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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Disclaimer

University of Guelph 2019

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.

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 Minister 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-supérieur-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) (c) 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 andhonours 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 involves the reduction 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: BIOL*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 consult with the appropriate faculty advisor.

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

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should consult with the appropriate faculty advisor.

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 (BIOD)
- 20.00 credits - Biological Science (BIOS)
- 20.00 credits - Bio-Medical Science (BIOM)
- 20.00 credits - Biomedical Toxicology (BTOX)
- 20.00 credits - Environmental Biology (ENVI)
- 20.00 credits - Food Science (FOOD)
- 20.00 credits - Human Kinetics (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)
- 20.00 credits - Zoology (ZOOL)

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

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 (ZOOL)
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.recruitguelph.ca/cecs/

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

GRS*2350 [0.50] Animal Production Systems, Health and Industry
BIOL*2580 [0.50] Introduction to Biochemistry
MBG*2040 [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*3170 [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
EQN*4020 [0.50] Advanced Equine Nutrition

Animal Physiology & Behaviour [0.50] Required
ANSC*3090 [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
BIOL*3560 [0.50] Structure and Function in Biochemistry
EQN*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.
Students must 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**
- BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
- CHEM*1040 [0.50] General Chemistry I
- MATH*1080 [0.50] Elements of Calculus II
- PHYS*1080 [0.50] Physics for Life Sciences
- 0.50 Liberal Education electives

**Semester 2**
- BIOL*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**
- BIOL*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**
- BIOL*3560 [0.50] Structure and Function in Biochemistry
- CHEM*2480 [0.50] Analytical Chemistry I
- CHEM*3750 [0.50] Organic Chemistry II
- electives or restricted electives to a maximum of 2.75 total credits

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

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

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

**Semester 8**
- BIOL*4540 [0.75] Enzymology
- 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 BIOL*4520, BIOL*4580, MCB*4050.
   - BIOL*4520 [0.50] Metabolic Processes
   - BIOL*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] Bacterial Genetics
   - 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
   - MCB*4510 [1.00] Research Project in Molecular & Cellular Biology
   - 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
   - PBI*3110 [0.50] Crop Physiology
   - PBI*4750 [0.50] Genetic Engineering of Plants
   - STAT*2050 [0.50] Statistics II
   - 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

**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

**Minor (Honours Program)**

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

- BIOL*3560 [0.50] Structure and Function in Biochemistry
- BIOL*3570 [0.75] Analytical Biochemistry
- BIOL*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:

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

**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.recruituoguelph.ca/cecc/). 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**

**Year** | **Fall** | **Winter** | **Summer**
---|---|---|---
1 | Academic Semester 1 | Academic Semester 2 | Off
2 | Academic Semester 3 | COOP*1000 Work Term I | Academic Semester 4
3 | Academic Semester 5 | COOP*2000 Work Term II | COOP*3000 Work Term III
4 | Academic Semester 6 | Academic Semester 7 | COOP*4000 Work Term IV
5 | Academic Semester 8 | N/A | N/A

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

**Year** | **Fall** | **Winter** | **Summer**
---|---|---|---
1 | Academic Semester 1 | Academic Semester 2 | Off
2 | Academic Semester 3 | COOP*1000 Work Term I | Academic Semester 4
3 | COOP*2000 Work Term II | Academic Semester 5 | COOP*3000 Work Term III
4 | Academic Semester 6 | Academic Semester 7 | COOP*4000 Work Term IV
5 | Academic Semester 8 | N/A | N/A
Students must take as part of their program: 0.50 credits from the following list:
- World of Viruses
- Protein and Nucleic Acid Structure

Restricted Electives

Students must take as part of their program: 0.50 credits from the following list:
- Metabolic Processes
- Membrane Biochemistry
- Applied Bioinformatics
- Biomedical Physiology
- Molecular Biology of the Gene
- Bacterial Genetics
- Cell Function and Signaling
- Advanced Cell Biology
- Protein and Nucleic Acid Structure
- Research Project in Molecular & Cellular Biology
- Research Project in Molecular & Cellular Biology
- Topics in Molecular and Cellular Biology
- Immunology
- World of Viruses
- Molecular Virology
- Immunology II
- Crop Physiology
- Genetic Engineering of Plants
- Statistics II
- Biochemical Toxicology

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

Sequence A

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

Semester 2 - Winter
- BIOL*1070 [0.50] Discovering Biodiversity
- BIOL*1080 [0.50] Biological Concepts of Health
- CHEM*1050 [0.50] General Chemistry II
- COOP*1100 [0.00] Introduction to Co-operative Education
- MATH*1080 [0.50] Elements of Calculus II
- PHYS*1070 [0.50] Physics for Life Sciences II

Summer Semester
- No academic semester or work term

Semester 3 - Fall
- BIOL*2580 [0.50] Introduction to Biochemistry
- CHEM*2480 [0.50] Analytical Chemistry I
- CHEM*2880 [0.50] Physical Chemistry
- MBG*2040 [0.50] Foundations in Molecular Biology and Genetics

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

Semester 4 - Summer
- BIOL*3570 [0.75] Analytical Biochemistry
- CHEM*2700 [0.50] Organic Chemistry I
- MICR*2420 [0.50] Introduction to Microbiology
- STAT*2040 [0.50] Statistics I

Winter Semester
- BIOL*3560 [0.50] Structure and Function in Biochemistry
- CHEM*3750 [0.50] Organic Chemistry II
- MCB*2050 [0.50] Molecular Biology of the Cell
- MICR*2430 [0.50] Methods in Microbial Culture and Physiology

Summer Semester
- No academic semester or work term

Semester 5 - Fall
- BIOL*3570 [0.75] Analytical Biochemistry
- CHEM*2700 [0.50] Organic Chemistry I
- MICR*2420 [0.50] Introduction to Microbiology
- STAT*2040 [0.50] Statistics I

Winter Semester
- BIOL*3560 [0.50] Structure and Function in Biochemistry
- MCB*2050 [0.50] Molecular Biology of the Cell
- MICR*2430 [0.50] Methods in Microbial Culture and Physiology

Sequence B

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

Semester 2 - Winter
- BIOL*1070 [0.50] Discovering Biodiversity
- BIOL*1080 [0.50] Biological Concepts of Health
- CHEM*1050 [0.50] General Chemistry II
- COOP*1100 [0.00] Introduction to Co-operative Education
- MATH*1080 [0.50] Elements of Calculus II
- PHYS*1070 [0.50] Physics for Life Sciences II

Summer Semester
- No academic semester or work term

Semester 3 - Fall
- BIOL*2580 [0.50] Introduction to Biochemistry
- CHEM*2480 [0.50] Analytical Chemistry I
- CHEM*2880 [0.50] Physical Chemistry
- MBG*2040 [0.50] Foundations in Molecular Biology and Genetics

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

Semester 4 - Summer
- BIOL*3570 [0.75] Analytical Biochemistry
- CHEM*2700 [0.50] Organic Chemistry I
- MICR*2420 [0.50] Introduction to Microbiology
- STAT*2040 [0.50] Statistics I

Winter Semester
- BIOL*3560 [0.50] Structure and Function in Biochemistry
- CHEM*3750 [0.50] Organic Chemistry II
- MCB*2050 [0.50] Molecular Biology of the Cell
- MICR*2430 [0.50] Methods in Microbial Culture and Physiology

2.50 electives or restricted electives

X. Degree Programs, Bachelor of Science (B.Sc.)
The major in Biodiversity is a flexible program that allows students, in consultation with faculty advisors, to pursue their own interests and design a customized program of study. For example, students may wish to select their electives to focus on a particular taxonomic group such as microbes, plants, invertebrates, or vertebrates, and/or one of the three areas of research strength in the Department of Integrative Biology: physiology, ecology, or evolution.

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. A minimum of 0.50 credits from:
   - BOT*2100 [0.50] Life Strategies of Plants
   - BOT*3050 [0.50] Plant Functional Ecology
   - ZOO*3600 [0.50] Comparative Animal Physiology I

3. A minimum of 0.50 credits from:
   - BOT*3310 [0.50] Plant Growth and Development
   - BOT*3410 [0.50] Plant Anatomy
   - ZOO*3650 [0.50] Developmental Biology

4. A minimum of 0.50 credits from the following list. Biodiversity students are strongly encouraged to take at least one field course. Students should keep in mind that some of these courses have prerequisites that are not required courses for the BIOD major and should plan their programs accordingly.
   - BIOL*4410 [0.75] Field Ecology
   - BIOL*4610 [0.75] Arctic Ecology
   - BIOL*4700 [0.50] Field Ecology
   - BIOL*4710 [0.25] Field Ecology
   - BIOL*4800 [0.50] Field Ecology
   - BIOL*4810 [0.25] Field Ecology
   - 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

**Restrictive Electives**

1. Students must take at least 1.00 credits from BIOC*4520, BIOC*4580, MCB*4050. At least 1.00 of these credits from BIOC*4520, BIOC*4580, MCB*4050.

2. A minimum of 0.50 credits from:
   - BOT*3710 [0.50] Plant Diversity and Evolution
   - ENVS*3090 [0.50] Insect Diversity and Biology
   - IBIO*3100 [0.50] Interpreting Biodiversity I

3. A minimum of 0.50 credits from:
   - BOT*3310 [0.50] Plant Growth and Development
   - BOT*3410 [0.50] Plant Anatomy

4. A minimum of 0.50 credits from the following list. Biodiversity students are strongly encouraged to take at least one field course. Students should keep in mind that some of these courses have prerequisites that are not required courses for the BIOD major and should plan their programs accordingly.
   - BIOL*4410 [0.75] Field Ecology
   - BIOL*4610 [0.75] Arctic Ecology
   - BIOL*4700 [0.50] Field Ecology
   - BIOL*4710 [0.25] Field Ecology
   - BIOL*4800 [0.50] Field Ecology
   - BIOL*4810 [0.25] Field Ecology
   - 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.**
Biological and Medical Physics (BMPH)

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**

- 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

Note: PHYS*1510 is recommended

**Semester 2**

- 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**

- 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**

- 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

**Semester 5**

- IPS*3000 [0.50] Science Communication
- PHYS*3130 [0.50] Mathematical Physics
- PHYS*3230 [0.50] Quantum Mechanics I

1.00 electives **

**Semester 6**

- 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 **

**Semester 7**

- PHYS*3170 [0.50] Radioactivity and Radiation Interactions
- PHYS*4500 [0.50] Advanced Physics Laboratory

One of:
- PHYS*4001 [0.50] Research in Physics

0.50 electives

1.00 electives **

**Semester 8**

- PHYS*4070 [0.50] Clinical Applications of Physics in Medicine

One of:
- PHYS*4002 [0.50] Research in Physics

0.50 electives **

1.50 electives **

Note: PHYS*4001/2 will be projects in biological or medical physics, some of which may be in areas outside the Department of Physics.

