 1.00 credits of Liberal Education electives is required. The list of Liberal Education electives for B.Sc. students can be found at: https://www.uwaterloo.ca/bsc/.

2. Select a minimum of 6.00 credits from the following lists of restricted electives during Semesters 3-8. 2.00 credits must be completed from List A. 1.00 credit must be completed from List B. A minimum 3.00 credits must be completed from List C.

3. Students should note that some restricted electives are prerequisites for other restricted electives. Students should consult the most recent undergraduate calendar for specific requirements.

**List A - Environmental Processes**

Minimum of 2.00 credits from the following list:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*2400</td>
<td>Evolution</td>
<td>0.50</td>
</tr>
<tr>
<td>BIOL*3020</td>
<td>Population Genetics</td>
<td>0.50</td>
</tr>
<tr>
<td>BOT*2100</td>
<td>Life Strategies of Plants</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*2090</td>
<td>Vertebrate Structure and Function</td>
<td>0.50</td>
</tr>
<tr>
<td>GEG*1220</td>
<td>Human Impact on the Environment</td>
<td>0.50</td>
</tr>
<tr>
<td>GEG*1300</td>
<td>Introduction to the Biophysical Environment</td>
<td>0.50</td>
</tr>
</tbody>
</table>

**List B - Organismal Biology**

Minimum of 1.00 credits from the following list:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOT*2100</td>
<td>Life Strategies of Plants</td>
<td>0.50</td>
</tr>
<tr>
<td>BOT*3050</td>
<td>Plant Functional Ecology</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*2080</td>
<td>Introduction to Environmental Microbiology</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*3090</td>
<td>Insect Diversity and Biology</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*4230</td>
<td>Biology of Aquatic Insects</td>
<td>0.50</td>
</tr>
<tr>
<td>MICR*3090</td>
<td>Mycology</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*4070</td>
<td>Animal Behaviour</td>
<td>0.50</td>
</tr>
</tbody>
</table>

**List C**

Students in the Environmental Biology Major are required to take a minimum 3.00 restricted elective credits from any of the following lists:

**Forestry**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENVS*3230</td>
<td>Agroforestry Systems</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*3250</td>
<td>Forest Health and Disease</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*3270</td>
<td>Forest Biodiversity</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*4350</td>
<td>Forest Ecology</td>
<td>0.50</td>
</tr>
</tbody>
</table>

**Soil/Aquatic Systems**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENVS*3060</td>
<td>Groundwater</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*3080</td>
<td>Soil and Water Conservation</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*3310</td>
<td>Soil Biodiversity and Ecosystem Function</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*4090</td>
<td>Soil Management</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*4160</td>
<td>Soil and Nutrient Management</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*4320</td>
<td>Laboratory and Field Methods in Soil Biodiversity</td>
<td>1.00</td>
</tr>
<tr>
<td>ENVS*4390</td>
<td>Soil Variability and Land Evaluation</td>
<td>1.00</td>
</tr>
</tbody>
</table>

**Environmental Toxicology/Pollutants**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*4350</td>
<td>Limnology of Natural and Polluted Waters</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*3290</td>
<td>Waterborne Disease Ecology</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*4180</td>
<td>Insecticide Biological Activity and Resistance</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*4410</td>
<td>Biological Activity of Herbicides</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*4700</td>
<td>Environmental Organic Chemistry</td>
<td>0.50</td>
</tr>
</tbody>
</table>
Credit Summary (20.00 Total Credits)

4.00 - B.Sc. core credits
5.00 - Required credits for the Major (4.50 if STAT*2040 is taken in Semester 2)
6.00 - Restricted elective credits for the Major (some restricted electives do not count as science electives towards degree therefore additional science electives may be required)
1.00 - Approved Science electives (1.50 if STAT 2040 is taken in semester 2)
1.00 - Liberal Education electives (#1 in restricted elective list)
3.00 - Free electives - any approved elective for B.Sc. students.

Of the total credits required, students are required to complete 16.00 credits in science of which 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Environmental Geomatics (EG)

Department of Geography, Environment and Geomatics, College of Social and Applied Human Sciences

This program provides opportunities for study of the processes and properties of the biophysical environment and a core foundation in the analytical techniques (i.e. Geographical Information Science and Remote Sensing) used for their interpretation, analysis and presentation.

Graduates of the program will have unique specialty in the application of spatial technologies to the study and assessment of biophysical and Earth surface processes.

Major (Honours Program)

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult with a B.Sc. Faculty Advisor in the Department of Geography, Environment and Geomatics. All students are encouraged to consult with the advisor on a regular basis.

The major will require the completion of 20.00 credits as indicated below:

Semester 1

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1070</td>
<td>Discovering Biodiversity</td>
<td>0.50</td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>General Chemistry I</td>
<td>0.50</td>
</tr>
<tr>
<td>GEOG*1350</td>
<td>Earth: Hazards and Global Change</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*1080</td>
<td>Physics for Life Sciences</td>
<td>0.50</td>
</tr>
</tbody>
</table>

One of:

- MATH*1080 [0.50] Elements of Calculus I
- MATH*1200 [0.50] Calculus I

Students who are lacking one 4U grade 12 course in Biology, Chemistry or Physics must take the equivalent introductory course in first semester. The required first-year science courses in that subject should be completed according to the revised schedule of studies available at: https://www.uoguelph.ca/bse/revised_SS

Semester 2

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1090</td>
<td>Introduction to Molecular and Cellular Biology</td>
<td>0.50</td>
</tr>
<tr>
<td>CHEM*1050</td>
<td>General Chemistry II</td>
<td>0.50</td>
</tr>
<tr>
<td>GEOG*1300</td>
<td>Introduction to the Biophysical Environment</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*1070</td>
<td>Physics for Life Sciences II</td>
<td>0.50</td>
</tr>
</tbody>
</table>

0.50 Liberal Education electives* (GEOG*1220 is recommended)

Semester 3

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENVS*2240</td>
<td>Fundamentals of Environmental Geology</td>
<td>0.50</td>
</tr>
<tr>
<td>GEOG*2000</td>
<td>Geomorphology</td>
<td>0.50</td>
</tr>
</tbody>
</table>

GEOG*2420 [0.50] The Earth From Space
GEOG*2480 [0.50] Mapping and GIS
0.50 Liberal Education electives*

Semester 4

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOG*2110</td>
<td>Climate and the Biophysical Environment</td>
<td>0.50</td>
</tr>
<tr>
<td>GEOG*2210</td>
<td>Environment and Resources</td>
<td>0.50</td>
</tr>
<tr>
<td>STAT*2040</td>
<td>Statistics I</td>
<td>0.50</td>
</tr>
</tbody>
</table>

One of:

- CIS*1200 [0.50] Introduction to Computing
- CIS*1500 [0.50] Introduction to Programming
- MATH*1210 [0.50] Calculus II
- MATH*1090 [0.50] Elements of Calculus II

0.50 approved Science electives*

Semester 5

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOG*3000</td>
<td>Fluvial Processes</td>
<td>0.50</td>
</tr>
<tr>
<td>GEOG*3110</td>
<td>Biotic and Natural Resources</td>
<td>0.50</td>
</tr>
</tbody>
</table>

One of:

- GEOG*3020 [0.50] Global Environmental Change
- GEOG*3090 [0.50] Gender and Environment
- GEOG*3210 [0.50] Management of the Biophysical Environment

1.00 electives, at least 0.50 from approved Science electives*

Semester 6

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOG*3420</td>
<td>Remote Sensing of the Environment</td>
<td>0.50</td>
</tr>
<tr>
<td>GEOG*3480</td>
<td>GIS and Spatial Analysis</td>
<td>0.50</td>
</tr>
<tr>
<td>GEOG*3610</td>
<td>Environmental Hydrology</td>
<td>0.50</td>
</tr>
</tbody>
</table>

1.00 electives, at least 0.50 from approved Science electives*

Semester 7

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOG*4110</td>
<td>Environmental Systems Analysis</td>
<td>1.00</td>
</tr>
</tbody>
</table>

1.50 electives, at least 0.50 from approved Science electives* (GEOG*4690 is recommended)

Semester 8

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOG*4150</td>
<td>Catchment Processes</td>
<td>0.50</td>
</tr>
<tr>
<td>GEOG*4480</td>
<td>Applied Geomatics</td>
<td>1.00</td>
</tr>
</tbody>
</table>

1.00 Approved Science electives*

Credit Summary (20.00 Total Credits)

4.50 - First year science credits
8.50 - Required science courses semesters 3 – 8
1.00 - Required social science courses semesters 3 – 8
3.00 - Approved Science electives
1.00 - Liberal Education electives
2.00 - Free electives - any approved elective for B.Sc. students.

Of the total credits required, students are required to complete 16.00 credits in science of which 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Environmental Geomatics (Co-op) (EG:C)

Department of Geography, Environment and Geomatics, College of Social and Applied Human Sciences

This program provides opportunities for study of the processes and properties of the biophysical environment and a core foundation in the analytical techniques (i.e. Geographical Information Science and Remote Sensing) used for their interpretation, analysis and presentation.

Program Requirements

The Co-op program in Environmental Geomatics is a five year program, including four work terms. Students must complete a Fall, Winter and Summer work term and must follow the academic work schedule as outlined below (also found on the Co-operative Education website: https://www.recruitguelph.ca/cecs/). Please refer to the Co-operative Education program policy with respect to adjusting this schedule.

Environmental Geomatics Academic and Co-op Work Term Schedule

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Winter</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Academic Semester 1</td>
<td>Academic Semester 2</td>
<td>Off</td>
</tr>
<tr>
<td>2</td>
<td>Academic Semester 3</td>
<td>COOP*1100</td>
<td>Academic Semester 4</td>
</tr>
<tr>
<td>3</td>
<td>Academic Semester 5</td>
<td>COOP*2000 Work Term II</td>
<td>Academic Semester 6</td>
</tr>
<tr>
<td>4</td>
<td>COOP*3000 Work Term III</td>
<td>COOP*4000 Work Term IV</td>
<td>Off</td>
</tr>
<tr>
<td>5</td>
<td>Academic Semester 7</td>
<td>Academic Semester 8</td>
<td>N/A</td>
</tr>
</tbody>
</table>
To be eligible to continue in the Co-op program, students must meet a minimum 70% cumulative average requirement after second semester, as well as meet all work term requirements. Please refer to the Co-operative Education program policy with respect to work term performance grading, work term report grading and program completion requirements.

For additional program information students should consult with their Co-op Co-ordinator and Co-op Faculty Advisor, listed on the Co-operative Education web site.

Credit Summary (21.50 Total Credits)*

4.50 - First year science credits
9.00 - Required science courses semesters 3 – 8
1.00 - Required social science courses semesters 3 – 8
2.50 - Approved Science electives
1.00 - Liberal Education electives
2.00 - Free electives - any approved elective for B.Sc. students.
1.50 - Co-op Work Terms

Of the total credits required, students are required to complete 16.00 credits in science of which 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 level and 4000 level.

Note: A minimum of three Co-op work terms including a Summer, Fall, and Winter are necessary to complete the Co-op requirement. *A fourth Co-op work term is optional and if completed, the total number of credits will equal 22.00.

The recommended program sequence is outlined below.

Major (Honours Program)

Semester 1 - Fall
BIO*1070 [0.50] Discovering Biodiversity
CHEM*1040 [0.50] General Chemistry I
GEOG*1350 [0.50] Earth: Hazards and Global Change
PHYS*1080 [0.50] Physics for Life Sciences
One of:
MATH*1080 [0.50] Elements of Calculus I
MATH*1200 [0.50] Calculus I

Students who are lacking one 4U /grade 12 course in Biology, Chemistry or Physics must take the equivalent introductory course in first semester. The required first-year science courses in that subject should be completed according to the revised schedule of studies available at: https://www.uoguelph.ca/bsc/revised_SS

Semester 2 - Winter
BIO*1090 [0.50] Introduction to Molecular and Cellular Biology
CHEM*1050 [0.50] General Chemistry II
GEOG*1300 [0.50] Introduction to the Biophysical Environment
PHYS*1070 [0.50] Physics for Life Sciences II
0.50 Liberal Education electives

Semester 3 - Fall
COOP*1100 [0.00] Introduction to Co-operative Education
ENVS*2240 [0.50] Fundamentals of Environmental Geology
GEOG*2420 [0.50] The Earth from Space
GEOG*2480 [0.50] Mapping and GIS
STAT*2040 [0.50] Statistics I

Semester 4 - Winter
GEOG*2110 [0.50] Climate and the Biophysical Environment
GEOG*2210 [0.50] Environment and Resources
GEOG*3420 [0.50] Remote Sensing of the Environment
One of:
CIS*1200 [0.50] Introduction to Computing
CIS*1500 [0.50] Introduction to Programming
MATH*1210 [0.50] Calculus II
MATH*1090 [0.50] Elements of Calculus II
0.50 approved Science electives

Summer Semester
COOP*1000 [0.50] Co-op Work Term I

Semester 5 - Fall
GEOG*3000 [0.50] Fluvial Processes
GEOG*3110 [0.50] Biotic and Natural Resources
GEOG*3480 [0.50] GIS and Spatial Analysis
0.50 approved Science electives
0.50 Liberal Education electives

Winter Semester
COOP*2000 [0.50] Co-op Work Term II

Semester 6 - Summer
GEOG*3610 [0.50] Environmental Hydrology
GEOG*4990 [0.50] Independent Study in Geography
One of:
GEOG*3200 [0.50] Management of the Biophysical Environment
GEOG*3210 [0.50] Global Environmental Change

Semester 7 - Fall
GEOG*4110 [1.00] Environmental Systems Analysis
1.50 electives, at least 1.00 from approved Science electives

Semester 8 - Winter
GEOG*4150 [0.50] Catchment Processes
GEOG*4480 [1.00] Applied Geomatics
1.00 electives, at least 0.50 from approved Science electives

Food Science (FOOD)

Department of Food Science, Ontario Agricultural College

Major (Honours Program)

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor.

Semester 1 - Fall
BIOI*1090 [0.50] Introduction to Molecular and Cellular Biology
CHEM*1050 [0.50] General Chemistry I
MATH*1080 [0.50] Elements of Calculus I
PHYS*1080 [0.50] Physics for Life Sciences
0.50 Liberal Education electives

Note: Note: CIS*1200, rather than an Liberal Education credit is recommended for those needing to improve their computer skills.

Semester 2 - Winter
BIOI*1080 [0.50] Biological Concepts of Health
CHEM*1050 [0.50] General Chemistry II
MATH*1090 [0.50] Elements of Calculus II
PHYS*1070 [0.50] Physics for Life Sciences II
0.50 Liberal Education electives

Semester 3 - Fall
BIOC*2580 [0.50] Introduction to Biochemistry
CHEM*2880 [0.50] Physical Chemistry
FOOD*2150 [0.50] Introduction to Nutritional and Food Science
MICR*2420 [0.50] Introduction to Microbiology
0.50 electives

Semester 4 - Winter
FOOD*2100 [0.50] Communication in Food Science
FOOD*2620 [0.50] Food Engineering Principles
NUTR*3210 [0.50] Fundamentals of Nutrition
STAT*2040 [0.50] Statistics I
0.50 electives

Semester 5 - Fall
FOOD*3030 [0.50] Food Chemistry I
FOOD*3160 [0.75] Food Processing I
FOOD*3230 [0.75] Food Microbiology
0.50 electives

Semester 6 - Winter
FOOD*3040 [0.50] Food Chemistry II
FOOD*3170 [0.50] Food Processing II
FOOD*3260 [0.50] Industrial Microbiology
FOOD*3700 [0.50] Sensory Evaluation of Foods
0.50 electives

Semester 7 - Fall
FOOD*4190 [0.50] Advanced Food Analysis
FOOD*4260 [0.50] Food Product Development I
1.50 electives

Semester 8 - Winter
FOOD*4270 [0.50] Food Product Development II
2.00 electives

Notes:
1. ENGL*1200 is recommended for those students needing to improve their English grammar.
2. FOOD*2150 could be replaced by FOOD*2100 with permission of department advisor.
3. Of the 6.50 electives credits:

2019-2020 Undergraduate Calendar

Last Revision: July 4, 2019
a. A least 2.00 credits must be Liberal Education electives.
b. At least 2.00 must be from list of Restricted electives.
c. At least 1.00 must be from additional Science electives (1.50 if MCS*3010 is chosen as a Restricted Elective)

**Restricted Electives:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOOD*4070</td>
<td>Food Packaging</td>
</tr>
<tr>
<td>FOOD*4090</td>
<td>Functional Foods and Nutraceuticals</td>
</tr>
<tr>
<td>FOOD*4110</td>
<td>Meat and Poultry Processing</td>
</tr>
<tr>
<td>FOOD*4220</td>
<td>Topics in Food Science</td>
</tr>
<tr>
<td>FOOD*4230</td>
<td>Research in Food Science</td>
</tr>
<tr>
<td>FOOD*4310</td>
<td>Food Safety Management Systems</td>
</tr>
<tr>
<td>FOOD*4400</td>
<td>Dairy Processing</td>
</tr>
<tr>
<td>FOOD*4520</td>
<td>Utilization of Cereal Grains for Human Food</td>
</tr>
<tr>
<td>MCS*3010</td>
<td>Quality Management</td>
</tr>
<tr>
<td>POPM*4040</td>
<td>Epidemiology of Food-borne Diseases</td>
</tr>
</tbody>
</table>

**Credit Summary (20.00 Total Credits)**

4.00 - 1st year science required
9.50 - Required in semesters 3-8
2.00 - Restricted electives
2.00 - Liberal Education electives
1.00 or 1.50 - Additional Science electives (See Note 3 above)
1.00 or 1.50 - Free electives (See Note 3 above)

Students not in the Food Science Major who are seeking further study in Food Science are encouraged to consider the Certificate in Food Science. See Special Study Opportunities, Chapter XI of the Calendar.

