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

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

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

The University is a full member of:

- Universities Canada

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Revision Information:

<table>
<thead>
<tr>
<th>Date</th>
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<tbody>
<tr>
<td>February 6, 2019</td>
<td>Initial Publication</td>
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</tbody>
</table>
Disclaimer
University of Guelph 2019

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

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

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

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

Published by: Enrolment Services
Introduction

Collection, Use and Disclosure of Personal Information

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

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

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

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

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

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

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

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

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

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

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

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

viii. developing key performance indicators.

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

Further information on the collection and use of student-level enrolment-related data can be obtained from the Ministry of Training, Colleges and Universities website: https://www.ontario.ca/page/ministry-advanced-education-and-skills-development or https://www.ontario.ca/fr/page/ministere-de-lenseignement-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 of Training, Colleges and Universities 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/pepg/publications/NoticeOfCollection.pdf

Authority to Disclose Personal Information to Statistics Canada

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

Notification of Disclosure of Personal Information to Statistics Canada

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

Address for University Communication

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

Email Address

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

Home Address

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

Name Changes

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

Student Confidentiality and Release of Student Information Policy Excerpt

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

Learning Outcomes

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

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

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

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

1. Critical and Creative Thinking

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

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

2. Literacy

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

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

3. Global Understanding:

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

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

4. Communicating

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

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

5. Professional and Ethical Behaviour

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

In addition, Professional and Ethical Behaviour includes, but is not limited to, the following outcomes: Teamwork, Ethical Reasoning, Leadership, and Personal Organization and Time Management.
# Table of Contents

**Bachelor of Science (B.Sc.)** ................................................................. 474

- The Three Semester System .......................................................... 474
- Transfer from One B.Sc. Program to Another ................................. 474
- Program Information ...................................................................... 474
- Special Study Options .................................................................. 474
- Doctor of Veterinary Medicine ...................................................... 475
- General Program (BSCG) ............................................................... 475
- Honours Programs (BSCH) ........................................................... 475
- Animal Biology (ABIO) ................................................................. 476
- Biochemistry (BIOC) .................................................................... 476
- Biochemistry (Co-op) (BIOC:C) .................................................... 477
- Biodiversity (Biod) ....................................................................... 479
- Biological and Medical Physics (BMPH) ........................................ 479
- Biological and Medical Physics (Co-op) (BMPH:C) ....................... 480
- Biological and Pharmaceutical Chemistry (BPCH) ......................... 481
- Biological and Pharmaceutical Chemistry (Co-op) (BPCH:C) ......... 482
- Biological Science (BIOS) ............................................................. 482
- Biology .......................................................................................... 483
- Bio-Medical Science (BIOM) ......................................................... 483
- Biomedical Toxicology (BTOX) ..................................................... 484
- Biomedical Toxicology (Co-op) (BTOX:C) .................................... 485
- Biotechnology (BIOT) ................................................................. 485
- Business Economics (BECN) ......................................................... 486
- Chemical Physics (CHPY) ............................................................. 486
- Chemical Physics (Co-op) (CHPY:C) ............................................ 486
- Chemistry (CHEM) ..................................................................... 487
- Chemistry (Co-op) (CHEM:C) ...................................................... 488
- Computing and Information Science (CIS) ..................................... 488
- Ecology (ECOL) .......................................................................... 489
- Environmental Biology (ENVB) ..................................................... 489
- Environmental Geomatics (EG) ...................................................... 490
- Environmental Geomatics (Co-op) (EG-C) ..................................... 490
- Food Science (FOOD) ................................................................. 491
- Food Science (Co-op) (FOOD:C) ................................................... 491
- Geographic Information Systems (GIS) and Environmental Analysis 492
- Human Kinetics (HK) ................................................................. 492
- Marine and Freshwater Biology (MFB) ......................................... 493
- Marine and Freshwater Biology (Co-op) (MFB:C) ......................... 493
- Mathematical Science (MSCI) ...................................................... 494
- Mathematics (MATH) ................................................................. 495
- Microbiology (MICR) .................................................................. 495
- Microbiology (Co-op) (MICR:C) ................................................... 496
- Molecular Biology and Genetics (MBG) ........................................ 497
- Nanoscience (NANO) ................................................................. 498
- Nanoscience (NANO:C) .............................................................. 498
- Neuroscience (NEUR) ............................................................... 499
- Nutritional and Nutraceutical Sciences (NANS) ............................ 500
- Physical Science (PSCI) .............................................................. 501
- Physics ....................................................................................... 502
- Physics (Co-op) (PHYS:C) .......................................................... 503
- Plant Science (PLSC) ................................................................. 503
- Statistics (STAT) ........................................................................ 505
- Theoretical Physics (THPY) ......................................................... 505
- Wildlife Biology and Conservation (WBC) .................................... 506
- Zoology (ZOO) .......................................................................... 507
Bachelor of Science (B.Sc.)