**At least 1.00 credits of Liberal Education electives are required. In addition, 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
- 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

**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.

**Biological and Medical Physics (Co-op) (BMPH:C)**

Department of Physics, College of Engineering and Physical Sciences

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.recruitguelph.ca/cecs/). 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

**Year** | **Fall** | **Winter** | **Summer**
---|---|---|---
1 | Academic Semester 1 | Academic Semester 2 | Off
2 | Academic Semester 3 | COOP*1100 | COOP*1000 Work Term I
3 | Academic Semester 5 | COOP*2000 Work Term II | COOP*3000 Work Term III
4 | Academic Semester 6 | Academic Semester 7 | COOP*4000 Work Term IV
5 | COOP*5000 Work Term V | Academic Semester 8 | 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 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
BIOC*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
BIOC*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*2240 [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*3320 [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)

Semester 6 - Fall
PHYS*3000 [0.50] Co-op Work Term III
(8-month work term in conjunction with COOP*2000)
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] Advanced Physics Laboratory
PHYS*4500 [0.50] Applications of Physics in Medicine
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

BIOC*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
BIOC*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
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

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)
2.50 credits from:
XSEN*3200 [0.50] Pharmaceutical Organic Chemistry
XSEN*3210 [0.50] Introduction to Pharmaceutical Manufacturing

2019-2020 Undergraduate Calendar
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:
   BIOL*3560 [0.50] Structure and Function in Biochemistry
   BIOL*4520 [0.50] Metabolic Processes
   BIOL*4540 [0.50] Enzymology **
   BIOL*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 **
   MIRC*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)

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.

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>
<tbody>
<tr>
<td>1</td>
<td>Academic Semester 1</td>
<td>Academic Semester 2 COOP*1100</td>
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<td>Academic Semester 3</td>
<td>COOP*1000 Work Term I</td>
<td>Academic Semester 4</td>
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<td>3</td>
<td>Academic Semester 5</td>
<td>Academic Semester 6 COOP*2000 Work Term II</td>
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<tr>
<td>4</td>
<td>COOP*3000 Work Term III</td>
<td>Academic Semester 7 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)*

4.00 - First year science credits
6.00 - 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)
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

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
0.50 Liberal Education electives

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:

2019-2020 Undergraduate Calendar
Chemistry of the Elements I  
**Pharmaceutical Product Formulations**  
**Pharmacology and Applied Toxicology**  
**Structure and Function in Biochemistry**  
Chemistry Research Project II  
**A minimum of 0.50 credits in Ecology:**  
**Statistics I**  
**Co-op Work Term IV**  
[0.50] Occupational Health and Chemistry  
**XSEN*3040 [0.50]**  
**XSEN*3060 [0.50]**  
**XSEN*3070 [0.50]**  
**XSEN*3090 [0.50]**  
**XSEN*3200 [0.50]**  
**XSEN*3210 [0.50]**  
**Introduction to Pharmaceutical Manufacturing**  
**Biological Science (BIOS)**  
**College of Biological Science**  
**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.queensu.ca/bioc/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*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.queensu.ca/bioc/](https://www.queensu.ca/bioc/)  
2. A minimum of 0.50 credits in Ecology:  
BIOL*2060 [0.50] Ecology
Introduction to Computer Applications
At least 2.00 credits of Liberal Education electives are required. The list of Liberal Biological Concepts of Health
Advanced Study Electives - 2.00 credits from BIOM*4030, BIOM*4050, BIOM*4070, 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)

<table>
<thead>
<tr>
<th>Semester</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BIOL<em>1080 [0.50] Biological Concepts of Health, CHEM</em>1040 [0.50] General Chemistry I, MATH<em>1080 [0.50] Elements of Calculus I, PHYS</em>1080 [0.50] Physics for Life Sciences</td>
</tr>
<tr>
<td>2</td>
<td>BIOL<em>1070 [0.50] Discovering Biodiversity, BIOL</em>1090 [0.50] Introduction to Molecular and Cellular Biology, CHEM<em>1050 [0.50] General Chemistry II, PHYS</em>1070 [0.50] Physics for Life Sciences II</td>
</tr>
<tr>
<td>3</td>
<td>BIOL<em>1070, MBG</em>2040 [0.50] Foundations in Molecular Biology and Genetics, STAT*2040 [0.50] Statistics I</td>
</tr>
<tr>
<td>4</td>
<td>MCB<em>2050 [0.50] Molecular Biology of the Cell, NUTR</em>3210 [0.50] Fundamentals of Nutrition, BIOM<em>3200 [1.00] Biomedical Physiology, HK</em>2810 [0.50] Human Physiology I - Concepts and Principles</td>
</tr>
<tr>
<td>5</td>
<td>BIOL<em>1070, MBG</em>2040, PATH<em>3610 [0.50] Principles of Pathology, POMP</em>3240 [0.50] Epidemiology</td>
</tr>
<tr>
<td>6</td>
<td>BIOL<em>3090 [0.50] Principles of Pharmacology, PATH</em>3610, POMP*3240</td>
</tr>
</tbody>
</table>

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

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

Semester 3 (see admission statement above)
- BIOL*2580 [0.50] Introduction to Biochemistry
- MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
- STAT*2040 [0.50] Statistics I

Semester 4
- MCB*2050 [0.50] Molecular Biology of the Cell
- NUTR*3210 [0.50] Fundamentals of Nutrition
- BIOM*3200 [1.00] Biomedical Physiology
- HK*2810 [0.50] Human Physiology I - Concepts and Principles

Semester 5
- BIOL*3090 [0.50] Principles of Pharmacology
- PATH*3610 [0.50] Principles of Disease
- POMP*3240 [0.50] Epidemiology

Semester 6
- BIOL*3090; PATH*3610; POMP*3240

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*4560 or MIRC*3230
3. Advanced Study Electives - 2.00 credits from BIOM*4030, BIOM*4050, BIOM*4070, MATH*4090, BIOM*4110, BIOM*4150, BIOM*4180, BIOM*4300, BIOM*4500, BIOM*4510, BIOM*4521, 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/
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**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1090</td>
<td>[0.50] Introduction to Molecular and Cellular Biology</td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>[0.50] General Chemistry I</td>
</tr>
<tr>
<td>MATH*1080</td>
<td>[0.50] Elements of Calculus I</td>
</tr>
<tr>
<td>PHYS*1080</td>
<td>[0.50] Physics for Life Sciences</td>
</tr>
</tbody>
</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](https://www.uoguelph.ca/bsc/revised_SS)

**Semester 2**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BIOL*1080</td>
<td>[0.50] Biological Concepts of Health</td>
</tr>
<tr>
<td>CHEM*1050</td>
<td>[0.50] General Chemistry II</td>
</tr>
<tr>
<td>PHYS*1070</td>
<td>[0.50] Physics for Life Sciences II</td>
</tr>
<tr>
<td>STAT*2040</td>
<td>[0.50] Statistics I</td>
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</table>

0.50 Liberal Education electives

**Semester 3**

<table>
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<tr>
<th>Course</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BIOC*2580</td>
<td>[0.50] Introduction to Biochemistry</td>
</tr>
<tr>
<td>MBG*2040</td>
<td>[0.50] Foundations in Molecular Biology and Genetics</td>
</tr>
<tr>
<td>TOX*2000</td>
<td>[0.50] Principles of Toxicology</td>
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1.00 elective or Liberal Education electives

**Semester 4**

<table>
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<th>Course</th>
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<tr>
<td>BIOM*3200</td>
<td>[1.00] Biomedical Physiology</td>
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<tr>
<td>CHEM*2480</td>
<td>[0.50] Analytical Chemistry I</td>
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<tr>
<td>CHEM*2700</td>
<td>[0.50] Organic Chemistry I</td>
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0.50 electives or restricted electives**

**Semester 5**

<table>
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<th>Course</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BIOC*3560</td>
<td>[0.50] Structure and Function in Biochemistry</td>
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<tr>
<td>MCB*2050</td>
<td>[0.50] Molecular Biology of the Cell</td>
</tr>
<tr>
<td>NUTR*3210</td>
<td>[0.50] Fundamentals of Nutrition</td>
</tr>
<tr>
<td>TOX*3300</td>
<td>[0.50] Analytical Toxicology</td>
</tr>
</tbody>
</table>

0.50 electives or restricted electives**

**Semester 6**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOM*3090</td>
<td>[0.50] Principles of Pharmacology</td>
</tr>
<tr>
<td>PATH*3610</td>
<td>[0.50] Principles of Disease</td>
</tr>
<tr>
<td>TOX*3360</td>
<td>[0.50] Environmental Chemistry and Toxicology</td>
</tr>
</tbody>
</table>

One of:

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOM*3040</td>
<td>[0.75] Medical Embryology</td>
</tr>
<tr>
<td>MBG*3350</td>
<td>[0.75] Laboratory Methods in Molecular Biology</td>
</tr>
</tbody>
</table>

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

**Semester 7**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUTR*4510</td>
<td>[0.50] Toxicology, Nutrition and Food</td>
</tr>
<tr>
<td>TOX*4000</td>
<td>[0.50] Medical Toxicology</td>
</tr>
<tr>
<td>TOX*4590</td>
<td>[0.50] Biochemical Toxicology</td>
</tr>
</tbody>
</table>

1.00 electives or restricted electives**

**Semester 8**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOM*4090</td>
<td>[0.50] Pharmacology</td>
</tr>
<tr>
<td>TOX*4100</td>
<td>[0.50] Toxicological Pathology</td>
</tr>
<tr>
<td>TOX*4200</td>
<td>[0.50] Topics in Toxicology</td>
</tr>
</tbody>
</table>

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.**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSC*4650</td>
<td>[0.50] Comparative Immunology</td>
</tr>
<tr>
<td>BIOM*3040</td>
<td>[0.75] Medical Embryology</td>
</tr>
<tr>
<td>BIOM*4050</td>
<td>[0.50] Biomedical Aspects of Aging</td>
</tr>
<tr>
<td>BIOM*4070</td>
<td>[0.50] Biomedical Histology</td>
</tr>
<tr>
<td>BIOM*4150</td>
<td>[0.50] Cancer Biology</td>
</tr>
<tr>
<td>CHEM*3750</td>
<td>[0.50] Organic Chemistry II</td>
</tr>
<tr>
<td>CHEM*3760</td>
<td>[0.50] Organic Chemistry III</td>
</tr>
<tr>
<td>CHEM*4740</td>
<td>[0.50] Topics in Bio-Organic Chemistry</td>
</tr>
<tr>
<td>MBG*3040</td>
<td>[0.50] Molecular Biology of the Gene</td>
</tr>
<tr>
<td>MBG*3350</td>
<td>[0.75] Laboratory Methods in Molecular Biology</td>
</tr>
<tr>
<td>MBG*4270</td>
<td>[0.50] DNA Replication, Recombination and Repair</td>
</tr>
</tbody>
</table>

**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

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 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/](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