### Food Science (Co-op) (FOOD:C)

**Department of Food Science, Ontario Agricultural College**

**Program Requirements**

The Co-op program in Food Science is a five year program, including four work terms. Students must complete a Fall, Winter and Summer work term and must follow the academic work schedule as outlined below (also found on the Co-operative Education website: https://www.recruitguelph.ca/cecs/). Please refer to the Co-operative Education program policy with respect to adjusting this schedule.

Food Science Academic and Co-op Work Term Schedule

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Winter</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Academic Semester 1</td>
<td>Academic Semester 2</td>
<td>Off</td>
</tr>
<tr>
<td>2</td>
<td>Academic Semester 3</td>
<td>Academic Semester 4</td>
<td>COOP*1000 Work Term I</td>
</tr>
<tr>
<td>3</td>
<td>Academic Semester 5</td>
<td>Academic Semester 6</td>
<td>COOP*2000 Work Term II</td>
</tr>
<tr>
<td>4</td>
<td>COOP*3000 Work Term III</td>
<td>COOP*4000 Work Term IV</td>
<td>Off</td>
</tr>
<tr>
<td>5</td>
<td>Academic Semester 7</td>
<td>Academic Semester 8</td>
<td>N/A</td>
</tr>
</tbody>
</table>

To be eligible to continue in the Co-op program, students must meet a minimum 70% cumulative average requirement after second semester, as well as meet all work term requirements. Please refer to the Co-operative Education program policy with respect to work term performance grading, work term report grading and program completion requirements.

For additional program information students should consult with their Co-op Co-ordinator and Co-op Faculty Advisor, listed on the Co-operative Education web site.

**Credit Summary (21.50 Total Credits)**

4.00 - First year science required
9.50 - Required in semesters 3-8
2.00 - Restricted electives
2.00 - Liberal Education electives
1.00 or 1.50 - Additional Science electives (1.50 if MCS*3010 is chosen as a Restricted Elective)
1.00 or 1.50 - Free electives (1.00 if MCS*3010 is chosen as a Restricted Elective)
1.50 - Co-op Work Terms

**Note:** A minimum of three Co-op work terms including a Summer, Fall, and Winter are necessary to complete the Co-op requirement. *A fourth Co-op work term is optional and if completed, the total number of credits will equal 22.00.*

Students not in the Food Science Major who are seeking further study in Food Science are encouraged to consider the Certificate in Food Science. See Special Study Opportunities, Chapter XI of the Calendar.

The recommended program sequence is outlined below.

**Major (Honours Program)**

**Semester 1 - Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1090</td>
<td>Introduction to Molecular and Cellular Biology</td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>General Chemistry I</td>
</tr>
<tr>
<td>MATH*1080</td>
<td>Elements of Calculus I</td>
</tr>
<tr>
<td>PHYS*1080</td>
<td>Physics for Life Sciences</td>
</tr>
</tbody>
</table>

0.50 Liberal Education electives

Note: CIS*1200, rather than an Liberal Education credit is recommended for those needing to improve their computer skills.

**Semester 2 - Winter**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1080</td>
<td>Biological Concepts of Health</td>
</tr>
<tr>
<td>CHEM*1050</td>
<td>General Chemistry II</td>
</tr>
<tr>
<td>MATH*1090</td>
<td>Elements of Calculus II</td>
</tr>
<tr>
<td>PHYS*1070</td>
<td>Physics for Life Sciences</td>
</tr>
</tbody>
</table>

0.50 Liberal Education electives

**Summer Semester**

Off

**Semester 3 - Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*2580</td>
<td>Introduction to Biochemistry</td>
</tr>
<tr>
<td>CHEM*2880</td>
<td>Physical Chemistry</td>
</tr>
<tr>
<td>COOP*1100</td>
<td>Introduction to Co-operative Education</td>
</tr>
<tr>
<td>FOOD*2150</td>
<td>Introduction to Nutritional and Food Science</td>
</tr>
<tr>
<td>MIRC*2420</td>
<td>Introduction to Microbiology</td>
</tr>
</tbody>
</table>

0.50 electives

**Semester 4 - Winter**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOOD*2100</td>
<td>Communication in Food Science</td>
</tr>
<tr>
<td>FOOD*2620</td>
<td>Food Engineering Principles</td>
</tr>
<tr>
<td>NUTR*3210</td>
<td>Fundamentals of Nutrition</td>
</tr>
<tr>
<td>STAT*3040</td>
<td>Statistics I</td>
</tr>
</tbody>
</table>

0.50 electives

**Summer Semester**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*1000</td>
<td>Co-op Work Term I</td>
</tr>
</tbody>
</table>

**Semester 5 - Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOOD*3030</td>
<td>Food Chemistry I</td>
</tr>
<tr>
<td>FOOD*3160</td>
<td>Food Processing I</td>
</tr>
<tr>
<td>FOOD*3230</td>
<td>Food Microbiology</td>
</tr>
</tbody>
</table>

0.50 electives

**Semester 6 - Winter**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOOD*3040</td>
<td>Food Chemistry II</td>
</tr>
<tr>
<td>FOOD*3170</td>
<td>Food Processing II</td>
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<td>FOOD*3260</td>
<td>Industrial Microbiology</td>
</tr>
<tr>
<td>FOOD*3700</td>
<td>Sensory Evaluation of Foods</td>
</tr>
</tbody>
</table>

0.50 electives

**Summer Semester**

Optional

**Fall Semester**

<table>
<thead>
<tr>
<th>Course Code</th>
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</thead>
<tbody>
<tr>
<td>COOP*2000</td>
<td>Co-op Work Term II</td>
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</table>

**Winter Semester**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>COOP*3000</td>
<td>Co-op Work Term III</td>
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</table>

**Semester 7 - Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOOD*4190</td>
<td>Advanced Food Analysis</td>
</tr>
<tr>
<td>FOOD*4260</td>
<td>Food Product Development I</td>
</tr>
</tbody>
</table>

1.50 electives

**Semester 8 - Winter**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOOD*4270</td>
<td>Food Product Development II</td>
</tr>
</tbody>
</table>

2.00 electives

**Notes:**

1. ENGL*1200 is recommended for those students needing to improve their English grammar.
2. FOOD*2150 could be replaced by FOOD*4010 with permission of department advisor.

**Restricted Electives**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOOD*4070</td>
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<tr>
<td>FOOD*4220</td>
<td>Topics in Food Science</td>
</tr>
<tr>
<td>FOOD*4230</td>
<td>Research in Food Science</td>
</tr>
<tr>
<td>FOOD*4310</td>
<td>Food Safety Management Systems</td>
</tr>
<tr>
<td>FOOD*4400</td>
<td>Dairy Processing</td>
</tr>
<tr>
<td>FOOD*4520</td>
<td>Utilization of Cereal Grains for Human Food</td>
</tr>
</tbody>
</table>
MCS*3010 [0.50] Quality Management
POPM*4040 [0.50] Epidemiology of Food-borne Diseases

Geographic Information Systems (GIS) and Environmental Analysis

Department of Geography, Environment and Geomatics, College of Social and Applied Human Sciences

Minor (Honours Program)

A minimum of 5.00 credits is required, including the following 3.50 credits:

- GEOG*1300 [0.50] Introduction to the Biophysical Environment
- GEOG*2110 [0.50] Climate and the Biophysical Environment
- GEOG*2210 [0.50] Environment and Resources
- GEOG*3110 [0.50] Biotic and Natural Resources
- GEOG*3210 [0.50] Management of the Biophysical Environment
- GEOG*4480 [1.00] Applied Geomatics
- GEOG*4210 [0.50] Environmental Governance

And at least 1.50 credits from:

- GEOG*2480 [0.50] Mapping and GIS
- GEOG*3480 [0.50] GIS and Spatial Analysis
- GEOG*4200 [1.00] Environmental Systems Analysis

Human Kinetics (HK)

Department of Human Health and Nutritional Sciences, College of Biological Science

Human Kinetics is concerned with understanding capacities for, and limits of, human movement at different ages and with the role of physical activity in human health. Through the use of electives, students may structure a program emphasizing biomechanics and ergonomics, human population biology or nutrition, exercise and metabolism. If lacking the fundamentals of word processing, spreadsheet use and data management, the student should select CIS*1200 as early in the program as possible.

Major (Honours Program)

B.Sc. students who were not admitted directly into the Human Kinetics major from high school and subsequently wish to transfer to the specialization must apply directly to the Department of Human Health and Nutritional Science by the last day of classes in the winter semester.

To be eligible after first year, applicants must have successfully completed 4.0 science credits in a B.Sc. specialization with an average of 70% or better in BIOL*1070, BIOL*1080 and BIOL*1090. For students with a 65-69.9% average in these three courses, admission to the major will be competitive based on available spaces.

Students wishing to transfer after second year or third year must have an average of 70% or better in their last two semesters (total of best 4.00 science credits). For students with a 65-69.9% average in these three courses, admission to the major will be competitive based on available spaces.

All decisions regarding transfers will be made by the end of June.

To complete the major, a minimum of 20.00 credits are required.

Semester 1

- BIOL*1070 [0.50] Discovering Biodiversity
- CHEM*1040 [0.50] General Chemistry I
- MATH*1080 [0.50] Elements of Calculus I
- PHYS*1080 [0.50] Physics for Life Sciences

0.50 Liberal Education electives

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at https://www.uoguelph.ca/bsc/revised_SS

Semester 2

- BIOL*1070 [0.50] Discovering Biodiversity
- CHEM*1000 [0.50] Introduction to Molecular and Cellular Biology
- CHEM*1050 [0.50] General Chemistry II
- PHYS*1070 [0.50] Physics for Life Sciences

0.50 Liberal Education electives

Semester 3

- BIOC*2580 [0.50] Introduction to Biochemistry
- HK*2270 [0.50] Principles of Human Biomechanics
- MBG*2400 [0.50] Foundations in Molecular Biology and Genetics
- STAT*2400 [0.50] Statistics I

0.50 Liberal Education electives

Semester 4

- HK*2810 [0.50] Human Physiology I - Concepts and Principles
- MCB*2050 [0.50] Molecular Biology of the Cell
- NUTR*3210 [0.50] Fundamentals of Nutrition

0.50 electives

0.50 Liberal Education electives

Semester 5

- HK*3600 [0.75] Applied Human Kinetics I
- HK*3810 [0.75] Human Physiology II - Integrated Systems
- NUTR*3360 [0.50] Lifestyle Genomics

One of

- HK*3401 [0.75] Human Anatomy: Dissection
- HK*3501 [0.75] Human Anatomy: Prosection

Semester 6

- BIOC*3560 [0.50] Structure and Function in Biochemistry
- HK*3100 [0.50] Neuromuscular Physiology
- HK*4600 [0.75] Applied Human Kinetics II

One of

- HK*3502 [0.75] Human Anatomy: Dissection (if registered in HK*3401 in semester 5)
- HK*3502 [0.75] Human Anatomy (if registered in HK*3501 in semester 5)

Semester 7

- HK*4550 [0.50] Human Cardio-respiratory Physiology
- NUTR*4210 [0.50] Nutrition, Exercise and Energy Metabolism

1.50 electives or restricted electives

Semester 8

2.25 electives or restricted electives

Restricted Electives

1. A minimum of 2.00 credits of Liberal Education electives is required. The list of Liberal Education electives for B.Sc. students can be found at: https://www.uoguelph.ca/bsc/

2. A minimum of 1.00 credits of restricted electives are required which must be selected from HK*4XXX, NUTR*4XXX (must be an approved B.Sc. Science Elective).

Credit Summary (20.00 Total Credits)

4.00 - First year science core
9.75 - Required science courses semesters 3 - 8
1.00 - Restricted elective (# 2 in restricted elective list)
1.25 - Approved Science electives
2.00 - Liberal Education electives (#1 in restricted elective list)
2.00 - Free electives - any approved electives for B.Sc. students.

Of the total credits required, students are required to complete 16.00 credits in science of which a minimum of 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Marine and Freshwater Biology (MFB)

Department of Integrative Biology, College of Biological Science

The Marine and Freshwater Biology major capitalizes on Guelph’s recognized excellence in aquatic research and provides a broad perspective on aquatic environments based on the physical as well as the biological sciences. In this major, students will build upon the specialized courses in ecology, evolution, genetics, and physiology of aquatic biota as they study freshwater and marine environments and work with aquatic organisms experimentally in the field and in the lab. They will have the opportunity to perform independent research projects under a variety of field and laboratory conditions to enhance their learning experience. The major prepares students for post-graduate work in the aquatic sciences, and provides a sound scientific background for students wishing to pursue careers in academia, government service, private sector (e.g., NGOs, fisheries, aquaculture, biotechnology, consulting), conservation, education and research.

Major (Honours Program)

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. A minimum total of 20.00 credits is required to complete the major.

Semester 1

- BIOL*1070 [0.50] Discovering Biodiversity
- CHEM*1040 [0.50] General Chemistry I
- MATH*1080 [0.50] Elements of Calculus I
- PHYS*1080 [0.50] Physics for Life Sciences

0.50 Liberal Education electives

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at https://www.uoguelph.ca/bsc/revised_SS

Semester 2

- BIOL*1070 [0.50] Discovering Biodiversity
- CHEM*1040 [0.50] General Chemistry I
- MATH*1080 [0.50] Elements of Calculus I
- PHYS*1080 [0.50] Physics for Life Sciences

0.50 Liberal Education electives

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at https://www.uoguelph.ca/bsc/revised_SS

Semester 3

- BIOL*1070 [0.50] Discovering Biodiversity
- CHEM*1040 [0.50] General Chemistry I
- MATH*1080 [0.50] Elements of Calculus I
- PHYS*1080 [0.50] Physics for Life Sciences

0.50 Liberal Education electives

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at https://www.uoguelph.ca/bsc/revised_SS

Semester 4

- BIOL*1070 [0.50] Discovering Biodiversity
- CHEM*1040 [0.50] General Chemistry I
- MATH*1080 [0.50] Elements of Calculus I
- PHYS*1080 [0.50] Physics for Life Sciences

0.50 Liberal Education electives

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at https://www.uoguelph.ca/bsc/revised_SS

Semester 5

- BIOL*1070 [0.50] Discovering Biodiversity
- CHEM*1040 [0.50] General Chemistry I
- MATH*1080 [0.50] Elements of Calculus I
- PHYS*1080 [0.50] Physics for Life Sciences

0.50 Liberal Education electives

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at https://www.uoguelph.ca/bsc/revised_SS

Semester 6

- BIOL*1070 [0.50] Discovering Biodiversity
- CHEM*1040 [0.50] General Chemistry I
- MATH*1080 [0.50] Elements of Calculus I
- PHYS*1080 [0.50] Physics for Life Sciences

0.50 Liberal Education electives

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at https://www.uoguelph.ca/bsc/revised_SS

Semester 7

- BIOL*1070 [0.50] Discovering Biodiversity
- CHEM*1040 [0.50] General Chemistry I
- MATH*1080 [0.50] Elements of Calculus I
- PHYS*1080 [0.50] Physics for Life Sciences

0.50 Liberal Education electives

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at https://www.uoguelph.ca/bsc/revised_SS
### Credit Summary (20.00 Total Credits)

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Winter</th>
<th>Summer</th>
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<tbody>
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<td>5</td>
<td>COOP*5000 Work Term V</td>
<td>Academic Semester 8</td>
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</tr>
</tbody>
</table>

To be eligible to continue in the Co-op program, students must meet a minimum 70\% cumulative average requirement after second semester, as well as meet all work term requirements. Please refer to the Co-operative Education program policy with respect to work term performance grading, work term report grading and program completion requirements.