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

The Three Semester System

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

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

Transfer from One B.Sc. Program to Another

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

Program Information

B.Sc. Program Requirements

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

1. Entry Credits

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

- BIOI*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 12 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**

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<thead>
<tr>
<th>Semester 1</th>
<th></th>
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<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></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: [http://www.bsc.uoguelph.ca/revisedds](http://www.bsc.uoguelph.ca/revisedds)

<table>
<thead>
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<th>Semester 2</th>
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<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>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.50]</td>
<td>Discovering Biodiversity</td>
</tr>
<tr>
<td></td>
<td>[0.50]</td>
<td>Biological Concepts of Health</td>
</tr>
<tr>
<td></td>
<td>[0.50]</td>
<td>Introduction to Molecular and Cellular Biology</td>
</tr>
<tr>
<td></td>
<td>[0.50]</td>
<td>Liberal Education electives</td>
</tr>
</tbody>
</table>

**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'.

**Honours Programs (BSCH)**

**Honours Program Majors**

The following honours majors are available:

**Biological Sciences:**

- 20.00 credits - Animal Biology (ABIO)
- 20.00 credits - Biochemistry (BIOC)
- 20.00 credits - Biodiversity (BIOD)
- 20.00 credits - Biological Science (BIOS)
- 20.00 credits - Bio-Medical Science (BIOM)
- 20.00 credits - Biomedical Toxicology (BTOX)
- 20.00 credits - Environmental Biology (ENVB)
- 20.00 credits - Food Science (FOOD)
- 20.00 credits - Human Genetics (HI)
- 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 (CHPHY)
- 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:**

- 20.00 credits - Biochemistry (Co-op) (BIOC)
- 20.00 credits - Biological and Medical Physics (Co-op) (BMPH)
- 20.00 credits - Biological and Pharmaceutical Chemistry (Co-op) (BPCH)
- 20.00 credits - Marine and Freshwater Biology (Co-op) (MBF)
- 20.00 credits - Biomedical Toxicology (Co-op) (BTOX)
- 20.00 credits - Chemical Physics (Co-op) (CHPHY)
- 20.00 credits - Chemistry (Co-op) (CHEM)
- 20.00 credits - Environmental Geomatics (Co-op) (EG)
- 20.00 credits - Food Science (Co-op) (FOOD)
- 20.00 credits - Nanoscience (NANO)
- 20.00 credits - Microbiology (Co-op) (MICR)
- 20.00 credits - Physics (Co-op) (PHYS)

**Honours Program Minors**

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

**Biological Sciences:**

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

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

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

Additional Disciplines:
5.00 credits - Business Economics (BECN)

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

Conditions for Graduation

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

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

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

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

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

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

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

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

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

0.50 electives or restricted electives

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

1.50 electives or restricted electives

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

1.00 electives or restricted electives

Semester 7
2.50 electives or restricted electives

Semester 8
2.50 electives or restricted electives

Restricted Electives
1. Students must complete 2.00 credits of Liberal Education electives ANSC*1210 is a Liberal Education course, 1.00 credit. 1.00 additional credits from Liberal Education courses are required. The list of liberal education electives for B.Sc. students can be found at: [http://www.uoguelph.ca/bsc]

2. 0.50 credits is required from each of the following areas: Animal Nutrition, Animal Breeding & Genetics, and Animal Physiology & Behaviour. Students are encouraged to consult with the Faculty Advisor for help in tailoring their selection to meet personal and career interests.

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

Animal Nutrition [0.50] Required
ANSC*3170 [0.50] Nutrition of Fish and Crustacea
ANSC*3180 [0.50] Wildlife Nutrition
ANSC*4260 [0.50] Beef Cattle Nutrition
ANSC*4270 [0.50] Dairy Cattle Nutrition
ANSC*4280 [0.50] Poultry Nutrition
ANSC*4290 [0.50] Swine Nutrition
ANSC*4560 [0.50] Pet Nutrition
EQN*4020 [0.50] Advanced Equine Nutrition

Animal Physiology & Behaviour [0.50] Required
ANSC*3090 [0.50] Vertebrate Ethology
ANSC*4090 [0.50] Applied Animal Behaviour
ANSC*4100 [0.50] Applied Environmental Physiology and Animal Housing
ANSC*4350 [0.50] Experiments in Animal Biology
ANSC*4470 [0.50] Animal Metabolism
ANSC*4490 [0.50] Applied Endocrinology

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

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

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

Biochemistry (BIOC)

Department of Molecular and Cellular Biology, College of Biological Science

A B.Sc. in Biochemistry offers a multidisciplinary curriculum that gives students broad exposure to the life sciences with specific attention paid to the physical and chemical nature of biomolecular systems. The lab-intensive experience in this program prepares students to pursue post-graduate research opportunities in many different life science related fields. Graduates are also positioned to be successful in obtaining entrance to a number of professional programs, as well as employment in industry and government.
Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. The major will require the completion of at least 20.00 credits as indicated below:

**Major (Honours Program)**

### Semester 1

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1090</td>
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</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>
</tbody>
</table>

0.50 Liberal Education electives.

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

### Semester 2

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
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<tbody>
<tr>
<td>BIOL*1070</td>
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</tr>
<tr>
<td>BIOL*1080</td>
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</tr>
<tr>
<td>CHEM*1050</td>
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<tr>
<td>MATH*1090</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*1070</td>
<td>0.50</td>
</tr>
</tbody>
</table>

0.50 Liberal Education electives.

### Semester 3

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BIOC*2580</td>
<td>0.50</td>
</tr>
<tr>
<td>MBG*2040</td>
<td>0.50</td>
</tr>
<tr>
<td>MICR*2420</td>
<td>0.50</td>
</tr>
<tr>
<td>STAT*2040</td>
<td>0.50</td>
</tr>
</tbody>
</table>

0.50 Liberal Education electives.

### Semester 4

<table>
<thead>
<tr>
<th>Course</th>
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<tbody>
<tr>
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</tr>
<tr>
<td>CHEM*2480</td>
<td>0.50</td>
</tr>
<tr>
<td>CHEM*2700</td>
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</tr>
<tr>
<td>MICR*2430</td>
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</table>