<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>COOP*2000 Work Term II</td>
</tr>
<tr>
<td>3</td>
<td>Academic Semester 4</td>
<td>Academic Semester 5</td>
<td>COOP*3000 Work Term III</td>
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<tr>
<td>4</td>
<td>COOP*4000 Work Term IV</td>
<td>Academic Semester 6</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 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**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>BIOL*1090</td>
<td>[0.50] Introduction to Molecular and Cellular Biology</td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>[0.50] General Chemistry I</td>
</tr>
<tr>
<td>MATH*1080</td>
<td>[0.50] Elements of Calculus I</td>
</tr>
<tr>
<td>PHYS*1080</td>
<td>[0.50] Physics for Life Sciences</td>
</tr>
</tbody>
</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

<table>
<thead>
<tr>
<th>Semester 2 - Winter</th>
<th>0.50 Liberal Education electives</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*2580 [0.50]</td>
<td>Introduction to Biochemistry</td>
</tr>
<tr>
<td>CHEM*2480 [0.50]</td>
<td>Analytical Chemistry I</td>
</tr>
<tr>
<td>MG*2040 [0.50]</td>
<td>Foundations in Molecular Biology and Genetics</td>
</tr>
<tr>
<td>TOX*2000 [0.50]</td>
<td>Principles of Toxicology</td>
</tr>
<tr>
<td></td>
<td>0.50 Liberal Education electives</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 3 - Fall</th>
<th>0.50 Co-op Work Term I</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*1000 [0.50]</td>
<td>Co-op Work Term I</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 4 - Fall</th>
<th>0.50 Co-op Work Term II</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*3550 [0.50]</td>
<td>Structure and Function in Biochemistry</td>
</tr>
<tr>
<td>MCB*2050 [0.50]</td>
<td>Molecular Biology of the Cell</td>
</tr>
<tr>
<td>NUTR*3210 [0.50]</td>
<td>Fundamentals of Nutrition</td>
</tr>
<tr>
<td>TOX*3300 [0.50]</td>
<td>Analytical Toxicology</td>
</tr>
<tr>
<td></td>
<td>0.50 electives or restricted electives*</td>
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</table>

<table>
<thead>
<tr>
<th>Semester 5 - Winter</th>
<th>0.50 Co-op Work Term III</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*3000 [0.50]</td>
<td>Co-op Work Term III</td>
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<table>
<thead>
<tr>
<th>Semester 6 - Winter</th>
<th>0.50 Co-op Work Term IV</th>
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<tbody>
<tr>
<td>BIOM*3090 [0.50]</td>
<td>Principles of Pharmacology</td>
</tr>
<tr>
<td>PATH*3610 [0.50]</td>
<td>Principles of Disease</td>
</tr>
<tr>
<td></td>
<td>BIOM*3040 [0.75] Medical Embryology</td>
</tr>
<tr>
<td></td>
<td>MBG*3350 [0.75] Laboratory Methods in Molecular Biology *</td>
</tr>
<tr>
<td>Electives or restricted electives to a maximum of 2.75 total credits in this semester</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 7 - Fall</th>
<th>0.50 Co-op Work Term IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*4090 [0.50]</td>
<td>Pharmacology</td>
</tr>
<tr>
<td>TOX*4900 [1.00]</td>
<td>Toxicology Research Project I</td>
</tr>
<tr>
<td></td>
<td>1.00 electives or restricted electives*</td>
</tr>
</tbody>
</table>

**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.

<table>
<thead>
<tr>
<th>Electives or restricted electives to 2.50 credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSC*4650 [0.50] Comparative Immunology</td>
</tr>
<tr>
<td>BIOM*3040 [0.50] Medical Embryology</td>
</tr>
<tr>
<td>BIOM*4050 [0.50] Biomedical Aspects of Aging</td>
</tr>
<tr>
<td>BIOM*4070 [0.50] Biomedical Histology</td>
</tr>
<tr>
<td>BIOM*4150 [0.50] Cancer Biology</td>
</tr>
<tr>
<td>CHEM*3750 [0.50] Organic Chemistry II</td>
</tr>
<tr>
<td>CHEM*3760 [0.50] Organic Chemistry III</td>
</tr>
<tr>
<td>CHEM*4740 [0.50] Topics in Bio-Organic Chemistry</td>
</tr>
<tr>
<td>MBG*3040 [0.50] Molecular Biology of the Gene</td>
</tr>
<tr>
<td>MBG*3350 [0.75] Laboratory Methods in Molecular Biology</td>
</tr>
<tr>
<td>MBG*4270 [0.50] DNA Replication, Recombination and Repair</td>
</tr>
<tr>
<td>MCB*4010 [0.50] Advanced Cell Biology</td>
</tr>
<tr>
<td>MICR*3230 [0.50] Immunology</td>
</tr>
<tr>
<td>NUTR*4090 [0.50] Functional Foods and Nutraceuticals</td>
</tr>
<tr>
<td>NUTR*4320 [0.50] Nutrition and Metabolic Control of Disease</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electives or restricted electives to 1.00 credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PATH*3040 [0.50] Principles of Parasitology</td>
</tr>
<tr>
<td>POPM*3240 [0.50] Epidemiology</td>
</tr>
<tr>
<td>POPM*4040 [0.50] Epidemiology of Food-borne Diseases</td>
</tr>
<tr>
<td>STAT*2050 [0.50] Statistics II</td>
</tr>
<tr>
<td>STAT*3510 [0.50] Environmental Risk Assessment</td>
</tr>
<tr>
<td>TOX*4900 [1.00] Toxicology Research Project I</td>
</tr>
<tr>
<td>TOX*4910 [1.00] Toxicology Research Project II</td>
</tr>
</tbody>
</table>

**Biotechnology (BIOT)**

Department of Molecular and Cellular Biology, College of Biological Science

**Minor (Honours Program)**

A minimum of 5.00 credits is required including:

<table>
<thead>
<tr>
<th>Electives or restricted electives to 1.00 credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECON*1050 [0.50] Introductory Microeconomics</td>
</tr>
<tr>
<td>ECON*1100 [0.50] Introductory Macroeconomics</td>
</tr>
<tr>
<td>ECON*2100 [0.50] Economic Growth and Environmental Quality</td>
</tr>
<tr>
<td>ECON*2310 [0.50] Intermediate Microeconomics</td>
</tr>
<tr>
<td>ECON*2410 [0.50] Intermediate Macroeconomics</td>
</tr>
<tr>
<td>MCS*1000 [0.50] Introductory Marketing</td>
</tr>
</tbody>
</table>

A minimum of 1.50 credits from:

<table>
<thead>
<tr>
<th>Electives or restricted electives to 0.75 credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSC*4050 [0.50] Biotechnology in Animal Science</td>
</tr>
<tr>
<td>BIOC*4540 [0.75] Enzymology</td>
</tr>
<tr>
<td>BIOL*3300 [0.50] Applied Bioinformatics</td>
</tr>
<tr>
<td>FOOD*3270 [0.50] Industrial Microbiology</td>
</tr>
<tr>
<td>MBG*3660 [0.50] Genomics</td>
</tr>
<tr>
<td>MBG*4240 [0.50] Applied Molecular Genetics in Medicine and Biotechnology</td>
</tr>
<tr>
<td>MCB*4050 [0.50] Protein and Nucleic Acid Structure</td>
</tr>
<tr>
<td>MICR*3230 [0.50] Immunology</td>
</tr>
<tr>
<td>PBIO*3750 [0.50] Plant Tissue Culture</td>
</tr>
<tr>
<td>PBIO*4750 [0.50] Genetic Engineering of Plants</td>
</tr>
</tbody>
</table>

**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:

<table>
<thead>
<tr>
<th>Electives or restricted electives to 1.00 credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACCT*1220 [0.50] Introductory Financial Accounting</td>
</tr>
<tr>
<td>ACCT*2230 [0.50] Management Accounting</td>
</tr>
<tr>
<td>ECON*1050 [0.50] Introductory Microeconomics</td>
</tr>
<tr>
<td>ECON*1100 [0.50] Introductory Macroeconomics</td>
</tr>
<tr>
<td>ECON*2310 [0.50] Intermediate Microeconomics</td>
</tr>
<tr>
<td>ECON*2410 [0.50] Intermediate Macroeconomics</td>
</tr>
<tr>
<td>ECON*2560 [0.50] Introduction to Finance</td>
</tr>
</tbody>
</table>

One of:

<table>
<thead>
<tr>
<th>Electives or restricted electives to 0.50 credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPS*1500 [1.00] Integrated Mathematics and Physics I</td>
</tr>
<tr>
<td>MATH*1030 [0.50] Business Mathematics</td>
</tr>
<tr>
<td>MATH*1080 [0.50] Elements of Calculus I</td>
</tr>
<tr>
<td>MATH*1200 [0.50] Calculus I</td>
</tr>
</tbody>
</table>

One of:

<table>
<thead>
<tr>
<th>Electives or restricted electives to 0.50 credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECON*2740 [0.50] Economic Statistics</td>
</tr>
<tr>
<td>PSYC*1010 [0.50] Making Sense of Data in Psychological Research</td>
</tr>
<tr>
<td>SOAN*2120 [0.50] Introductory Methods</td>
</tr>
<tr>
<td>STAT*2040 [0.50] Statistics I</td>
</tr>
<tr>
<td>STAT*2060 [0.50] Statistics for Business Decisions</td>
</tr>
<tr>
<td>STAT*2080 [0.50] Introductory Applied Statistics I</td>
</tr>
<tr>
<td>STAT*2120 [0.50] Probability and Statistics for Engineers</td>
</tr>
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</table>

One of:

<table>
<thead>
<tr>
<th>Electives or restricted electives to 0.50 credits</th>
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</thead>
<tbody>
<tr>
<td>ECON*3660 [0.50] Investments</td>
</tr>
<tr>
<td>ECON*4400 [0.50] Managerial Economics</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>CTS*1300</td>
<td>0.50</td>
</tr>
<tr>
<td>IPS*1500</td>
<td>1.00</td>
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<tr>
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</tr>
<tr>
<td>BIOL*1070</td>
<td>0.50</td>
</tr>
<tr>
<td>BIOL*1080</td>
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</tr>
<tr>
<td>BIOL*1090</td>
<td>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

Semester 2

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
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<tr>
<td>IPS*1510</td>
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<td>MATH*1160</td>
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<tr>
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<tr>
<td>BIOL*1080</td>
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Semester 3

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
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</thead>
<tbody>
<tr>
<td>CHEM*2060</td>
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<tr>
<td>MATH*2200</td>
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<tr>
<td>MATH*2270</td>
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<tr>
<td>PHYS*2330</td>
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</table>

0.50 Liberal Education electives

Semester 4

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
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</thead>
<tbody>
<tr>
<td>CHEM*2070</td>
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<tr>
<td>CHEM*2480</td>
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<td>PHYS*2180</td>
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<td>PHYS*2340</td>
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</table>

Semester 5

<table>
<thead>
<tr>
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<th>Credit</th>
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</thead>
<tbody>
<tr>
<td>CHEM*3860</td>
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<tr>
<td>PHYS*3130</td>
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<td>PHYS*3230</td>
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<td>CHEM*2820</td>
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<td>PHYS*2240</td>
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<td>IPS*3000</td>
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0.50 electives

Semester 6

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
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</thead>
<tbody>
<tr>
<td>CHEM*3430</td>
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<tr>
<td>NANO*3600</td>
<td>0.50</td>
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<tr>
<td>PHYS*3000</td>
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<tr>
<td>PHYS*4040</td>
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<tr>
<td>CHEM*3870</td>
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<tr>
<td>CHEM*4880</td>
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Semester 7

<table>
<thead>
<tr>
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<th>Credit</th>
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</thead>
<tbody>
<tr>
<td>CHEM*3440</td>
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</tr>
<tr>
<td>PHYS*4120</td>
<td>0.50</td>
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<tr>
<td>PHYS*4240</td>
<td>0.50</td>
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<tr>
<td>One of:</td>
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<tr>
<td>PHYS*4001</td>
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0.50 electives + 0.50 electives

Semester 8

One of:

<table>
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<tr>
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<tr>
<td>CHEM*3870</td>
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<tr>
<td>CHEM*4880</td>
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One of:

<table>
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<tbody>
<tr>
<td>CHEM*4900</td>
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One of:

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</thead>
<tbody>
<tr>
<td>IPS*3000</td>
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</table>

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/cecs/). Please refer to the Co-operative Education program policy with respect to adjusting this schedule.

