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

Contact Information:

University of Guelph
Guelph, Ontario, Canada
N1G 2W1
519-824-4120
https://www.uoguelph.ca

Revision Information:

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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 (English) or https://www.ontario.ca/fre-page/ministere-de-lenseignement-superieur-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 Act Notice of Disclosure Activities is posted at https://www.ontario.ca/page/ministry-advanced-education-and-skills-development

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

Authority to Disclose Personal Information to Statistics Canada

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

Notification of Disclosure of Personal Information to Statistics Canada

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

Address for University Communication

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

Email Address

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

Home Address

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

Name Changes

The University of Guelph is committed to the integrity of its student records, therefore, each student is required to provide either on application for admission or on personal data forms required for registration, their 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 their 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**

<table>
<thead>
<tr>
<th>Course</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>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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</tbody>
</table>

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

**Semester 2**

<table>
<thead>
<tr>
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<th>Credits</th>
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<tbody>
<tr>
<td>BIOL*1070</td>
<td>0.50</td>
<td>Discovering Biodiversity</td>
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<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</td>
</tr>
<tr>
<td>One of:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CIS*1000</td>
<td>0.50</td>
<td>Introduction to Computer Applications</td>
</tr>
<tr>
<td>CIS*1200</td>
<td>0.50</td>
<td>Introduction to Computing</td>
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<tr>
<td>CIS*1500</td>
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<td>Introduction to Programming</td>
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<tr>
<td>STAT*2040</td>
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<td>Statistics I</td>
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<tr>
<td>MATH*1090</td>
<td>0.50</td>
<td>Elements of Calculus II</td>
</tr>
<tr>
<td>0.50 Liberal Education electives</td>
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</tbody>
</table>

*BOL*1008 is a prerequisite for some courses in the biological sciences. Students are strongly recommended to also complete this course by the end of the third semester.

**Semester 3 to 6**

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

**Recommended Schedule for Students in Physical Science Areas**

**Semester 1**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Description</th>
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</thead>
<tbody>
<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>One of:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIOL*1070</td>
<td>0.50</td>
<td>Discovering Biodiversity</td>
</tr>
<tr>
<td>BIOL*1080</td>
<td>0.50</td>
<td>Biological Concepts of Health</td>
</tr>
<tr>
<td>BIOL*1090</td>
<td>0.50</td>
<td>Introduction to Molecular and Cellular Biology</td>
</tr>
<tr>
<td>0.50 Liberal Education electives</td>
<td></td>
<td></td>
</tr>
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</table>

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

**Semester 2**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Description</th>
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<tr>
<td>CHEM*1050</td>
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<td>General Chemistry II</td>
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<td>IPS*1510</td>
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<tr>
<td>BIOL*1070</td>
<td>0.50</td>
<td>Discovering Biodiversity</td>
</tr>
<tr>
<td>BIOL*1080</td>
<td>0.50</td>
<td>Biological Concepts of Health</td>
</tr>
<tr>
<td>BIOL*1090</td>
<td>0.50</td>
<td>Introduction to Molecular and Cellular Biology</td>
</tr>
<tr>
<td>0.50 Liberal Education electives</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Semester 3 to 6**

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

**Honours Programs (BSCH)**

**Honours Program Majors**

The following honours majors are available:

**Biological Sciences:**

- 20.00 credits - Animal Biology (ABIO)
- 20.00 credits - Biochemistry (BIOC)
- 20.00 credits - Biodiversity (BID)
- 20.00 credits - Biological Science (BIOS)
- 20.00 credits - Bio-Medical Science (BIOM)
- 20.00 credits - Biomedical Toxicology (BTOX)
- 20.00 credits - Environmental Biology (ENVB)
- 20.00 credits - Food Science (FOOD)
- 20.00 credits - Human Kinetics (HK)
- 20.00 credits - Marine and Freshwater Biology (MBF)
- 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 (ZOO)

**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 - Biotechnology (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) (MBF: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 (ZOO)
### Conditions for Graduation

#### Schedules 1 and 2

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

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

#### Co-operative Education Program

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

#### 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

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1050</td>
<td>0.50</td>
<td>Biology of Plants &amp; Animals in Managed Ecosystems</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</td>
<td>Liberal Education electives</td>
</tr>
</tbody>
</table>

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at: [https://www.uoguelph.ca/bsc/revised_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>ANSC*1210</td>
<td>1.00</td>
<td>Principles of Animal Care and Welfare</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></td>
<td></td>
<td>0.50 Liberal Education electives</td>
</tr>
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</table>

#### Semester 3

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>AGRIC*2350</td>
<td>0.50</td>
<td>Animal Production Systems, Health and Industry</td>
</tr>
<tr>
<td>BIOL*2580</td>
<td>0.50</td>
<td>Introduction to Biochemistry</td>
</tr>
<tr>
<td>MBG*2040</td>
<td>0.50</td>
<td>Fundamentals in Molecular Biology and Genetics</td>
</tr>
<tr>
<td>MBG*2400</td>
<td>0.50</td>
<td>Fundamentals of Plant and Animal Genetics</td>
</tr>
<tr>
<td></td>
<td>0.50</td>
<td>electives or restricted electives</td>
</tr>
</tbody>
</table>

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

#### Semester 4

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSC*2340</td>
<td>0.50</td>
<td>Structure of Farm Animals</td>
</tr>
<tr>
<td>MBG*2050</td>
<td>0.50</td>
<td>Molecular Biology of the Cell</td>
</tr>
<tr>
<td>NUTR*3210</td>
<td>0.50</td>
<td>Fundamentals of Nutrition</td>
</tr>
<tr>
<td>STAT*2040</td>
<td>0.50</td>
<td>Statistics I</td>
</tr>
<tr>
<td></td>
<td>0.50</td>
<td>electives or restricted electives</td>
</tr>
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#### Semester 5

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSC*3080</td>
<td>0.50</td>
<td>Agricultural Animal Physiology</td>
</tr>
<tr>
<td>ANSC*3120</td>
<td>0.50</td>
<td>Introduction to Animal Nutrition</td>
</tr>
<tr>
<td></td>
<td>1.50</td>
<td>electives or restricted electives</td>
</tr>
</tbody>
</table>

### 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)**
- **2.00 - Free electives - any approved elective for B.Sc. students.**

**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**
- BIOC*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

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/bse/revised_SS](https://www.uoguelph.ca/bse/revised_SS).

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

**Semester 3**
- BIOC*2580 [0.50] Introduction to Biochemistry
- MBG*2400 [0.50] Foundations in Molecular Biology and Genetics
- MICR*2420 [0.50] Introduction to Microbiology
- STAT*2040 [0.50] Statistics I
- 0.50 Liberal Education electives

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

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

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

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

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

**Restricted Electives**

1. Students must take as part of their program: 4.00 credits from the following list, with at least 1.00 of these credits from BIOC*4520, BIOC*4580, MCB*4050.
   - BIOC*4520 [0.50] Metabolic Processes
   - BIOC*4580 [0.50] Membrane Biochemistry
   - BIOL*3300 [0.50] Applied Bioinformatics
   - BIOM*3200 [1.00] Biomedical Physiology
   - MBG*3040 [0.50] Molecular Biology of the Gene
   - MBG*3080 [0.50] 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 I
   - MCB*4510 [1.00] Research Project in Molecular & Cellular Biology II
   - MCB*4600 [0.50] Topics in Molecular and Cellular Biology
   - MICR*3230 [0.50] Immunology
   - MICR*3330 [0.50] World of Viruses
   - MICR*4330 [0.50] Molecular Virology
   - MICR*4530 [0.50] Immunology II
   - PBIO*3110 [0.50] Crop Physiology
   - PBIO*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
- 2.25 - Free electives – any approved electives for B.Sc. students

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

**Minor (Honours Program)**

A minor in Biochemistry consists of at least 5.00 course credits. The following courses are required:
- BIOC*3560 [0.50] Structure and Function in Biochemistry
- BIOC*3570 [0.75] Analytical Biochemistry
- BIOC*4540 [0.75] Enzymology
- CHEM*2480 [0.50] Analytical Chemistry I
- CHEM*2700 [0.50] Organic Chemistry I
- 0.25 - Liberal Education electives

In addition, at least 1.00 credits must be chosen from the following courses, with at least 1.00 credits from the first three courses listed:
- BIOC*4520 [0.50] Metabolic Processes
- BIOC*4580 [0.50] Membrane Biochemistry
- MBG*3350 [0.75] Laboratory Methods in Molecular Biology
- MCB*4050 [0.50] Protein and Nucleic Acid Structure
- MICR*3230 [0.50] Immunology
- MICR*3330 [0.50] World of Viruses
- TOX*4590 [0.50] Biochemical Toxicology

**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/](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**

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Winter</th>
<th>Summer</th>
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</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>Academic Semester 4</td>
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<td>5</td>
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<td>N/A</td>
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**Biochemistry Academic and Co-op Work Term Schedule – Sequence B**

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

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

Credit Summary (21.50 Total Credits)*

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

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

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
COOP*1100 [0.00] Introduction to Co-operative Education
MATH*1090 [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

0.50 Liberal Education electives

Winter Semester

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

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

Electives or restricted electives to a maximum of 2.75 total credits

Semester 5 - Fall
BIOL*3560 [0.50] Structure and Function in Biochemistry
CHEM*3750 [0.50] Organic Chemistry II
MBG*2050 [0.50] Molecular Biology of the Cell
MICR*2430 [0.50] Methods in Microbial Culture and Physiology

0.50 electives or restricted electives

Winter Semester

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

Semester 6 - Summer

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

Semester 7 - Fall
MBG*3350 [0.75] Laboratory Methods in Molecular Biology electives or restricted electives to a maximum of 2.75 total credits

Semester 8 - Winter

BIOL*4540 [0.75] Enzymology electives or restricted electives to a maximum of 2.75 total credits

Summer Semester

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

Semester 8 - Fall

2.50 electives or restricted electives

Restricted Electives

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

   BIOC*4520 [0.50] Metabolic Processes
   BIOC*4580 [0.50] Membrane Biochemistry
   BIOL*3300 [0.50] Applied Bioinformatics
   BIOM*3200 [1.00] Biomedical Physiology
   MBG*3040 [0.50] Molecular Biology of the Gene
   MBG*3080 [0.50] 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
   MCB*3230 [0.50] Immunology
   MCB*3330 [0.50] World of Viruses
   MCB*4330 [0.50] Molecular Virology
   MCB*4530 [0.50] Immunology II
   PBIO*3110 [0.50] Crop Physiology
   PBIO*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

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

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
COOP*1100 [0.00] Introduction to Co-operative Education
MATH*1090 [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

0.50 Liberal Education electives

Winter Semester

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

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

Electives or restricted electives to a maximum of 2.75 total credits

Semester 5 - Fall
BIOL*3560 [0.50] Structure and Function in Biochemistry
CHEM*3750 [0.50] Organic Chemistry II
MBG*2050 [0.50] Molecular Biology of the Cell
MICR*2430 [0.50] Methods in Microbial Culture and Physiology

0.50 electives or restricted electives

Winter Semester

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

Semester 6 - Summer

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

Semester 7 - Fall
MBG*3350 [0.75] Laboratory Methods in Molecular Biology electives or restricted electives to a maximum of 2.75 total credits

Semester 8 - Winter

BIOL*4540 [0.75] Enzymology electives or restricted electives to a maximum of 2.75 total credits

Fall Semester

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

Semester 5 - Winter

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

1.00 electives or restricted electives
X. Degree Programs, Bachelor of Science (B.Sc.)