### Semester 5

<table>
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<tr>
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</tr>
<tr>
<td>CHEM*2880</td>
<td>0.50</td>
</tr>
<tr>
<td>CHEM*3750</td>
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</table>

### Semester 6

<table>
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</thead>
<tbody>
<tr>
<td>MBG*3350</td>
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### Semester 7

<table>
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<tbody>
<tr>
<td>BIOC*4540</td>
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</table>

### 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, MICR*4050.

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*4520</td>
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</tr>
<tr>
<td>BIOC*4580</td>
<td>0.50</td>
</tr>
<tr>
<td>CHEM*3300</td>
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</tr>
<tr>
<td>BIOM*3200</td>
<td>1.00</td>
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<tr>
<td>MBG*3040</td>
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<tr>
<td>MBG*3080</td>
<td>0.50</td>
</tr>
<tr>
<td>MCB*3010</td>
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</tr>
<tr>
<td>MCB*4010</td>
<td>0.50</td>
</tr>
<tr>
<td>MCB*4050</td>
<td>0.50</td>
</tr>
<tr>
<td>MCB*4500</td>
<td>1.00</td>
</tr>
<tr>
<td>MCB*4510</td>
<td>1.00</td>
</tr>
<tr>
<td>MCB*4600</td>
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</tr>
<tr>
<td>MICR*3230</td>
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<tr>
<td>MICR*3330</td>
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<tr>
<td>MICR*4330</td>
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<tr>
<td>MICR*4530</td>
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<tr>
<td>PBIO*3110</td>
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<td>PBIO*4750</td>
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<tr>
<td>STAT*2050</td>
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<tr>
<td>TOX*4590</td>
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</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Course</th>
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</thead>
<tbody>
<tr>
<td>PHYS*2030</td>
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<tr>
<td>PHYS*2240</td>
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</tr>
<tr>
<td>PHYS*2330</td>
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</tr>
<tr>
<td>PHYS*2600</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*3080</td>
<td>0.50</td>
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</tbody>
</table>

### 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:

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
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<tr>
<td>BIOC*3560</td>
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<tr>
<td>CHEM*3570</td>
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<tr>
<td>CHEM*4540</td>
<td>0.75</td>
</tr>
<tr>
<td>CHEM*2480</td>
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</tr>
<tr>
<td>CHEM*2700</td>
<td>0.50</td>
</tr>
<tr>
<td>MICR*2420</td>
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</tr>
</tbody>
</table>

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

- BIOC*4520 | 0.50 - Metabolic Processes
- BIOC*4580 | 0.50 - Membrane Biochemistry
- MBG*3350 | 0.75 - Laboratory Methods in Molecular Biology
- MCB*4050 | 0.50 - Protein and Nucleic Acid Structure
- MICR*3320 | 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 employment in industry and government.

Students must follow the academic work sequence for their program and meet all co-op requirements to be eligible to graduate with co-op certification. For more information on co-operative education policies see the Co-operative Education & Career Services website at [https://www.recruituoguelph.ca/cecs/](https://www.recruituoguelph.ca/cecs/). This major requires the completion of a minimum of 20.00 credits as indicated below.

### Stream A

#### Semester 1 - Fall

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
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<tbody>
<tr>
<td>BIOL*1090</td>
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<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>
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</tr>
<tr>
<td>BIOC*4520</td>
<td>0.50</td>
</tr>
<tr>
<td>BIOC*4580</td>
<td>0.50</td>
</tr>
<tr>
<td>MICR*4050</td>
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</tbody>
</table>

#### Semester 2 - Winter

<table>
<thead>
<tr>
<th>Course</th>
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<tbody>
<tr>
<td>BIOL*1070</td>
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<tr>
<td>BIOL*1080</td>
<td>0.50</td>
</tr>
<tr>
<td>CHEM*1050</td>
<td>0.50</td>
</tr>
<tr>
<td>MATH*1090</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*1070</td>
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</table>

#### Summer Semester

No academic semester or work term

#### Semester 3 - Fall

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>BIOC*2580</td>
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<tr>
<td>CHEM*2480</td>
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<tr>
<td>CHEM*2880</td>
<td>0.50</td>
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<tr>
<td>MBG*2040</td>
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#### Winter Semester

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*1000</td>
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#### Semester 4 - Summer

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BIOC*3570</td>
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</tr>
<tr>
<td>CHEM*2700</td>
<td>0.50</td>
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</table>
### Degree Programs, Bachelor of Science (B.Sc.)

#### Credit Summary (20.00 Total Credits)

<table>
<thead>
<tr>
<th>Semester 1 - Fall</th>
<th>Semester 2 - Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*2450 [0.50] Introduction to Molecular &amp; Cellular Biology</td>
<td>PHYS*2230 [0.50] Electromagnetism</td>
</tr>
<tr>
<td>BIOC*2500 [0.50] Metabolism</td>
<td>PHYS*2230 [0.50] General Astronomy</td>
</tr>
<tr>
<td>BIOC*2550 [0.50] Membrane Biochemistry</td>
<td>PHYS*3080 [0.50] Energy</td>
</tr>
<tr>
<td>CHEM*3100 [0.50] Analytical Chemistry</td>
<td>PHY*1070 [0.50] General Chemistry II</td>
</tr>
<tr>
<td>MCB*2050 [0.50] Molecular Biology of the Cell</td>
<td>MCB*2430 [0.50] Methods in Microbial Culture and Physiology</td>
</tr>
<tr>
<td>MCB*2480 [0.50] Introduction to Microbiology</td>
<td>MCB*3330 [0.50] Molecular Biology of the Cell</td>
</tr>
<tr>
<td>MET*2480 [0.50] Physical Chemistry</td>
<td>MCB*3430 [0.50] World of Viruses</td>
</tr>
<tr>
<td>MCB*2480 [0.50] Molecular Biology of the Cell</td>
<td>MCB*3500 [0.50] Molecular Virology</td>
</tr>
<tr>
<td>MCB*2480 [0.50] Introduction to Microbiology</td>
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</tr>
<tr>
<td>MCB*2480 [0.50] Methods in Microbial Culture and Physiology</td>
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<td>0.50 Liberal Education electives</td>
<td>0.50 Liberal Education electives</td>
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#### Semester 3 - Fall