Chemical Physics Academic and Co-op Work Term Schedule

<table>
<thead>
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<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*1000 Work Term  I</td>
<td>Academic Semester 4</td>
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<td>COOP*2000 Work Term  II</td>
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<td>COOP*3000 Work Term  III</td>
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<td>Academic Semester 6</td>
<td>COOP*4000 Work Term  IV</td>
<td>COOP*5000 Work Term  V</td>
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<td>5</td>
<td>Academic Semester 7</td>
<td>Academic Semester 8</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
10.50 - 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

Major (Honours Program)

Semester 1 - Fall

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
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<tbody>
<tr>
<td>CHEM*1040</td>
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</tr>
<tr>
<td>CIS*1300</td>
<td>0.50</td>
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</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 - 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
0.50 Liberal Education electives

Semester 4 - Winter
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

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

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

Semester 5 - Winter
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 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*3820 [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 7** - 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 may 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

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

Semester 3
BIOL*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 *

Semester 4
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* or restricted electives**

Semester 5
CHEM*2820 [0.50] Thermodynamics 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
CHEM*3650 [0.50] Chemistry of the Elements II
CHEM*3760 [0.50] Organic Chemistry III
1.50 electives* or restricted 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.
** A minimum of 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.recruituoguelph.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

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<th>Winter</th>
<th>Summer</th>
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<td>Academic Semester 1</td>
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<tr>
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<td>COOP*1100</td>
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<td>Academic Semester 3</td>
<td>COOP*1000 Work Term I</td>
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<td>Academic Semester 6</td>
<td>Academic Semester 7</td>
<td>COOP*4000 Work Term IV</td>
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<td>5</td>
<td>Academic Semester 8</td>
<td>N/A</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 (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*2600 [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] Thermodynamics 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 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:
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)

- **CIS**1300 [0.50] Programming
- **CIS**1910 [0.50] Discrete Structures in Computing I
- **CIS**2170 [0.75] User Interface Design
- **CIS**2430 [0.50] Object Oriented Programming
- **CIS**2500 [0.50] Intermediate Programming
- **CIS**2520 [0.50] Data Structures
- **CIS**2750 [0.75] Software Systems Development and Integration

0.50 additional credits from CIS courses at the 2000 level or above

0.50 additional credits from CIS courses at the 3000 level or above

**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 [0.50] Ecology
- **BIOL**3010 [0.50] Laboratory and Field Work in Ecology
- **BIOL**3060 [0.50] Populations, Communities & Ecosystems
- **BIOL**4110 [1.00] Ecological Methods
- **BIOL**4120 [0.50] Evolutionary Ecology

Of the remaining 2.00 required credits, students will select from the following:

At least one of:

- **BIOL**2400 [0.50] Evolution
- **BIOL**3020 [0.50] Population Genetics

At least one of:

- **BOT**2100 [0.50] Life Strategies of Plants
- **ZOO**2090 [0.50] Vertebrate Structure and Function

One of:

- **GEOG**1220 [0.50] Human Impact on the Environment
- **GEOG**1300 [0.50] Introduction to the Biophysical Environment

**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**

- **BIOL**1070 [0.50] Discovering Biodiversity
- **CHEM**1040 [0.50] General Chemistry I
- **ENVS**1100 [0.50] Fundamentals of Environmental Sciences
- **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
- **STAT**2040 [0.50] Statistics I

0.50 Liberal Education elective

**Semester 3**

- **BIOC**2580 [0.50] Introduction to Biochemistry
- **STAT**2040 [0.50] Statistics I (if not taken in semester 2)
- **TOX**2600 [0.50] Principles of Toxicology

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**

- **BIOL**2060 [0.50] Ecology
- **ENVS**2090 [0.50] Problem Solving in Environmental Biology
- **MBG**2040 [0.50] Foundations in Molecular Biology and Genetics

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 [0.50] Project in Environmental Sciences

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 [0.50] Toxicological Risk Assessment
- **ENVS**4002 [0.50] Project in Environmental Sciences

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

**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/

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:

- **BIOL**2040 [0.50] Evolution
- **ENVS**2040 [0.50] Plant Health and the Environment
- **ENVS**2060 [0.50] Soil Science
- **ENVS**2330 [0.50] Current Issues in Ecosystem Science and Biodiversity
- **ENVS**3010 [0.50] Climate Change Biology
- **ENVS**3020 [0.50] Pesticides and the Environment
- **ENVS**3040 [0.50] Natural Chemicals in the Environment
- **ENVS**3150 [0.50] Aquatic Systems
- **ENVS**3220 [0.50] Terrestrial Chemistry
- **ENVS**3340 [0.50] Use and Management of Environmental Data
- **ENVS**3370 [0.50] Terrestrial Ecosystem Ecology

**List B - Organismal Biology**

Minimum of 1.00 credits from the following list:

- **BOT**2100 [0.50] Life Strategies of Plants
- **BOT**3050 [0.50] Plant Functional Ecology
- **ENVS**2080 [0.50] Introduction to Environmental Microbiology
- **ENVS**3090 [0.50] Insect Diversity and Biology
- **ENVS**4230 [0.50] Biology of Aquatic Insects
- **MIRC**3090 [0.50] Mycology
- **ZOO**4070 [0.50] Animal Behaviour

**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**
  - **ENVS**3230 [0.50] Agroforestry Systems
  - **ENVS**3250 [0.50] Forest Health and Disease
  - **ENVS**3270 [0.50] Forest Biodiversity
  - **ENVS**4350 [0.50] Forest Ecology

- **Soil/Aquatic Systems**
  - **ENVS**3060 [0.50] Groundwater
  - **ENVS**3080 [0.50] Soil and Water Conservation
  - **ENVS**3310 [0.50] Soil Biodiversity and Ecosystem Function
  - **ENVS**4090 [0.50] Soil Management
  - **ENVS**4160 [0.50] Soil and Nutrient Management
  - **ENVS**4320 [1.00] Laboratory and Field Methods in Soil Biodiversity
  - **ENVS**4390 [1.00] Soil Variability and Land Evaluation

- **Environmental Toxicology/Pollutants**
  - **BIOL**4350 [0.50] Limnology of Natural and Polluted Waters
  - **ENVS**3290 [0.50] Waterborne Disease Ecology
  - **ENVS**4180 [0.50] Insecticide Biological Activity and Resistance
  - **ENVS**4190 [0.50] Biological Activity of Herbicides
  - **ENVS**4370 [0.50] Environmental Organic Chemistry
**X. Degree Programs, Bachelor of Science (B.Sc.)**

PBIO*4530 [0.50] Plants and Environmental Pollution
TOX*3360 [0.50] Environmental Chemistry and Toxicology
Conservation of Biodiversity and Plant Protection
BIOL*3060 [0.50] Populations, Communities & Ecosystems
BIOL*3130 [0.50] Conservation Biology
BIOL*4150 [0.50] Wildlife Conservation and Management
BIOL*4500 [0.50] Natural Resource Policy Analysis
ENVS*2120 [0.50] Introduction to Environmental Stewardship
ENVS*3210 [0.50] Plant Pathology
ENVS*4070 [0.50] Pollinator Conservation
ENVS*4100 [0.50] Integrated Management of Invasive Insect Pests
ENVS*4260 [0.50] Field Entomology
ENVS*4350 [0.50] Forest Ecology
ENVS*4390 [1.00] Soil Variability and Land Evaluation
PBIO*4000 [0.50] Molecular and Cellular Aspects of Plant-Microbe Interactions
PBIO*4750 [0.50] Genetic Engineering of Plants

**List D - Independent Research and Study Courses**

BIOL*4610 [0.75] Arctic Ecology
ENVS*3030 [0.50] Conservation Field Course
ENVS*4260 [0.50] Field Entomology
ENVS*4410 [0.50] Introduction to Advanced Independent Research
ENVS*4420 [0.50] Advanced Independent Research
ENVS*4430 [1.00] Advanced Independent Research
ENVS*4510 [0.50] Topics in Environmental Sciences

**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>
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<tr>
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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**

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<td>0.50 Liberal Education electives* (GEOG*1220 is recommended)</td>
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**Semester 3**

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Last Revision: July 4, 2019

2019-2020 Undergraduate Calendar
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)*

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Notes:
1. ENGL*1200 is recommended for those students needing to improve their English grammar.
2. FOOD*2150 could be replaced by FOOD*2010 with permission of department advisor.
3. Of the 6.50 electives credits:
a. At 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:**

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**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.**

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**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.recruitagrophilp.ca/cecs/). Please refer to the Co-operative Education program policy with respect to adjusting this schedule.