For additional program information students should consult with their Co-op Co-ordinator and Co-op Faculty Advisor, listed on the Co-operative Education web site.

### Credit Summary (22.00 Total Credits)*

<table>
<thead>
<tr>
<th>Semester</th>
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<td>Academic Semester 8</td>
<td>N/A</td>
</tr>
</tbody>
</table>

* CIS 1200 is recommended for those needing to improve their computer skills

## Marine and Freshwater Biology (Co-op) (MFB:C)

### Department of Integrative Biology, College of Biological Science

The Marine and Freshwater Biology major capitalizes on Guelph's recognized excellence in aquatic research and provides a broad perspective on aquatic environments based on the physical as well as biological sciences. In this major, you will build upon core courses in ecology, evolution, genetics, and physiology of aquatic biota as you study freshwater and marine environments and work with aquatic organisms experimentally in the field and in the lab. You will have the opportunity to perform independent research projects under a variety of field and laboratory conditions to enhance your learning experience.

Work placements enable students to gain knowledge, skills and values appropriate for work with individuals and groups in a variety of settings. The major prepares students for post-graduate work in the aquatic sciences, and provides a sound scientific background for students wishing to pursue careers in academia, government service, private sector (e.g., NGOs, fisheries, aquaculture, biotechnology, consulting), conservation, education and research.

### Program Requirements

The Co-op program in Marine and Freshwater Biology is a five year program, including five work terms. Students must complete a Fall, Winter and Summer work term and must follow the academic work schedule as outlined below (also found on the Co-operative Education website: https://www.recruitguelph.ca/ccss). Please refer to the Co-operative Education program policy with respect to adjusting this schedule.

### Marine and Freshwater Biology Academic and Co-op Work Term Schedule

<table>
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<th>Year</th>
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<th>Summer</th>
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<td>Academic Semester 3 COOP*1100</td>
<td>Academic Semester 4</td>
<td>COOP*1000 Work Term I</td>
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<td>Academic Semester 5</td>
<td>COOP*2000 Work Term II</td>
<td>COOP*3000 Work Term III</td>
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<td>Academic Semester 6</td>
<td>Academic Semester 7</td>
<td>COOP*4000 Work Term IV</td>
</tr>
</tbody>
</table>

* CIS 1200 is recommended for those needing to improve their computer skills

## Major (Honours Program)

### Semester 1 - Fall

- BIOL*1070 [0.50] Discovering Biodiversity
- CHEM*1040 [0.50] General Chemistry I
- MATH*1080 [0.50] Elements of Calculus I
- PHYS*1080 [0.50] Physics for Life Sciences
- 0.50 Liberal Education electives

### Semester 2 - Winter

- BIOL*1080 [0.50] Biological Concepts of Health
- BIOL*2040 [0.50] Evolution
- COOP*1100 [0.00] Introduction to Co-operative Education
- ZOO*2090 [0.50] Vertebrate Structure and Function
- 1.00 electives or restricted electives*

### Semester 4 - Winter

- BIOL*2060 [0.50] Ecology
- BIOL*2040 [0.50] Evolution
- COOP*1100 [0.00] Introduction to Co-operative Education
- ZOO*2090 [0.50] Vertebrate Structure and Function
- 1.00 electives or restricted electives*

### Summer Semester

- COOP*1000 [0.50] Co-op Work Term I

### Semester 5 - Fall

- BIOL*3450 [0.50] Introduction to Aquatic Environments
- ZOO*3600 [0.50] Comparative Animal Physiology I
- ZOO*3610 [0.25] Lab Studies in Animal Physiology I
- ZOO*3700 [0.50] Integrative Biology of Invertebrates
- Electives or restricted electives to a maximum of 2.75 total credits in this semester.

### Winter Semester

- COOP*2000 [0.50] Co-op Work Term II

### Summer Semester

- COOP*3000 [0.50] Co-op Work Term III

### Semester 6 - Fall

- BIOL*4350 [0.50] Limnology of Natural and Polluted Waters
- IBIO*4600 [1.00] Integrative Marine and Freshwater Research
- 1.00 electives or restricted electives

### Semester 7 - Winter

- BIOL*3060 [0.50] Populations, Communities & Ecosystems
- ZOO*3050 [0.50] Developmental Biology
Comparative Animal Physiology II
CIS*3530 [0.50] Lab Studies in Animal Physiology II

Electives or restricted electives to a maximum of 2.75 total credits in this semester.

Summer Semester
CIS*4000 [0.50] Co-op Work Term IV

Fall Semester
CIS*4000 [0.50] Co-op Work Term V

Semester 8 - Winter
BIOL*4010 [0.50] Adapational Physiology
ZOOG*4330 [0.50] Biology of Fishes
ZOOG*4570 [0.50] Marine Ecological Processes

1.00 electives or restricted electives

* CIS*1200 is recommended for those needing to improve their computer skills

Electives

A minimum of 1.00 credits of Liberal Education electives is required. The list of Liberal Education electives for B.Sc. students can be found at: https://www.uoguelph.ca/bsc/eductl

Mathematical Science (MSCI)

Department of Mathematics & Statistics, College of Engineering and Physical Sciences

Major (Honours Program)

Knowledge of Mathematics and Statistics is crucial for understanding our world. This unique program provides a core of both mathematics and statistics with a choice of a Mathematics stream or a Statistics stream. This major also requires the completion of an area of emphasis as listed. Students are encouraged to speak with a Program Counsellor when choosing courses for the selected stream and area of emphasis.

Students may enter this major in Semester I or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. A total of 20.00 credits is required to complete the Major which includes at least 10.00 credits in Mathematics & Statistics, 0.50 credits in Computing and Information Science, and an additional 2.50 credits in an area of emphasis.

Note: Students majoring in Mathematical Science cannot minor in Mathematics or Statistics.

Semester 1

CHEM*1040 [0.50] General Chemistry I
MATH*1160 [0.50] Linear Algebra I

One of ***

BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1080 [0.50] Biological Concepts of Health
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology

1.00 electives from: IPS*1510, or (MATH*1210, PHYS*1080) or (MATH*1200, PHYS*1080)

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at: https://www.uoguelph.ca/bsc/revised_MS

Semester 2

CHEM*1050 [0.50] General Chemistry II
STAT*2040 [0.50] Statistics I

One of ***

BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1080 [0.50] Biological Concepts of Health
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology

1.00 electives from: IPS*1510, or (PHYS*1010 and 0.50 credits from: MATH*1090, MATH*1210)***

Semester 3

MATH*2200 [0.50] Advanced Calculus I
STAT*3100 [0.50] Introductory Mathematical Statistics I

One of:

CIS*1300 [0.50] Programming
CIS*1500 [0.50] Introduction to Programming

1.00 electives or restricted electives

Semester 4

MATH*2130 [0.50] Numerical Methods
STAT*2050 [0.50] Statistics II

1.00 electives or restricted electives

Semester 5

2.50 electives or restricted electives

Semester 6

2.50 electives or restricted electives

Semester 7

2.50 electives or restricted electives

Semester 8

MATH*4440 [0.50] Case Studies in Mathematics and Statistics

2.00 electives or restricted electives

* Students entering the major in first year are strongly advised to take IPS*1500 or (MATH*1200, PHYS*1080). Students declaring the Energy and Mass Transfer, the Electricity and Systems, or the Signal Processing Area of Emphasis should take (MATH*1200, PHYS*1080).

** Students entering the major in first year are strongly advised to take IPS*1510 or (MATH*1210, PHYS*1010). Students declaring the Energy and Mass Transfer, the Electricity and Systems, or the Signal Processing Area of Emphasis should take (MATH*1210, PHYS*1010).

*** BIOL*1070 and BIOL*1090 are recommended if taking either the BINF or the BBM Area of Emphasis

RESTRICTED ELECTIVES

1. A minimum of 1.00 credits of Liberal Education electives is required. The list of Liberal Education electives for B.Sc. students can be found at: https://www.uoguelph.ca/bsc/eductl

2. 5.50 credits from either the Mathematics Stream or the Statistics Stream as follows:

3. 2.50 credits from an Area of Emphasis

Mathematics Stream:

MATH*2000 [0.50] Proofs, Sets, and Numbers
MATH*2210 [0.50] Advanced Calculus II
MATH*2270 [0.50] Applied Differential Equations
MATH*3160 [0.50] Linear Algebra II
MATH*3200 [0.50] Real Analysis

3.00 additional credits in MATH or STAT at the 3000 level or above of which at least 1.50 credits must be MATH at the 4000 level

Statistics Stream:

STAT*3110 [0.50] Introductory Mathematical Statistics II
STAT*3240 [0.50] Applied Regression Analysis

0.50 additional credits in MATH at 2000 level or above

1.00 additional credits in MATH or STAT at the 2000 level or above

3.00 additional credits in MATH or STAT at the 3000 level or above of which at least 1.50 credits must be STAT at the 4000 level

AREAS OF EMPHASIS

Students are required to complete one of the following Areas of Emphasis. Each Area of Emphasis is 2.50 credits from a single field of study.

BIOMATHEMATICAL OR BIOSTATISTICAL MODELLING (BBM)

The following credits must be taken:

BIOL*2400 [0.50] Evolution
BIOL*3020 [0.50] Population Genetics
BIOL*3040 [0.50] Methods in Evolutionary Biology
BIOL*3300 [0.50] Applied Bioinformatics
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics

BIOMATHEMATICAL OR BIOSTATISTICAL MODELLING (BBM)

The following credits must be taken:

BIOL*2060 [0.50] Ecology
BIOL*2400 [0.50] Evolution
BIOL*3060 [0.50] Populations, Communities & Ecosystems
BIOL*3130 [0.50] Conservation Biology
BIOL*4150 [0.50] Wildlife Conservation and Management

COMPUTER SCIENCE (CS)

The following credits must be taken:

CIS*2430 [0.50] Object Oriented Programming
CIS*2500 [0.50] Intermediate Programming
CIS*2520 [0.50] Data Structures

at least 1.00 credits from:

CIS*3110 [0.50] Operating Systems I
CIS*3190 [0.50] Software for Legacy Systems
CIS*3490 [0.50] The Analysis and Design of Computer Algorithms
CIS*3530 [0.50] Data Base Systems and Concepts

Note: CIS*2750 is recommended in addition to the Area of Emphasis requirements for students interested in Computer Science

ECONOMICS (ECON)

The following credits must be taken:

ECON*1050 [0.50] Introductory Microeconomics
ECON*1100 [0.50] Introductory Macroeconomics
ECON*2310 [0.50] Intermediate Microeconomics

at least 1.00 credits from:

ECON*3100 [0.50] Game Theory
ECON*3710 [0.50] Advanced Microeconomics
ECON*4710 [0.50] Advanced Topics in Microeconomics

Note: ECON*1050 and ECON*1100 are approved Liberal Education electives for B.Sc. students

ENERGY AND MASS TRANSFER (EMT)

The following credits must be taken:

ENG*1210 [0.50] Engineering Mechanics I
**Electrical and Computer Engineering Systems (EAS)**

The following courses must be taken:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>ENGG*1210</td>
<td>0.50</td>
<td>Engineering Mechanics I</td>
</tr>
<tr>
<td>ENGG*2400</td>
<td>0.50</td>
<td>Engineering Systems Analysis</td>
</tr>
<tr>
<td>ENGG*2450</td>
<td>0.50</td>
<td>Electric Circuits</td>
</tr>
</tbody>
</table>

At least 1.00 credits from:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit</th>
<th>Description</th>
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<tbody>
<tr>
<td>ENGG*3410</td>
<td>0.50</td>
<td>Systems and Control Theory</td>
</tr>
<tr>
<td>ENGG*3450</td>
<td>0.50</td>
<td>Electronic Devices</td>
</tr>
<tr>
<td>ENGG*4460</td>
<td>0.50</td>
<td>Robotic Systems</td>
</tr>
</tbody>
</table>

Note: No more than 3.00 credits in ENGG courses may be taken.

**SIGNAL PROCESSING (SP)**

The following courses must be taken:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGG*1210</td>
<td>0.50</td>
<td>Engineering Mechanics I</td>
</tr>
<tr>
<td>ENGG*2400</td>
<td>0.50</td>
<td>Engineering Systems Analysis</td>
</tr>
<tr>
<td>ENGG*2450</td>
<td>0.50</td>
<td>Electric Circuits</td>
</tr>
<tr>
<td>ENGG*3390</td>
<td>0.50</td>
<td>Signal Processing</td>
</tr>
<tr>
<td>ENGG*4660</td>
<td>0.50</td>
<td>Medical Image Processing</td>
</tr>
</tbody>
</table>

Note: No more than 3.00 credits in ENGG courses may be taken.

**Minor (Honours Program)**

This requires 1.00 calculus credits and 4.00 other credits chosen from mathematics, statistics, and computing and information science. For these 4.00 credits students will choose at least 0.50 from each discipline. At least 1.00 credits must be at the 3000 level or above. CIS*2050 and CIS*3000 cannot be counted toward this minor. This minor cannot be combined with a major in Mathematics, Statistics, or Bachelor of Computing program.

**Mathematics (MATH)**

Department of Mathematics & Statistics, College of Engineering and Physical Sciences

Knowledge of mathematics is crucial for understanding our world. The Minor in Mathematics is designed to provide considerable flexibility for students to pursue their own mathematical interests, whether they be in the concepts of "pure" mathematics or techniques and applications. Students minoring in Mathematics will develop skills that are valued in many sectors such as business, education, government, and industry.

**Minor (Honours Program)**

A total of 5.00 credits is required to complete the Minor, including:

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>MATH*1080</td>
<td>0.50</td>
<td>Linear Algebra I</td>
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<tr>
<td>MATH*1090</td>
<td>0.50</td>
<td>Linear Algebra II</td>
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<td>MATH*1160</td>
<td>0.50</td>
<td>Linear Algebra I</td>
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<tr>
<td>MATH*2000</td>
<td>0.50</td>
<td>Proofs, Sets, and Numbers</td>
</tr>
<tr>
<td>MATH*2200</td>
<td>0.50</td>
<td>Advanced Calculus I</td>
</tr>
<tr>
<td>STAT*2040</td>
<td>0.50</td>
<td>Statistics I</td>
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</tbody>
</table>

0.50 additional Mathematics credits at the 2000 level or above.

1.50 additional Mathematics credits at the 3000 or 4000 level.

* IPS*1500 can count toward this 0.50 credit

** IPS*1510 can count toward this 0.50 credit

Note: Students majoring in Mathematical Science cannot minor in Mathematics.

**Microbiology (MICR)**

Department of Molecular and Cellular Biology, College of Biological Science

Microbiology programs are designed to give students a good understanding of microorganisms, including diversity, ecology, physiology, molecular genetics, current approaches in bacterial genomics/proteomics, and microbial associations with animal hosts and the environments. Such knowledge will provide the basis for further work with microbes in medicine, agricultural industries (including biotechnology, pharmaceuticals, food and beverage) and the environment (surveillance and bioremediation).

Students can take the B.Sc. program with a Major in Microbiology, or combine the minor with another major. Students should plan their programs in consultation with the microbiology faculty advisor. As course offerings may change during the program, students are strongly encouraged to review their plans at least once a year with their advisors, and to check the departmental website for program news.

**Major (Honours Program)**

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor.

**Semester 1**

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<thead>
<tr>
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<td>Introduction to Molecular and Cellular Biology</td>
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<td>CHEM*1040</td>
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<td>MATH*1080</td>
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<td>Elements of Calculus I</td>
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<tr>
<td>PHYS*1080</td>
<td>0.50</td>
<td>Physics for Life Sciences</td>
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0.50 Liberal Education electives

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at [https://www.uoguelph.ca/bsc/revised_SS](https://www.uoguelph.ca/bsc/revised_SS).