Co-op Work Term III
Marine Biology and Oceanography
General Chemistry I
Energy
Plant Anatomy

Field Biology
Membrane Biochemistry

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

Biological Concepts of Health
Arctic Ecology
Elements of Calculus I
Vertebrate Structure and Function

Semester 4
BiOL*2060 [0.50] Ecology
BiOL*2400 [0.50] Evolution
STAT*2230 [0.50] Biostatistics for Integrative Biology
ZOO*2700 [0.50] Invertebrate Morphology & Evolution

Semester 5
2.50 electives or restricted electives*
or
Study Abroad*

Semester 6
BOT*3710 [0.50] Plant Diversity and Evolution
ENVS*3090 [0.50] Insect Diversity and Biology
IBIO*3100 [0.50] Interpreting Biodiversity I

1.00 electives or restricted electives*

Semester 7
IBIO*4100 [1.00] Interpreting Biodiversity II

1.50 electives or restricted electives*

Semester 8
2.50 electives or restricted electives*

* Restricted Electives
The major in Biodiversity is a flexible program that allows students, in consultation with faculty advisors, to design their own courses and choose from a wide range of science courses.

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/learning/credit-electives

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*3050 [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 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.

** Study Abroad can include an exchange, international letter of permission, semester abroad or field school. Full details on the institutions and experiences available, along with application deadlines and admission requirements can be found on the University of Guelph, Centre for International Programs website: https://www.uoguelph.ca/cip/

Credit Summary (20.00 Total Credits)

- 4.00 - First year science credits
- 6.50 - Required science courses semesters 3 - 8
- 1.50 - Restricted elective (# 2, 3 and 4 in restricted elective list)
- 4.00 - Approved Science electives
- 1.00 - Liberal Education (#1 in restricted electives)
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 anytime 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: 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 study schedule for this major found at: [https://www.uoguelph.ca/bsc/revised_SS](https://www.uoguelph.ca/bsc/revised_SS)

**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

**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

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**
- BIOL*3560 [0.50] Structure and Function in Biochemistry
- BIOL*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 - 1st 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.

The recommended program sequence is outlined below.

**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.recruitinguelph.ca/cecs/](https://www.recruitinguelph.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**

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<th>Year</th>
<th>Fall</th>
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<th>Summer</th>
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<td>COOP*3000 Work Term III</td>
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<td>COOP*4000 Work Term IV</td>
<td>Academic Semester 7</td>
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<td>5</td>
<td>COOP*5000 Work Term V</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
- 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.+
Major (Honours Program)

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

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

* IPS*1500 is recommended

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

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

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

* IPS*1510 is recommended

Semester 3 - Fall
COOP*1100 [0.00] Introduction to Co-operative Education
MATH*2200 [0.50] Advanced Calculus I
MATH*2270 [0.50] Applied Differential Equations

PHYS*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)

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

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

1.50 electives ***

Semester 7 - Winter
NANO*3600 [0.50] Computational Methods in Materials Science
PHYS*3510 [0.50] Intermediate Laboratory

PHYS*4040 [0.50] Quantum Mechanics II
PHYS*4540 [0.50] Molecular Biophysics

0.50 electives ***

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

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

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

1.50 electives ***

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

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

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

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

Biological and Pharmaceutical Chemistry (BPCH)

Department of Chemistry, College of Engineering and Physical Sciences

Major (Honours Program)

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

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

0.50 Liberal Education electives

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

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)
XSEN*3210 [0.50] Pharmaceutical Organic Chemistry
XSEN*3210 [0.50] Introduction to Pharmaceutical Manufacturing

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

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

Semester 8
2.50 electives or restricted electives *

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

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

2. A minimum of 1.50 credits at the 4000 level and 2.50 credits at the 3000/4000 level from the following list:
BIOC*3560 [0.50] Structure and Function in Biochemistry
BIOC*4520 [0.50] Metabolic Processes
BIOC*4540 [0.75] Enzymology **
BIOC*4580 [0.50] Membrane Biochemistry
BIOM*3090 [0.50] Principles of Pharmacology **
BIOM*3200 [1.00] Biomedical Physiology
BIOM*4090 [0.50] Pharmacology **
CHEM*3360 [0.50] Environmental Chemistry and Toxicology
CHEM*3440 [0.50] Analytical Chemistry III: Analytical Instrumentation
CHEM*3640 [0.50] Chemistry of the Elements I
CHEM*3650 [0.50] Chemistry of the Elements II **
CHEM*3760 [0.50] Organic Chemistry III
CHEM*4010 [0.50] Chemistry and Industry
CHEM*4400 [0.50] Advanced Topics in Analytical Chemistry
CHEM*4630 [0.50] Bioinorganic Chemistry **
CHEM*4720 [0.50] Organic Reactivity **
CHEM*4730 [0.50] Synthetic Organic Chemistry **
CHEM*4740 [0.50] Topics in Bio-Organic Chemistry
CHEM*4900 [1.00] Chemistry Research Project I **
CHEM*4910 [1.00] Chemistry Research Project II **
MBG*3040 [0.50] Molecular Biology of the Gene **
MBG*3350 [0.75] Laboratory Methods in Molecular Biology **
MCB*4050 [0.50] Protein and Nucleic Acid Structure **
MICR*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
5.00 - Restricted electives (#1 and #2 in restricted electives list)
0.50 - Approved Science electives
1.00 - Liberal Education electives
3.00 - Free electives - any approved elective for B.Sc. students. (could be less if restricted electives do not count as science)

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

Biological and Pharmaceutical Chemistry (Co-op) (BPCH:C)

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.recruituoguelph.ca/ccecc/). 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

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<th>Fall</th>
<th>Winter</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
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<td>1</td>
<td>Academic Semester 1</td>
<td>Academic Semester 2</td>
<td>Co-op*1100 Off</td>
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<td>COOP*1000 Work Term I</td>
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<td>COOP*2000 Work Term II</td>
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<td>4</td>
<td>COOP*3000 Work Term III</td>
<td>Academic Semester 7</td>
<td>COOP*4000 Work Term IV</td>
</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

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

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

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

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

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

Semester 5 - Fall
BIOL*3204 [0.50] Analytical Biochemistry
CHEM*3430 [0.50] Analytical Chemistry II
One of:
### 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**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1090</td>
<td>0.50</td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>0.50</td>
</tr>
<tr>
<td>MATH*1080</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*1080</td>
<td>0.50</td>
</tr>
<tr>
<td>0.50 Liberal Education electives</td>
<td></td>
</tr>
</tbody>
</table>

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

**Semester 2**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BIOL*1070</td>
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</tr>
<tr>
<td>BIOL*1080</td>
<td>0.50</td>
</tr>
<tr>
<td>CHEM*1050</td>
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</tr>
<tr>
<td>PHYS*1070</td>
<td>0.50</td>
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<tr>
<td>0.50 Liberal Education electives</td>
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</table>

**Semester 3**

<table>
<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>BIOL*2400</td>
<td>0.50</td>
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<tr>
<td>1.00 electives or restricted electives</td>
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</table>

**Semester 4**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
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<tr>
<td>STAT*2040</td>
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</tr>
<tr>
<td>1.00 electives or restricted electives</td>
<td></td>
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</table>

**Semester 5**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.50 electives of restricted electives</td>
<td></td>
</tr>
</tbody>
</table>

Students are encouraged to consider study abroad options.

**Semester 6**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.50 electives of restricted electives</td>
<td></td>
</tr>
</tbody>
</table>

Students are encouraged to consider study abroad options.

**Semester 7 and 8**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.50 electives of restricted electives</td>
<td></td>
</tr>
</tbody>
</table>

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/bsc/](https://www.queensu.ca/bsc/).

2. A minimum of 0.50 credits in Ecology:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*2060</td>
<td>0.50</td>
</tr>
</tbody>
</table>

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Last Revision: July 4, 2019

2019-2020 Undergraduate Calendar
Discovering Biodiversity
Biomedical Physiology
Immunology Elective - ANSC*4650 or MICR*3230
Fundamentals of Nutrition
Physics for Life Sciences
General Chemistry II
Statistics II

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

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

Credit Summary (20.00 Total Credits)
4.00 - First year science core
3.50 - Required science courses semesters 3 - 8 (# 2, 3 and 4 in restricted elective list)
5.50 - Approved Biological Science electives of which 4.00 must be 3000/4000 level (# 5 in restricted elective list)
3.00 - Approved Science electives of which 2.00 credits must be 3000/4000 level* May include 1 of BIOL*1020, CHEM*1060
2.00 - Liberal Education electives
2.00 - Electives

*Biology (BIOL)

College of Biological Science

Minor (Honours Program)

A minor in Biology consists of a minimum of 5.00 credits including the following courses:
   BIOL*1070 [0.50] Discovering Biodiversity
   BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
   MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
   One of:
   BIOL*2060 [0.50] Ecology
   BOT*3050 [0.50] Plant Functional Ecology

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

Bio-Medical Science (BIOM)

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

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

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

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

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

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

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

Major (Honours Program)

A minimum of 20.00 credits is required.

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

0.50 electives or restricted electives

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

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

0.50 electives or restricted electives

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

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

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

Semester 5
   BIOM*3560 [0.50] Structure and Function in Biochemistry
   Electives or restricted electives to a maximum of 2.75 total credits in this semester.
   BIOM*3210 is recommended.

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

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

Semester 7
   2.50 electives or restricted electives

2.50 electives or restricted electives

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

Credit Summary (20.00 Total Credits)
4.00 - First year science credits
5.75 - Required science courses semesters 3 – 8 (with HK 2810,3810) or 5.50 (with BIOM 3200)
4.00 - Restricted elective (with HK 3401/2 or HK 3501/2) 3.75 (with BIOM 3010, BIOM 3040) (Restricted elective #1, #2 and #3)
2.25 – 2.75 Approved Science electives depending on which anatomy and physiology courses are completed above.
2.00 - Liberal Education electives
2.00 - Free electives - any approved elective for B.Sc. students.
Biomedical Toxicology (BTOX)

Interdisciplinary Program, Departments of Biomedical Sciences, Chemistry, School of Environmental Sciences, Molecular and Cellular Biology

Major (Honours Program)

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

Semester 1

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

0.50 Liberal Education electives

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

Semester 2

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

0.50 Liberal Education electives

Semester 3

BioC*2580 [0.50] Introduction to Biochemistry
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
TOX*2000 [0.50] Principles of Toxicology

1.00 elective or Liberal Education electives

Semester 4

BIOM*3200 [1.00] Biomedical Physiology
CHEM*2480 [0.50] Analytical Chemistry I
CHEM*2700 [0.50] Organic Chemistry I

0.50 electives or restricted electives*

Semester 5

BioC*3560 [0.50] Structure and Function in Biochemistry
MCB*2050 [0.50] Molecular Biology of the Cell
NUTR*3210 [0.50] Fundamentals of Nutrition
TOX*3300 [0.50] Analytical Toxicology

0.50 electives or restricted electives*

Semester 6

BIOM*3090 [0.50] Principles of Pharmacology
PATH*3610 [0.50] Principles of Disease
TOX*3360 [0.50] Environmental Chemistry and Toxicology

One of:

- BIOM*3040 [0.75] Medical Embryology
- MBG*3350 [0.75] Laboratory Methods in Molecular Biology *

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

Semester 7

NUTR*4510 [0.50] Toxicology, Nutrition and Food
TOX*4000 [0.50] Medical Toxicology
TOX*4590 [0.50] Biochemical Toxicology

1.00 electives or restricted electives*

Semester 8

BIOM*4090 [0.50] Pharmacology
TOX*4100 [0.50] Toxicological Pathology
TOX*4200 [0.50] Topics in Toxicology

1.00 electives or restricted electives*

* Restricted Electives

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

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

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

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

Credit Summary (20.00 Total Credits)*

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

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.

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>
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<td>3</td>
<td>Academic Semester 4</td>
<td>Academic Semester 5</td>
<td>COOP*3000 Work Term III</td>
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<td>4</td>
<td>COOP*4000 Work Term IV</td>
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<td>5</td>
<td>Academic Semester 7</td>
<td>Academic Semester 8</td>
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</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
1.50 - Co-op Work Terms

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.