Food Science Academic Co-op Work Term Schedule

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<th>Fall Semester</th>
<th>Winter Semester</th>
<th>Summer Semester</th>
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<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 adjusting this schedule. 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.
### 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:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOG*1300</td>
<td>Introduction to the Biophysical Environment</td>
<td>0.50</td>
</tr>
<tr>
<td>GEOG*2420</td>
<td>The Earth From Space</td>
<td>0.50</td>
</tr>
<tr>
<td>GEOG*2480</td>
<td>Mapping and GIS</td>
<td>0.50</td>
</tr>
<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*4480</td>
<td>Applied Geomatics</td>
<td>1.00</td>
</tr>
</tbody>
</table>

And at least 1.50 credits from:

<table>
<thead>
<tr>
<th>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>GEOG*3110</td>
<td>Biotic and Natural Resources</td>
<td>0.50</td>
</tr>
<tr>
<td>GEOG*3210</td>
<td>Management of the Biophysical Environment</td>
<td>0.50</td>
</tr>
<tr>
<td>GEOG*4110</td>
<td>Environmental Systems Analysis</td>
<td>1.00</td>
</tr>
<tr>
<td>GEOG*4210</td>
<td>Environmental Governance</td>
<td>0.50</td>
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</table>

### 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%, 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

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1080</td>
<td>Biological Concepts of Health</td>
<td>0.50</td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>General Chemistry I</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>
</tbody>
</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](https://www.uoguelph.ca/bsc/revised_SS)

#### Semester 2

<table>
<thead>
<tr>
<th>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>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</td>
<td>0.50</td>
</tr>
</tbody>
</table>

0.50 Liberal Education electives

#### Semester 3

<table>
<thead>
<tr>
<th>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>HK*2270</td>
<td>Principles of Human Biomechanics</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*2040</td>
<td>Statistics I</td>
<td>0.50</td>
</tr>
</tbody>
</table>

0.50 Liberal Education electives

#### Semester 4

<table>
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<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>HK*2810</td>
<td>Human Physiology I - Concepts and Principles</td>
<td>0.50</td>
</tr>
<tr>
<td>MCB*2050</td>
<td>Molecular Biology of the Cell</td>
<td>0.50</td>
</tr>
<tr>
<td>NUTR*3210</td>
<td>Fundamentals of Nutrition</td>
<td>0.50</td>
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</tbody>
</table>

0.50 electives

0.50 Liberal Education electives

#### Semester 5

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>HK*3600</td>
<td>Applied Human Kinetics I</td>
<td>0.75</td>
</tr>
<tr>
<td>HK*3810</td>
<td>Human Physiology II - Integrated Systems</td>
<td>0.75</td>
</tr>
<tr>
<td>NUTR*3360</td>
<td>Lifestyle Genomics</td>
<td>0.50</td>
</tr>
</tbody>
</table>

### 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 core 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

<table>
<thead>
<tr>
<th>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>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>
</tbody>
</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](https://www.uoguelph.ca/bsc/revised_SS)

#### Semester 2

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1080</td>
<td>Biological Concepts of Health</td>
<td>0.50</td>
</tr>
<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</td>
<td>0.50</td>
</tr>
</tbody>
</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](https://www.uoguelph.ca/bsc/revised_SS)

#### Semester 3

<table>
<thead>
<tr>
<th>Code</th>
<th>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*
Semester 4

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*2580</td>
<td>0.50</td>
<td>Introduction to Biochemistry</td>
</tr>
<tr>
<td>MBG*2040</td>
<td>0.50</td>
<td>Foundations in Molecular Biology and Genetics</td>
</tr>
<tr>
<td>STAT*2230</td>
<td>0.50</td>
<td>Biostatistics for Integrative Biology</td>
</tr>
<tr>
<td>ZOO*2700</td>
<td>0.50</td>
<td>Invertebrate Morphology &amp; Evolution</td>
</tr>
<tr>
<td>0.50 electives*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Semester 5**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*3450</td>
<td>0.50</td>
<td>Introduction to Aquatic Environments</td>
</tr>
<tr>
<td>ZOO*3600</td>
<td>0.50</td>
<td>Comparative Animal Physiology I</td>
</tr>
<tr>
<td>ZOO*3610</td>
<td>0.25</td>
<td>Lab Studies in Animal Physiology I</td>
</tr>
<tr>
<td>ZOO*3700</td>
<td>0.50</td>
<td>Integrative Biology of Invertebrates</td>
</tr>
<tr>
<td>1.00 electives</td>
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<td></td>
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</tbody>
</table>

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

**Semester 6**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*3060</td>
<td>0.50</td>
<td>Populations, Communities &amp; Ecosystems</td>
</tr>
<tr>
<td>ZOO*3050</td>
<td>0.50</td>
<td>Developmental Biology</td>
</tr>
<tr>
<td>ZOO*3620</td>
<td>0.50</td>
<td>Comparative Animal Physiology II</td>
</tr>
<tr>
<td>ZOO*3630</td>
<td>0.25</td>
<td>Lab Studies in Animal Physiology II</td>
</tr>
<tr>
<td>1.00 electives</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

**Semester 7**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*4350</td>
<td>0.50</td>
<td>Limnology of Natural and Polluted Waters</td>
</tr>
<tr>
<td>IBIO*4560</td>
<td>0.50</td>
<td>Integrative Marine and Freshwater Research</td>
</tr>
<tr>
<td>1.00 electives</td>
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</table>

**Semester 8**

<table>
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<th>Credits</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>BIOL*4010</td>
<td>0.50</td>
<td>Adapational Physiology</td>
</tr>
<tr>
<td>ZOO*4330</td>
<td>0.50</td>
<td>Biology of Fishes</td>
</tr>
<tr>
<td>ZOO*4570</td>
<td>0.50</td>
<td>Marine Ecological Processes</td>
</tr>
<tr>
<td>1.00 electives</td>
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</table>

* 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/](https://www.uoguelph.ca/bsc/)

**Credit Summary (20.00 Total Credits)**

- 4.00 - First year science core
- 10.00 - Required science courses semesters 3 - 8
- 2.00 - 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)**

**Semester 1 - Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1070</td>
<td>0.50</td>
<td>Discovering Biodiversity</td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>0.50</td>
<td>General Chemistry I</td>
</tr>
<tr>
<td>MATH*1080</td>
<td>0.50</td>
<td>Elements of Calculus I</td>
</tr>
<tr>
<td>PHYS*1080</td>
<td>0.50</td>
<td>Physics for Life Sciences</td>
</tr>
<tr>
<td>0.50 Liberal Education electives</td>
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</tr>
</tbody>
</table>

**Semester 2 - Winter**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1080</td>
<td>0.50</td>
<td>Biological Concepts of Health</td>
</tr>
<tr>
<td>BIOL*1090</td>
<td>0.50</td>
<td>Introduction to Molecular and Cellular Biology</td>
</tr>
<tr>
<td>CHEM*1050</td>
<td>0.50</td>
<td>General Chemistry II</td>
</tr>
<tr>
<td>PHYS*1070</td>
<td>0.50</td>
<td>Physics for Life Sciences II</td>
</tr>
<tr>
<td>0.50 Liberal Education electives</td>
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</table>

**Semester 3 - Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*2060</td>
<td>0.50</td>
<td>Ecology</td>
</tr>
<tr>
<td>BIOL*2400</td>
<td>0.50</td>
<td>Evolution</td>
</tr>
<tr>
<td>COOP*1100</td>
<td>0.00</td>
<td>Introduction to Co-operative Education</td>
</tr>
<tr>
<td>ZOO*2090</td>
<td>0.50</td>
<td>Vertebrate Structure and Function</td>
</tr>
<tr>
<td>1.00 electives or restricted electives*</td>
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**Semester 4 - Winter**

<table>
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<tr>
<th>Course Code</th>
<th>Credits</th>
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</tr>
</thead>
<tbody>
<tr>
<td>BIOC*2580</td>
<td>0.50</td>
<td>Introduction to Biochemistry</td>
</tr>
<tr>
<td>MBG*2040</td>
<td>0.50</td>
<td>Foundations in Molecular Biology and Genetics</td>
</tr>
<tr>
<td>STAT*2230</td>
<td>0.50</td>
<td>Biostatistics for Integrative Biology</td>
</tr>
<tr>
<td>ZOO*3600</td>
<td>0.50</td>
<td>Comparative Animal Physiology I</td>
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<tr>
<td>ZOO*3610</td>
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<td>Lab Studies in Animal Physiology I</td>
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<tr>
<td>ZOO*3700</td>
<td>0.50</td>
<td>Integrative Biology of Invertebrates</td>
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**Summer Semester**

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<tbody>
<tr>
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<td>Co-op Work Term I</td>
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**Semester 5 - Fall**

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<th>Credits</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>BIOL*3450</td>
<td>0.50</td>
<td>Introduction to Aquatic Environments</td>
</tr>
<tr>
<td>ZOO*3600</td>
<td>0.50</td>
<td>Comparative Animal Physiology I</td>
</tr>
<tr>
<td>ZOO*3610</td>
<td>0.25</td>
<td>Lab Studies in Animal Physiology I</td>
</tr>
<tr>
<td>ZOO*3700</td>
<td>0.50</td>
<td>Integrative Biology of Invertebrates</td>
</tr>
<tr>
<td>1.00 electives or restricted electives</td>
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<td></td>
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</tbody>
</table>

**Winter Semester**

<table>
<thead>
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<th>Credits</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>COOP*2000</td>
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<td>Co-op Work Term II</td>
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**Summer Semester**

<table>
<thead>
<tr>
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<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*3000</td>
<td>0.50</td>
<td>Co-op Work Term III</td>
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**Semester 6 - Fall**

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<tr>
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<th>Credits</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>BIOL*4350</td>
<td>0.50</td>
<td>Limnology of Natural and Polluted Waters</td>
</tr>
<tr>
<td>IBIO*4600</td>
<td>1.00</td>
<td>Integrative Marine and Freshwater Research</td>
</tr>
<tr>
<td>1.00 electives or restricted electives</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Semester 7 - Winter**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*3060</td>
<td>0.50</td>
<td>Populations, Communities &amp; Ecosystems</td>
</tr>
<tr>
<td>ZOO*3050</td>
<td>0.50</td>
<td>Developmental Biology</td>
</tr>
</tbody>
</table>

**Credit Summary (22.00 Total Credits)**

- 4.00 - First year science core
- 10.00 - Required science courses semesters 3 - 8
- 2.00 - 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

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.

**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.recruiuoguelph.ca/cecs/]. 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>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Winter</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>Academic Semester 5</td>
<td>COOP*2000 Work Term II</td>
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<tr>
<td>4</td>
<td>Academic Semester 6</td>
<td>Academic Semester 7</td>
<td>COOP*4000 Work Term IV</td>
</tr>
</tbody>
</table>
Comparative Animal Physiology II
Lab Studies in Animal Physiology II
Electives or restricted electives to a maximum of 2.75 total credits in this semester.

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

BIOL*4010 [0.50] Adapational Physiology
ZO0*4330 [0.50] Biology of Fishes
ZO0*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/

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 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 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 (PHYS*1010 and 0.50 credits from: MATH*1090, 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_SS

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/

2. 2.50 credits from either the Mathematics Stream or the Statistics Stream as follows:

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.

BIOMETRICS (BINF)

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 Biometrics
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*3110 [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*1120 [0.50] Engineering Mechanics I
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**
- 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](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**
- BIOC*3560 [0.50] Structure and Function in Biochemistry
- MCB*2430 [0.50] Methods in Microbial Culture and Physiology
- 0.50 electives
- 0.50 Liberal Education electives

**Semester 4**
- MCB*3080 [0.50] Bacterial Genetics
- MCB*3420 [0.50] Microbial Diversity and Ecology
- 1.50 electives or restricted electives

**Semester 5**
- MCB*3350 [0.75] Laboratory Methods in Molecular Biology
- MCB*3260 [0.50] Microbial Adaptation
- MCB*3430 [0.75] Advanced Methods in Microbiology
- A minimum of 0.50 electives or restricted electives

**Semester 6**
- MCB*3350 [0.75] Laboratory Methods in Molecular Biology
- MCB*3260 [0.50] Microbial Adaptation
- MCB*3430 [0.75] Advanced Methods in Microbiology
- A minimum of 0.50 electives or restricted 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.