**Semester 2**

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<td>BIOL*1070</td>
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<td>Discovering Biodiversity</td>
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<tr>
<td>BIOL*1080</td>
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<td>Biological Concepts of Health</td>
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<tr>
<td>CHEM*1050</td>
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<td>General Chemistry II</td>
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<tr>
<td>PHYS*1070</td>
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<td>Physics for Life Sciences II</td>
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0.50 Liberal Education electives

**Semester 3**

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<tr>
<td>BIOC*3560</td>
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<td>Structure and Function in Biochemistry</td>
</tr>
<tr>
<td>MCB*2040</td>
<td>0.50</td>
<td>Foundations in Molecular Biology and Genetics</td>
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<tr>
<td>MCB*2430</td>
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<td>Methods in Microbial Culture and Physiology</td>
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0.50 Liberal Education electives

**Semester 4**

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<tr>
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<td>BIOC*3350</td>
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<td>Laboratory Methods in Molecular Biology</td>
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<td>MCB*2360</td>
<td>0.50</td>
<td>Microbial Adaptation</td>
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<tr>
<td>MCB*3340</td>
<td>0.75</td>
<td>Advanced Methods in Microbiology</td>
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</tbody>
</table>

A minimum of 0.50 electives or restricted electives

**Semester 5**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCB*3080</td>
<td>0.50</td>
<td>Bacterial Genetics</td>
</tr>
<tr>
<td>MCB*3420</td>
<td>0.50</td>
<td>Microbial Diversity and Ecology</td>
</tr>
</tbody>
</table>

1.50 electives or restricted electives

**Semester 6**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCB*3350</td>
<td>0.75</td>
<td>Laboratory Methods in Molecular Biology</td>
</tr>
<tr>
<td>MCB*3430</td>
<td>0.75</td>
<td>Microbial Adaptation</td>
</tr>
<tr>
<td>MCB*3450</td>
<td>0.75</td>
<td>Advanced Methods in Microbiology</td>
</tr>
</tbody>
</table>

1.00 - Liberal Education electives

**Semester 7**

2.50 electives or restricted electives which can include MCB*4500

**Semester 8**

2.50 electives or restricted electives which can include MCB*4510

**Restricted Electives**

1. A minimum of 2.00 credits of Liberal Education electives is required. The list of Liberal Education electives for B.Sc. students can be found at: [https://www.uoguelph.ca/bsc/](https://www.uoguelph.ca/bsc/)

2. 3.50 restricted elective credits of which 1.00 credits must be at the 4000 level.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*4540</td>
<td>0.75</td>
<td>Enzymology</td>
</tr>
<tr>
<td>BIOC*4580</td>
<td>0.50</td>
<td>Membrane Biochemistry</td>
</tr>
<tr>
<td>ENVS*3290</td>
<td>0.50</td>
<td>Waterborne Disease Ecology</td>
</tr>
<tr>
<td>FOOD*3230</td>
<td>0.75</td>
<td>Food Microbiology</td>
</tr>
<tr>
<td>FOOD*3240</td>
<td>0.50</td>
<td>Food Microbiology</td>
</tr>
<tr>
<td>FOOD*3260</td>
<td>0.50</td>
<td>Industrial Microbiology</td>
</tr>
<tr>
<td>FOOD*3270</td>
<td>0.50</td>
<td>Industrial Microbiology</td>
</tr>
<tr>
<td>FOOD*4400</td>
<td>0.50</td>
<td>Dairy Processing</td>
</tr>
<tr>
<td>MCB*3010</td>
<td>0.50</td>
<td>Dynamics of Cell Function and Signaling</td>
</tr>
<tr>
<td>MCB*4500</td>
<td>1.00</td>
<td>Research Project in Molecular &amp; Cellular Biology</td>
</tr>
<tr>
<td>MCB*4510</td>
<td>1.00</td>
<td>Research Project in Molecular &amp; Cellular Biology</td>
</tr>
<tr>
<td>MCB*4600</td>
<td>0.50</td>
<td>Topics in Molecular and Cellular Biology</td>
</tr>
<tr>
<td>MCR*3090</td>
<td>0.50</td>
<td>Mycology</td>
</tr>
<tr>
<td>MCR*3220</td>
<td>0.50</td>
<td>Plant Microbiology</td>
</tr>
</tbody>
</table>
To be eligible to continue in the Co-op program, students must meet a minimum 70% cumulative average requirement after second semester, as well as meet all work term requirements. Please refer to the Co-operative Education program policy with respect to work term performance grading, work term report grading and program completion requirements.

For additional program information students should consult with their Co-op Co-ordinator and Co-op Faculty Advisor, listed on the Co-operative Education web site.

Credit Summary (21.50 Total Credits)*
4.00 - First year science core
6.50 - Required science courses semesters 3 - 8
3.50 - Restricted electives (#2 in restricted electives list)
2.00 - Approved Science electives
2.00 - Liberal Education electives (#1 in restricted electives list)
2.00 - Free electives - any approved electives for B.Sc. students.

Of the total credits required, students are required to complete 16.00 credits in science of which a minimum of 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Minor (Honours Program)
The minor in Microbiology consists of the following 5.00 credits including:

BIOC*3560 [0.50] Structure and Function in Biochemistry
MICR*2420 [0.50] Introduction to Microbiology
MICR*2430 [0.50] Methods in Microbial Culture and Physiology

A minimum of 2.50 credits from:

FOOD*3230 [0.75] Food Microbiology
FOOD*3240 [0.50] Food Microbiology
FOOD*3260 [0.50] Industrial Microbiology
FOOD*3270 [0.50] Industrial Microbiology
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
MBG*3080 [0.50] Bacterial Genetics
MBG*3350 [0.75] Laboratory Methods in Molecular Biology
MICR*3090 [0.50] Mycology
MICR*3220 [0.50] Plant Microbiology
MICR*3230 [0.50] Immunology
MICR*3260 [0.50] Microbial Adaptation
MICR*3330 [0.50] World of Viruses
MICR*3420 [0.50] Microbial Diversity and Ecology
MICR*3430 [0.75] Advanced Methods in Microbiology

1.00 credits from:

MICR*4010 [0.50] Pathogenic Microbiology
MICR*4330 [0.50] Molecular Virology
MICR*4430 [0.50] Medical Virology
MICR*4520 [0.50] Microbial Cell Biology
MICR*4530 [0.50] Immunology II

Microbiology Co-op (MICR:C)

Department of Molecular and Cellular Biology, College of Biological Science

Microbiology programs are designed to give students a good understanding of microorganisms, including diversity, ecology, physiology, molecular genetics, current approaches in bacterial genomics/proteomics, and microbial associations with animal hosts and the environments. Such knowledge will provide the basis for further work with microbes in medicine, agricultural industries (including biotechnology, pharmaceuticals, food and beverage) and the environment (surveillance and bioremediation).

Program Requirements
The Co-op program in Microbiology is a five year program, including four work terms. Students must complete a Fall, Winter and Summer work term and must follow the academic work schedule as outlined below (also found on the Co-operative Education website: https://www.uoguelph.ca/cecs/). Please refer to the Co-operative Education program policy with respect to adjusting this schedule.

Microbiology Academic and Co-op Work Term Schedule

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Winter</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Academic Semester 1</td>
<td>Academic Semester 2</td>
<td>Off</td>
</tr>
<tr>
<td>2</td>
<td>Academic Semester 3</td>
<td>Academic Semester 4</td>
<td>COOP*1100 Work Term I</td>
</tr>
<tr>
<td>3</td>
<td>Academic Semester 5</td>
<td>Academic Semester 6</td>
<td>COOP*2000 Work Term II</td>
</tr>
<tr>
<td>4</td>
<td>COOP*3000 Work Term III</td>
<td>COOP*4000 Work Term IV</td>
<td>Off</td>
</tr>
<tr>
<td>5</td>
<td>Academic Semester 7</td>
<td>Academic Semester 8</td>
<td>N/A</td>
</tr>
</tbody>
</table>
A minimum of 2.00 credits of Liberal Education electives is required. The list of Liberal Education electives for B.Sc. students can be found at: https://www.uoguelph.ca/bsc/.

2.30 restricted elective credits of which 1.00 credits must be at the 4000 level.

- **BIOL*4540** [0.75] Enzymology
- **BIOL*4580** [0.50] Membrane Biochemistry
- **ENVS*3290** [0.50] Waterborne Disease Ecology
- **FOOD*3230** [0.75] Food Microbiology
- **FOOD*3240** [0.50] Food Microbiology
- **FOOD*3260** [0.50] Industrial Microbiology
- **FOOD*3270** [0.50] Industrial Microbiology
- **FOOD*4400** [0.50] Dairy Processing
- **MCB*3010** [0.50] Dynamics of Cell Function and Signaling
- **MCB*4500** [1.00] Research Project in Molecular & Cellular Biology I
- **MCB*4510** [1.00] Research Project in Molecular & Cellular Biology II
- **MCB*4500** [0.50] Topics in Molecular and Cellular Biology
- **MCIR*3090** [0.50] Mycology
- **MCIR*3220** [0.50] Plant Microbiology
- **MCIR*3230** [0.50] Immunology
- **MCIR*3330** [0.50] World of Viruses
- **MCIR*4010** [0.50] Pathogenic Microbiology
- **MCIR*4330** [0.50] Molecular Virology
- **MCIR*4430** [0.50] Medical Virology
- **MCIR*4520** [0.50] Microbial Cell Biology
- **MCIR*4530** [0.50] Immunology II
- **PATH*3040** [0.50] Principles of Parasitology

### Molecular Biology and Genetics (MBG)

**Department of Molecular and Cellular Biology, College of Biological Science**

The B.Sc. program with a Major in Molecular Biology and Genetics is a broadly based program in genetics including related areas of cell and molecular biology. In consultation with the Faculty Advisor, students can choose a general program or can focus their courses in areas such as molecular biology, cell biology, developmental biology, genetics, or agricultural genetics. The program qualifies students for postgraduate training in cell or molecular biology and genetics including clinical genetics and genetic counselling, and provides an excellent background for careers in biotechnology, toxicology, agriculture and medical research. Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor.

### Major (Honours Program)

A total of 20.00 credits is required to complete the major.

#### Semester 1

- **BIOL*1090** [0.50] Introduction to Molecular and Cellular Biology
- **CHEM*1040** [0.50] General Chemistry I
- **MATH*1080** [0.50] Elements of Calculus I
- **PHYS*1080** [0.50] Physics for Life Sciences
- **PHYS*1080** [0.50] Physics for Life Sciences
- **0.50 Liberal Education electives**

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at https://www.uoguelph.ca/bsc/revised_SS.

#### Semester 2

- **BIOL*1070** [0.50] Discovering Biodiversity
- **BIOL*1080** [0.50] Biological Concepts of Health
- **CHEM*1050** [0.50] General Chemistry II
- **PHYS*1070** [0.50] Physics for Life Sciences II
- **0.50 Liberal Education electives**

#### Semester 3

- **BIOL*2580** [0.50] Introduction to Biochemistry
- **MBG*2040** [0.50] Foundations in Molecular Biology and Genetics
- **MCIR*2420** [0.50] Introduction to Microbiology
- **STAT*2040** [0.50] Statistics I
- **0.50 Liberal Education electives**

#### Semester 4

- **BIOL*3560** [0.50] Structure and Function in Biochemistry
- **CHEM*2700** [0.50] Organic Chemistry I
- **MCIR*2050** [0.50] Molecular Biology of the Cell
- **MCIR*2430** [0.50] Methods in Microbial Culture and Physiology
- **0.50 Liberal Education electives**

#### Semester 5

- **MBG*3040** [0.50] Molecular Biology of the Gene
- **MBG*3350** [0.75] Laboratory Methods in Molecular Biology
- **MBG*4500** [1.00] Research Project in Molecular & Cellular Biology I
- **MBG*4510** [1.00] Research Project in Molecular & Cellular Biology II
- **MBG*4500** [0.50] Topics in Molecular and Cellular Biology
- **MCIR*3090** [0.50] Mycology
- **MCIR*3220** [0.50] Plant Microbiology
- **MCIR*3230** [0.50] Immunology
- **MCIR*3330** [0.50] World of Viruses
- **MCIR*4010** [0.50] Pathogenic Microbiology
- **MCIR*4330** [0.50] Molecular Virology
- **MCIR*4430** [0.50] Medical Virology
- **MCIR*4520** [0.50] Microbial Cell Biology
- **MCIR*4530** [0.50] Immunology II
- **PATH*3040** [0.50] Principles of Parasitology
- **STAT*2050** [0.50] Statistics II
- **STAT*3560** [0.50] Fundamental Methods in Statistics
- **STAT*4510** [0.50] Advanced Statistical Methods

### Credit Summary (20.00 Total Credits)

- **4.00** - First year science core
- **7.25** - Required science courses semesters 3 - 8
- **3.00** - Restricted electives (#2 and 3 in restricted electives list)
- **1.75** - Approved science electives
- **2.00** - Liberal Education electives (#1 in restricted elective list)
- **2.00** - Free electives - any approved elective for B.Sc. Students

Of the total credits required, students are required to complete 16.00 credits in science of which a minimum of 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

### Minor (Honours Program)

A minor in Molecular Biology and Genetics requires 5.00 credits in Molecular Biology and Genetics chosen in consultation with the faculty advisor, and will include:

- **MBG*2040** [0.50] Foundations in Molecular Biology and Genetics
- **MBG*2050** [0.50] Molecular Biology of the Cell
- **MBG*3060** [0.50] Quantitative Genetics
- **MBG*3080** [0.50] Bacterial Genetics
- **MBG*3100** [0.50] Plant Genetics
- **MBG*3350** [0.75] Laboratory Methods in Molecular Biology
- **MBG*3660** [0.50] Genomics

**Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at:**

https://www.uoguelph.ca/bsc/revised_SS.

2.00 - Liberal Education electives (#1 in restricted elective list)

2.50 Liberal Education electives

2.00 - Free electives - any approved elective for B.Sc. Students

### Notes:

1. A minimum of 2.00 credits of Liberal Education electives is required. The list of Liberal Education electives for B.Sc. students can be found at: https://www.uoguelph.ca/bsc/.

2. Physiology Elective - 0.50 credits

- **BIOM*3200** [1.00] Biomedical Physiology
- **BOT*3310** [0.50] Plant Growth and Development
- **HK*2810** [0.50] Human Physiology I - Concepts and Principles
- **ZOO*3600** [0.50] Comparative Animal Physiology I

3. Subject Area Electives - 2.50 credits (4.00 if MCB*4600 is taken instead of MCB*4500 and MCB*4510)

- **BIOL*3020** [0.50] Population Genetics
- **BIOL*3300** [0.50] Applied Bioinformatics
- **MBG*2400** [0.50] Fundamentals of Plant and Animal Genetics
- **MBG*3050** [0.50] Human Genetics
- **MBG*3060** [0.50] Quantitative Genetics
- **MBG*3080** [0.50] Bacterial Genetics
- **MBG*3100** [0.50] Plant Genetics
- **MBG*3660** [0.50] Genomics
- **MBG*4030** [0.50] Animal Breeding Methods and Applications
- **MBG*4040** [0.50] Genetics and Molecular Biology of Development
- **MBG*4110** [0.50] Epigenetics
- **MBG*4160** [0.50] Plant Breeding
- **MBG*4240** [0.50] Applied Molecular Genetics in Medicine and Biotechnology
- **MBG*4270** [0.50] DNA Replication, Recombination and Repair
- **MBG*4300** [0.50] Plant Molecular Genetics
- **MBG*3010** [0.50] Dynamics of Cell Function and Signaling
- **MBG*4010** [0.50] Advanced Cell Biology
- **MBG*4050** [0.50] Protein and Nucleic Acid Structure
- **MICR*3330** [0.50] World of Viruses
- **MICR*4330** [0.50] Molecular Virology
- **STAT*2050** [0.50] Statistics II

#### 2019-2020 Undergraduate Calendar
Administered jointly by the Department of Chemistry and the Department of the Physics, College of Engineering and Physical Sciences

Major (Honours Program)

The major will require the completion of 20.00 credits as indicated below.