<table>
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<tr>
<th>Semester 4 - Winter</th>
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<tbody>
<tr>
<td>BIOC*2500 [0.50] Analytical Biochemistry</td>
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<tr>
<td>MCB*2050 [0.50] Molecular Biology of the Cell</td>
</tr>
<tr>
<td>MCB*2480 [0.50] Introduction to Microbiology</td>
</tr>
<tr>
<td>MET*2480 [0.50] Physical Chemistry</td>
</tr>
<tr>
<td>MCB*2480 [0.50] Methods in Microbial Culture and Physiology</td>
</tr>
<tr>
<td>0.50 Liberal Education electives</td>
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</table>

#### Semester 5 - Fall

<table>
<thead>
<tr>
<th>Semester 6 - Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*3560 [0.50] Structure and Function in Biochemistry</td>
</tr>
<tr>
<td>CHEM*2880 [0.50] Analytical Chemistry</td>
</tr>
<tr>
<td>CHEM*3750 [0.50] Organic Chemistry II</td>
</tr>
<tr>
<td>MCB*2050 [0.50] Molecular Biology of the Cell</td>
</tr>
<tr>
<td>MCB*2430 [0.50] Methods in Microbial Culture and Physiology</td>
</tr>
<tr>
<td>0.50 electives or restricted electives</td>
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</table>

#### Semester 7 - Winter

<table>
<thead>
<tr>
<th>Semester 8 - Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*4540 [0.75] Enzymology</td>
</tr>
<tr>
<td>CHEM*3750 [0.50] Organic Chemistry II</td>
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<tr>
<td>CHEM*3750 [0.50] Organic Chemistry II</td>
</tr>
<tr>
<td>CHEM*2880 [0.50] Analytical Chemistry</td>
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<tr>
<td>CHEM*3750 [0.50] Organic Chemistry II</td>
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<tr>
<td>CHEM*3750 [0.50] Organic Chemistry II</td>
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<tr>
<td>0.50 Liberal Education electives</td>
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</table>

#### Restricted Electives

- 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.
- 2.50 electives or restricted electives

#### Stream B

**Semester 1 - Fall**

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BIOC*4520</td>
<td>Metabolic Processes</td>
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</tr>
<tr>
<td>BIOC*4580</td>
<td>Membrane Biochemistry</td>
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</tr>
<tr>
<td>BIOL*3300</td>
<td>Applied Bioinformatics</td>
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</tr>
<tr>
<td>BIOM*3200</td>
<td>Biomedical Physiology</td>
<td>1.00</td>
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<tr>
<td>MBG*3040</td>
<td>Molecular Biology of the Gene</td>
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</tr>
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<td>MBG*3080</td>
<td>Bacterial Genetics</td>
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<tr>
<td>MCB*3010</td>
<td>Dynamics of Cell Function and Signaling</td>
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<td>MCB*4010</td>
<td>Advanced Cell Biology</td>
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<tr>
<td>MCB*4050</td>
<td>Protein and Nucleic Acid Structure</td>
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<tr>
<td>MCB*4500</td>
<td>Research Project in Molecular &amp; Cellular Biology</td>
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**Semester 2 - Winter**

<table>
<thead>
<tr>
<th>Subject Code</th>
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<tbody>
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<td>PHYS*2240</td>
<td>Thermal Physics</td>
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</tr>
<tr>
<td>PHYS*2330</td>
<td>Electricity and Magnetism I</td>
<td>0.50</td>
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<tr>
<td>PHYS*2600</td>
<td>General Astronomy</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*3080</td>
<td>Energy</td>
<td>0.50</td>
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</tbody>
</table>

**Summer Semester**

No academic semester or work term
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.

### Biodiversity (BIOD)

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

The Major in Biodiversity offers a broad education in the diversity and evolution of life while providing a more specialized understanding of biology at the level of the organism. It is the most flexible of the majors offered by the Department of Integrative Biology and as such, it allows students the opportunity to design a customized program around their interests. The major qualifies students for postgraduate work in biodiversity, botany, zoology, and other life sciences and provides a sound science background for students wishing to pursue professional life science degrees or careers in teaching, government service or the private sector.