**Microbiology (MICR)**

Department of Molecular and Cellular Biology, College of Biological Science
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 environment. 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.recruitguelph.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>
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<th>Summer</th>
</tr>
</thead>
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<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 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)

- 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

### 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 environment. 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.recruitguelph.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>
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<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 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.

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

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*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

#### Summer Semester

No academic semester or work term

#### Semester 3 - Fall

- BIOC*2580 [0.50] Introduction to Biochemistry
- COOP*1100 [0.00] Introduction to Co-operative Education
- 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 - Winter

- BIOC*3560 [0.50] Structure and Function in Biochemistry
- MCB*2050 [0.50] Molecular Biology of the Cell
- MICR*2430 [0.50] Methods in Microbial Culture and Physiology

0.50 electives

0.50 Liberal Education electives

#### Summer Semester

No academic semester or work term

#### Semester 5 - Fall

- MBG*3080 [0.50] Bacterial Genetics
- MICR*3420 [0.50] Microbial Diversity and Ecology

1.50 electives or restricted electives

#### Semester 6 - Winter

- MBG*3350 [0.75] Laboratory Methods in Molecular Biology
- MICR*3260 [0.50] Microbial Adaptation
- MICR*3430 [0.75] Advanced Methods in Microbiology

A minimum of 0.50 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

#### Winter Semester

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

[Last Revision: July 4, 2019]
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. 3.50 restricted elective credits of which 1.00 credits must be at the 4000 level.

**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.

<table>
<thead>
<tr>
<th>Semester 1</th>
<th>BIOL*1090 [0.50] Introduction to Molecular and Cell Biology</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CHEM*1040 [0.50] General Chemistry I</td>
</tr>
<tr>
<td></td>
<td>MATH*1080 [0.50] Elements of Calculus I</td>
</tr>
<tr>
<td></td>
<td>PHYS*1080 [0.50] Physics for Life Sciences</td>
</tr>
<tr>
<td></td>
<td>0.50 Liberal Education electives</td>
</tr>
<tr>
<td></td>
<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>
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<thead>
<tr>
<th>Semester 2</th>
<th>BIOL*1070 [0.50] Discovering Biodiversity</th>
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<tbody>
<tr>
<td></td>
<td>BIOL*1080 [0.50] Biological Concepts of Health</td>
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<tr>
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<td>CHEM*1050 [0.50] General Chemistry II</td>
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<td>PHYS*1070 [0.50] Physics for Life Sciences II</td>
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<table>
<thead>
<tr>
<th>Semester 3</th>
<th>BIOL*2580 [0.50] Introduction to Biochemistry</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>MBG*2040 [0.50] Foundations in Molecular Biology and Genetics</td>
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<tr>
<td></td>
<td>MICR*2420 [0.50] Introduction to Microbiology</td>
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<tr>
<td></td>
<td>STAT*2040 [0.50] Statistics I</td>
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<td>0.50 Liberal Education electives</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 4</th>
<th>BIOL*3560 [0.50] Structure and Function in Biochemistry</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>CHEM*2700 [0.50] Organic Chemistry I</td>
</tr>
<tr>
<td></td>
<td>MCB*2050 [0.50] Molecular Biology of the Cell</td>
</tr>
<tr>
<td></td>
<td>MICR*2430 [0.50] Methods in Microbial Culture and Physiology</td>
</tr>
<tr>
<td></td>
<td>0.50 Liberal Education electives</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 5</th>
<th>MBG*3040 [0.50] Molecular Biology of the Gene</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MBG*3350 [0.75] Laboratory Methods in Molecular Biology</td>
</tr>
</tbody>
</table>

**Semester 6**

2.50 electives or restricted electives

**Semester 7**

MBG*4500 [1.00] Research Project in Molecular & Cellular Biology I 1.50 electives or restricted electives

**Semester 8**

MBG*4510 [1.00] Research Project in Molecular & Cellular Biology 1.50 electives or restricted electives

*instead of the 2 semester sequence of MCB*4500 / MCB*4510 students may choose to take MCB*4600 and 1.50 subject area electives at the 4000 level.

**Restricted Electives**

Note: Some courses have prerequisites, so be sure to consult the undergraduate calendar.

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/

**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:

<table>
<thead>
<tr>
<th>MBG*2040 [0.50] Foundations in Molecular Biology and Genetics</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCB*2050 [0.50] Molecular Biology of the Cell</td>
</tr>
</tbody>
</table>

A minimum of 4.00 credits from:

<table>
<thead>
<tr>
<th>BIOL*3560 [0.50] Structure and Function in Biochemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*3020 [0.50] Population Genetics</td>
</tr>
<tr>
<td>BIOL*3300 [0.50] Applied Bioinformatics</td>
</tr>
<tr>
<td>MBG*2400 [0.50] Fundamentals of Plant and Animal Genetics</td>
</tr>
<tr>
<td>MBG*3040 [0.50] Molecular Biology of the Gene</td>
</tr>
<tr>
<td>MBG*3050 [0.50] Human Genetics</td>
</tr>
<tr>
<td>MBG*3060 [0.50] Quantitative Genetics</td>
</tr>
<tr>
<td>MBG*3080 [0.50] Bacterial Genetics</td>
</tr>
<tr>
<td>MBG*3100 [0.50] Plant Genetics</td>
</tr>
<tr>
<td>MBG*3350 [0.75] Laboratory Methods in Molecular Biology</td>
</tr>
<tr>
<td>MBG*3660 [0.50] Genomics</td>
</tr>
</tbody>
</table>

Last Revision: July 4, 2019
Nanoscience (NANO)

Administered jointly by the Department of Chemistry and the Department of 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>Description</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>Description</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>
</tbody>
</table>

One of:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</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>
</tbody>
</table>

**Semester 3**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM*2060</td>
<td>0.50</td>
<td>Structure and Bonding</td>
</tr>
<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>
<td>0.50</td>
<td>Electricity and Magnetism I</td>
</tr>
</tbody>
</table>

One of:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM*2820</td>
<td>0.50</td>
<td>Thermodynamics and Kinetics</td>
</tr>
<tr>
<td>PHYS*2240</td>
<td>0.50</td>
<td>Thermal Physics</td>
</tr>
</tbody>
</table>

**Semester 4**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM*2070</td>
<td>0.50</td>
<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>
<td>0.50</td>
<td>Mechanics</td>
</tr>
</tbody>
</table>

1.00 electives*

**Semester 5**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</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>
</tr>
</tbody>
</table>

One of:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM*3860</td>
<td>0.50</td>
<td>Quantum Chemistry</td>
</tr>
<tr>
<td>PHYS*3230</td>
<td>0.50</td>
<td>Quantum Mechanics I</td>
</tr>
</tbody>
</table>

1.00 electives

**Semester 6**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<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>
</tr>
</tbody>
</table>

1.50 electives

**Semester 7**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NANO*4100</td>
<td>0.50</td>
<td>Biological Nanomaterials</td>
</tr>
<tr>
<td>NANO*4700</td>
<td>0.50</td>
<td>Concepts in Quantum Computing</td>
</tr>
</tbody>
</table>

1.50 electives

**Semester 8**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NANO*4200</td>
<td>0.50</td>
<td>Topics in Nanomaterials</td>
</tr>
</tbody>
</table>

2.00 electives

* 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*3640
  - 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 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>
<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>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>
</tbody>
</table>
5 COOP*5000 Work Term V Academic Semester 8 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 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
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
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:
BIOL*1070 [0.50] Discovering Biodiversity
BIOL*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
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 Liberal Education elective

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
MATH*1050 [0.50] Elements of Calculus II
PHYS*1070 [0.50] Physics for Life Sciences
0.50 Liberal Education elective

Semester 3
BIOL*2070 [0.50] Introduction to Biochemistry
MGSC*2040 [0.50] Foundations in Molecular Biology and Genetics
PSYC*1000 [0.50] Introduction to Psychology

Semester 4
MBG*2580 [0.50] Introduction to Biochemistry
MBG*2404 [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
MCB*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 5
BIOM*3000 [0.50] Functional Mammalian Neuroanatomy
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 **

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

*Indicates courses that require additional prerequisites.

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 I *
- PSYC*4470 [0.50] Advanced Topics in Behavioural and Cognitive Neuroscience
- PSYC*4750 [0.50] Seminar in Motivation and Emotion

Computation, 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 Science
- BIOL*3560 [0.50] Structure and Function in Biochemistry
- BIOL*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] Neuromuscular 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 [1.00] 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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>HK*3100</td>
<td>0.50</td>
<td>Neuromuscular Physiology</td>
</tr>
<tr>
<td>MBG*2040</td>
<td>0.50</td>
<td>Foundations in Molecular Biology and Genetics</td>
</tr>
<tr>
<td>MBG*3050</td>
<td>0.50</td>
<td>Human Genetics</td>
</tr>
<tr>
<td>MCB*2050</td>
<td>0.50</td>
<td>Molecular Biology of the Cell</td>
</tr>
<tr>
<td>NEUR*3100</td>
<td>0.50</td>
<td>Molecular Biology of Neurodevelopmental and Degenerative Disease</td>
</tr>
<tr>
<td>NEUR*4000</td>
<td>0.50</td>
<td>Current Issues in Neuroscience</td>
</tr>
<tr>
<td>NEUR*4100</td>
<td>0.50</td>
<td>Neuropharmacology</td>
</tr>
<tr>
<td>PHYS*2030</td>
<td>0.50</td>
<td>Biophysics of Excitable Cells</td>
</tr>
<tr>
<td>PHYS*2330</td>
<td>0.50</td>
<td>Electricity and Magnetism I</td>
</tr>
<tr>
<td>PSYC*2390</td>
<td>0.50</td>
<td>Sensation and Perception</td>
</tr>
<tr>
<td>PSYC*2650</td>
<td>0.50</td>
<td>Cognitive Psychology</td>
</tr>
<tr>
<td>PSYC*3030</td>
<td>0.50</td>
<td>Neurochemical Basis of Behaviour</td>
</tr>
<tr>
<td>PSYC*3270</td>
<td>0.50</td>
<td>Cognitive Neuroscience</td>
</tr>
<tr>
<td>PSYC*3330</td>
<td>0.50</td>
<td>Memory and Attention</td>
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<tr>
<td>PSYC*3410</td>
<td>0.50</td>
<td>Behavioural Neuroscience II</td>
</tr>
<tr>
<td>PSYC*4750</td>
<td>0.50</td>
<td>Seminar in Motivation and Emotion</td>
</tr>
</tbody>
</table>

Of the 2.00 additional credits, students may select one course from:

- BIOM*3540 0.75 Medical Embryology
- MBG*4040 0.50 Genetics and Molecular Biology of Development
- ZOO*3050 0.50 Developmental Biology

Please note that some of the restricted electives require prerequisites that are not included in the minor.