**Semester 1**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1090</td>
<td>0.50</td>
<td>Introduction to Molecular and Cellular Biology</td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>0.50</td>
<td>General Chemistry I</td>
</tr>
<tr>
<td>IPS*1500</td>
<td>1.00</td>
<td>Integrated Mathematics and Physics I</td>
</tr>
<tr>
<td>NANO*1000</td>
<td>0.50</td>
<td>Introduction to Nanoscience</td>
</tr>
</tbody>
</table>

Students who are lacking one 4U/grade 12 course in Biology, Chemistry or Physics must take the equivalent introductory course in first semester. The required first-year science courses in that subject should be completed according to the revised schedule of studies available at: https://www.uoguelph.ca/bsc/revised_SS

**Semester 2**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM*1050</td>
<td>0.50</td>
<td>General Chemistry II</td>
</tr>
<tr>
<td>IPS*1510</td>
<td>1.00</td>
<td>Integrated Mathematics and Physics II</td>
</tr>
<tr>
<td>MATH*1160</td>
<td>0.50</td>
<td>Linear Algebra I</td>
</tr>
<tr>
<td>One of:</td>
<td></td>
<td>Discovering Biodiversity</td>
</tr>
<tr>
<td>BIO*1070</td>
<td>0.50</td>
<td>Biological Concepts of Health</td>
</tr>
<tr>
<td>BIO*1080</td>
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<td>Biological Concepts of Health</td>
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**Semester 3**

<table>
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<th>Credits</th>
<th>Course Name</th>
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<tbody>
<tr>
<td>CHEM*2060</td>
<td>0.50</td>
<td>Structure and Bonding</td>
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<tr>
<td>MATH*2270</td>
<td>0.50</td>
<td>Applied Differential Equations</td>
</tr>
<tr>
<td>NANO*2000</td>
<td>0.50</td>
<td>Synthesis and Characterization of Nanomaterials I</td>
</tr>
<tr>
<td>PHYS*2330</td>
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<td>Electricity and Magnetism I</td>
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<tr>
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<td>Thermodynamics and Kinetics</td>
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<tr>
<td>PHYS*2240</td>
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<td>Thermal Physics</td>
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**Semester 4**

<table>
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<th>Credits</th>
<th>Course Name</th>
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</thead>
<tbody>
<tr>
<td>CHEM*2070</td>
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<td>Structure and Spectroscopy</td>
</tr>
<tr>
<td>NANO*2100</td>
<td>0.50</td>
<td>Synthesis and Characterization of Nanomaterials II</td>
</tr>
<tr>
<td>PHYS*2310</td>
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<td>Mechanics</td>
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<tr>
<td>1.00 electives*</td>
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</table>

**Semester 5**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Name</th>
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</thead>
<tbody>
<tr>
<td>NANO*3200</td>
<td>0.50</td>
<td>Nanolithographic Techniques</td>
</tr>
<tr>
<td>NANO*3500</td>
<td>0.50</td>
<td>Thin Film Science</td>
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<tr>
<td>One of:</td>
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<td>Quantum Chemistry</td>
</tr>
<tr>
<td>CHEM*3860</td>
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<td>Quantum Chemistry</td>
</tr>
<tr>
<td>PHYS*3230</td>
<td>0.50</td>
<td>Quantum Mechanics I</td>
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**Semester 6**

<table>
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<th>Credits</th>
<th>Course Name</th>
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<tbody>
<tr>
<td>NANO*3300</td>
<td>0.50</td>
<td>Spectroscopy of Nanomaterials</td>
</tr>
<tr>
<td>NANO*3600</td>
<td>0.50</td>
<td>Computational Methods in Materials Science</td>
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<tr>
<td>1.50 electives</td>
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</table>

**Semester 7**

<table>
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<th>Course Code</th>
<th>Credits</th>
<th>Course Name</th>
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</thead>
<tbody>
<tr>
<td>NANO*4100</td>
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<td>Biological Nanomaterials</td>
</tr>
<tr>
<td>NANO*4700</td>
<td>0.50</td>
<td>Concepts in Quantum Computing</td>
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<td>1.50 electives</td>
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**Semester 8**

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<th>Course Code</th>
<th>Credits</th>
<th>Course Name</th>
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</thead>
<tbody>
<tr>
<td>NANO*4200</td>
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<td>Topics in Nanomaterials</td>
</tr>
<tr>
<td>2.00 electives</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* To take PHYS*3230 in semester 5, PHYS*2340 must be selected as an elective in semester 4.

Note: In semesters 7 and 8, the student must select to do either NANO*4900 or NANO*4910.

Areas of Focus

In completing the science requirements for the degree, some suggested complementary areas of focus are:

**Chemistry: Inorganic**

Semester 4: CHEM*2480
Semester 5: CHEM*3460
Semester 6: CHEM*3650
Semester 7: CHEM*4620
Semester 8: CHEM*2700

**Chemistry: Organic**

Semester 4: CHEM*2700
Semester 5: CHEM*3750
Semester 6: CHEM*3760
Semester 7: CHEM*4730
Semester 8: CHEM*2480, CHEM*4720

**Chemistry: Physical/Analytical**

Semester 4: CHEM*2480
Semester 5: CHEM*3860
Semester 6: CHEM*3430 or CHEM*3870
Semester 7: CHEM*3440
Semester 8: CHEM*3430 or CHEM*3870

**Engineering**

Semester 2: CIS*1500
Semester 4: ENGG*2450
Semester 5: ENGG*2410, ENGG*3450
Semester 6: ENGG*4550
Semester 7: ENGG*4080

**Mathematics and Statistics**

Semester 4: STAT*2040
Semester 5: STAT*3100
Semester 6: MATH*2130
Semester 7: MATH*4240
Semester 8: MATH*3160

**Physics**

Semester 4: PHYS*2340
Semester 5: MATH*2200, PHYS*3130
Semester 6: PHYS*3000
Semester 7: PHYS*4180, PHYS*4240
Semester 8: PHYS*4040, PHYS*4150

*Note: Courses marked with an asterisk may require additional prerequisites. Students should consult the relevant course descriptions for further information.

**Credit Summary (20.00 Total Credits)**

4.50 - First year science credits
8.00 - Required science courses semesters 3 – 8
0.50 or 1.00- Restricted electives (either NANO 4900 (1.00) or NANO 4910 (0.50) )
2.50 to 3.00 - Approved Science electives (depending on restricted elective chosen above)
1.00 - Liberal Education electives
3.00 - Free electives - any approved elective for B.Sc. students. (could be less if restricted electives do not count as science)

Of the total credits required, students are required to complete 16.00 credits in science of which 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

**Nanoscience (NANO:C)**

Administered jointly by the Department of Chemistry and the Department of the Physics, College of Engineering and Physical Sciences

**Program Requirements**

The Co-op program in Nanoscience is a five year program, including five work terms. Students must complete a Fall, Winter and Summer work term and must follow the academic work schedule as outlined below (also found on the Co-operative Education website: https://www.recruitguelph.ca/cecs/). Please refer to the Co-operative Education program policy with respect to adjusting this schedule.

Nanoscience Academic and Co-op Work Term Schedule

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Winter</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Academic Semester 1</td>
<td>Academic Semester 2</td>
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<tr>
<td>2</td>
<td>Academic Semester 3</td>
<td>COOP*1100</td>
<td>Academic Semester 4</td>
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<td></td>
<td>COOP*1000 Work Term I</td>
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<td>COOP*3000 Work Term III</td>
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<td>3</td>
<td>Academic Semester 5</td>
<td>COOP*2000 Work Term II</td>
<td>COOP*3000 Work Term III</td>
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<td>4</td>
<td>Academic Semester 6</td>
<td>Academic Semester 7</td>
<td>COOP*4000 Work Term IV</td>
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</table>
To be eligible to continue in the Co-op program, students must meet a minimum 70% cumulative average requirement after second semester, as well as meet all work term requirements. Please refer to the Co-operative Education program policy with respect to work term performance grading, work term report grading and program completion requirements.

For additional program information students should consult with their Co-op Co-ordinator and Co-op Faculty Advisor, listed on the Co-operative Education web site.

Credit Summary (22.00 Total Credits)*

4.50 - First year science core
8.00 - Required science courses semesters 3 - 8
0.50 or 1.00 - Restricted electives (either NANO 4900 (1.00) or NANO 4910 (0.50))
2.50 to 3.00 - Approved Science electives (depending on restricted elective chosen above)
1.00 - Liberal Education electives
3.00 - Free electives - any approved elective for B.Sc. students. (could be less if restricted electives do not count as science)
2.00 - Co-op Work Terms

Of the total credits required, students are required to complete 16.00 credits in science of which a minimum of 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Note: A minimum of four Co-op work terms including a Summer, Fall, and Winter are necessary to complete the Co-op requirement. *A fifth Co-op work term is optional and if completed, the total number of credits will equal 22.50

The recommended program sequence is outlined below.

Major (Honours Program)

Semester 1 - Fall
BIOI*1090 [0.50] Introduction to Molecular and Cellular Biology
CHEM*1040 [0.50] General Chemistry I
IPS*1500 [1.00] Integrated Mathematics and Physics I
NANO*1000 [0.50] Introduction to Nanoscience

Students who are lacking one 4U /grade 12 course in Biology, Chemistry or Physics must take the equivalent introductory course in first semester. The required first-year science courses in that subject should be completed according to the revised schedule of studies available at: https://www.uoguelph.ca/bsc/revised_SS

Semester 2 - Winter
CHEM*1050 [0.50] General Chemistry II
IPS*1510 [1.00] Integrated Mathematics and Physics II
MATH*1160 [0.50] Linear Algebra I

One of:
BIOI*1070 [0.50] Discovering Biodiversity
BIOI*1080 [0.50] Biological Concepts of Health

Semester 3 - Fall
CHEM*2060 [0.50] Structure and Bonding
COOP*1100 [0.00] Introduction to Co-operative Education
MATH*2270 [0.50] Applied Differential Equations
NANO*2000 [0.50] Synthesis and Characterization of Nanomaterials I
PHYS*2330 [0.50] Electricity and Magnetism I

One of:
CHEM*2820 [0.50] Thermodynamics and Kinetics
PHYS*2240 [0.50] Thermal Physics

Semester 4 - Winter
CHEM*2070 [0.50] Structure and Spectroscopy
NANO*2100 [0.50] Synthesis and Characterization of Nanomaterials II
PHYS*2310 [0.50] Mechanics

1.00 electives*

Summer Semester
COOP*1000 [0.50] Co-op Work Term I

Semester 5 - Fall
NANO*3200 [0.50] Nanolithographic Techniques
NANO*3500 [0.50] Thin Film Science

One of:
CHEM*3860 [0.50] Quantum Chemistry
PHYS*3230 [0.50] Quantum Mechanics I

1.00 electives

Winter Semester
COOP*2000 [0.50] Co-op Work Term II
(8-month work term in conjunction with COOP*3000)

Summer Semester
COOP*3000 [0.50] Co-op Work Term III

(8-month work term in conjunction with COOP*2000)

Semester 6 - Fall
NANO*4100 [0.50] Biological Nanomaterials
NANO*4700 [0.50] Concepts in Quantum Computing
1.50 electives

Semester 7 - Winter
NANO*3300 [0.50] Spectroscopy of Nanomaterials
NANO*3600 [0.50] Computational Methods in Materials Science
1.50 electives

Summer Semester
COOP*4000 [0.50] Co-op Work Term IV

Fall Semester
COOP*5000 [0.50] Co-op Work Term V

Semester 8 -- Winter
NANO*4200 [0.50] Topics in Nanomaterials
2.00 electives

* To take PHYS*3230 in semester 5, then PHYS*2340 must be selected as an elective in semester 4.

Note: In semesters 7 and 8, the student must select to do either NANO*4900 or NANO*4910.

Neuroscience (NEUR)

Departments of Biomedical Sciences (Ontario Veterinary College), Human Health and Nutritional Sciences (College of Biological Science), Molecular & Cellular Biology (College of Biological Science), and Psychology (College of Social and Applied Human Science).

Major (Honours Program)

This Honours program provides a foundation in the natural sciences and an opportunity to develop advanced knowledge of nervous system structure and function, and the skills required for independent inquiry within neuroscience. The specialization is unique in its emphasis on integrative/interdisciplinary problem solving. Through the use of electives, students may structure a program that emphasizes molecular and biomedical neuroscience, behavioural and cognitive neuroscience, or comparative neuroscience.

The major prepares students for professional programs in health science (medical, physiotherapy, pharmacy, veterinary medicine, nursing), post-graduate degrees in neuroscience research, and provides a strong foundation for students wishing to pursue careers in the pharmaceutical and biotechnology industries, public health, teaching, and scientific publishing & journalism.

Students may enter this major in Semester I or any semester thereafter. A student wishing to declare the major may wish to consult with a Faculty Advisor. A minimum total of 20.00 credits is required to complete the major.

Semester 1
BIOI*1080 [0.50] Biological Concepts of Health
CHEM*1040 [0.50] General Chemistry I
MATH*1080 [0.50] Elements of Calculus I
PHYS*1080 [0.50] Physics for Life Sciences

0.50 Liberal Education elective

Semester 2
BIOI*1070 [0.50] Discovering Biodiversity
BIOI*1090 [0.50] Introduction to Molecular and Cellular Biology
CHEM*1050 [0.50] General Chemistry II
MATH*1080 [0.50] Elements of Calculus I
PHYS*1080 [0.50] Physics for Life Sciences

0.50 Liberal Education elective

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at: https://www.uoguelph.ca/bsc/revised_SS

Semester 3
BIOI*1080 [0.50] Introduction to Molecular and Cellular Biology
CHEM*1050 [0.50] General Chemistry II
PHYS*1070 [0.50] Physics for Life Sciences II
PSYC*1000 [0.50] Introduction to Psychology

Semester 4
BIOC*2580 [0.50] Introduction to Biochemistry
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
NEUR*2000 [0.50] Introduction to Neuroscience

One of:
STAT*2040 [0.50] Statistics I
PSYC*1010 [0.50] Making Sense of Data in Psychological Research

0.50 Liberal Education elective

Semester 5
MCR*2050 [0.50] Molecular Biology of the Cell
PHYS*2030 [0.50] Biophysics of Excitable Cells
PSYC*3410 [0.50] Behavioural Neuroscience II

1.00 electives or restricted electives

Note: Physiology restricted elective (# 3) must be taken before registering in BIOM*3090 in semester 6.

Semester 6
BIOM*3000 [0.50] Functional Mammalian Neuroanatomy
Neur*3100 [0.50] Molecular Biology of Neurodevelopmental and Degenerative Disease

Psych*3270 [0.50] Cognitive Neuroscience

1.00 electives or restricted electives

Note: Physiology restrictive elective (# 3) must be taken before registering in BIOM*3090 in semester 6.

Semester 6

BIOM*3090 [0.50] Principles of Pharmacology

NEUR*3500 [0.50] Techniques in Neuroscience

1.50 electives or restricted electives

Semester 7

NEUR*4000 [0.50] Current Issues in Neuroscience

NEUR*4100 [0.50] Neuropharmacology

1.50 electives or restricted electives

Semester 8

2.50 electives or restricted electives

Restricted Electives

Students are advised to pay particular attention to pre-requisite requirements when choosing individual courses, and seek advice as needed. *Indicates courses that require additional prerequisites.

1. A minimum of 0.50 credits of Critical thinking/ Philosophy / Ethics from:

   BIOM*3210 [0.50] Critical Thinking in the Health Sciences
   PHIL*2100 [0.50] Critical Thinking
   PHIL*2110 [0.50] Formal Logic
   PHIL*2120 [0.50] Ethics
   PHIL*2180 [0.50] Philosophy of Science
   PHIL*2240 [0.50] Knowledge and Belief

   Note: if a PHIL course is completed from this list, students are required to take an additional 0.50 credit approved science course as an elective to ensure the minimum science requirement is met.

2. A minimum of 0.50 credits of Developmental Biology

   BIOM*3040 [0.75] Medical Embryology *
   MBG*3040 [0.50] Molecular Biology of the Gene
   ZOO*3050 [0.50] Developmental Biology

3. A minimum of 0.50 credits of Physiology

   BIOM*3200 [1.00] Biomedical Physiology
   HK*2810 [0.50] Human Physiology I - Concepts and Principles
   ZOO*3600 [0.50] Comparative Animal Physiology I *

   NOTE: If HK*2810 is completed in Semester 4, HK*3810 must be completed in Semester 5 in order to meet the BIOM*3090 pre-requisite requirement.

4. A minimum of 0.50 credits of additional statistics or experimental design

   PSYC*2360 [0.50] Psychological Methods and Statistics
   STAT*2050 [0.50] Statistics II

5. A minimum of 1.00 credits of Independent Study

For students who are interested in graduate studies, a research course is recommended. *Indicates courses that have additional prerequisites.