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

### Major (Honours Program)

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

#### Semester 1

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1070</td>
<td>Discovering Biodiversity</td>
<td>0.50</td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>General Chemistry I</td>
<td>0.50</td>
</tr>
<tr>
<td>MATH*1080</td>
<td>Elements of Calculus I</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*1080</td>
<td>Physics for Life Sciences</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>Liberal Education electives</td>
<td>0.50</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>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1080</td>
<td>Biological Concepts of Health</td>
<td>0.50</td>
</tr>
<tr>
<td>BIOL*1090</td>
<td>Introduction to Molecular and Cellular Biology</td>
<td>0.50</td>
</tr>
<tr>
<td>CHEM*1050</td>
<td>General Chemistry II</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*1070</td>
<td>Physics for Life Sciences II</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>Liberal Education electives</td>
<td>0.50</td>
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</tbody>
</table>

#### Semester 3

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*2580</td>
<td>Introduction to Biochemistry</td>
<td>0.50</td>
</tr>
<tr>
<td>MBG*2040</td>
<td>Foundations in Molecular Biology and Genetics</td>
<td>0.50</td>
</tr>
<tr>
<td>MICR*2420</td>
<td>Introduction to Microbiology</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*2090</td>
<td>Vertebrate Structure and Function</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>Liberal Education electives</td>
<td>0.50</td>
</tr>
</tbody>
</table>

#### Semester 4

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</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>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>
<tr>
<td></td>
<td>Liberal Education electives</td>
<td>0.50</td>
</tr>
</tbody>
</table>

#### Semester 5

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.50 electives or restricted electives*</td>
<td></td>
</tr>
<tr>
<td>or</td>
<td>Study Abroad*</td>
<td></td>
</tr>
</tbody>
</table>

#### Semester 6

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOT*3710</td>
<td>Plant Diversity and Evolution</td>
<td>0.50</td>
</tr>
<tr>
<td>ENV*3090</td>
<td>Insect Diversity and Biology</td>
<td>0.50</td>
</tr>
<tr>
<td>IBIO*3100</td>
<td>Interpreting Biodiversity I</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>Liberal Education electives</td>
<td>1.00</td>
</tr>
</tbody>
</table>

#### Semester 7

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBIO*4100</td>
<td>Interpreting Biodiversity II</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>Liberal Education electives</td>
<td>1.50</td>
</tr>
</tbody>
</table>

#### Semester 8

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.50 electives or restricted electives*</td>
<td></td>
</tr>
</tbody>
</table>

* **Restricted Electives**

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

1. At least 1.00 credits of Liberal Education electives are required. The list of Liberal Education electives for B.Sc. students can be found at: [https://www.uoguelph.ca/bsc](https://www.uoguelph.ca/bsc)
2. A minimum of 0.50 credits from:

### Credit Summary (20.00 Total Credits)

<table>
<thead>
<tr>
<th>Semester 1</th>
<th>Semester 2</th>
<th>Semester 3</th>
<th>Semester 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.50 electives or restricted electives*</td>
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<td>2.50 electives or restricted electives*</td>
<td>2.50 electives or restricted electives*</td>
</tr>
<tr>
<td>Study Abroad*</td>
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</tr>
</tbody>
</table>

**Major (Honours Program)**

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

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

#### Semester 1

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1090</td>
<td>Introduction to Molecular and Cellular Biology</td>
<td>0.50</td>
</tr>
<tr>
<td>CHEM*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></td>
<td>1.00 credits from: IPS<em>1500, or (MATH</em>1080, PHYS<em>1080) or (MATH</em>1200, PHYS*1080)</td>
<td></td>
</tr>
</tbody>
</table>

* IPS*1500 is recommended

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

#### Semester 2

<table>
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<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1080</td>
<td>Biological Concepts of Health</td>
<td>0.50</td>
</tr>
<tr>
<td>CHEM*1050</td>
<td>General Chemistry II</td>
<td>0.50</td>
</tr>
<tr>
<td>MATH*1160</td>
<td>Linear Algebra I</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>1.00 credits from: IPS<em>1510, or (MATH</em>1090, PHYS<em>1070) or (MATH</em>1210, PHYS*1010)</td>
<td>1.00</td>
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</table>

* IPS*1510 is recommended

#### Semester 3

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH*2200</td>
<td>Advanced Calculus I</td>
<td>0.50</td>
</tr>
<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>
<tr>
<td></td>
<td>Liberal Education electives</td>
<td>0.50</td>
</tr>
</tbody>
</table>

#### Semester 4

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*2580</td>
<td>Introduction to Biochemistry</td>
<td>0.50</td>
</tr>
</tbody>
</table>
PHYS*2030 [0.50] Biophysics of Excitable Cells
PHYS*2180 [0.50] Experimental Techniques in Physics
PHYS*2310 [0.50] Mechanics
PHYS*2340 [0.50] Electricity and Magnetism II

** Semester 5 **

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

1.00 electives **

** Semester 6 **

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>NANO*3600</td>
<td>Computational Methods in Materials Science</td>
</tr>
<tr>
<td>PHYS*3510</td>
<td>Intermediate Laboratory</td>
</tr>
<tr>
<td>PHYS*4040</td>
<td>Quantum Mechanics II</td>
</tr>
<tr>
<td>PHYS*4540</td>
<td>Molecular Biophysics</td>
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</tbody>
</table>

0.50 electives **

** Semester 7 **

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
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<tbody>
<tr>
<td>PHYS*3170</td>
<td>Radioactivity and Radiation Interactions</td>
</tr>
<tr>
<td>PHYS*4500</td>
<td>Advanced Physics Laboratory</td>
</tr>
</tbody>
</table>

One of:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS*4001</td>
<td>Research in Physics</td>
</tr>
</tbody>
</table>

0.50 electives

1.00 electives **

** Semester 8 **

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS*4070</td>
<td>Clinical Applications of Physics in Medicine</td>
</tr>
</tbody>
</table>

One of:

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

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 **

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

** List B: Medical Physics stream **

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOM*2000</td>
<td>Concepts in Human Physiology</td>
</tr>
<tr>
<td>ENGG*4040</td>
<td>Medical Imaging Modalities</td>
</tr>
<tr>
<td>MBG*2040</td>
<td>Foundations in Molecular Biology and Genetics</td>
</tr>
<tr>
<td>PATH*3610</td>
<td>Principles of Disease</td>
</tr>
<tr>
<td>PHYS*3000</td>
<td>Optics: Fundamentals and Applications</td>
</tr>
<tr>
<td>PHYS*4130</td>
<td>Subatomic Physics</td>
</tr>
</tbody>
</table>

** Credit Summary (20.00 Total Credits) **

5.00 - First year science credits

9.50 - Required science courses semesters 3 – 8

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

1.00 - Liberal Education electives

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

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

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

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

** 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 must follow the academic work sequence for their program and meet all co-op requirements to be eligible to graduate with co-op certification. For more information on co-operative education policies see the Co-operative Education & Career Services website at: https://www.recruitguelph.ca.