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

<table>
<thead>
<tr>
<th>Semester 2 - Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1080 [0.50] Biological Concepts of Health</td>
</tr>
<tr>
<td>CHEM*1050 [0.50] General Chemistry II</td>
</tr>
<tr>
<td>COOP*1100 [0.00] Introduction to Co-operative Education</td>
</tr>
<tr>
<td>PHYS*1070 [0.50] Physics for Life Sciences II</td>
</tr>
<tr>
<td>STAT*2040 [0.50] Statistics I</td>
</tr>
<tr>
<td>0.50 Liberal Education electives</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 3 - Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*2580 [0.50] Introduction to Biochemistry</td>
</tr>
<tr>
<td>CHEM*2480 [0.50] Analytical Chemistry I</td>
</tr>
<tr>
<td>MBG*2040 [0.50] Foundations in Molecular Biology and Genetics</td>
</tr>
<tr>
<td>TOX*2000 [0.50] Principles of Toxicology</td>
</tr>
<tr>
<td>0.50 Liberal Education electives</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 4 - Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*3560 [0.50] Structure and Function in Biochemistry</td>
</tr>
<tr>
<td>MCB*2050 [0.50] Molecular Biology of the Cell</td>
</tr>
<tr>
<td>NUTR*3210 [0.50] Fundamentals of Nutrition</td>
</tr>
<tr>
<td>TOX*3300 [0.50] Analytical Toxicology</td>
</tr>
<tr>
<td>0.50 electives or restricted electives</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 5 - Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM*2700 [0.50] Organic Chemistry I</td>
</tr>
<tr>
<td>BIOM*3200 [1.00] Biomedical Physiology</td>
</tr>
<tr>
<td>TOX*3360 [0.50] Environmental Chemistry and Toxicology</td>
</tr>
<tr>
<td>0.50 electives or restricted electives*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 6 - Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOM*3090 [0.50] Principles of Pharmacology</td>
</tr>
<tr>
<td>PATH*3610 [0.50] Principles of Disease</td>
</tr>
<tr>
<td>One of:</td>
</tr>
<tr>
<td>BIOM*3040 [0.75] Medical Embryology</td>
</tr>
<tr>
<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>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 7 - Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUTR*4510 [0.50] Toxicology, Nutrition and Food</td>
</tr>
<tr>
<td>TOX*4000 [0.50] Medical Toxicology</td>
</tr>
<tr>
<td>TOX*4590 [0.50] Biochemical Toxicology</td>
</tr>
<tr>
<td>One of:</td>
</tr>
<tr>
<td>BIOM*4090 [0.50] Pharmacology</td>
</tr>
<tr>
<td>TOX*4900 [1.00] Toxicology Research Project I</td>
</tr>
<tr>
<td>1.00 electives or restricted electives*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 8- Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOM*4090 [0.50] Pharmacology (if not taken in Semester 7)</td>
</tr>
<tr>
<td>TOX*4100 [0.50] Toxicological Pathology</td>
</tr>
<tr>
<td>TOX*4200 [0.50] Topics in Toxicology</td>
</tr>
<tr>
<td>Electives or restricted electives* to 2.50 credits</td>
</tr>
</tbody>
</table>

* Restricted Electives

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

| PATH*3040 [0.50] Principles of Parasitology |
| POPM*3240 [0.50] Epidemiology |
| POPM*4040 [0.50] Epidemiology of Food-borne Diseases |
| STAT*2050 [0.50] Statistics II |
| STAT*3510 [0.50] Environmental Risk Assessment |
| TOX*4900 [1.00] Toxicology Research Project I |
| TOX*4910 [1.00] Toxicology Research Project II |

<table>
<thead>
<tr>
<th>Biotechnology (BIOT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department of Molecular and Cellular Biology, College of Biological Science</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Minor (Honours Program)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A minimum of 5.00 credits is required including:</td>
</tr>
<tr>
<td>BIOC*3560 [0.50] Structure and Function in Biochemistry</td>
</tr>
<tr>
<td>MBG*2040 [0.50] Foundations in Molecular Biology and Genetics</td>
</tr>
<tr>
<td>MICR*2420 [0.50] Introduction to Microbiology</td>
</tr>
<tr>
<td>MICR*2430 [0.50] Methods in Microbial Culture and Physiology</td>
</tr>
<tr>
<td>0.50 credits from:</td>
</tr>
<tr>
<td>ENGG*2660 [0.50] Biological Engineering Systems I</td>
</tr>
<tr>
<td>ENGG*3830 [0.50] Bio-Process Engineering</td>
</tr>
<tr>
<td>FOOD*2410 [0.50] Introduction to Food Processing</td>
</tr>
<tr>
<td>FOOD*2420 [0.50] Introduction to Food Microbiology</td>
</tr>
<tr>
<td>FOOD*2620 [0.50] Food Engineering Principles</td>
</tr>
<tr>
<td>1.00 credits from:</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*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:

| ANSC*4050 [0.50] Biotechnology in Animal Science |
| BIOC*4540 [0.75] Enzymology |
| BIOL*3300 [0.50] Applied Bioinformatics |
| FOOD*3270 [0.50] Industrial Microbiology |
| MBG*3660 [0.50] Genomics |
| MBG*4240 [0.50] Applied Molecular Genetics in Medicine and Biotechnology |
| MCB*4050 [0.50] Protein and Nucleic Acid Structure |
| MICR*3230 [0.50] Immunology |
| PBO*3750 [0.50] Plant Tissue Culture |
| PBO*4750 [0.50] Genetic Engineering of Plants |

<table>
<thead>
<tr>
<th>Business Economics (BECN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department of Economics and Finance, Gordon S. Lang School of Business and Economics</td>
</tr>
</tbody>
</table>

Interdisciplinary study in Business Economics is offered as a minor in the honors 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.

<table>
<thead>
<tr>
<th>Minor (Honours Program)</th>
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<tbody>
<tr>
<td>A minimum of 5.00 credits is required, including:</td>
</tr>
<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>
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<tr>
<td>ECON*1100 [0.50] Introductory Macroeconomics</td>
</tr>
<tr>
<td>ECON*2310 [0.50] Intermediate Microeconomics</td>
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<tr>
<td>ECON*2410 [0.50] Intermediate Macroeconomics</td>
</tr>
<tr>
<td>ECON*2560 [0.50] Introduction to Finance</td>
</tr>
<tr>
<td>One of:</td>
</tr>
<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>
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<td>One of:</td>
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<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>
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<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>
<tr>
<td>One of:</td>
</tr>
<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
CHEM*1040 [0.50] General Chemistry I
CTIS*1300 [0.50] Programming
IPS*1500 [1.00] Integrated Mathematics and Physics I
One of:
BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1080 [0.50] Biological Concepts of Health
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
Students who are lacking one 4U/grade 12 course in Biology, Chemistry or Physics must take the equivalent introductory course in first semester. The required first-year science courses in that subject should be completed according to the revised schedule of studies available at: https://www.uoguelph.ca/bsc/revised_SS

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

Semester 3
CHEM*2060 [0.50] Structure and Bonding
MATH*2200 [0.50] Advanced Calculus I
MATH*2270 [0.50] Applied Differential Equations
PHYS*2330 [0.50] Electricity and Magnetism I
0.50 Liberal Education electives

Semester 4
CHEM*2070 [0.50] Structure and Spectroscopy
CHEM*2480 [0.50] Analytical Chemistry I
PHYS*2180 [0.50] Experimental Techniques in Physics
PHYS*2310 [0.50] Mechanics
PHYS*2340 [0.50] Electricity and Magnetism II

Semester 5
CHEM*3860 [0.50] Quantum Chemistry
PHYS*3130 [0.50] Mathematical Physics
PHYS*3230 [0.50] Quantum Mechanics I
One of:
CHEM*2820 [0.50] Thermodynamics and Kinetics
PHYS*2240 [0.50] Thermal Physics
One of:
IPS*3000 [0.50] Science Communication
0.50 electives

Semester 6
CHEM*3430 [0.50] Analytical Chemistry II: Instrumental Analysis
NANO*3600 [0.50] Computational Methods in Materials Science
PHYS*3000 [0.50] Optics: Fundamentals and Applications
PHYS*4040 [0.50] Quantum Mechanics II
One of:
CHEM*3870 [0.50] Molecular Spectroscopy
CHEM*4880 [0.50] Topics in Advanced Physical Chemistry

Semester 7
CHEM*3440 [0.50] Analytical Chemistry III: Analytical Instrumentation
PHYS*4120 [0.50] Atomic and Molecular Physics
PHYS*4240 [0.50] Statistical Physics II
One of:
PHYS*4001 [0.50] Research in Physics +
0.50 electives +
0.50 electives

Semester 8
One of:
CHEM*3870 [0.50] Molecular Spectroscopy
CHEM*4880 [0.50] Topics in Advanced Physical Chemistry
One of:
CHEM*4900 [1.00] Chemistry Research Project I +
PHYS*4002 and 0.50 electives
One of:
IPS*3000 [0.50] Science Communication
0.50 electives +
0.50 electives
+ Students must complete either (PHYS*4001, PHYS*4002 in semester 7 and 8) or (CHEM*4900 in semester 8).
+ One of CHEM*3870 or CHEM*4880 is required for graduation.

Credit Summary (20.00 Total Credits)
5.00 - First year science credits
11.50 - Required science courses semesters 3 – 8
1.00 - Liberal Education electives
2.50 - Free electives - any approved elective for B.Sc. students

Chemical 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 | Academic Semester 4 | COOP*1000 Work Term I
3 | COOP*2000 Work Term II | Academic Semester 5 | COOP*3000 Work Term III
4 | Academic Semester 6 | COOP*4000 Work Term IV | COOP*5000 Work Term V
5 | Academic Semester 7 | 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
10.50 - Required science courses semesters 3 – 8
0.50 - Approved science electives
1.00 - Liberal Education electives
3.00 - Free electives - any approved elective for B.Sc. students.
2.00 - Co-op Work Terms

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

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

The recommended program sequence is outlined below.

Major (Honours Program)

Semester 1 - Fall
CHEM*1040 [0.50] General Chemistry I
CIS*1300 [0.50] Programming
Integrated Mathematics and Physics I
Integrated Mathematics and Physics I
Topics in Advanced Physical Chemistry
Organic Chemistry II
Introduction to Molecular and Cellular Biology
General Chemistry II
Discovering Biodiversity
Co-op Work Term I
Co-op Work Term IV
Analytical Chemistry III: Analytical Instrumentation
Organic Chemistry III
Thermodynamics and Kinetics
Discovering Biodiversity
Approval of the Faculty Advisor must be obtained for the selection of courses not
Applied Differential Equations
Linear Algebra I
Introduction to Biochemistry
Applied Differential Equations
Science Communication
Chemistry of the Elements II
General Chemistry II
Analytical Chemistry II: Instrumental Analysis
Quantum Mechanics I
Biological Concepts of Health
Molecular Spectroscopy +
Thermal Physics
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/
** 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
BIOC*1090 [0.50] Introduction to Molecular and Cellular Biology
CHEM*1040 [0.50] General Chemistry I
IPS*1510 [1.00] Integrated Mathematics and Physics I
0.50 Liberal Education electives

Semester 2
CHEM*1050 [0.50] General Chemistry II
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 3 - Fall
CHEM*2060 [0.50] Structure and Bonding
COOP*1100 [0.00] Introduction to Co-operative Education
MATH*2240 [0.50] STU:Mathematics I
MATH*2270 [0.50] Applied Differential Equations
PHYS*2330 [0.50] Electricity and Magnetism II

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*3340 [0.50] Analytical Chemistry II: Instrumental Analysis
One of:
CHEM*3870 [0.50] Molecular Spectroscopy +
0.50 electives *
One of:
PHYS*3250 [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*3240 [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*3340 [0.50] Analytical Chemistry III: Analytical Instrumentation
PHYS*4240 [0.50] Statistical Physics II
One of:
CHEM*3640 [0.50] Chemistry of the Elements I
CHEM*3750 [0.50] Organic Chemistry II
0.50 electives *
1.00 electives *

Semester 8** - Winter
NANO*3600 [0.50] Computational Methods in Materials Science
PHYS*3000 [0.50] Optics: Fundamentals and Applications
PHYS*4040 [0.50] Quantum Mechanics II
One of:
CHEM*3870 [0.50] Molecular Spectroscopy +
CHEM*4880 [0.50] Topics in Advanced Physical Chemistry +
0.50 electives *
0.50 electives *
* A minimum of 1.00 credits of Liberal Education electives is required for completion of this program. The list of Liberal Education electives for B.Sc. students can be found at: https://www.uoguelph.ca/bsc/
** A minimum of 2.00 credits in science courses at the 4000 level is required for graduation.