** faculty advisor will determine if this course is an eligible science elective, depending on the instructor and topic

BIOM*4500 [0.50] Literature-based Research in Biomedical Sciences
BIOM*4510 [1.00] Research in Biomedical Sciences
BIOM*4521/2 [2.00] Research in Biomedical Sciences
HK*4230 [0.50] Advanced Study in Human Health and Nutritional Sciences
HK*4360 [1.00] Research in Human Health and Nutritional Sciences
HK*4371/2 [1.00] Research in Human Health and Nutritional Sciences II
IBIO*4500 [1.00] Research in Integrative Biology I
IBIO*4510 [1.00] Research in Integrative Biology II
IBIO*4521/2 [2.00] Thesis in Integrative Biology
MCB*4500 [1.00] Research Project in Molecular & Cellular Biology I *
MCB*4510 [1.00] Research Project in Molecular & Cellular Biology *
MCB*4600 [0.50] Topics in Molecular and Cellular Biology *
NEUR*4401/2 [1.00] Research in Neurosciences
NEUR*4450 [1.00] Research in Neurosciences
PSYC*3240 [0.50] Independent Research Project **
PSYC*4240 [0.50] Advanced Independent Research Project **
PSYC*4870 [0.50] Honours Thesis I **
PSYC*4880 [1.00] Honours Thesis II **

** Indicates courses that require additional prerequisites.

Lists of recommended electives

The following lists contain recommended electives for students wishing to emphasize particular areas in neuroscience.

Psychology

   PSYC*2330 [0.50] Principles of Learning
   PSYC*2390 [0.50] Sensation and Perception
   PSYC*2650 [0.50] Cognitive Psychology
   PSYC*3030 [0.50] Neurochemical Basis of Behaviour *
   PSYC*3100 [0.50] Evolutionary Psychology *
   PSYC*3330 [0.50] Memory and Attention *
   PSYC*3410 [0.50] Behavioural Neuroscience II
   PSYC*4470 [0.50] Advanced Topics in Behavioural and Cognitive Neuroscience
   PSYC*4750 [0.50] Seminar in Motivation and Emotion

Computations, Modeling and Statistics

   CIS*1300 [0.50] Programming
   CIS*2500 [0.50] Intermediate Programming *
   MATH*1090 [0.50] Elements of Calculus II
   MATH*1160 [0.50] Linear Algebra I
   MATH*2270 [0.50] Applied Differential Equations *
   MATH*3510 [0.50] Biomathematics *
   PSYC*3250 [0.50] Psychological Measurement *
   PSYC*3290 [0.50] Conducting Statistical Analyses in Psychology *
   STAT*3240 [0.50] Applied Regression Analysis *

Biological Sciences

   BIOC*3560 [0.50] Structure and Function in Biochemistry
   BIOC*4580 [0.50] Membrane Biochemistry *
   BIOM*4070 [0.50] Biomedical Histology *
   MBG*3050 [0.50] Human Genetics
   MCB*3010 [0.50] Dynamics of Cell Function and Signaling
   MCB*4010 [0.50] Advanced Cell Biology *
   ZOO*3000 [0.50] Comparative Histology *

Health & Disease

   BIOM*3040 [0.75] Medical Embryology *
   BIOM*4030 [0.50] Endocrine Physiology *
   BIOM*4050 [0.50] Biomedical Aspects of Aging *
   HK*3100 [0.50] Neuro muscular Physiology *
   HK*3810 [0.75] Human Physiology II - Integrated Systems *
   HK*4070 [0.50] Clinical Biomechanics *
   TOX*4000 [0.50] Medical Toxicology

Credit Summary (20.00 Total Credits)

4.00 – First year science core

7.00 – Required science courses semester 3-8

3.00 – Restricted elective (#1,2,3,4,5 in restricted electives list)

2.00 – Approved Science elective*

0.50 - Required Liberal Education elective (PSYC*1000)

1.00 – Liberal Education electives

2.50 – Free electives

Of the 20 total credits required, students must complete 16.00 credits in science of which a minimum of 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

*2.50 Approved Science Electives if a PHIL*XXXX course is selected for restricted electives #1

Minor (Honours Program)

A minor in Neuroscience requires a minimum of 5.00 credits including:

BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
PSYC*1000 [0.50] Introduction to Psychology
PSYC*2330 [0.50] Principles of Learning

One of:

   NEUR*2000 [0.50] Introduction to Neuroscience
   PSYC*2410 [0.50] Behavioural Neuroscience I

One of:

   PSYC*1010 [0.50] Making Sense of Data in Psychological Research
   STAT*2040 [0.50] Statistics I

A minimum of 0.50 credits from:

   BIOM*2000 [0.50] Concepts in Human Physiology
   BIOM*3200 [1.00] Biomedical Physiology
   HK*2810 [0.50] Human Physiology I - Concepts and Principles
   ZOO*3600 [0.50] Comparative Animal Physiology I

A minimum of 2.00 credits from:

   BIOM*3000 [0.50] Functional Mammalian Neuroanatomy
   BIOM*3090 [0.50] Principles of Pharmacology
   BIOM*4030 [0.50] Endocrine Physiology
Nutritional and Nutraceutical Sciences (NANS)

Department of Human Health and Nutritional Sciences, College of Biological Science

The Nutritional and Nutraceutical Sciences major is concerned with understanding the contribution of food, beverage and nutritional supplement consumption to growth, development of optimal biological function, maintenance of health, and treatment of disease.

If lacking the fundamentals of word processing, spreadsheet use and data management, the student should select CIS*1200 as early in the program as possible.

Major (Honours Program)

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. A total of 20.00 credits is required.

Semester 1

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<th>Course Name</th>
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<td>BIOL*1080</td>
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<td>Biological Concepts of Health</td>
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<tr>
<td>CHEM*1040</td>
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<tr>
<td>MATH*1080</td>
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<td>Elements of Calculus I</td>
</tr>
<tr>
<td>PHYS*1080</td>
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<td>Physics for Life Sciences</td>
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</table>

0.50 Liberal Education electives

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at https://www.uoguelph.ca/bsc/revised_SS

Semester 2

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<td>BIOL*1070</td>
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<td>Discovering Biodiversity</td>
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<tr>
<td>BIOL*1090</td>
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<td>Introduction to Molecular and Cellular Biology</td>
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<tr>
<td>CHEM*1050</td>
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<tr>
<td>PHYS*1070</td>
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<td>Physics for Life Sciences II</td>
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0.50 Liberal Education electives

Semester 3

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<td>BIOC*2580</td>
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<td>Introduction to Biochemistry</td>
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<tr>
<td>MBG*2040</td>
<td>0.50</td>
<td>Foundations in Molecular Biology and Genetics</td>
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<tr>
<td>STAT*2040</td>
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<td>Statistics I</td>
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0.50 electives or restricted electives

0.50 Liberal Education electives

Semester 4

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<tr>
<td>BIOC*3560</td>
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<td>Structure and Function in Biochemistry</td>
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<tr>
<td>HK*2810</td>
<td>0.50</td>
<td>Human Physiology I - Concepts and Principles</td>
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<td>MCB*2050</td>
<td>0.50</td>
<td>Molecular Biology of the Cell</td>
</tr>
<tr>
<td>NUTR*3210</td>
<td>0.50</td>
<td>Fundamentals of Nutrition</td>
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0.50 Liberal Education electives

Semester 5

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<th>Credits</th>
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<tr>
<td>HK*3810</td>
<td>0.75</td>
<td>Human Physiology II - Integrated Systems</td>
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<tr>
<td>NUTR*3330</td>
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<td>Micronutrients, Phytochemicals and Health</td>
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<tr>
<td>NUTR*3360</td>
<td>0.50</td>
<td>Lifestyle Genomics</td>
</tr>
<tr>
<td>NUTR*3390</td>
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<td>Applied Nutritional and Nutraceutical Sciences I</td>
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Semester 6

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<td>BIOM*3090</td>
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<td>Principles of Pharmacology</td>
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<tr>
<td>NUTR*4090</td>
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<td>Functional Foods and Nutraceuticals</td>
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<td>NUTR*4320</td>
<td>0.50</td>
<td>Nutrition and Metabolic Control of Disease</td>
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<tr>
<td>NUTR*4330</td>
<td>0.75</td>
<td>Applied Nutritional and Nutraceutical Sciences II</td>
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Credit Summary (20.00 Total Credits)

4.00 - First year science core

9.25 - Required science courses semesters 3 - 8

1.00 - Restricted electives (#2 in restricted electives list)

1.75 - Approved science electives

2.00 - Liberal Education electives (#1 in restricted electives list)

2.00 - Free electives - any approved electives for B.Sc. students.

2.00 - Free electives - any approved electives for B.Sc. students.

Minor (Honours Program)

A minor in Nutritional and Nutraceutical Sciences (NANS) requires 5.00 credits as follows:

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<th>Course Name</th>
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<tbody>
<tr>
<td>BIOC*2580</td>
<td>0.50</td>
<td>Introduction to Biochemistry</td>
</tr>
<tr>
<td>NUTR*3210</td>
<td>0.50</td>
<td>Fundamentals of Nutrition</td>
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<tr>
<td>NUTR*3330</td>
<td>0.50</td>
<td>Micronutrients, Phytochemicals and Health</td>
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<tr>
<td>NUTR*4090</td>
<td>0.50</td>
<td>Functional Foods and Nutraceuticals</td>
</tr>
<tr>
<td>STAT*2040</td>
<td>0.50</td>
<td>Statistics I</td>
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At least 0.50 credits from:

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<th>Course Code</th>
<th>Credits</th>
<th>Course Name</th>
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<tbody>
<tr>
<td>ANSC*8080</td>
<td>0.50</td>
<td>Agricultural Animal Physiology (restricted to ABIO majors)</td>
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<tr>
<td>BIOM*3200</td>
<td>1.00</td>
<td>Biomedical Physiology</td>
</tr>
<tr>
<td>HK*2810</td>
<td>0.50</td>
<td>Human Physiology I - Concepts and Principles</td>
</tr>
<tr>
<td>ZOO*3600</td>
<td>0.50</td>
<td>Comparative Animal Physiology</td>
</tr>
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</table>

and 2.00 credits from:

<table>
<thead>
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<th>Course Code</th>
<th>Credits</th>
<th>Course Name</th>
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<tbody>
<tr>
<td>ANSC*3170</td>
<td>0.50</td>
<td>Nutrition of Fish and Crustacea</td>
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<tr>
<td>ANSC*3180</td>
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<td>Wildlife Nutrition</td>
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<td>ANSC*4260</td>
<td>0.50</td>
<td>Beef Cattle Nutrition</td>
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<td>ANSC*4270</td>
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<td>Dairy Cattle Nutrition</td>
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<td>ANSC*4280</td>
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<td>FOOD*2010</td>
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<td>Principles of Food Science</td>
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<tr>
<td>HK*3810</td>
<td>0.75</td>
<td>Human Physiology II - Integrated Systems</td>
</tr>
<tr>
<td>HK*4230</td>
<td>0.50</td>
<td>Advanced Study in Human Health and Nutritional Sciences</td>
</tr>
</tbody>
</table>

Physical Science (PSCI)

College of Engineering and Physical Sciences
Major (Honours Program)

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. This major will require the completion of 20.00 credits as indicated below:

1. **Basic Science Core - 4.00 credits**
   - 1.00 - Biology (BIOL*1070, BIOL*1080, BIOL*1090)
   - 1.00 - Chemistry (CHEM*1040, CHEM*1050)
   - 1.00 - Physics (PHYS*1080, (1 of PHYS*1010, PHYS*1070, PHYS*1130))
   - 1.00 - Mathematical Science ([MATH*1080, MATH*1090] or [MATH*1200, MATH*1210])
   * IPS*1500 can be taken instead of PHYS*1080 and MATH*1200, and IPS*1510 can be taken instead of PHYS*1010 and MATH*1210.

2. **Subject Area Core - 8.00 credits**
   - 0.50 STAT*2040
   - 0.50 (1 of CIS*1200, CIS*1300, CIS*1500)
   - 7.00 physical science credits, including at least 4.00 credits at the 3000 or 4000 level of which 2.00 credits must be at the 4000 level.

3. **Science Electives - 4.00 credits**
   - 4.00 science credits from the List of Approved Science Electives for B.Sc. Students*

4. **Liberal Education - 2.00**
   - 2.00 acceptable Liberal Education credits selected from the List of Approved B.Sc. Electives*

5. **Free Electives - 2.00 credits**
   - Note: the program must include a total of 6.00 science credits at the 3000 or 4000 level. Of these, at least 2.00 credits must be physical science at the 4000 level.

**Semester 1**

**CHEM*1040 [0.50] General Chemistry I**
One of:
- PHYS*1080 [0.50] Physics for Life Sciences
- PHYS*1130 [0.50] Physics with Applications

One of:
- MATH*1080 [0.50] Elements of Calculus I
- MATH*1200 [0.50] Calculus I
  * IPS*1500 can be taken instead of PHYS*1080 and MATH*1200.

One of:
- BIOL*1070 [0.50] Discovering Biodiversity
- BIOL*1080 [0.50] Biological Concepts of Health
- BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology

0.50 Liberal Education electives

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at: [https://www.uoguelph.ca/bsc/revised_SS](https://www.uoguelph.ca/bsc/revised_SS)

**Semester 2**

**CHEM*1050 [0.50] General Chemistry II**
One of:
- PHYS*1010 [0.50] Introductory Electricity and Magnetism
- PHYS*1080 [0.50] Physics for Life Sciences

One of:
- MATH*1210 [0.50] Calculus II
- MATH*1090 [0.50] Elements of Calculus II
  * IPS*1510 can be taken instead of PHYS*1010 and MATH*1210.

One of:
- BIOL*1070 [0.50] Discovering Biodiversity
- BIOL*1080 [0.50] Biological Concepts of Health
- BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology

0.50 Liberal Education electives

**Semester 3**

1.50 science electives from the approved list of acceptable B.Sc. science electives* 0.50 electives

One of:
- CIS*1200 [0.50] Introduction to Computing
- CIS*1300 [0.50] Programming
- CIS*1500 [0.50] Introduction to Programming

OR
- STAT*2040 [0.50] Statistics I

**Semester 4**

1.50 science electives from the approved list of B.Sc. science electives* 0.50 electives

One of:
- CIS*1200 [0.50] Introduction to Computing
- CIS*1300 [0.50] Programming
- CIS*1500 [0.50] Introduction to Programming

(if a statistics course is chosen in Semester 3)

OR
- STAT*2040 [0.50] Statistics I
  (if a computing course is chosen in Semester 3)

**Semester 5 to 8**

Total of 2.50 credits per semester including at least 2.00 science electives.

Sufficient courses at the 3000 or 4000 level must be selected in Semesters 5 through 8 to total 6.00 credits in science at the 3000 or 4000 level with at least 2.00 physical science at the 4000 level.

*approved course lists are available in the B.Sc. Academic Counselling Office or at: [https://www.uoguelph.ca/bsc/Approved_electives](https://www.uoguelph.ca/bsc/Approved_electives)

**Credit Summary (20.00 Total Credits)**

4.00 - First year science credits

8.00 - Subject area core semesters 3 – 8 (including STAT 2040 and CIS 1200 or CIS 1500)

4.00 - Approved Science electives

2.00 - Liberal Education electives (# 1 in restricted elective list)

2.00 - Free electives - any approved elective for B.Sc. students. (could be less if restricted electives do not count as science)

Of the total credits required, students are required to complete 16.00 credits in science of which 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

**Honours Physical Science (With a Minor)**

The requirements and schedules are the same as for Honours Physical Science. Available Minor subjects are listed at the beginning of the B.Sc. Program section under the heading Honours Program Minors.

**Physics (PHYS)**

**Department of Physics, College of Engineering and Physical Sciences**

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. Since some of the required courses are not offered every semester, students entering the Major in Honours Physics should plan their program in consultation with the Department of Physics Faculty Advisor.

**Major (Honours Program)**

This major requires the completion of 20.00 credits. At least 1.00 credits must be from Arts and/or Social Science courses.