This major requires the completion of 20.00 credits as follows:

** Semester 1 - Fall **

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1090</td>
<td>Introduction to Molecular and Cellular Biology</td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>General Chemistry I</td>
</tr>
<tr>
<td>CIS*1300</td>
<td>Programming</td>
</tr>
</tbody>
</table>

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 **

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1080</td>
<td>Biological Concepts of Health</td>
</tr>
<tr>
<td>CHEM*1050</td>
<td>General Chemistry II</td>
</tr>
<tr>
<td>MATH*1160</td>
<td>Linear Algebra I</td>
</tr>
</tbody>
</table>

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

* IPS*1510 is recommended

** Semester 3 - Fall **

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>COOP*1100</td>
<td>Introduction to Co-operative Education</td>
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<tr>
<td>MATH*2200</td>
<td>Advanced Calculus I</td>
</tr>
<tr>
<td>MATH*2270</td>
<td>Applied Differential Equations</td>
</tr>
<tr>
<td>PHYS*2240</td>
<td>Thermal Physics</td>
</tr>
<tr>
<td>PHYS*2330</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>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*2580</td>
<td>Introduction to Biochemistry</td>
</tr>
<tr>
<td>PHYS*2030</td>
<td>Biophysics of Excitable Cells</td>
</tr>
<tr>
<td>PHYS*2180</td>
<td>Experimental Techniques in Physics</td>
</tr>
<tr>
<td>PHYS*2310</td>
<td>Mechanics</td>
</tr>
<tr>
<td>PHYS*2340</td>
<td>Electricity and Magnetism II</td>
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</tbody>
</table>

** Summer Semester **

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>COOP*1000</td>
<td>Co-op Work Term I ++</td>
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** Semester 5 - Fall **

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

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

** Summer Semester **

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

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

** Semester 6 - Fall **

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPS*3000</td>
<td>Science Communication</td>
</tr>
<tr>
<td>PHYS*3170</td>
<td>Radioactivity and Radiation Interactions</td>
</tr>
</tbody>
</table>

1.50 electives ***

** Semester 7 - Winter **

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>NANO*3600</td>
<td>Computational Methods in Materials Science</td>
</tr>
<tr>
<td>PHYS*3510</td>
<td>Intermediate Laboratory</td>
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<tr>
<td>PHYS*4040</td>
<td>Quantum Mechanics II</td>
</tr>
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<td>PHYS*4540</td>
<td>Molecular Biophysics</td>
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</table>

0.50 electives ***

** Summer Semester **

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*4000</td>
<td>Co-op Work Term IV ++</td>
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</table>

** Fall Semester **

<table>
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<tr>
<th>Course Code</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>COOP*5000</td>
<td>Co-op Work Term V ++</td>
</tr>
</tbody>
</table>

** Semester 8 - Winter **

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS*4070</td>
<td>Clinical Applications of Physics in Medicine</td>
</tr>
<tr>
<td>PHYS*4500</td>
<td>Advanced Physics Laboratory</td>
</tr>
</tbody>
</table>

1.50 electives ***

++Four work terms are required for the completion of the co-op degree. It is also necessary that there be at least one work term in each of Fall, Winter and Summer semesters. Therefore, one of the summer work terms could be missed and the student would still graduate successfully. Whether the student completes four or five work terms, a report is required for each work term completed. Contact the co-op faculty advisor for further details.

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

** List A: Biological Physics stream **

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

2019-2020 Undergraduate Calendar

Last Revision: February 6, 2019
List B: Medical Physics stream

BIOM*2000 [0.50] Concepts in Human Physiology
ENGG*4040 [0.50] Medical Imaging Modalities
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
PATH*3610 [0.50] Principles of Disease
PHYS*3000 [0.50] Optics: Fundamentals and Applications
PHYS*4130 [0.50] Subatomic Physics

Credit Summary (20.00 Total Credits)
5.00 - First year science credits
9.50 - Required science courses semesters 3 – 8
1.50 - Restricted electives (from List A OR List B)
1.00 - Liberal Education electives
3.00 - Free electives - any approved elective for B.Sc. students.

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

Biological and 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/bse/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
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*3200 is a substitute for CHEM*3430 in Semester 6

Semester 6
Select either Option A or Option B

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

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

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

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)**

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

**Major (Honours Program)**

Students must follow the academic work sequence for their program and meet all co-op requirements to be eligible to graduate with co-op certification. For more information on co-operative education policies see the Co-operative Education & Career Services website at: https://www.recruituoguelph.ca.