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

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
BIOC*1090 [0.50] Introduction to Molecular and Cellular Biology
CHEM*1040 [0.50] General Chemistry I
IPS*1510 [1.00] Integrated Mathematics and Physics I
0.50 Liberal Education electives

Semester 2
CHEM*1050 [0.50] General Chemistry II
IPS*1510 [1.00] Integrated Mathematics and Physics II
MATH*1160 [0.50] Linear Algebra I
One of:
BIOC*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*3340 [0.50] Analytical Chemistry II: Instrumental Analysis
One of:
CHEM*3870 [0.50] Molecular Spectroscopy +
0.50 electives *
One of:
PHYS*3250 [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*3240 [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*3340 [0.50] Analytical Chemistry III: Analytical Instrumentation
PHYS*4240 [0.50] Statistical Physics II
One of:
CHEM*3640 [0.50] Chemistry of the Elements I
CHEM*3750 [0.50] Organic Chemistry II
0.50 electives *
1.00 electives *

Semester 8** - Winter
NANO*3600 [0.50] Computational Methods in Materials Science
PHYS*3000 [0.50] Optics: Fundamentals and Applications
PHYS*4040 [0.50] Quantum Mechanics II
One of:
CHEM*3870 [0.50] Molecular Spectroscopy +
CHEM*4880 [0.50] Topics in Advanced Physical Chemistry +
0.50 electives *
0.50 electives *
* A minimum of 1.00 credits of Liberal Education electives is required for completion of this program. The list of Liberal Education electives for B.Sc. students can be found at: https://www.uoguelph.ca/bsc/
** A minimum of 2.00 credits in science courses at the 4000 level is required for graduation.
+ One of CHEM*3870 or CHEM*4880 is required for graduation.
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 term work, and must follow the academic work schedule as outlined below (also found on the Co-operative Education website: https://www.recruitguelph.ca/cecs/). Please refer to the Co-operative Education program policy with respect to adjusting this schedule.

Chemistry Academic and Co-op Work Term Schedule

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

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

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

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

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

The recommended program sequence is outlined below.

Major (Honours Program)

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

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

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

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

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

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

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

Semester 5 - Fall
CHEM*2820 [0.50] 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

Last Revision: July 4, 2019
A knowledge of Computing is a complement to most areas of study. The Minor in Computing and Information Science is directed towards students who wish to supplement their studies in another area with some experience in Computing. Students interested in pursuing a Major in Computing can do so through the Bachelor of Computing Degree Program.

**Minor (Honours Program)**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIS*1300</td>
<td>Programming</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CIS*1910</td>
<td>Discrete Structures in Computing I</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CIS*2170</td>
<td>User Interface Design</td>
<td>[0.75]</td>
</tr>
<tr>
<td>CIS*2430</td>
<td>Object Oriented Programming</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CIS*2500</td>
<td>Intermediate Programming</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CIS*2520</td>
<td>Data Structures</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CIS*2750</td>
<td>Software Systems Development and Integration</td>
<td>[0.75]</td>
</tr>
</tbody>
</table>

**Ecology (ECOL)**

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

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

**Minor (Honours Program)**

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

- **BIOL*2060** [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](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**

- **BIOL*2580** [0.50] Introduction to Biochemistry
- **STAT*2040** [0.50] Statistics I (if not taken in semester 2)
- **TOX*2000** [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**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BIOL*2060</td>
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<tr>
<td>ENVS*2090</td>
<td>Problem Solving in Environmental Biology</td>
<td>[0.50]</td>
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<tr>
<td>MBG*2040</td>
<td>Foundations in Molecular Biology and Genetics</td>
<td>[0.50]</td>
</tr>
</tbody>
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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] Toxological 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/](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*2400** [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 - Organisinal 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
- **MICR*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*4110 [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
BIOL*1070 [0.50] Discovering Biodiversity
CHEM*1040 [0.50] General Chemistry I
GEOG*1350 [0.50] Earth: Hazards and Global Change
PHYS*1080 [0.50] Physics for Life Sciences
One of:
MATH*1080 [0.50] Elements of Calculus I
MATH*1200 [0.50] Calculus I
Students who are lacking one 4U /grade 12 course in Biology, Chemistry or Physics must take the equivalent introductory course in first semester.
The required first-year science courses in that subject should be completed according to the revised schedule of studies available at: https://www.uoguelph.ca/bse/revised_SS

Semester 2
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
CHEM*1050 [0.50] General Chemistry II
GEOG*1300 [0.50] Introduction to the Biophysical Environment
PHYS*1070 [0.50] Physics for Life Sciences II
0.50 Liberal Education electives* (GEOG*1220 is recommended)

Semester 3
ENVS*2240 [0.50] Fundamentals of Environmental Geology
GEOG*2000 [0.50] Geomorphology

Credit Summary (20.00 Total Credits)
1.00 Approved Science electives*
5.00 - Required credits for the Major (4.50 if STAT*2040 is taken in Semester 2)
4.50 - First year science credits
8.50 - Required science courses semesters 3 – 8
1.00 - Required social science courses semesters 3 – 8
3.00 - Approved Science electives
1.00 - Liberal Education electives
2.00 - Free electives - any approved elective for B.Sc. students.

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

Environmental Geomatics (Co-op) (EG:C)
Department of Geography, Environment and Geomatics, College of Social and Applied Human Sciences
This program provides opportunities for study of the processes and properties of the biophysical environment and a core foundation in the analytical techniques (i.e. Geographical Information Science and Remote Sensing) used for their interpretation, analysis and presentation.

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

Environmental Geomatics Academic and Co-op Work Term Schedule

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Winter</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Academic Semester 1</td>
<td>Academic Semester 2</td>
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<tr>
<td>2</td>
<td>Academic Semester 3</td>
<td>COOP*1100</td>
<td>Academic Semester 4</td>
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<td>COOP*4000 Work Term IV</td>
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</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)**

<table>
<thead>
<tr>
<th>Semester 1 - Fall</th>
<th>Course Code</th>
<th>Credit</th>
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<tbody>
<tr>
<td>BIOL*1070</td>
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<tr>
<td>CHEM*1040</td>
<td>[0.50]</td>
<td></td>
</tr>
<tr>
<td>GEOG*1350</td>
<td>[0.50]</td>
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<tr>
<td>PHYS*1080</td>
<td>[0.50]</td>
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<tr>
<td>BIOL*1090</td>
<td>[0.50]</td>
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<tr>
<td>CHEM*1050</td>
<td>[0.50]</td>
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<tr>
<td>GEOG*1300</td>
<td>[0.50]</td>
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<tr>
<td>PHYS*1070</td>
<td>[0.50]</td>
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<tr>
<td>MATH*1080</td>
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<td>MATH*1200</td>
<td>[0.50]</td>
<td>Calculus I</td>
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</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](https://www.uoguelph.ca/bsc/revised_SS)

**Semester 2 - Winter**

<table>
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<th>Course Code</th>
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<tr>
<td>BIO*2110</td>
<td>[0.50] Introduction to Molecular and Cellular Biology</td>
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<tr>
<td>CHEM*1045</td>
<td>[0.50] General Chemistry I</td>
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<td>MATH*1085</td>
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<td>PHYS*1085</td>
<td>[0.50] Physics for Life Sciences</td>
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<tr>
<td>MATH*1205</td>
<td>[0.50] Elements of Calculus II</td>
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<td>STAT*2040</td>
<td>[0.50] Statistics I</td>
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**Semester 3 - Fall**

<table>
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<tr>
<th>Course Code</th>
<th>Credit</th>
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<tbody>
<tr>
<td>GEO*2110</td>
<td>[0.50] Climate and the Biophysical Environment</td>
</tr>
<tr>
<td>GEO*2210</td>
<td>[0.50] Environment and Resources</td>
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<tr>
<td>GEO*3420</td>
<td>[0.50] Remote Sensing of the Environment</td>
</tr>
<tr>
<td>CIS*1200</td>
<td>[0.50] Introduction to Computing</td>
</tr>
<tr>
<td>CIS*1500</td>
<td>[0.50] Introduction to Programming</td>
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<tr>
<td>MATH*1210</td>
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<td>MATH*1090</td>
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**Summer Semester**

<table>
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<tr>
<th>Course Code</th>
<th>Credit</th>
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<tbody>
<tr>
<td>GEO*4000</td>
<td>[0.50] Environmental Hydrology</td>
</tr>
<tr>
<td>GEO*4990</td>
<td>[0.50] Independent Study in Geography</td>
</tr>
</tbody>
</table>

To improve their computer skills.

**Semester 4 - Winter**

<table>
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<tr>
<th>Course Code</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOOD*2150</td>
<td>[0.50] Food Analysis</td>
</tr>
<tr>
<td>MICR*2420</td>
<td>[0.50] Introduction to Microbiology</td>
</tr>
<tr>
<td>NUTR*3210</td>
<td>[0.50] Fundamentals of Nutrition</td>
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<tr>
<td>STAT*2040</td>
<td>[0.50] Statistics I</td>
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**Semester 5 - Fall**

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<th>Course Code</th>
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<tbody>
<tr>
<td>FOOD*3030</td>
<td>[0.50] Food Chemistry I</td>
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<tr>
<td>FOOD*3160</td>
<td>[0.75] Food Processing I</td>
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<tr>
<td>FOOD*3230</td>
<td>[0.75] Food Microbiology</td>
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**Semester 6 - Winter**

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<th>Course Code</th>
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<tbody>
<tr>
<td>FOOD*3040</td>
<td>[0.50] Food Chemistry II</td>
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<tr>
<td>FOOD*3170</td>
<td>[0.50] Food Processing II</td>
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<tr>
<td>FOOD*3260</td>
<td>[0.50] Industrial Microbiology</td>
</tr>
<tr>
<td>FOOD*3700</td>
<td>[0.50] Sensory Evaluation of Foods</td>
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**Semester 7 - Fall**

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<th>Course Code</th>
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<tbody>
<tr>
<td>FOOD*4190</td>
<td>[0.50] Advanced Food Analysis</td>
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<tr>
<td>FOOD*4260</td>
<td>[0.50] Food Product Development I</td>
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**Semester 8 - Winter**

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<th>Course Code</th>
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<tbody>
<tr>
<td>FOOD*4270</td>
<td>[0.50] Food Product Development II</td>
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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)

**Restrictive Electives:**

<table>
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<tr>
<th>Course Code</th>
<th>Title</th>
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<tbody>
<tr>
<td>FOOD*4070</td>
<td>Food Packaging</td>
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<tr>
<td>FOOD*4090</td>
<td>Functional Foods and Nutraceuticals</td>
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<tr>
<td>FOOD*4110</td>
<td>Meat and Poultry Processing</td>
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<tr>
<td>FOOD*4220</td>
<td>Topics in Food Science</td>
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<tr>
<td>FOOD*4230</td>
<td>Research in Food Science</td>
</tr>
<tr>
<td>FOOD*4310</td>
<td>Food Safety Management Systems</td>
</tr>
<tr>
<td>FOOD*4400</td>
<td>Dairy Processing</td>
</tr>
<tr>
<td>FOOD*4520</td>
<td>Utilization of Cereal Grains for Human Food</td>
</tr>
<tr>
<td>MCS*3010</td>
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<tr>
<td>POPM*4040</td>
<td>Epidemiology of Food-borne Diseases</td>
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**Credit Summary (20.00 Total Credits)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Winter</th>
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<tbody>
<tr>
<td>1</td>
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<td>5</td>
<td>Academic Semester 7</td>
<td>Academic Semester 8</td>
<td>N/A</td>
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</table>

To be eligible to complete 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.