**Semester 1**

**CHEM*1040 [0.50] General Chemistry I**

CIS*1300 [0.50] Programming

IPS*1500 [1.00] Integrated Mathematics and Physics I

One of:
- BIOL*1070 [0.50] Discovering Biodiversity
- BIOL*1080 [0.50] Biological Concepts of Health
- BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology

0.50 Liberal Education electives

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at: [https://www.uoguelph.ca/bsc/revised_SS](https://www.uoguelph.ca/bsc/revised_SS)

**Semester 2**

**CHEM*1050 [0.50] General Chemistry II**

CIS*1300 [0.50] Programming

IPS*1500 [1.00] Integrated Mathematics and Physics II

MATH*1160 [0.50] Linear Algebra I

One of:
- BIOL*1070 [0.50] Discovering Biodiversity
- BIOL*1080 [0.50] Biological Concepts of Health
- BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology

Students who are lacking one 4U /grade 12 course in Biology, Chemistry or Physics must take the equivalent introductory course in first semester. The required first-year science courses in that subject should be completed according to the revised schedule of studies available at: [https://www.uoguelph.ca/bsc/revised_SS](https://www.uoguelph.ca/bsc/revised_SS)

**Semester 3**

**MATH*2200 [0.50] Advanced Calculus I**

MATH*2270 [0.50] Applied Differential Equations

PHYS*2240 [0.50] Thermal Physics

PHYS*2330 [0.50] Electricity and Magnetism I

0.50 Liberal Education electives

**Semester 4**

**PHYS*2180 [0.50] Experimental Techniques in Physics**

PHYS*2310 [0.50] Mechanics

PHYS*2340 [0.50] Electricity and Magnetism II

1.00 electives

**Semester 5**

**IPS*3000 [0.50] Science Communication**

PHYS*3130 [0.50] Mathematical Physics

**Last Revision: July 4, 2019**
The Co-op program in Physics is a five year program, including five work terms. Students are required to complete 16.00 credits in science of which a minimum of 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Note: A minimum of four Co-op work terms including a Summer, Fall, and Winter are necessary to complete the Co-op requirement. A fifth Co-op work term is optional and if completed, the total number of credits will equal 22.50.

The recommended program sequence is outlined below.

**Major (Honours Program)**

<table>
<thead>
<tr>
<th>Semester 1 - Fall</th>
<th>Semester 2 - Winter</th>
<th>Semester 3 - Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM*1040 [0.50]</td>
<td>General Chemistry I</td>
<td>Introduction to Co-operative Education</td>
</tr>
<tr>
<td>CIS*1300 [0.50]</td>
<td>Programming</td>
<td>MATH*2200 [0.50]</td>
</tr>
<tr>
<td>IPS*1500 [1.00]</td>
<td>Integrated Mathematics and Physics I</td>
<td>PHYS*2270 [0.50]</td>
</tr>
<tr>
<td></td>
<td>1.00 - Approved Science electives</td>
<td>PHYS*240 [0.50]</td>
</tr>
<tr>
<td></td>
<td>1.00 - Co-op Work Terms</td>
<td>PHYS*2330 [0.50]</td>
</tr>
</tbody>
</table>

Students who are lacking one 4U /grade 12 course in Biology, Chemistry or Physics must take the equivalent introductory course in first semester. The required first-year science courses including:

PHYS*1070 [0.50] General Physics I
PHYS*1080 [0.50] General Physics II
PHYS*1130 [0.50] Intermediate Laboratory

At least 1.00 credits must be from the restricted electives listed below.

**Restricted Electives**

PHYS*4120 [0.50] Atomic and Molecular Physics
PHYS*4130 [0.50] Subatomic Physics
PHYS*4150 [0.50] Solid State Physics

**Credit Summary (22.00 Total Credits)**

5.00 - First year science credits
8.50 - Required science courses semesters 3 – 8
1.00 - Restricted electives
1.50 - Approved Science electives
3.00 - Free electives - any approved elective for B.Sc. students

Of the total credits required, students are required to complete 16.00 credits in science of which 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

### Minor (Honours Program)

A minor in Physics requires 5.00 credits in interdisciplinary physical science or physics courses including:

PHYS*2180 [0.50] Experimental Techniques in Physics
PHYS*2310 [0.50] Mechanics
PHYS*2330 [0.50] Electricity and Magnetism I
PHYS*2340 [0.50] Electricity and Magnetism II

A maximum of 1.00 credits from the following courses may be used towards the minor:

PHYS*1010 [0.50] Introductory Electricity and Magnetism
PHYS*1070 [0.50] Physics for Life Sciences I
PHYS*1080 [0.50] Physics for Life Sciences II
PHYS*1130 [0.50] Physics with Applications
IPS*1510 [1.00] Integrated Mathematics and Physics II

A minimum of 1.00 credits are required at the 3000 or 4000 level.

**Note:** PHYS*1300, PHYS*1600 and PHYS*1810 may not be taken for credit toward this minor.

### Physics (Co-op) (PHYS:C)

**Department of Physics, College of Engineering and Physical Sciences**

**Program Requirements**

The Co-op program in Physics is a five year program, including five work terms. Students must complete a Fall, Winter and Summer work term and must follow the academic work schedule as outlined below (also found on the Co-operative Education website: https://www.uoguelph.ca/escs/). Please refer to the Co-operative Education program policy with respect to adjusting this schedule.

**Physics Academic and Co-op Work Term Schedule**

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Winter</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Academic Semester 1</td>
<td>Academic Semester 2</td>
<td>Off</td>
</tr>
</tbody>
</table>

To be eligible to continue in the Co-op program, students must meet a minimum 70% cumulative average requirement after second semester, as well as meet all work term requirements. Please refer to the Co-operative Education program policy with respect to work term performance grading, work term report grading and program completion requirements.

For additional program information students should consult with their Co-op Co-ordinator and Co-op Faculty Advisor, listed on the Co-operative Education web site.

### Credit Summary (20.00 Total Credits)*

5.00 - First year science credits
8.50 - Required science courses semesters 3 – 8
1.00 - Restricted electives
1.50 - Approved Science electives
3.00 - Free electives - any approved elective for B.Sc. students
2.00 - Co-op Work Terms

Of the total credits required, students are required to complete 16.00 credits in science of which a minimum of 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

**Note:** A minimum of four Co-op work terms including a Summer, Fall, and Winter are necessary to complete the Co-op requirement. **A fifth Co-op work term is optional and if completed, the total number of credits will equal 22.50.

The recommended program sequence is outlined below.

### Major (Honours Program)

<table>
<thead>
<tr>
<th>Semester 1 - Fall</th>
<th>Semester 2 - Winter</th>
<th>Semester 3 - Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM*1040 [0.50]</td>
<td>General Chemistry I</td>
<td>Introduction to Co-operative Education</td>
</tr>
<tr>
<td>CIS*1300 [0.50]</td>
<td>Programming</td>
<td>MATH*2200 [0.50]</td>
</tr>
<tr>
<td>IPS*1500 [1.00]</td>
<td>Integrated Mathematics and Physics I</td>
<td>PHYS*2270 [0.50]</td>
</tr>
<tr>
<td></td>
<td>1.00 - Approved Science electives</td>
<td>PHYS*240 [0.50]</td>
</tr>
<tr>
<td></td>
<td>1.00 - Co-op Work Terms</td>
<td>PHYS*2330 [0.50]</td>
</tr>
</tbody>
</table>

Students who are lacking one 4U /grade 12 course in Biology, Chemistry or Physics must take the equivalent introductory course in first semester. The required first-year science courses in that subject should be completed according to the revised schedule of studies available at: https://www.uoguelph.ca/bsc/revised_SS

<table>
<thead>
<tr>
<th>Semester 2 - Winter</th>
<th>Semester 3 - Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM*1050 [0.50]</td>
<td>Introduction to Co-operative Education</td>
</tr>
<tr>
<td>IPS*1510 [1.00]</td>
<td>MATH*2200 [0.50]</td>
</tr>
<tr>
<td>MATH*1160 [0.50]</td>
<td>PHYS*2270 [0.50]</td>
</tr>
<tr>
<td>One of:</td>
<td>PHYS*240 [0.50]</td>
</tr>
<tr>
<td></td>
<td>PHIS*2330 [0.50]</td>
</tr>
<tr>
<td></td>
<td>Electricity and Magnetism I</td>
</tr>
<tr>
<td>0.50 Liberal Education electives*</td>
<td>Introduction to Molecular and Cellular Biology</td>
</tr>
</tbody>
</table>

### Semester 4 - Winter

<table>
<thead>
<tr>
<th>Semester 4 - Winter</th>
<th>Semester 5 - Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS*2180 [0.50]</td>
<td>Introduction to Co-operative Education</td>
</tr>
<tr>
<td>PHYS*2310 [0.50]</td>
<td>MATH*2200 [0.50]</td>
</tr>
<tr>
<td>PHYS*2340 [0.50]</td>
<td>Applied Differential Equations</td>
</tr>
<tr>
<td>One of:</td>
<td>PHYS*240 [0.50]</td>
</tr>
<tr>
<td></td>
<td>PHYS*2330 [0.50]</td>
</tr>
<tr>
<td></td>
<td>Electricity and Magnetism I</td>
</tr>
<tr>
<td>0.50 Liberal Education electives*</td>
<td>Intermediate Programming</td>
</tr>
</tbody>
</table>

### Summer Semester

<table>
<thead>
<tr>
<th>Summer Semester</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*1000 [0.50]</td>
<td>Co-op Work Term I ++</td>
</tr>
</tbody>
</table>
Semester 5 - Fall
IPS*3000 [0.50] Science Communication
PHYS*3130 [0.50] Mathematical Physics
PHYS*3230 [0.50] Quantum Mechanics I
PHYS*3400 [0.50] Advanced Mechanics
0.50 electives

Winter Semester
COOP*2000 [0.50] Co-op Work Term II ++
(8-month work term in conjunction with COOP*3000)

Semester 6 - Fall +
PHYS*4180 [0.50] Advanced Electromagnetic Theory
One of:
CIS*2520 [0.50] Data Structures
0.50 electives**
One of:
PHYS*4240 [0.50] Statistical Physics II
0.50 electives**
1.00 electives **

Semester 7 - Winter +
NANO*3600 [0.50] Computational Methods in Materials Science
PHYS*3000 [0.50] Optics: Fundamentals and Applications
PHYS*3510 [0.50] Intermediate Laboratory
PHYS*4040 [0.50] Quantum Mechanics II
One of:
MATH*3260 [0.50] Complex Analysis
0.50 electives**

Summer Semester
COOP*4000 [0.50] Co-op Work Term IV ++

Fall Semester
COOP*5000 [0.50] Co-op Work Term V ++

Semester 8 - Winter +
PHYS*4500 [0.50] Advanced Physics Laboratory
One of:
PHYS*4130 [0.50] Subatomic Physics
0.50 electives**
One of:
PHYS*4150 [0.50] Solid State Physics
0.50 electives**
1.00 electives **
+ students going on to graduate school in physics should take PHYS*4130, PHYS*4150, and PHYS*4240
** At least 1.00 credits must be from the restricted electives listed below.

Restricted Electives
PHYS*4130 [0.50] Subatomic Physics
PHYS*4150 [0.50] Solid State Physics
PHYS*4240 [0.50] Statistical Physics II

Plant Science (PLSC)
Department of Plant Agriculture, Ontario Agricultural College
School of Environmental Sciences, Ontario Agricultural College
Department of Integrative Biology, College of Biological Science
Department of Molecular and Cellular Biology, College of Biological Science

Major (Honours Program)
Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. The major requires the completion of 20.00 credits.

Semester 1
BIOL*1070 [0.50] Discovering Biodiversity
CHEM*1040 [0.50] General Chemistry I
ENGL*1030 [0.50] Effective Writing
MATH*1080 [0.50] Elements of Calculus I
PHYS*1080 [0.50] Physics for Life Sciences
Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at: https://www.uoguelph.ca/bsc/revised_SS

Semester 2
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
CHEM*1050 [0.50] General Chemistry II
PHYS*1070 [0.50] Physics for Life Sciences II
One of:
CIS*1200 [0.50] Introduction to Computing
CIS*1500 [0.50] Introduction to Programming
MATH*1090 [0.50] Elements of Calculus II

0.50 Liberal Education electives

Semester 3
AGR*2470 [0.50] Introduction to Plant Agriculture
BIOL*2580 [0.50] Introduction to Biochemistry
BOT*2100 [0.50] Life Strategies of Plants
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
0.50 Liberal Education

Semester 4
MCB*2050 [0.50] Molecular Biology of the Cell
STAT*2040 [0.50] Statistics I
One of:
AGR*2050 [0.50] Agroecology
BIOL*2060 [0.50] Ecology
1.00 electives or restricted electives

Semester 5
BOT*3410 [0.50] Plant Anatomy
2.00 electives or restricted electives

Semester 6
BOT*3310 [0.50] Plant Growth and Development
2.00 electives or restricted electives

Option A

Semester 7
One of:
AGR*4450 [1.00] Research Project I
IBIO*4500 [1.00] Research in Integrative Biology I
MCB*4500 [1.00] Research Project in Molecular & Cellular Biology I
1.50 electives or restricted electives

Semester 8
MCB*4500 [1.00] Research Project in Molecular & Cellular Biology I
1.00 electives or restricted electives

Restricted Electives
1. A minimum of 1.00 credits of Liberal Education electives is required. The list of Liberal Education electives for B.Sc. students can be found at: https://www.uoguelph.ca/bsc/ Liberal Education electives for B.Sc. students can be found at: https://www.uoguelph.ca/bsc/ Liberal Education electives for B.Sc. students can be found at: https://www.uoguelph.ca/bsc/ Liberal Education electives for B.Sc. students can be found at: https://www.uoguelph.ca/bsc/

2. 5.00 credits from within their area of emphasis from the lists below

Note: Restricted electives indicated with † are non-science electives. If non-science restricted electives are chosen students are reminded that they will still be responsible for meeting the minimum requirement of 16.00 credits in science and that the credit summary may vary from what is specified below.

Note: Restricted electives indicated with ** require other restricted electives as prerequisites. Students should consult the most recent undergraduate calendar for specific requirements.

‡ Students are required to take one of (AGR*4450 or IBIO*4500 or MCB4500) in semester 7 OR AGR*4600 in semester 8. For those choosing (AGR*4450 or IBIO*4500 or MCB*4500), one of the following may count towards restricted elective requirements in an area of emphasis.

AGR*4460 [1.00] Research Project II
IBIO*4510 [1.00] Research in Integrative Biology II
MCB*4510 [1.00] Research Project in Molecular & Cellular Biology

Credit Summary (20.00 Total Credits)

Option A
4.00 - First year science core
6.00 - Required science courses semesters 3 - 8
5.00 - Restricted electives for the declared area of emphasis ‡ (some restricted electives do not count as science electives towards the degree. Therefore additional science electives may be required.)
1.00 - Approved science electives, if all restricted electives chosen are approved science electives
1.00 - Liberal Education electives
0.50 - ENGL*1030

2019-2020 Undergraduate Calendar
Last Revision: July 4, 2019
### Applied Plant Science (APSC)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CROP*4240</td>
<td>Weed Science</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*2060</td>
<td>Soil Science</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*3210</td>
<td>Plant Pathology</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*4100</td>
<td>Integrated Management of Invasive Insect Pests **</td>
<td>0.50</td>
</tr>
</tbody>
</table>

### Plant Biotechnology (PBTC)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBG*3100</td>
<td>Plant Genetics</td>
<td>0.50</td>
</tr>
<tr>
<td>MBG*3350</td>
<td>Laboratory Methods in Molecular Biology</td>
<td>0.75</td>
</tr>
<tr>
<td>PBIO*3750</td>
<td>Plant Tissue Culture</td>
<td>0.50</td>
</tr>
<tr>
<td>PBIO*4750</td>
<td>Genetic Engineering of Plants</td>
<td>0.50</td>
</tr>
</tbody>
</table>

### Plant Environmental Science (PESC)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOT*3050</td>
<td>Plant Functional Ecology</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*2040</td>
<td>Plant Health and the Environment</td>
<td>0.50</td>
</tr>
<tr>
<td>ENVS*4350</td>
<td>Forest Ecology</td>
<td>0.50</td>
</tr>
<tr>
<td>GEOG*2480</td>
<td>Mapping and GIS</td>
<td>0.50</td>
</tr>
</tbody>
</table>

### Botany (BOT)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOT*3050</td>
<td>Plant Functional Ecology</td>
<td>0.50</td>
</tr>
<tr>
<td>MBG*3100</td>
<td>Plant Genetics</td>
<td>0.50</td>
</tr>
<tr>
<td>MBG*3400</td>
<td>Molecular and Cellular Aspects of Plant-Microbe Interactions</td>
<td>0.50</td>
</tr>
<tr>
<td>PBIO*4150</td>
<td>Molecular and Cellular Aspects of Plant Development</td>
<td>0.50</td>
</tr>
</tbody>
</table>

### Minor (Honours Program)

A minor in Plant Science requires a minimum of 5.00 credits in the Plant Science Program chosen in consultation with the Faculty Advisor. The courses include:

- AGR*2470  
- BOT*2100  
- BOT*3310  
- BOT*3410  
- BOT*3710  
- BOT*3710  

A minor in Environmental Science requires a minimum of 5.00 credits in the Environmental Science Program chosen in consultation with the Faculty Advisor. The courses include:

- BIOL*3010  
- BIOL*3060  
- BIOL*3130  
- BIOL*4500  
- BOT*3710  

### Unspecialized (UNSP)

Choose 5.00 credits from any courses listed in the other areas of emphasis.
Statistics (STAT)

Department of Mathematics and Statistics, College of Engineering and Physical Sciences

Statistics plays a fundamental role in virtually all scientific disciplines, including biology, physics, chemistry, medicine, epidemiology, kinesiology, and toxicology. Students minoring in Statistics will develop practical skills in data visualization and analysis, statistical computing, technical writing and communication in a variety of applications areas, preparing them well for careers in the modern workplace.