**Semester 1 - Fall**

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

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**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>CHEM*1050</td>
<td>0.50</td>
<td>General Chemistry II</td>
</tr>
<tr>
<td>COOP*1100</td>
<td>0.00</td>
<td>Introduction to Co-operative Education</td>
</tr>
<tr>
<td>IPS*1510</td>
<td>1.00</td>
<td>Integrated Mathematics and Physics II</td>
</tr>
</tbody>
</table>

One of

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1070</td>
<td>0.50</td>
<td>Discovering Biodiversity</td>
</tr>
<tr>
<td>BIOL*1080</td>
<td>0.50</td>
<td>Biological Concepts of Health</td>
</tr>
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</table>

0.50 Liberal Education electives

**Semester 3 - Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>BIOC*2580</td>
<td>0.50</td>
<td>Introduction to Biochemistry</td>
</tr>
<tr>
<td>CHEM*2060</td>
<td>0.50</td>
<td>Structure and Bonding</td>
</tr>
<tr>
<td>CHEM*2400</td>
<td>0.75</td>
<td>Analytical Chemistry I</td>
</tr>
<tr>
<td>CHEM*2880</td>
<td>0.50</td>
<td>Physical Chemistry</td>
</tr>
</tbody>
</table>

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

**Winter Semester**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*1000</td>
<td>0.00</td>
<td>Co-op Work Term I</td>
</tr>
</tbody>
</table>

**Semester 4 - Summer**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM*2070</td>
<td>0.50</td>
<td>Structure and Spectroscopy</td>
</tr>
<tr>
<td>CHEM*2700</td>
<td>0.50</td>
<td>Organic Chemistry I</td>
</tr>
<tr>
<td>CHEM*3430</td>
<td>0.50</td>
<td>Analytical Chemistry II: Instrumental Analysis</td>
</tr>
<tr>
<td>STAT*2040</td>
<td>0.50</td>
<td>Statistics I</td>
</tr>
</tbody>
</table>

0.50 electives or restricted electives *

**Semester 5 - Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*3570</td>
<td>0.75</td>
<td>Analytical Biochemistry</td>
</tr>
<tr>
<td>CHEM*3750</td>
<td>0.50</td>
<td>Organic Chemistry II</td>
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</table>

One of:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM*3640</td>
<td>0.50</td>
<td>Chemistry of the Elements I **</td>
</tr>
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</table>

0.50 electives or restricted electives *

**Semester 6 - Winter**

Select either Option A or Option B

**Option A (at Guelph)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*3560</td>
<td>0.50</td>
<td>Structure and Function in Biochemistry</td>
</tr>
<tr>
<td>CHEM*3650</td>
<td>0.50</td>
<td>Chemistry of the Elements II</td>
</tr>
<tr>
<td>CHEM*3760</td>
<td>0.50</td>
<td>Organic Chemistry III</td>
</tr>
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</table>

1.00 electives or restricted electives *

**Option B (at Seneca)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>XSEN*3030</td>
<td>0.50</td>
<td>Pharmacology and Applied Toxicology</td>
</tr>
<tr>
<td>XSEN*3040</td>
<td>0.50</td>
<td>Occupational Health and Chemistry</td>
</tr>
<tr>
<td>XSEN*3060</td>
<td>0.50</td>
<td>Pharmaceutical Analysis - Advanced</td>
</tr>
<tr>
<td>XSEN*3070</td>
<td>0.50</td>
<td>Pharmaceutical Product Formulations</td>
</tr>
<tr>
<td>XSEN*3090</td>
<td>0.50</td>
<td>Biopharmaceuticals</td>
</tr>
<tr>
<td>XSEN*3200</td>
<td>0.50</td>
<td>Pharmaceutical Organic Chemistry</td>
</tr>
<tr>
<td>XSEN*3210</td>
<td>0.50</td>
<td>Introduction to Pharmaceutical Manufacturing</td>
</tr>
</tbody>
</table>

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

**Summer Semester**

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

**Fall Semester**

<table>
<thead>
<tr>
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<th>Credits</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>COOP*3000</td>
<td>0.00</td>
<td>Co-op Work Term III</td>
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</tbody>
</table>

**Semester 7 - Winter**

2.50 electives or restricted electives *

**Summer Semester**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*4000</td>
<td>0.00</td>
<td>Co-op Work Term IV</td>
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**Semester 8 - Fall**

One of:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM*4730</td>
<td>0.50</td>
<td>Synthetic Organic Chemistry</td>
</tr>
<tr>
<td>CHEM*4740</td>
<td>0.50</td>
<td>Topics in Bio-Organic Chemistry</td>
</tr>
</tbody>
</table>