Food Science and Co-op Work Term Schedule

- The Co-op program in Food Science is a five year program, including four work terms.
- Students must complete a Fall, Winter semester work term and must follow the academic work schedule as outlined below (also found on the Co-operative Education website: https://www.receutielpc.ca/coe.cs/). Please refer to the Co-operative Education program policy with respect to adjusting this schedule.
- Food Science Academic and Co-op Work Term Schedule
  - **Fall Semester:**
    - 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
  - **Winter Semester:**
    - 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
  - **Summer Semester:**
    - COOP*1000 [0.50] Co-op Work Term I
  - **Fall Semester:**
    - COOP*2000 [0.50] Co-op Work Term II
  - **Winter Semester:**
    - COOP*3000 [0.50] Co-op Work Term III
  - **Summer Semester:**
    - COOP*4000 [0.50] Co-op Work Term IV
  - **Fall Semester:**
    - 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
  - **Winter Semester:**
    - 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
  - **Summer Semester:**
    - COOP*1000 [0.50] Co-op Work Term I

**Restrictive Electives:**

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</tbody>
</table>

**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.

**Restrictive Electives:**

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

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

**Additional Requirements:**

- 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

**Summer Semester:**

- **Fall Semester:**
  - 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

- **Winter Semester:**
  - 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

- **Co-op Work Terms:**
  - COOP*1000 Work Term I
  - COOP*2000 Work Term II
  - COOP*3000 Work Term III
  - COOP*4000 Work Term IV

**Credit Summary (21.50 Total Credits)**

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

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

- GEG*1300 [0.50] Introduction to the Biophysical Environment
- GEG*2420 [0.50] The Earth From Space
- GEG*2480 [0.50] Mapping and GIS
- GEG*3420 [0.50] Remote Sensing of the Environment
- GEG*3480 [0.50] GIS and Spatial Analysis
- GEG*4480 [1.00] Applied Geomatics

And at least 1.50 credits from:

- GEG*2110 [0.50] Climate and the Biophysical Environment
- GEG*2210 [0.50] Environment and Resources
- GEG*3110 [0.50] Biotic and Natural Resources
- GEG*3210 [0.50] Management of the Biophysical Environment
- GEG*4110 [1.00] Environmental Systems Analysis
- GEG*4210 [0.50] Environmental Governance

Human Kinetics (HK)

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

Human Kinetics is concerned with understanding capacities for, and limits of, human movement at different ages and with the role of physical activity in human health. Through the use of electives, students may structure a program emphasizing biomechanics and ergonomics, human population biology or nutrition, exercise and metabolism.

If lacking the fundamentals of word processing, spreadsheet use and data management, the student should select CIS*1200 as early in the program as possible.

Major (Honours Program)

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

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

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

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

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

Semester 1

- BIOL*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 electives

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

Semester 2

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

0.50 Liberal Education electives

Semester 3

- BIOC*2580 [0.50] Introduction to Biochemistry
- HK*2270 [0.50] Principles of Human Biomechanics
- MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
- STAT*240 [0.50] Statistics I

0.50 Liberal Education electives

Semester 4

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

0.50 electives

0.50 Liberal Education electives

Semester 5

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

Credit Summary (20.00 Total Credits)

1.00 - Restricted elective (# 2 in restricted elective list)
2.25 electives or restricted electives

Restricted Electives

1. A minimum of 2.00 credits of Liberal Education electives is required. The list of Liberal Education electives for B.Sc. students can be found at: https://www.uoguelph.ca/bsc/
2. A minimum of 1.00 credits of restricted electives are required which must be selected from HK*4XXX, NUTR*4XXX (must be an approved B.Sc. Science Elective).

Credit Summary (20.00 Total Credits)

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

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

Marine and Freshwater Biology (MFB)

Department of Integrative Biology, College of Biological Science

The Marine and Freshwater Biology major capitalizes on Guelph’s recognized excellence in aquatic research and provides a broad perspective on aquatic environments based on the physical as well as the biological sciences. In this major, students will build upon 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

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

0.50 Liberal Education electives

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

Semester 2

- BIOL*1070 [0.50] Biological Concepts of Health
- BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
- CHEM*1050 [0.50] General Chemistry II
- PHYS*1070 [0.50] Physics for Life Sciences

0.50 Liberal Education electives

Semester 3

- HK*2270 [0.50] Principles of Human Biomechanics
- MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
- STAT*240 [0.50] Statistics I

0.50 Liberal Education electives

Semester 4

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

0.50 electives

0.50 Liberal Education electives

Semester 5

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

One of

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

Semester 6

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

One of

- HK*3402 [0.75] Human Anatomy: Dissection (if registered in HK*3401 in semester 5)
- HK*3502 [0.75] Human Anatomy (if registered in HK*3501 in semester 5)

Semester 7

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

1.50 electives or restricted electives

Semester 8

2.25 electives or restricted electives

Credit Summary (20.00 Total Credits)

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

Of the total credits required, students are required to complete 16.00 credits in science of which a minimum of 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.
Semester 4
BIOL*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*

Semester 5
BIOL*3450 [0.50] Introduction to Aquatic Environments
ZOO*3600 [0.50] Comparative Animal Physiology I
ZOO*3610 [0.25] Lab Studies in Animal Physiology I
ZOO*3700 [0.50] Integrative Biology of Invertebrates
Electives 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 to a maximum of 2.75 total credits in this semester.

Semester 7
BIOL*4350 [0.50] Limnology of Natural and Polluted Waters
IBIO*4600 [1.00] Integrative Marine and Freshwater Research
1.00 electives

Semester 8
BIOL*4010 [0.50] Adapational Physiology
ZOO*4330 [0.50] Biology of Fishes
ZOO*4570 [0.50] Marine Ecological Processes
1.00 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/bse/

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
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 a minimum of 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Marine and Freshwater Biology (Co-op) (MFB:C)
Department of Integrative Biology, College of Biological Science
The Marine and Freshwater Biology major capitalizes on Guelph’s recognized excellence in aquatic research and provides a broad perspective on aquatic environments based on the physical as well as biological sciences. In this major, you will build upon core courses in ecology, evolution, genetics, and physiology of aquatic biota as you study freshwater and marine environments and work with aquatic organisms experimentally in the field and in the lab. You will have the opportunity to perform independent research projects under a variety of field and laboratory conditions to enhance your learning experience.
Work placements enable students to gain knowledge, skills and values appropriate for work with individuals and groups in a variety of settings. The major prepares students for work with individuals and groups in a variety of settings. The major prepares students for work with individuals and groups in a variety of settings.

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 (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.

Marine and Freshwater Biology 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*4000 Work Term IV
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

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)*
4.00 - 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

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

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

Semester 2 - Winter
BIOL*1080 [0.50] Biological Concepts of Health
BIOL*2000 [0.50] Evolution
COOP*1100 [0.00] Introduction to Co-operative Education
ZOO*2090 [0.50] Vertebrate Structure and Function
1.00 electives or restricted electives*

Semester 4 - Winter
COOP*2000 [0.50] Introduction to Biochemistry
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
STAT*2230 [0.50] Biostatistics for Integrative Biology
ZOO*3700 [0.50] Invertebrate Morphology & Evolution
0.50 electives or restricted electives*

Semester 5 - Fall
BIOL*3450 [0.50] Introduction to Aquatic Environments
ZOO*3600 [0.50] Comparative Animal Physiology I
ZOO*3610 [0.25] Lab Studies in Animal Physiology I
ZOO*3700 [0.50] Integrative Biology of Invertebrates
Electives or restricted electives to a maximum of 2.75 total credits in this semester.

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

Semester 6 - Fall
BIOL*4350 [0.50] Limnology of Natural and Polluted Waters
IBIO*4600 [1.00] Integrative Marine and Freshwater Research
1.00 electives or restricted electives

Semester 7 - Winter
BIOL*3060 [0.50] Populations, Communities & Ecosystems
ZOO*3050 [0.50] Developmental Biology

Last Revision: July 4, 2019
2019-2020 Undergraduate Calendar
**Comparative Animal Physiology II**
**Applied Differential Equations**
**Adaptational Physiology**
**Advanced Calculus II**
**Introduction to Molecular and Cellular Biology**
**Methods in Evolutionary Biology**
**Operating Systems I**
**Introductory Mathematical Statistics I**
**Discovering Biodiversity**
**Co-op Work Term IV**
**Linear Algebra I**
**General Chemistry I**
**Biology of Fishes**

2.50 credits from an Area of Emphasis

**MLE2**

**Case Studies in Mathematics and Statistics**
**Foundations in Molecular Biology and Genetics**
**Introduction to Programming**
**Ecology**
**Population Genetics**
**Data Structures**
**Introductory Macroeconomics**
**Intermediate Microeconomics**
**Lab Studies in Animal Physiology II**
**Data Base Systems and Concepts**
**Biological Concepts of Health**
**Proofs, Sets, and Numbers**
**Statistics I**
**Advanced Topics in Microeconomics**
**Advanced Microeconomics**
**Introductory Microeconomics**
**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:**

**Fall Semester**

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

**Full Semester**

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

**Semester 8 - Winter**

Biol*4010 [0.50] Adaptable Physiology

ZOO*4330 [0.50] Biology of Fishes

ZOO*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*1500, or (Math*1080, Phys*1080) or (Math*1200, Phys*1080)*

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at: [https://www.uoguelph.ca/bsc/revised_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. 5.50 credits from either the Mathematics Stream or the Statistics Stream as follows:

3. 2.50 credits from an Area of Emphasis

**Mathematics Stream:**

Math*2000 [0.50] Proofs, Sets, and Numbers

Math*2210 [0.50] Advanced Calculus II

Math*2270 [0.50] Applied Differential Equations

Math*3160 [0.50] Linear Algebra II

Math*3200 [0.50] Real Analysis

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

**Statistics Stream:**

Stat*3110 [0.50] Introductory Mathematical Statistics I

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.

**BIOINFORMATICS (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 Bioinformatics

MBG*2040 [0.50] Foundations in Molecular Biology and Genetics

**BIOMATHEMATICAL OR BIOSTATISTICAL MODELLING (BBM)**

The following credits must be taken:

Biol*2060 [0.50] Ecology

Biol*2400 [0.50] Evolution

Biol*3060 [0.50] Populations, Communities & Ecosystems

Biol*3130 [0.50] Conservation Biology

Biol*4150 [0.50] Wildlife Conservation and Management

**COMPUTER SCIENCE (CS)**

The following credits must be taken:

CIS*2430 [0.50] Object Oriented Programming

CIS*2500 [0.50] Intermediate Programming

CIS*2520 [0.50] Data Structures

at least 1.00 credits from:

CIS*3110 [0.50] Operating System I

CIS*3190 [0.50] Software for Legacy Systems

CIS*3490 [0.50] The Analysis and Design of Computer Algorithms

CIS*3530 [0.50] Data Base Systems and Concepts

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

**ECONOMICS (ECON)**

The following credits must be taken:

Econ*1050 [0.50] Introductory Microeconomics

Econ*1100 [0.50] Introductory Macroeconomics

Econ*2310 [0.50] Intermediate Microeconomics

at least 1.00 credits from:

Econ*3100 [0.50] Game Theory

Econ*3710 [0.50] Advanced Microeconomics

Econ*4710 [0.50] Advanced Topics in Microeconomics

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

**ENERGY AND MASS TRANSFER (EMT)**

The following credits must be taken:

Engg*1210 [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

**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*2580** [0.50] Introduction to Biochemistry
- **MBG*2040** [0.50] Foundations in Molecular Biology and Genetics
- **MCR*2420** [0.50] Introduction to Microbiology
- **STAT*2040** [0.50] Statistics I

0.50 Liberal Education electives

**Semester 4**

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

0.50 electives

0.50 Liberal Education electives

**Semester 5**

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

A minimum of 0.50 electives or restricted electives

**Semester 6**

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

**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/

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

- **BIOC*4540** [0.75] Enzymology
- **BIOC*4580** [0.50] Membrane Biochemistry
- **ENVS*3290** [0.50] Waterborne Disease Ecology
- **FOOD*3230** [0.75] Food Microbiology
- **FOOD*3240** [0.50] Food Microbiology
- **FOOD*3260** [0.50] Industrial Microbiology
- **FOOD*3270** [0.50] Industrial Microbiology
- **FOOD*4400** [0.50] Dairy Processing
- **MCR*3010** [0.50] Dynamics of Cell Function and Signaling
- **MCR*4500** [1.00] Research Project in Molecular & Cellular Biology

**Microbiology (MICR)**

- **MCR*4510** [1.00] Research Project in Molecular & Cellular Biology
- **MCR*4600** [0.50] Topics in Molecular and Cellular Biology
- **MICR*3090** [0.50] Mycology
- **MICR*3220** [0.50] Plant Microbiology
Credit Summary (20.00 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.