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.

Minor (Honours Program)

A minor in Nutritional and Nutraceutical Sciences (NANS) requires 5.00 credits as follows:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<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>
</tr>
<tr>
<td>NUTR*3330</td>
<td>0.50</td>
<td>Micronutrients, Phytochemicals and Health</td>
</tr>
<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>
</tr>
</tbody>
</table>

At least 0.50 credits from:

- ANSC*3080 0.50 Agricultural Animal Physiology (restricted to ABIO majors)
- BIOM*3200 1.00 Biomedical Physiology
- HK*2810 0.50 Human Physiology I - Concepts and Principles
- ZOO*3600 0.50 Comparative Animal Physiology I

and 2.00 credits from:

- ANSC*3170 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
- EGN*4020 0.50 Advanced Equine Nutrition
- FOOD*2010 0.50 Principles of Food Science
- HK*3810 0.75 Human Physiology II - Integrated Systems
- HK*4230 0.50 Advanced Study in Human Health and Nutritional Sciences
- HK*4340 0.50 Genomics: Exercise and Disease
- HK*4360 1.00 Research in Human Health and Nutritional Sciences
- HK*4371/2 1.00 Research in Human Health and Nutritional Sciences II
- HK*4510 1.00 Teaching, Learning & Knowledge Transfer
- HK*4511/2 1.00 Teaching, Learning & Knowledge Transfer II
- NUTR*3360 0.50 Lifestyle Genomics
- NUTR*3390 0.75 Applied Nutritional and Nutraceutical Sciences I
- NUTR*4210 0.50 Nutrition, Exercise and Energy Metabolism
- NUTR*4320 0.50 Nutrition and Metabolic Control of Disease
- NUTR*4330 0.75 Applied Nutritional and Nutraceutical Sciences II
- NUTR*4510 0.50 Toxicology, Nutrition and Food

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

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

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

Students who are lacking 1GU or 4U Biology, Chemistry or Physics should plan their program in consultation with the Department of Physics 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.

Semester 2*

CHEM*1050 [0.50] General Chemistry II
CIS*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 1GU or 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 3

MATH*2200 [0.50] Advanced Calculus I
MATH*2270 [0.50] Applied Differential Equations
PHYS*2240 [0.50] Thermal Physics

PHYS*2230 [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
### 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/bsc/revised_SS](https://www.uoguelph.ca/bsc/revised_SS)). 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 (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
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 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

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM*1040</td>
<td>General Chemistry I</td>
<td>0.50</td>
</tr>
<tr>
<td>CIS*1300</td>
<td>Programming</td>
<td>0.50</td>
</tr>
<tr>
<td>IPS*1500</td>
<td>Integrated Mathematics and Physics I</td>
<td>1.00</td>
</tr>
</tbody>
</table>

One of:

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

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 - Winter

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM*1050</td>
<td>General Chemistry II</td>
<td>0.50</td>
</tr>
<tr>
<td>IPS*1510</td>
<td>Integrated Mathematics and Physics II</td>
<td>1.00</td>
</tr>
<tr>
<td>MATH*1160</td>
<td>Linear Algebra I</td>
<td>0.50</td>
</tr>
</tbody>
</table>

One of:

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

#### Semester 3 - Fall

<table>
<thead>
<tr>
<th>Code</th>
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</tr>
</thead>
<tbody>
<tr>
<td>COOP*1100</td>
<td>Introduction to Co-operative Education</td>
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</tr>
<tr>
<td>MATH*2230</td>
<td>Advanced Calculus I</td>
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<tr>
<td>MATH*2270</td>
<td>Applied Differential Equations</td>
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</tr>
<tr>
<td>PHYS*2240</td>
<td>Thermal Physics</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*2330</td>
<td>Electricity and Magnetism I</td>
<td>0.50</td>
</tr>
<tr>
<td>0.50 Liberal Education electives*</td>
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#### Semester 4 - Winter

<table>
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<tr>
<th>Code</th>
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<tbody>
<tr>
<td>PHYS*2180</td>
<td>Experimental Techniques in Physics</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*2310</td>
<td>Mechanics</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*2340</td>
<td>Electricity and Magnetism II</td>
<td>0.50</td>
</tr>
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</table>

One of:

- CIS*2500 | Intermediate Programming     | 0.50    |
| 0.50 electives |               |         |

#### Summer Semester

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*1000</td>
<td>Co-op Work Term I ++</td>
<td>0.50</td>
</tr>
</tbody>
</table>

### 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 II
- PHYS*1080 [0.50] Physics for Life Sciences
- PHYS*1130 [0.50] Physics with Applications
- IPS*1510 [0.50] 0.50 Physics electives

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.

### 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 (20.00 Total Credits)

<table>
<thead>
<tr>
<th>Semester 1</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
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<tr>
<td>Winter</td>
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<tr>
<td>Summer</td>
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#### Semester 2

<table>
<thead>
<tr>
<th>Semester 2</th>
<th>Credits</th>
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<tbody>
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<td>Fall</td>
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<tr>
<td>Winter</td>
<td>0.50</td>
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<tr>
<td>Summer</td>
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#### Semester 3

<table>
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<tr>
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<tbody>
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<td>Fall</td>
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<td>Winter</td>
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<td>Summer</td>
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#### Semester 4

<table>
<thead>
<tr>
<th>Semester 4</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>Fall</td>
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<tr>
<td>Winter</td>
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<tr>
<td>Summer</td>
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#### Summer Semester

<table>
<thead>
<tr>
<th>Semester 5</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
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</tr>
<tr>
<td>Summer</td>
<td>0.50</td>
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</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)
Summer Semester
COOP*3000 [0.50] Co-op Work Term III ++
(8-month work term in conjunction with COOP*2000)
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
AGR*4600 [1.00] Agriculture and Food Issues Problem Solving
BOT*4380 [0.50] Metabolism in the Whole Life of Plants
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 educación electives.
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

Last Revision: July 4, 2019
2.50 - 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 a minimum of 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.

Option B

4.00 - First year science core

5.00 - Required science courses semesters 3 - 8

1.00 - AGR*4600

5.00 - Restricted electives for the declared area of emphasis (2) (some restricted electives do not count as science electives towards the degree therefore additional science electives may be required)

2.00 - Approved science electives, if all restricted electives chosen are approved science electives (can be reduced to 1.00 of approved science electives if AGR*4600 is approved as science by faculty advisor and all restricted electives chosen are approved science electives)

1.00 - Liberal Education electives

0.50 - ENGL*1030

1.50 - 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 a minimum of 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.

Area of Emphasis

Applied Plant Science (APSC)

CROP*4240 [0.50] Weed Science
ENVS*2060 [0.50] Soil Science
ENVS*3210 [0.50] Plant Pathology
ENVS*4100 [0.50] Integrated Management of Invasive Insect Pests **

‡ 3.00 credits from:

AGR*3450 [0.50] Research Methods in Agricultural Science
BOT*3710 [0.50] Plant Diversity and Evolution
CROP*3300 [0.50] Grain Crops
CROP*3310 [0.50] Protein and Oilseed Crops
CROP*3340 [0.50] Managed Grasslands
CROP*4220 [0.50] Cropping Systems **
ENVS*2040 [0.50] Plant Health and the Environment
ENVS*3020 [0.50] Pesticides and the Environment
ENVS*3080 [0.50] Soil and Water Conservation **
ENVS*3140 [0.50] Management of Turfgrass Diseases **
ENVS*3310 [0.50] Soil Biodiversity and Ecosystem Function **
ENVS*4090 [0.50] Soil Management
HORT*2450 [0.50] Introduction to Turfgrass Science
HORT*3010 [0.50] Annual, Perennial and Indoor Plants - Identification and Use
HORT*3050 [0.50] Management of Turfgrass Insect Pests and Weeds **
HORT*3150 [0.50] Principles and Applications of Plant Propagation
HORT*3270 [0.50] Medicinal Plants
HORT*3280 [0.50] Greenhouse Production
HORT*3310 [0.50] Plants, Food and Health
HORT*3430 [0.50] Wine-Grape Culture
HORT*3510 [0.50] Vegetable Production
HORT*4200 [0.50] Plants, the Environment and Society
HORT*4300 [0.50] Postharvest Physiology
HORT*4420 [0.50] Fruit Crops
HORT*4450 [0.50] Advanced Turfgrass Science
LARC*2240 [0.50] Plants in the Landscape
MBG*2400 [0.50] Fundamentals of Plant and Animal Genetics
MBG*3100 [0.50] Plant Genetics
MBG*4160 [0.50] Plant Breeding
OAGR*2070 [1.00] Introduction to Organic Agriculture
OAGR*4050 [1.00] Design of Organic Production Systems **
PBIO*3410 [0.50] Crop Physiology
PBIO*3750 [0.50] Plant Tissue Culture
PBIO*4750 [0.50] Genetic Engineering of Plants
STAT*2050 [0.50] Statistics II
STAT*3210 [0.50] Experimental Design

Botany (BOT)

BOT*3050 [0.50] Plant Functional Ecology
MBG*3100 [0.50] Plant Genetics
PBIO*4000 [0.50] Molecular and Cellular Aspects of Plant-Microbe Interactions
PBIO*4150 [0.50] Molecular and Cellular Aspects of Plant Development

‡ 3.00 credits from:

AGR*3450 [0.50] Research Methods in Agricultural Science
BOT*3710 [0.50] Plant Diversity and Evolution
MBG*4300 [0.50] Plant Molecular Genetics
MICR*2420 [0.50] Introduction to Microbiology
MICR*3090 [0.50] Mycology
MICR*3320 [0.50] Plant Microbiology
PBIO*3110 [0.50] Crop Physiology
PBIO*3750 [0.50] Plant Tissue Culture
PBIO*4750 [0.50] Genetic Engineering of Plants
STAT*3210 [0.50] Experimental Design **

Plant Biotechnology (PBTC)

MBG*3100 [0.50] Plant Genetics
MBG*3350 [0.75] Laboratory Methods in Molecular Biology
PBIO*3750 [0.50] Plant Tissue Culture
PBIO*4750 [0.50] Genetic Engineering of Plants

‡ minimum of 2.75 credits from:

AGR*3450 [0.50] Research Methods in Agricultural Science
BOT*3710 [0.50] Plant Diversity and Evolution
BIOL*3300 [0.50] Applied Biomatics
MBG*2400 [0.50] Fundamentals of Plant and Animal Genetics
MBG*3660 [0.50] Genomics
MBG*4160 [0.50] Plant Breeding
MBG*4300 [0.50] Plant Molecular Genetics
MCB*4010 [0.50] Advanced Cell Biology
MICR*2420 [0.50] Introduction to Microbiology
MICR*3220 [0.50] Plant Microbiology
MICR*3330 [0.50] Immunology
MICR*3330 [0.50] World of Viruses
PBIO*3110 [0.50] Crop Physiology
PBIO*4150 [0.50] Molecular and Cellular Aspects of Plant Development
STAT*2050 [0.50] Statistics II
STAT*3210 [0.50] Experimental Design **