Students may declare this minor in any semester.

Minor (Honours Program)

A total of 5.00 credits is required to complete the minor, including:

(MATH*1080 or MATH*1200)*
(MATH*1090 or MATH*1210)**
MATH*1160 [0.50] Linear Algebra I
STAT*2040 [0.50] Statistics I
STAT*2050 [0.50] Statistics II
STAT*3100 [0.50] Introductory Mathematical Statistics I
STAT*3110 [0.50] Introductory Mathematical Statistics II
STAT*3240 [0.50] Applied Regression Analysis

0.50 additional credits in Statistics

0.50 additional credits in Statistics or Mathematics at the 2000 level or above

* IPS*1500 can count toward this 0.50 credit
** IPS*1510 can count toward this 0.50 credit

Note: Students majoring in Mathematical Science cannot minor in Statistics.

Theoretical Physics (THPY)

Department of Physics, College of Engineering and Physical Sciences

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. Some of the required courses are not offered every semester, students entering the Major in Theoretical Physics should plan their program in consultation with the Faculty Advisor.

Major (Honours Program)

This major requires the completion of 20.00 credits. At least 1.00 of these credits must be obtained from the completion of Liberal Education electives.

Semester 1

CHEM*1040 [0.50] General Chemistry I
CIS*1300 [0.50] Programming
IPS*1500 [1.00] Integrated Mathematics and Physics I
One of:
BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1080 [0.50] Biological Concepts of Health
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology

Students who are lacking one 4U grade 12 course in Biology, Chemistry or Physics must take the equivalent introductory course in first semester. The required first-year science courses in that subject should be completed according to the revised schedule of studies available at: https://www.uoguelph.ca/bsc/revised_SS

Semester 2

CHEM*1050 [0.50] General Chemistry II
IPS*1510 [1.00] Integrated Mathematics and Physics II
MATH*1160 [0.50] Linear Algebra I
One of:
BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1080 [0.50] Biological Concepts of Health
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology

Note: students who have taken physics courses other than IPS*1500 or PHYS*1080 in Semester 1 and IPS*1510 or PHYS*1010 in Semester 2, may proceed to semester 3 with the permission of the Department of Physics

Semester 3

MATH*2200 [0.50] Advanced Calculus I
MATH*2270 [0.50] Applied Differential Equations
PHYS*2240 [0.50] Thermal Physics
PHYS*2330 [0.50] Electricity and Magnetism I

0.50 Liberal Education electives

Semester 4

MATH*2210 [0.50] Advanced Calculus II
PHYS*2180 [0.50] Experimental Techniques in Physics
PHYS*2310 [0.50] Mechanics
PHYS*2340 [0.50] Electricity and Magnetism II

0.50 electives*

Semester 5

IPS*3000 [0.50] Science Communication
PHYS*3130 [0.50] Mathematical Physics
PHYS*3230 [0.50] Quantum Mechanics I
PHYS*3400 [0.50] Advanced Mechanics

0.50 electives*

Semester 6

NANO*3600 [0.50] Computational Methods in Materials Science
PHYS*3000 [0.50] Optics: Fundamentals and Applications
PHYS*3510 [0.50] Intermediate Laboratory
PHYS*4040 [0.50] Quantum Mechanics II

0.50 electives*

Semester 7

PHYS*4120 [0.50] Atomic and Molecular Physics
PHYS*4180 [0.50] Advanced Electromagnetic Theory
PHYS*4240 [0.50] Statistical Physics II
Two of:
PHYS*4001 [0.50] Research in Physics
PHYS*4500 [0.50] Advanced Physics Laboratory

0.50 electives*

Semester 8

MATH*3260 [0.50] Complex Analysis
PHYS*4130 [0.50] Subatomic Physics
PHYS*4150 [0.50] Solid State Physics

One of:
PHYS*4002 [0.50] Research in Physics

0.50 electives*

*Restricted Electives

Students must complete 2.00 credits from the following list:

CIS*2500 [0.50] Intermediate Programming
MATH*2000 [0.50] Proofs, Sets, and Numbers
MATH*2130 [0.50] Numerical Methods
MATH*3100 [0.50] Differential Equations II
MATH*3130 [0.50] Abstract Algebra
MATH*3160 [0.50] Linear Algebra II
MATH*3200 [0.50] Real Analysis
MATH*3240 [0.50] Operations Research

Credit Summary (20.00 Total Credits)

5.00 - First year science credits
11.00 - Required science courses semesters 3 – 8
2.00 - Restricted electives
1.00 - Liberal Education electives
1.00 - Free electives - any approved elective for B.Sc. students. could be less if restricted electives do not count as science

Of the total credits required, students are required to complete 16.00 credits in science of which 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Wildlife Biology and Conservation (WBC)

Department of Integrative Biology, College of Biological Science

The core of this major will provide students with an integrated foundation in three disciplines necessary to understand the origins, interactions, and protection of biological diversity: evolution, ecology, and conservation biology. After the second semester, the student has the opportunity to take a wide variety of electives, including courses that meet his/her specific interests within one or two of these disciplines. The program offers a sound scientific background in preparation for careers in resource management, conservation, ecological consulting, teaching, and government service. This major also qualifies students for post-graduate work in ecology, evolutionary biology, environmental sciences, or wildlife management.

Major (Honours Program)

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. A minimum total of 20.00 credits is required to complete the major.

Semester 1

BIOL*1070 [0.50] Discovering Biodiversity
CHEM*1040 [0.50] General Chemistry I
MATH*1080 [0.50] Elements of Calculus I
PHYS*1080 [0.50] Physics for Life Sciences

0.50 Liberal Education electives

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at https://www.uoguelph.ca/bsc/revised_SS
Semester 2

BIOL*1080 [0.50] Biological Concepts of Health
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
CHEM*1050 [0.50] General Chemistry II
PHYS*1070 [0.50] Physics for Life Sciences II
0.50 Liberal Education electives

Semester 3

BIOC*2580 [0.50] Introduction to Biochemistry
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
1.50 electives or restricted electives

Semester 4

BIOL*2060 [0.50] Ecology
BIOL*2400 [0.50] Evolution
STAT*2230 [0.50] Biostatistics for Integrative Biology
1.00 electives or restricted electives

Semester 5

BIOL*3010 [0.50] Laboratory and Field Work in Ecology
2.00 electives or restricted electives

Semester 6

BIOL*3040 [0.50] Methods in Evolutionary Biology
BIOL*3060 [0.50] Populations, Communities & Ecosystems
BIOL*3130 [0.50] Conservation Biology
1.00 electives or restricted electives

Semester 7

BIOL*4110 [1.00] Ecological Methods
BIOL*4150 [0.50] Wildlife Conservation and Management
1.00 electives or restricted electives

Note: For students considering graduate research programs, BIOL*4110 may be substituted by an independent research course (1.00 credits minimum). Course options include: (IBIO*4500 and IBIO*4510), IBIO*4521/IBIO*4522.

Semester 8

BIOL*4500 [0.50] Natural Resource Policy Analysis
2.00 electives or restricted electives

Restricted Electives

Note that some courses have prerequisites, so be sure to consult the undergraduate calendar.

1. A minimum of 1.00 credits of Liberal Education electives is required. The list of Liberal Education electives for B.Sc. students can be found at: https://www.uoguelph.ca/bsc/

2. A minimum of 0.50 credits from:
   - BOT*2100 [0.50] Life Strategies of Plants
   - ZOO*2090 [0.50] Vertebrate Structure and Function
   - ZOO*2700 [0.50] Invertebrate Morphology & Evolution

3. A minimum of 0.50 credits from:
   - BOT*3050 [0.50] Plant Functional Ecology
   - ZOO*3600 [0.50] Comparative Animal Physiology I

4. A minimum of 0.50 credits from:
   - BIOL*3020 [0.50] Population Genetics
   - BIOL*4120 [0.50] Evolutionary Ecology

5. A minimum of 3.00 credits from any of the following lists of courses. The courses are broken into disciplines for which they are most suitable to help students tailor their electives towards a specific field if desired.

   *Some of the restricted electives will require additional courses outside of the required courses listed in Semesters 3-8

   ** Please note not all restricted electives are considered science electives for B.Sc students. If the non-science restricted electives are chosen, students are reminded that they will still be responsible for meeting the minimum of 16.00 credits in science and that the credit summary may vary from what is specified below.

Evolution

BIOL*3020 [0.50] Population Genetics
BIOL*3300 [0.50] Applied Bioinformatics
BOT*3710 [0.50] Plant Diversity and Evolution
ENVS*3090 [0.50] Insect Diversity and Biology
ENVS*3180 [0.50] Sedimentary Environments
MBG*3040 [0.50] Molecular Biology of the Gene
MBG*4110 [0.50] Epigenetics
MBG*4270 [0.50] DNA Replication, Recombination and Repair
ZOO*2700 [0.50] Invertebrate Morphology & Evolution
ZOO*3050 [0.50] Developmental Biology

Ecology

ANSC*3180 [0.50] Wildlife Nutrition
BIOL*3450 [0.50] Introduction to Aquatic Environments
ENVS*3000 [0.50] Nature Interpretation
ENVS*3270 [0.50] Forest Biodiversity

Credit Summary (20.00 Total Credits)

4.00 - First year science core
6.50 - Required science courses semesters 3 - 8
4.50 - Restricted electives (# 2, 3, 4 and 5 in restricted electives list)**
1.00 - Approved Science electives
1.00 - Liberal Education electives (#1 in restricted electives list)
3.00 - Free electives - any approved elective for B.Sc. students

Of the total credits required, students are required to complete 16.00 credits in science of which a minimum of 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Zoology (ZOO)

Department of Integrative Biology, College of Biological Science

The Major in Zoology offers a broad education in the life sciences while providing a more specialized understanding of the structure, function and ecology of animals. This major qualifies students for post-graduate work in zoology and other life sciences and provides a sound science background for students wishing to pursue careers in teaching, government service or the private sector.

Major (Honours Program)

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. A minimum total of 20.00 credits is required to complete the major. At least 6.00 science credits must be at the 3000 or 4000 level, 2.00 of which must be at the 4000 level.

Semester 1

BIOL*1070 [0.50] Discovering Biodiversity
CHEM*1040 [0.50] General Chemistry I
MATH*1080 [0.50] Elements of Calculus I
PHYS*1080 [0.50] Physics for Life Sciences
0.50 Liberal Education electives

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at https://www.uoguelph.ca/bsc/revised_SS

Semester 2

BIOL*1080 [0.50] Biological Concepts of Health
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
CHEM*1050 [0.50] General Chemistry II
PHYS*1070 [0.50] Physics for Life Sciences II
### Semester 3

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*2060</td>
<td>Ecology</td>
<td>0.50</td>
</tr>
<tr>
<td>BIOL*2400</td>
<td>Evolution</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*2090</td>
<td>Vertebrate Structure and Function</td>
<td>0.50</td>
</tr>
</tbody>
</table>

*1.00 electives or restricted electives*

### Semester 4

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*2580</td>
<td>Introduction to Biochemistry</td>
<td>0.50</td>
</tr>
<tr>
<td>MBG*2040</td>
<td>Foundations in Molecular Biology and Genetics</td>
<td>0.50</td>
</tr>
<tr>
<td>STAT*2230</td>
<td>Biostatistics for Integrative Biology</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*2700</td>
<td>Invertebrate Morphology &amp; Evolution</td>
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</tbody>
</table>

*0.50 electives or restricted electives*

### Semester 5

<table>
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<tr>
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<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>ZOO*3000</td>
<td>Comparative Histology</td>
<td>0.50</td>
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<tr>
<td>ZOO*3660</td>
<td>Comparative Animal Physiology I</td>
<td>0.50</td>
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<tr>
<td>ZOO*3610</td>
<td>Lab Studies in Animal Physiology I</td>
<td>0.25</td>
</tr>
<tr>
<td>ZOO*3700</td>
<td>Integrative Biology of Invertebrates</td>
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### Semester 6

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>BIOL*3060</td>
<td>Populations, Communities &amp; Ecosystems</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*3050</td>
<td>Developmental Biology</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*3620</td>
<td>Comparative Animal Physiology II</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*3630</td>
<td>Lab Studies in Animal Physiology II</td>
<td>0.25</td>
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</table>

### Semester 7

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZOO*4070</td>
<td>Animal Behaviour</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*4910</td>
<td>Integrative Vertebrate Biology</td>
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</tbody>
</table>

*1.50 electives or restricted electives*

### Semester 8

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>ZOO*4070</td>
<td>Animal Behaviour</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*4910</td>
<td>Integrative Vertebrate Biology</td>
<td>0.50</td>
</tr>
</tbody>
</table>

*2.50 electives or restricted electives*

* CIS*1200 is recommended for those needing to improve their computer skills.

### Restricted Electives must include:

1. A minimum of 1.00 credits of Liberal Education electives is required. The list of Liberal Education electives for B.Sc. students can be found at: [https://www.uoguelph.ca/bsc/](https://www.uoguelph.ca/bsc/)

2. A minimum of 0.50 credits from:

   - ZOO*4330  [0.50] Biology of Fishes
   - ZOO*4920  [0.25] Lab Studies in Ornithology
   - ZOO*4940  [0.25] Lab Studies in Herpetology
   - ZOO*4950  [0.25] Lab Studies in Mammalogy

3. A minimum of 0.50 credits from:

   - BIOL*4410  [0.75] Field Ecology
   - BIOL*4610  [0.75] Arctic Ecology
   - BIOL*4700  [0.50] Field Biology
   - BIOL*4710  [0.25] Field Biology
   - BIOL*4800  [0.50] Field Biology
   - BIOL*4810  [0.25] Field Biology
   - IBIO*4500  [1.00] Research in Integrative Biology I
   - IBIO*4510  [1.00] Research in Integrative Biology II
   - IBIO*4521/2 [2.00] Thesis in Integrative Biology
   - ZOO*4170  [0.50] Experimental Comparative Animal Physiology
   - ZOO*4300  [0.75] Marine Biology and Oceanography

Other field or research courses with approval of faculty advisor.

### Credit Summary (20.00 Total Credits)

- 4.00 - First year science core
- 8.00 - Required science courses semesters 3 - 8
- 1.00 - Restricted electives (# 2, and 3 in restricted electives list)
- 3.00 - Approved Science electives
- 1.00 - Liberal Education electives (#1 in restricted electives)
- 3.00 - Free electives - any approved elective for B.Sc. students

Of the total credits required, students are required to complete 16.00 credits in science of which a minimum of 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

### Minor (Honours Program)

Students in majors other than Zoology, Biodiversity, Wildlife Biology & Conservation and Marine & Freshwater Biology who have a strong interest in Zoology may choose to take a minor in Zoology.

A minor in Zoology requires a minimum of 5.00 credits, 4.00 of which must be from the following list:

<table>
<thead>
<tr>
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<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*2060</td>
<td>Ecology</td>
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<tr>
<td>BIOL*2400</td>
<td>Evolution</td>
<td>0.50</td>
</tr>
<tr>
<td>BIOL*3060</td>
<td>Populations, Communities &amp; Ecosystems</td>
<td>0.50</td>
</tr>
</tbody>
</table>

**Note:** The remaining 1.00 credits may also come from this list or from outside this list, in consultation with a faculty advisor.