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

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

Credit Summary (21.50 Total Credits)*

4.00 - First year science required
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.

1.50 - Co-op Work Terms

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

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

The recommended program sequence is outlined below.

Major (Honours Program)

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

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
BIOL*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
BIOL*3560 [0.50] Structure and Function in Biochemistry
MBG*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 Adaption
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

Department of Microbial and Cellular Biology, College of Biological Science

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

Program Requirements

The Co-op program in Microbiology is a five year program, including four work terms. Students must complete a Fall, Winter and Summer work term and must follow the academic work schedule as outlined below (also found on the Co-operative Education website: https://www.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>
<th>Year</th>
<th>Fall</th>
<th>Winter</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Academic Semester 1</td>
<td>Academic Semester 2</td>
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<tr>
<td>2</td>
<td>Academic Semester 3</td>
<td>Academic Semester 4</td>
<td>COOP*1000 Work Term I</td>
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<tr>
<td>3</td>
<td>Academic Semester 5</td>
<td>Academic Semester 6</td>
<td>COOP*2000 Work Term II</td>
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<td>4</td>
<td>COOP*3000 Work Term III</td>
<td>COOP*4000 Work Term IV</td>
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<td>5</td>
<td>Academic Semester 7</td>
<td>Academic Semester 8</td>
<td>N/A</td>
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</table>
Semester 7 - Fall
2.50 electives or restricted electives which can include MCB*4500
Semester 8 - Winter
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/
2. 3.50 restricted elective credits of which 1.00 credits must be at the 4000 level.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>BIOC*4540</td>
<td>Enzymology</td>
</tr>
<tr>
<td>BIOC*4580</td>
<td>Membrane Biochemistry</td>
</tr>
<tr>
<td>ENV*3290</td>
<td>Waterborne Disease Ecology</td>
</tr>
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<td>FOOD*3230</td>
<td>Food Microbiology</td>
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<td>FOOD*3240</td>
<td>Food Microbiology</td>
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<td>FOOD*3260</td>
<td>Industrial Microbiology</td>
</tr>
<tr>
<td>FOOD*3270</td>
<td>Industrial Microbiology</td>
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<tr>
<td>FOOD*4400</td>
<td>Dairy Processing</td>
</tr>
<tr>
<td>MCB*3010</td>
<td>Dynamics of Cell Function and Signaling</td>
</tr>
<tr>
<td>MCB*4500</td>
<td>Research Project in Molecular &amp; Cellular Biology</td>
</tr>
</tbody>
</table>

MCB*4510 Research Project in Molecular & Cellular Biology

MCB*4520 and MCB*4510) restricted electives

Molecular Biology and Genetics (MBG)

Department of Molecular and Cellular Biology, College of Biological Science

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

Major (Honours Program)

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

Semester 1

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

0.50 Liberal Education electives

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

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

0.50 Liberal Education electives

Semester 3

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>BIOC*2580</td>
<td>Introduction to Biochemistry</td>
</tr>
<tr>
<td>MBG*2040</td>
<td>Foundations in Molecular Biology and Genetics</td>
</tr>
<tr>
<td>MCB*2420</td>
<td>Introduction to Microbiology</td>
</tr>
<tr>
<td>STAT*2040</td>
<td>Statistics I</td>
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</table>

0.50 Liberal Education electives

Semester 4

<table>
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<tr>
<th>Course Code</th>
<th>Title</th>
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<tbody>
<tr>
<td>BIOC*3560</td>
<td>Structure and Function in Biochemistry</td>
</tr>
<tr>
<td>CHEM*2700</td>
<td>Organic Chemistry I</td>
</tr>
<tr>
<td>MCB*2050</td>
<td>Molecular Biology of the Cell</td>
</tr>
<tr>
<td>MCB*2430</td>
<td>Methods in Microbial Culture and Physiology</td>
</tr>
</tbody>
</table>

0.50 Liberal Education electives

Semester 5

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>MCB*3040</td>
<td>Molecular Biology of the Gene</td>
</tr>
<tr>
<td>MBG*3350</td>
<td>Laboratory Methods in Molecular Biology</td>
</tr>
</tbody>
</table>

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 electives 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>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCB*2040</td>
<td>Foundations in Molecular Biology and Genetics</td>
</tr>
<tr>
<td>MCB*2050</td>
<td>Molecular Biology of the Cell</td>
</tr>
</tbody>
</table>

A minimum of 4.00 credits from:

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

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/
In completing the science requirements for the degree, some suggested complementary Areas of Focus

**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**
- **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**
- **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
  - **PHYS*2240** [0.50] Thermal Physics

**Semester 3**
- **CHEM*2060** [0.50] Structure and Bonding
- **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**
- **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*

**Semester 5**
- **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

**Semester 6**
- **NANO*3300** [0.50] Spectroscopy of Nanomaterials
- **NANO*3600** [0.50] Computational Methods in Materials Science
  - 1.50 electives

**Semester 7**
- **NANO*4100** [0.50] Biological Nanomaterials
- **NANO*4700** [0.50] Concepts in Quantum Computing
  - 1.50 electives

**Semester 8**
- **NANO*4200** [0.50] Topics in Nanomaterials
  - 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>
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</tr>
<tr>
<td>2</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>
### Credit Summary (22.00 Total Credits)*

#### 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](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

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.

### 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
- CHEM*1050 [0.50] General Chemistry II
- MATH*1160 [0.50] Linear Algebra I

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

#### Semester 3

- BIOL*1080 [0.50] Biological Concepts of Health
- 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

1.00 electives*

#### Summer Semester

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

#### Semester 4

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

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

0.50 Liberal Education elective

#### 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 Sciences).

**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
- CHEM*1050 [0.50] General Chemistry II
- MATH*1160 [0.50] Linear Algebra I

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

#### Semester 3

- BIOL*1080 [0.50] Biological Concepts of Health
- 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

1.00 electives*

#### Summer Semester

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

#### Semester 4

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

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

0.50 Liberal Education elective

#### 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)
Students are advised to pay particular attention to prerequisite 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/Religion 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] Molecular 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 eligible for science elective, depending on 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 I *
- 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 II *
- 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
- BIOC*3560 [0.50] Structure and Function in Biochemistry
- BIOC*4580 [0.50] Membrane Biochemistry *
- BIOM*4070 [0.50] Biomedical Histology *
- MBG*3050 [0.50] Human Genetics
- MCB*3010 [0.50] Dynamics of Cell Function and Signaling
- MCB*4010 [0.50] Advanced Cell Biology *
- ZOO*3000 [0.50] Comparative Histology *

** Health & Disease
- BIOM*3040 [0.75] Medical Embryology *
- BIOM*4030 [0.50] Endocrine Physiology *
- BIOM*4050 [0.50] Biomedical Aspects of Aging *
- HK*3100 [0.50] Neuromuscular Physiology *
- HK*3810 [0.75] Human Physiology I - 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
- PSYC*2410 [0.50] Behavioural Neuroscience I
- PSYC*4010 [0.50] Making Sense of Data in Psychological Research
- STAT*2040 [0.50] Statistics I

A minimum of 0.50 credits from:
- BIOM*2000 [0.50] Concepts in Human Physiology
- BIOM*3200 [1.00] Biomedical Physiology
- HK*2810 [0.50] Human Physiology I - Concepts and Principles
- ZOO*3600 [0.50] Comparative Animal Physiology I

A minimum of 2.00 credits from:
- BIOM*3000 [0.50] Functional Mammalian Neuroanatomy
- BIOM*3090 [0.50] Principles of Pharmacology
- BIOM*4030 [0.50] Endocrine Physiology
Nutritional and Nutraceutical Sciences (NANS)

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

The Nutritional and Nutraceutical Sciences major is concerned with understanding the development of optimal biological function, maintenance of health, and treatment of disease.

If lacking the fundamentals of word processing, spreadsheet use and data management, the student should select CIS*1200 as early in the program as possible.

Major (Honours Program)

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

Semester 1

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<tr>
<td>BIOL*1080</td>
<td>Biological Concepts of Health</td>
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<td>CHEM*1040</td>
<td>General Chemistry I</td>
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<tr>
<td>MATH*1080</td>
<td>Elements of Calculus I</td>
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<tr>
<td>PHYS*1080</td>
<td>Physics for Life Sciences</td>
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</table>

0.50 Liberal Education electives

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

Semester 2

<table>
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<td>BIOL*1070</td>
<td>Discovering Diversity</td>
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<tr>
<td>BIOL*1090</td>
<td>Introduction to Molecular and Cellular Biology</td>
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<tr>
<td>CHEM*1050</td>
<td>General Chemistry II</td>
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<tr>
<td>PHYS*1070</td>
<td>Physics for Life Sciences</td>
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0.50 Liberal Education electives

Semester 3

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<tr>
<td>BIOC*2580</td>
<td>Introduction to Biochemistry</td>
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<tr>
<td>MBG*2040</td>
<td>Foundations in Molecular Biology and Genetics</td>
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<tr>
<td>STAT*2040</td>
<td>Statistics I</td>
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0.50 electives or restricted electives

0.50 Liberal Education electives

Semester 4

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<tbody>
<tr>
<td>BIOC*3560</td>
<td>Structure and Function in Biochemistry</td>
<td>0.50</td>
</tr>
<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>
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<tr>
<td>NUTR*3210</td>
<td>Fundamentals of Nutrition</td>
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0.50 Liberal Education electives

Semester 5

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<tr>
<td>HK*3810</td>
<td>Human Physiology II - Integrated Systems</td>
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<tr>
<td>NUTR*3330</td>
<td>Micronutrients, Phytochemicals and Health</td>
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<tr>
<td>NUTR*3360</td>
<td>Lifestyle Genomics</td>
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<tr>
<td>NUTR*3390</td>
<td>Applied Nutritional and Nutraceutical Sciences</td>
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</table>

Semester 6

<table>
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<th>Code</th>
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<tr>
<td>BIOM*3090</td>
<td>Principles of Pharmacology</td>
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<tr>
<td>NUTR*4090</td>
<td>Functional Foods and Nutraceuticals</td>
<td>0.50</td>
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<tr>
<td>NUTR*4320</td>
<td>Nutrition and Metabolic Control of Disease</td>
<td>0.50</td>
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<tr>
<td>NUTR*4330</td>
<td>Applied Nutritional and Nutraceutical Sciences II</td>
<td>0.75</td>
</tr>
</tbody>
</table>

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

- BIOM*3040: Medical Embryology
- MBG*3040: Genetics and Molecular Biology of Development
- ZOO*3050: 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 required science courses)
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)

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

- BIOC*2580: Introduction to Biochemistry
- NUTR*3210: Fundamentals of Nutrition
- NUTR*3330: Micronutrients, Phytochemicals and Health
- STAT*2040: Statistics

At least 0.50 credits from:

- ANSC*3080: Advanced Study in Human Health and Nutritional Sciences
- BIOM*3200: Biomedical Physiology
- HK*2810: Human Physiology I - Concepts and Principles
- ZOO*3600: Comparative Animal Physiology

and 2.00 credits from:

- ANSC*3170: Nutrition of Fish and Crustaceae
- ANSC*3180: Wildlife Nutrition
- ANSC*4260: Beef Cattle Nutrition
- ANSC*4270: Dairy Cattle Nutrition
- ANSC*4280: Poultry Nutrition
- ANSC*4290: Swine Nutrition
- ANSC*4560: Pet Nutrition
- EQN*4020: Advanced Equine Nutrition
- FOOD*2010: Principles of Food Science
- HK*3810: Human Physiology II - Integrated Systems
- HK*4230: Advanced Study in Human Health and Nutritional Sciences
- HK*4340: Genomics: Exercise and Disease
- HK*4360: Research in Human Health and Nutritional Sciences
- HK*4371/2: Research in Human Health and Nutritional Sciences II
- HK*4510: Teaching, Learning & Knowledge Transfer
- HK*4511/2: Teaching, Learning & Knowledge Transfer II
- HK*4660: Regulation of Human Metabolism
- NUTR*4360: Current Issues in Nutrigenomics
- PATH*3610: Principles of Disease

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 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

* students who have taken physics courses other than IPS*1500 or PHYS*1080 in Semester 1 and IPS*1510 or PHYS*1010 in Semester 2, may proceed to semester 3 with the permission of the Department of Physics.