Plant Environmental Science (PESC)

BOT*3050 [0.50] Plant Functional Ecology
ENVS*2040 [0.50] Plant Health and the Environment
ENVS*4350 [0.50] Forest Ecology
GEOG*2480 [0.50] Mapping and GIS

‡ 3.00 credits from:

AGR*3450 [0.50] Research Methods in Agricultural Science
BIOL*3010 [0.50] Laboratory and Field Work in Ecology
BIOL*3060 [0.50] Populations, Communities & Ecosystems
BIOL*3130 [0.50] Conservation Biology
BIOL*4500 [0.50] Natural Resource Policy Analysis
BOT*3710 [0.50] Plant Diversity and Evolution
ENVS*2060 [0.50] Soil Science
ENVS*3210 [0.50] Introduction to Environmental Stewardship **
ENVS*2330 [0.50] Current Issues in Ecosystem Science and Biodiversity
ENVS*3000 [0.50] Nature Interpretation
ENVS*3020 [0.50] Pesticides and the Environment
ENVS*3040 [0.50] Natural Chemicals in the Environment
ENVS*3090 [0.50] Insect Diversity and Biology
ENVS*3210 [0.50] Plant Pathology
ENVS*3250 [0.50] Forest Health and Disease
ENVS*4100 [0.50] Integrated Management of Invasive Insect Pests **
GEOG*2210 [0.50] Environment and Resources
GEOG*3210 [0.50] Management of the Biophysical Environment **
GEOG*4210 [0.50] Environmental Governance **
GEOG*4220 [0.50] Local Environmental Management
HORT*3310 [0.50] Plants, Food and Health
LARC*3200 [0.50] Principles of Landscape Ecology **
PHIL*2070 [0.50] Philosophy of the Environment
POLS*3370 [0.50] Environmental Politics and Governance
STAT*2050 [0.50] Statistics II
STAT*3210 [0.50] Experimental Design **

Unspecialized (UNSP)

Choose 5.00 credits from any courses listed in the other areas of emphasis.

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 [0.50] Introduction to Plant Agriculture
BOT*2100 [0.50] Life Strategies of Plants
BOT*3310 [0.50] Plant Growth and Development
BOT*3410 [0.50] Plant Anatomy
BOT*3710 [0.50] Plant Diversity and Evolution

2019-2020 Undergraduate Calendar

X. Degree Programs, Bachelor of Science (B.Sc.)
<table>
<thead>
<tr>
<th>Semester 5</th>
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<tbody>
<tr>
<td>IPS*3000 [0.50]</td>
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<tr>
<td>PHYS*3130 [0.50]</td>
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<td>PHYS*3230 [0.50]</td>
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<td>PHYS*3400 [0.50]</td>
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<td>0.50 electives*</td>
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<td>Semester 6</td>
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<tr>
<td>NANO*3600 [0.50]</td>
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<td>PHYS*3000 [0.50]</td>
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<tr>
<th>Semester 7</th>
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<tr>
<td>PHYS*4120 [0.50]</td>
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<td>PHYS*4180 [0.50]</td>
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<td>PHYS*4240 [0.50]</td>
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<td>PHYS*4001 [0.50]</td>
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<td>PHYS*4500 [0.50]</td>
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<tr>
<td>Semester 8</td>
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<td>MATH*3260 [0.50]</td>
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<td>PHYS*4130 [0.50]</td>
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<td>PHYS*4150 [0.50]</td>
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<td>One of:</td>
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<td>PHYS*4002 [0.50]</td>
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<td>0.50 electives*</td>
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<td>0.50 electives*</td>
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</table>

*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
- PHYS*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](https://www.uoguelph.ca/bsc/revised_SS)
### Semester 2

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<th>Course Title</th>
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<tbody>
<tr>
<td>BIOL*1080</td>
<td>0.50</td>
<td>Biological Concepts of Health</td>
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<tr>
<td>BIOL*1090</td>
<td>0.50</td>
<td>Introduction to Molecular and Cellular Biology</td>
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<tr>
<td>CHEM*1050</td>
<td>0.50</td>
<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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<td>0.50 Liberal Education electives</td>
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### 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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<td>1.50 electives or restricted electives</td>
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### Semester 4

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<td>BIOL*2060</td>
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<td>Ecology</td>
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<td>BIOL*2400</td>
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<td>Evolution</td>
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<td>STAT*2230</td>
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<td>Biostatistics for Integrative Biology</td>
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### Semester 5

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<tr>
<td>BIOL*3010</td>
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<td>Laboratory and Field Work in Ecology</td>
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### Semester 6

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<td>BIOL*3040</td>
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<td>Methods in Evolutionary Biology</td>
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<tr>
<td>BIOL*3060</td>
<td>0.50</td>
<td>Populations, Communities &amp; Ecosystems</td>
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<tr>
<td>BIOL*3130</td>
<td>0.50</td>
<td>Conservation Biology</td>
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<td>1.00 electives or restricted electives</td>
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### Semester 7

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<th>Course Title</th>
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<td>BIOL*4110</td>
<td>1.00</td>
<td>Ecological Methods</td>
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<tr>
<td>BIOL*4150</td>
<td>0.50</td>
<td>Wildlife Conservation and Management</td>
</tr>
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<td>1.00 electives or restricted electives</td>
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</table>

#### 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

<table>
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<th>Course Code</th>
<th>Credit</th>
<th>Course Title</th>
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</thead>
<tbody>
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<td>BIOL*4500</td>
<td>0.50</td>
<td>Natural Resource Policy Analysis</td>
</tr>
<tr>
<td></td>
<td>2.00 electives or restricted electives</td>
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</tr>
</tbody>
</table>

### 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/](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.

#### 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 *
- ENVS*4350 [0.50] Forest Ecology *
- NUTR*3210 [0.50] Fundamentals of Nutrition
- ZOO*4300 [0.75] Marine Biology and Oceanography *
- ZOO*4570 [0.50] Marine Ecological Processes *

#### Conservation

- BIOL*4350 [0.50] Limnology of Natural and Polluted Waters *
- ECON*1050 [0.50] Introductory Microeconomics
- ECON*2100 [0.50] Economic Growth and Environmental Quality **
- ENV*2030 [0.50] Meteorology and Climatology
- ENV*3010 [0.50] Climate Change Biology
- FARE*2700 [0.50] Survey of Natural Resource Economics **
- GEOG*1220 [0.50] Human Impact on the Environment **
- GEOG*2480 [0.50] Mapping and GIS
- GEOG*3480 [0.50] GIS and Spatial Analysis
- GEOG*4230 [0.50] Environmental Impact Assessment *
- GEOG*4480 [1.00] Applied Geomatics

### Integrative/Cross-Disciplinary

- 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*2050 [0.50] Molecular Biology of the Cell
- ZOO*3610 [0.25] Lab Studies in Animal Physiology I
- ZOO*3620 [0.50] Comparative Animal Physiology II
- ZOO*3630 [0.25] Lab Studies in Animal Physiology II
- ZOO*3700 [0.50] Integrative Biology of Invertebrates *
- ZOO*4070 [0.50] Animal Behaviour
- ZOO*4910 [0.50] Integrative Vertebrate Biology *
- ZOO*4920 [0.25] Lab Studies in Ornithology
- ZOO*4940 [0.25] Lab Studies in Herpetology
- ZOO*4950 [0.25] Lab Studies in Mammalogy

### Field Courses

- 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
- BIOL*4900 [0.50] Field Biology

#### Credit Summary (20.00 Total Credits)

<table>
<thead>
<tr>
<th>Category</th>
<th>Credit</th>
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<tbody>
<tr>
<td>First year science core</td>
<td>4.00</td>
</tr>
<tr>
<td>Required science courses semesters 3-8</td>
<td>6.50</td>
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<tr>
<td>Restricted electives (# 2, 3, 4 and 5 in restricted electives list)**</td>
<td>4.50</td>
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<tr>
<td>Approved Science electives</td>
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<tr>
<td>Liberal Education electives (#1 in restricted electives list)</td>
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<tr>
<td>Free electives - any approved elective for B.Sc. students</td>
<td>3.00</td>
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<tr>
<td>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.</td>
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</tr>
</tbody>
</table>

### 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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1070</td>
<td>0.50</td>
<td>Discovering Biodiversity</td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>0.50</td>
<td>General Chemistry I</td>
</tr>
<tr>
<td>MATH*1080</td>
<td>0.50</td>
<td>Elements of Calculus I</td>
</tr>
<tr>
<td>PHYS*1080</td>
<td>0.50</td>
<td>Physics for Life Sciences</td>
</tr>
<tr>
<td></td>
<td>0.50 Liberal Education electives</td>
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</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_SS](https://www.uoguelph.ca/bsc/revised_SS)

### Semester 2

<table>
<thead>
<tr>
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<th>Credit</th>
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</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1080</td>
<td>0.50</td>
<td>Biological Concepts of Health</td>
</tr>
<tr>
<td>BIOL*1090</td>
<td>0.50</td>
<td>Introduction to Molecular and Cellular Biology</td>
</tr>
<tr>
<td>CHEM*1050</td>
<td>0.50</td>
<td>General Chemistry II</td>
</tr>
<tr>
<td>PHYS*1070</td>
<td>0.50</td>
<td>Physics for Life Sciences II</td>
</tr>
</tbody>
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Last Revision: July 4, 2019

2019-2020 Undergraduate Calendar
0.50 Liberal Education electives

**Semester 3**
- BIOL*2060 [0.50] Ecology
- BIOL*2400 [0.50] Evolution
- ZOO*2090 [0.50] Vertebrate Structure and Function

1.00 electives or restricted electives *

**Semester 4**
- BIOC*2580 [0.50] Introduction to Biochemistry
- MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
- STAT*2230 [0.50] Biostatistics for Integrative Biology
- ZOO*2700 [0.50] Invertebrate Morphology & Evolution

0.50 electives or restricted electives *

**Semester 5**
- ZOO*3000 [0.50] Comparative Histology
- 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.

**Semester 6**
- BIOL*3060 [0.50] Populations, Communities & Ecosystems
- ZOO*3050 [0.50] Developmental Biology
- ZOO*3620 [0.50] Comparative Animal Physiology II
- ZOO*3630 [0.25] Lab Studies in Animal Physiology II

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

**Semester 7**
- ZOO*4070 [0.50] Animal Behaviour
- ZOO*4910 [0.50] Integrative Vertebrate Biology

1.50 electives or restricted electives

**Semester 8**
- 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:
- BIOL*2060 [0.50] Ecology
- BIOL*2400 [0.50] Evolution
- BIOL*3060 [0.50] Populations, Communities & Ecosystems