Semester 3

MATH*2200 [0.50] Advanced Calculus I
MATH*2270 [0.50] Applied Differential Equations
PHYS*2240 [0.50] Thermodynamics
PHYS*2330 [0.50] Electricity and Magnetism I
0.50 Liberal Education electives

Semester 4

PHYS*2180 [0.50] Experimental Techniques in Physics
PHYS*2310 [0.50] Mechanics
PHYS*2340 [0.50] Electricity and Magnetism II
1.00 electives

Semester 5

IPS*3000 [0.50] Science Communication
PHYS*3130 [0.50] Mathematical Physics
X. Degree Programs, Bachelor of Science (B.Sc.)

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Winter</th>
<th>Summer</th>
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<tr>
<td>2</td>
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<td>Academic Semester 4</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>
</tr>
<tr>
<td>5</td>
<td>COOP*5000 Work Term V</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 (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>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM*1040</td>
<td>0.50</td>
<td>General Chemistry</td>
</tr>
<tr>
<td>CIS*1300</td>
<td>0.50</td>
<td>Programming</td>
</tr>
<tr>
<td>IPS*1500</td>
<td>1.00</td>
<td>Integrated Mathematics and Physics I</td>
</tr>
</tbody>
</table>

One of:

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

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

#### Semester 2 - Winter

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</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:

- 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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*1100</td>
<td>0.00</td>
<td>Introduction to Co-operative Education</td>
</tr>
<tr>
<td>MATH*2230</td>
<td>0.50</td>
<td>Advanced Calculus I</td>
</tr>
<tr>
<td>MATH*2270</td>
<td>0.50</td>
<td>Applied Differential Equations</td>
</tr>
<tr>
<td>PHYS*2240</td>
<td>0.50</td>
<td>Thermal Physics</td>
</tr>
<tr>
<td>PHYS*2330</td>
<td>0.50</td>
<td>Electricity and Magnetism I</td>
</tr>
</tbody>
</table>

0.50 Liberal Education electives*

#### Semester 4 - Winter

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

One of:

- CIS*2500 0.50 Intermediate Programming

0.50 electives

#### Summer Semester

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

---

### Mathematics and Physics for Computer Science (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.recruitguelph.ca/cecs/). 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>
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<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Academic Semester 1</td>
<td>Academic Semester 2</td>
<td>Off</td>
</tr>
</tbody>
</table>

---

### Notes

- A minimum of 1.00 credits are required from the restricted electives listed below.
- At least 1.00 credits must be from the restricted electives listed below.
- At least 1.00 credits must be from the restricted electives listed below.

---

*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.
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
BIOC*2580 [0.50] Introduction to Biochemistry
BOT*2100 [0.50] Life Strategies of Plants
MBGI*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
BIOC*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
BIOC*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/
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 BIOC*4500 or MCB*4500) in semester 7 OR AGR*4600 in semester 8. For those choosing (AGR*4450 or BIOC*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
   BIOC*4510 [1.00] Research in Integrative Biology II
   MCB*4510 [1.00] Research Project in Molecular & Cellular Biology

Credit Summary (20.00 Total Credits)
Option A
4.00 - First year science core
6.00 - Required science courses semesters 3 - 8
5.00 - Restricted electives for the declared area of emphasis (‡) (some restricted electives do not count as science electives towards the degree. Therefore additional science electives may be required.)
1.00 - Approved science electives, if all restricted electives chosen are approved science electives
1.00 - Liberal Education electives
0.50 - ENGL*1030

2019-2020 Undergraduate Calendar
Last Revision: July 4, 2019
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*3110 [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*2050 [0.50] Statistics II

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 Bioinformatics
MBG*2400 [0.50] Fundamentals of Plant and Animal Genetics
MBG*3660 [0.50] Conservation Biology
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*3230 [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*2120 [0.50] Introduction to Environmental Stewardship **
ENVS*2230 [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*3230 [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
### Statistics (STAT)

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

Statistics plays a fundamental role in virtually all scientific disciplines, including biology, physics, chemistry, medicine, epidemiology, kinesiology, and toxicology. Students minoring in Statistics will develop practical skills in data visualization and analysis, statistical computing, technical writing and communication in a variety of applications areas, preparing them well for careers in the modern workplace.

Students may declare this minor in any semester.

### Minor (Honours Program)

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

(MATH*1080 or MATH*1200)*  
(MATH*1090 or MATH*1210)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH*1160</td>
<td>Linear Algebra I</td>
<td>0.50</td>
</tr>
<tr>
<td>STAT*2040</td>
<td>Statistics I</td>
<td>0.50</td>
</tr>
<tr>
<td>STAT*2050</td>
<td>Statistics II</td>
<td>0.50</td>
</tr>
<tr>
<td>STAT*3100</td>
<td>Introductory Mathematical Statistics</td>
<td>0.50</td>
</tr>
<tr>
<td>STAT*3110</td>
<td>Introductory Mathematical Statistics II</td>
<td>0.50</td>
</tr>
<tr>
<td>STAT*3240</td>
<td>Applied Regression Analysis</td>
<td>0.50</td>
</tr>
</tbody>
</table>

0.50 additional credits in Statistics

0.50 additional credits in Statistics or Mathematics at the 2000 level or above

* IPS*1500 can count toward this 0.50 credit

** IPS*1510 can count toward this 0.50 credit

**Note:** Students majoring in Mathematical Science cannot minor in Statistics.

### Theoretical Physics (THPY)

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

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. Since some of the required courses are not offered every semester, students entering the Major in Theoretical Physics should plan their program in consultation with the Faculty Advisor.

### Major (Honours Program)

This major requires the completion of 20.00 credits. At least 1.00 of these credits must be obtained from the completion of Liberal Education electives.

#### Semester 1

<table>
<thead>
<tr>
<th>Course 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</td>
<td>1.00</td>
</tr>
</tbody>
</table>

One of:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1070</td>
<td>Discovering Biodiversity</td>
<td>0.50</td>
</tr>
<tr>
<td>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>
</tbody>
</table>

#### Semester 2

<table>
<thead>
<tr>
<th>Course 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>
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</tbody>
</table>

One of:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1070</td>
<td>Discovering Biodiversity</td>
<td>0.50</td>
</tr>
<tr>
<td>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>
</tbody>
</table>

**Note:** Students who have taken physics courses other than IPS*1500 or PHYS*1080 in Semester 1 and IPS*1510 or PHYS*1010 in Semester 2, may proceed to semester 3 with the permission of the Department of Physics.

#### Semester 3

<table>
<thead>
<tr>
<th>Course Code</th>
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<tbody>
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<tr>
<td>MATH*2270</td>
<td>Applied Differential Equations</td>
<td>0.50</td>
</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>
</tbody>
</table>

0.50 Liberal Education electives

#### Semester 4

<table>
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<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
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<tbody>
<tr>
<td>MATH*2210</td>
<td>Advanced Calculus II</td>
<td>0.50</td>
</tr>
<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>
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0.50 electives

### Semester 5

<table>
<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>IPS*3000</td>
<td>Science Communication</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*3130</td>
<td>Mathematical Physics</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*3230</td>
<td>Quantum Mechanics I</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*3400</td>
<td>Advanced Mechanics</td>
<td>0.50</td>
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0.50 electives

### Semester 6

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>NANO*3600</td>
<td>Computational Methods in Materials Science</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*3000</td>
<td>Optics: Fundamentals and Applications</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*3510</td>
<td>Intermediate Laboratory</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*4040</td>
<td>Quantum Mechanics II</td>
<td>0.50</td>
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0.50 electives

### Semester 7

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS*4120</td>
<td>Atomic and Molecular Physics</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*4180</td>
<td>Advanced Electromagnetic Theory</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*4240</td>
<td>Statistical Physics II</td>
<td>0.50</td>
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Two of:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>PHYS*4001</td>
<td>Research in Physics</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*4500</td>
<td>Advanced Physics Laboratory</td>
<td>0.50</td>
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</table>

0.50 electives

### Semester 8

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH*3260</td>
<td>Complex Analysis</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*4130</td>
<td>Subatomic Physics</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*4150</td>
<td>Solid State Physics</td>
<td>0.50</td>
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One of:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>PHYS*4002</td>
<td>Research in Physics</td>
<td>0.50</td>
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0.50 electives

### Credit Summary (20.00 Total Credits)

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<tr>
<th>Credit Hours</th>
<th>Description</th>
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<tr>
<td>5.00</td>
<td>First-year science credits</td>
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<tr>
<td>11.00</td>
<td>Required science courses semesters 3 – 8</td>
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<tr>
<td>2.00</td>
<td>Restricted electives</td>
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<tr>
<td>1.00</td>
<td>Liberal Education electives</td>
</tr>
<tr>
<td>1.00</td>
<td>Fee electives - any approved elective for B.Sc. students. could be less if restricted electives do not count as science</td>
</tr>
</tbody>
</table>

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 their 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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
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<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>
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</tr>
<tr>
<td>PHYS*1080</td>
<td>Physics for Life Sciences</td>
<td>0.50</td>
</tr>
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</table>

0.50 Liberal Education electives

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at https://www.uoguelph.ca/bsc/revised_SS
<table>
<thead>
<tr>
<th>Semester 2</th>
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<tbody>
<tr>
<td>BIOL*1080</td>
<td>[0.50] Biologica Concepts of Health</td>
<td></td>
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<tr>
<td>BIOL*1090</td>
<td>[0.50] Introduction to Molecular and Cellular Biology</td>
<td></td>
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<tr>
<td>CHEM*1050</td>
<td>[0.50] General Chemistry II</td>
<td></td>
</tr>
<tr>
<td>PHYS*1070</td>
<td>[0.50] Physics for Life Sciences II</td>
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</tr>
<tr>
<td>0.50 Liberal Education electives</td>
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<table>
<thead>
<tr>
<th>Semester 3</th>
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<tbody>
<tr>
<td>BIOC*2580</td>
<td>[0.50] Introduction to Biochemistry</td>
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</tr>
<tr>
<td>MBG*2040</td>
<td>[0.50] Foundations in Molecular Biology and Genetics</td>
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</tr>
<tr>
<td>1.50 electives or restricted electives</td>
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<table>
<thead>
<tr>
<th>Semester 4</th>
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<tbody>
<tr>
<td>BIOL*2060</td>
<td>[0.50] Ecology</td>
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<tr>
<td>BIOL*2400</td>
<td>[0.50] Evolution</td>
<td></td>
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<tr>
<td>STAT*2230</td>
<td>[0.50] Biostatistics for Integrative Biology</td>
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<tr>
<td>1.00 electives or restricted electives</td>
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<thead>
<tr>
<th>Semester 5</th>
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<tbody>
<tr>
<td>BIOL*3010</td>
<td>[0.50] Laboratory and Field Work in Ecology</td>
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</tr>
<tr>
<td>2.00 electives or restricted electives</td>
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<table>
<thead>
<tr>
<th>Semester 6</th>
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<tbody>
<tr>
<td>BIOL*3040</td>
<td>[0.50] Methods in Evolutionary Biology</td>
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<tr>
<td>BIOL*3060</td>
<td>[0.50] Populations, Communities &amp; Ecosystems</td>
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<tr>
<td>BIOL*3130</td>
<td>[0.50] Conservation Biology</td>
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<td>1.00 electives or restricted electives</td>
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<table>
<thead>
<tr>
<th>Semester 7</th>
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<tbody>
<tr>
<td>BIOL*4110</td>
<td>[1.00] Ecological Methods</td>
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<tr>
<td>BIOL*4150</td>
<td>[0.50] Wildlife Conservation and Management</td>
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</tr>
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<td>0.50 Liberal Education electives</td>
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<table>
<thead>
<tr>
<th>Restricted Electives</th>
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<tbody>
<tr>
<td>Note: For students considering graduate research programs, BIOL<em>4110 may be substituted by an independent research course (1.00 credits minimum). Course options include: (IBIO</em>4500 and IBIO<em>4510), IBIO</em>4521/IBIO*4522.</td>
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<thead>
<tr>
<th>Semester 8</th>
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<tbody>
<tr>
<td>BIOL*4500</td>
<td>[0.50] Natural Resource Policy Analysis</td>
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<tr>
<td>2.00 electives or restricted electives</td>
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<table>
<thead>
<tr>
<th>Credit Summary (20.00 Total Credits)</th>
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<tbody>
<tr>
<td>4.00 - First year science core</td>
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<tr>
<td>6.50 - Required science courses semesters 3 - 8</td>
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<tr>
<td>4.50 - Restricted electives (# 2, 3, 4 and 5 in restricted electives list)**</td>
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<tr>
<td>1.00 - Approved Science electives</td>
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<tr>
<td>1.00 - Liberal Education electives (#1 in restricted electives list)</td>
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<tr>
<td>3.00 - Free electives - any approved elective for B.Sc. students</td>
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<tr>
<td>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.</td>
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<table>
<thead>
<tr>
<th>Evolution</th>
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</thead>
<tbody>
<tr>
<td>BIOL*3020</td>
<td>[0.50] Population Genetics</td>
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<tr>
<td>BIOL*3300</td>
<td>[0.50] Applied Bioinformatics</td>
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</tr>
<tr>
<td>BOT*3710</td>
<td>[0.50] Plant Diversity and Evolution</td>
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<tr>
<td>ENVS*3090</td>
<td>[0.50] Insect Diversity and Biology</td>
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<td>ENVS*3180</td>
<td>[0.50] Sedimentary Environments</td>
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<tr>
<td>MBG*3040</td>
<td>[0.50] Molecular Biology of the Gene</td>
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<tr>
<td>MBG*4110</td>
<td>[0.50] Epigenetics</td>
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<tr>
<td>MBG*4270</td>
<td>[0.50] DNA Replication, Recombination and Repair</td>
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<tr>
<td>ZOO*2700</td>
<td>[0.50] Vertebrate Morphology &amp; Evolution</td>
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<tr>
<td>ZOO*3050</td>
<td>[0.50] Developmental Biology</td>
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<table>
<thead>
<tr>
<th>Ecology</th>
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<tbody>
<tr>
<td>ANSC*3180</td>
<td>[0.50] Wildlife Nutrition</td>
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<tr>
<td>BIOL*3450</td>
<td>[0.50] Introduction to Aquatic Environments</td>
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<tr>
<td>ENVS*3000</td>
<td>[0.50] Nature Interpretation</td>
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<tr>
<td>ENVS*3270</td>
<td>[0.50] Forest Biodiversity</td>
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<table>
<thead>
<tr>
<th>Conservation</th>
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<tbody>
<tr>
<td>BIOL*4350</td>
<td>[0.50] Limnology of Natural and Polluted Waters</td>
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<tr>
<td>ECON*1050</td>
<td>[0.50] Introductory Microeconomics</td>
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<td>ECON*2100</td>
<td>[0.50] Economic Growth and Environmental Quality</td>
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<td>ENV*2030</td>
<td>[0.50] Meteorology and Climatology</td>
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<td>ENV*3010</td>
<td>[0.50] Climate Change Biology</td>
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<td>FARE*2700</td>
<td>[0.50] Survey of Natural Resource Economics</td>
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<tr>
<td>GEOG*1220</td>
<td>[0.50] Human Impact on the Environment</td>
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<tr>
<td>GEOG*2480</td>
<td>[0.50] Mapping and GIS</td>
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<tr>
<td>GEOG*3480</td>
<td>[0.50] GIS and Spatial Analysis</td>
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<tr>
<td>GEOG*4230</td>
<td>[0.50] Environmental Impact Assessment</td>
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<tr>
<td>GEOG*4480</td>
<td>[1.00] Applied Geomatics</td>
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<table>
<thead>
<tr>
<th>Integrative/Cross-Disciplinary</th>
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<tbody>
<tr>
<td>IBIO*4500</td>
<td>[1.00] Research in Integrative Biology</td>
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<tr>
<td>IBIO*4510</td>
<td>[1.00] Research in Integrative Biology</td>
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<tr>
<td>IBIO*4521/2</td>
<td>[2.00] Thesis in Integrative Biology</td>
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<tr>
<td>MCB*2050</td>
<td>[0.50] Molecular Biology of the Cell</td>
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<tr>
<td>ZOO*3610</td>
<td>[0.25] Lab Studies in Animal Physiology I</td>
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<tr>
<td>ZOO*3620</td>
<td>[0.50] Comparative Animal Physiology II</td>
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</tr>
<tr>
<td>ZOO*3630</td>
<td>[0.25] Lab Studies in Animal Physiology II</td>
<td></td>
</tr>
<tr>
<td>ZOO*3700</td>
<td>[0.50] Integrative Biology of Invertebrates</td>
<td></td>
</tr>
<tr>
<td>ZOO*4070</td>
<td>[0.50] Animal Behaviour</td>
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</tr>
<tr>
<td>ZOO*4910</td>
<td>[0.50] Integrative Vertebrate Biology</td>
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</tr>
<tr>
<td>ZOO*4920</td>
<td>[0.25] Lab Studies in Ornithology</td>
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<tr>
<td>ZOO*4940</td>
<td>[0.25] Lab Studies in Herpetology</td>
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<tr>
<td>ZOO*4950</td>
<td>[0.25] Lab Studies in Mammalogy</td>
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<table>
<thead>
<tr>
<th>Field Courses</th>
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<tbody>
<tr>
<td>BIOL*4410</td>
<td>[0.75] Field Ecology</td>
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<tr>
<td>BIOL*4610</td>
<td>[0.75] Arctic Ecology</td>
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<tr>
<td>BIOL*4700</td>
<td>[0.50] Field Biology</td>
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<tr>
<td>BIOL*4710</td>
<td>[0.25] Field Biology</td>
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<td>BIOL*4800</td>
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<tr>
<td>BIOL*4810</td>
<td>[0.25] Field Biology</td>
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<tr>
<td>BIOL*4900</td>
<td>[0.50] Field Biology</td>
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<table>
<thead>
<tr>
<th>Zoology (ZOO)</th>
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</thead>
<tbody>
<tr>
<td>Department of Integrative Biology, College of Biological Science</td>
<td></td>
<td></td>
</tr>
<tr>
<td>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.</td>
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<table>
<thead>
<tr>
<th>Major (Honours Program)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td></td>
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<table>
<thead>
<tr>
<th>Semester 1</th>
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</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1070</td>
<td>[0.50] Discovering Biodiversity</td>
<td></td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>[0.50] General Chemistry I</td>
<td></td>
</tr>
<tr>
<td>MATH*1080</td>
<td>[0.50] Elements of Calculus I</td>
<td></td>
</tr>
<tr>
<td>PHYS*1080</td>
<td>[0.50] Physics for Life Sciences</td>
<td></td>
</tr>
<tr>
<td>0.50 Liberal Education electives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at <a href="https://www.uoguelph.ca/bsc/revised_SS">https://www.uoguelph.ca/bsc/revised_SS</a></td>
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</table>

<table>
<thead>
<tr>
<th>Semester 2</th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1080</td>
<td>[0.50] Biological Concepts of Health</td>
<td></td>
</tr>
<tr>
<td>BIOL*1090</td>
<td>[0.50] Introduction to Molecular and Cellular Biology</td>
<td></td>
</tr>
<tr>
<td>CHEM*1050</td>
<td>[0.50] General Chemistry II</td>
<td></td>
</tr>
<tr>
<td>PHYS*1070</td>
<td>[0.50] Physics for Life Sciences II</td>
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</tbody>
</table>
0.50 Liberal Education electives

**Semester 3**

<table>
<thead>
<tr>
<th>Course 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>
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1.00 electives or restricted electives *

**Semester 4**

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

0.50 electives or restricted electives *

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZOO*3000</td>
<td>Comparative Histology</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*3600</td>
<td>Comparative Animal Physiology I</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*3610</td>
<td>Lab Studies in Animal Physiology I</td>
<td>0.25</td>
</tr>
<tr>
<td>ZOO*3620</td>
<td>Comparative Animal Physiology II</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*3630</td>
<td>Lab Studies in Animal Physiology II</td>
<td>0.25</td>
</tr>
<tr>
<td>ZOO*3700</td>
<td>Integrative Biology of Invertebrates</td>
<td>0.50</td>
</tr>
</tbody>
</table>

**Semester 5**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
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</tr>
</thead>
<tbody>
<tr>
<td>ZOO*3050</td>
<td>Developmental Biology</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*3620</td>
<td>Comparative Animal Physiology II</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*3630</td>
<td>Lab Studies in Animal Physiology II</td>
<td>0.25</td>
</tr>
</tbody>
</table>

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

**Semester 6**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*3060</td>
<td>Populations, Communities &amp; Ecosystems</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*3050</td>
<td>Developmental Biology</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*3620</td>
<td>Comparative Animal Physiology II</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*3630</td>
<td>Lab Studies in Animal Physiology II</td>
<td>0.25</td>
</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 Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZOO*4070</td>
<td>Animal Behaviour</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*4910</td>
<td>Integrative Vertebrate Biology</td>
<td>0.50</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZOO*4330</td>
<td>Biology of Fishes</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*4920</td>
<td>Lab Studies in Ornithology</td>
<td>0.25</td>
</tr>
<tr>
<td>ZOO*4940</td>
<td>Lab Studies in Herpetology</td>
<td>0.25</td>
</tr>
<tr>
<td>ZOO*4950</td>
<td>Lab Studies in Mammalogy</td>
<td>0.25</td>
</tr>
</tbody>
</table>

3. A minimum of 0.50 credits from:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*4410</td>
<td>Field Ecology</td>
<td>0.75</td>
</tr>
<tr>
<td>BIOL*4610</td>
<td>Arctic Ecology</td>
<td>0.75</td>
</tr>
<tr>
<td>BIOL*4700</td>
<td>Field Biology</td>
<td>0.50</td>
</tr>
<tr>
<td>BIOL*4710</td>
<td>Field Biology</td>
<td>0.25</td>
</tr>
<tr>
<td>BIOL*4800</td>
<td>Field Biology</td>
<td>0.50</td>
</tr>
<tr>
<td>BIOL*4810</td>
<td>Field Biology</td>
<td>0.25</td>
</tr>
<tr>
<td>IBIO*4500</td>
<td>Research in Integrative Biology I</td>
<td>1.00</td>
</tr>
<tr>
<td>IBIO*4510</td>
<td>Research in Integrative Biology II</td>
<td>1.00</td>
</tr>
<tr>
<td>IBIO*4521/2</td>
<td>Thesis in Integrative Biology</td>
<td>2.00</td>
</tr>
<tr>
<td>ZOO*4170</td>
<td>Experimental Comparative Animal Physiology</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*4300</td>
<td>Marine Biology and Oceanography</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Other field or research courses with approval of faculty advisor.

**Credit Summary (20.00 Total Credits)**

4.00 - First year science core

8.00 - Required science courses semesters 3 - 8

1.00 - Restricted electives (# 2, and 3 in restricted electives list)

3.00 - Approved Science electives

1.00 - Liberal Education electives (#1 in restricted electives)

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

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

**Minor (Honours Program)**

Students in majors other than Zoology, Biodiversity, Wildlife Biology & Conservation and Marine & Freshwater Biology who have a strong interest in Zoology may choose to take a minor in Zoology.

A minor in Zoology requires a minimum of 5.00 credits, 4.00 of which must be from the following list:

<table>
<thead>
<tr>
<th>Course 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>BIOL*3060</td>
<td>Populations, Communities &amp; Ecosystems</td>
<td>0.50</td>
</tr>
</tbody>
</table>