2.00 electives or restricted electives *

**Restricted Electives**

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

1. MIRC*2420 | 0.50 | Introduction to Microbiology |
2. 1.00 credits from the following:
   - MGB*2040 | 0.50 | Foundations in Molecular Biology and Genetics |
   - MCB*2050 | 0.50 | Molecular Biology of the Cell |
   - TOX*2000 | 0.50 | Principles of Toxicology |
3. A minimum of 1.50 credits at the 4000 level and 2.50 credits at the 3000/4000 level from the following list:
   - BIOC*3560 | 0.50 | Structure and Function in Biochemistry |
   - BIOC*4520 | 0.50 | Metabolic Processes |
   - BIOC*4540 | 0.75 | Enzymology ** |
   - BIOC*4580 | 0.50 | Membrane Biochemistry |
   - BIOM*3090 | 0.50 | Principles of Pharmacology ** |
   - BIOM*3200 | 1.00 | Biomedical Physiology |
   - BIOM*4090 | 0.50 | Pharmacology ** |
   - CHEM*3360 | 0.50 | Environmental Chemistry and Toxicology |
   - CHEM*3440 | 0.50 | Analytical Chemistry III: Analytical Instrumentation |
   - CHEM*3640 | 0.50 | Chemistry of the Elements I |
   - CHEM*3650 | 0.50 | Chemistry of the Elements II ** |
   - CHEM*3760 | 0.50 | Organic Chemistry III |
   - CHEM*4010 | 0.50 | Chemistry and Industry |
   - CHEM*4400 | 0.50 | Advanced Topics in Analytical Chemistry |
   - CHEM*4630 | 0.50 | Bioinorganic Chemistry ** |
   - CHEM*4720 | 0.50 | Organic Reactivity ** |
   - CHEM*4730 | 0.50 | Synthetic Organic Chemistry ** |
   - CHEM*4740 | 0.50 | Topics in Bio-Organic Chemistry |
   - CHEM*4900 | 1.00 | Chemistry Research Project I ** |
   - CHEM*4910 | 1.00 | Chemistry Research Project II ** |
   - MBG*3040 | 0.50 | Molecular Biology of the Gene ** |
   - MBG*3350 | 0.75 | Laboratory Methods in Molecular Biology ** |
   - MCB*4050 | 0.50 | Protein and Nucleic Acid Structure ** |
   - MIRC*3230 | 0.50 | Immunology |
   - NUTR*3210 | 0.50 | Fundamentals of Nutrition |
   - PATH*3610 | 0.50 | Principles of Disease |
   - TOX*4590 | 0.50 | Biochemical Toxicology ** |
   - XSEN*3030 | 0.50 | Pharmacology and Applied Toxicology |
   - XSEN*3040 | 0.50 | Occupational Health and Chemistry |
   - XSEN*3060 | 0.50 | Pharmaceutical Analysis - Advanced |
   - XSEN*3070 | 0.50 | Pharmaceutical Product Formulations |
   - XSEN*3090 | 0.50 | Biopharmaceuticals |
   - XSEN*3200 | 0.50 | Pharmaceutical Organic Chemistry |
   - XSEN*3210 | 0.50 | Introduction to Pharmaceutical Manufacturing |

**Credit Summary (20.00 Total Credits)**

4.00 - First year science credits
6.00 - 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)

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 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

<table>
<thead>
<tr>
<th>Semester 1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1090 [0.50]</td>
<td>Introduction to Molecular and Cellular Biology</td>
</tr>
<tr>
<td>CHEM*1040 [0.50]</td>
<td>General Chemistry I</td>
</tr>
<tr>
<td>MATH*1080 [0.50]</td>
<td>Elements of Calculus I</td>
</tr>
<tr>
<td>PHYS*1080 [0.50]</td>
<td>Physics for Life Sciences</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.uoguelph.ca/bsc/revision_SS](https://www.uoguelph.ca/bsc/revision_SS).

<table>
<thead>
<tr>
<th>Semester 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1070 [0.50]</td>
<td>Discovering Biodiversity</td>
</tr>
<tr>
<td>BIOL*1080 [0.50]</td>
<td>Biological Concepts of Health</td>
</tr>
<tr>
<td>CHEM*1050 [0.50]</td>
<td>General Chemistry II</td>
</tr>
<tr>
<td>PHYS*1070 [0.50]</td>
<td>Physics for Life Sciences II</td>
</tr>
<tr>
<td>0.50 Liberal Education electives</td>
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</table>

<table>
<thead>
<tr>
<th>Semester 3</th>
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</tr>
</thead>
<tbody>
<tr>
<td>BIOL*2400 [0.50]</td>
<td>Evolution</td>
</tr>
<tr>
<td>One of:</td>
<td></td>
</tr>
<tr>
<td>BIOL*2580 [0.50]</td>
<td>Introduction to Biochemistry</td>
</tr>
<tr>
<td>MBG*2040 [0.50]</td>
<td>Foundations in Molecular Biology and Genetics</td>
</tr>
<tr>
<td>1.00 electives or restricted electives *</td>
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</tr>
<tr>
<td>0.50 Liberal Education elective</td>
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<table>
<thead>
<tr>
<th>Semester 4</th>
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<tbody>
<tr>
<td>STAT*2040 [0.50]</td>
<td>Statistics I</td>
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<tr>
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</tr>
<tr>
<td>BIOL*2580 [0.50]</td>
<td>Introduction to Biochemistry</td>
</tr>
<tr>
<td>MBG*2040 [0.50]</td>
<td>Foundations in Molecular Biology and Genetics</td>
</tr>
<tr>
<td>1.00 electives or restricted electives *</td>
<td></td>
</tr>
<tr>
<td>0.50 Liberal Education elective</td>
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</table>

<table>
<thead>
<tr>
<th>Semester 5</th>
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<tbody>
<tr>
<td>2.50 credits of electives or restricted electives*</td>
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</table>

Students are encouraged to consider study abroad options†

<table>
<thead>
<tr>
<th>Semester 6</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2.50 credits of electives or restricted electives*</td>
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</tbody>
</table>

Students are encouraged to consider study abroad options†

<table>
<thead>
<tr>
<th>Semester 7 and 8</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2.50 credits of electives or 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.uoguelph.ca/bsc/](https://www.uoguelph.ca/bsc/)

2. A minimum of 0.50 credits in Ecology:
   - BIOL*2060 [0.50] Ecology
   - BOT*3050 [0.50] Plant Functional Ecology

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

4. A minimum of 0.50 credits in Physiology:
   - BIOM*3200 [1.00] Biomedical Physiology
   - BOT*2100 [0.50] Life Strategies of Plants

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/](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 at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Biology (BIOL)

College of Biological Science

Minor (Honours Program)

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

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

One of:

- BIOL*2060 [0.50] Ecology
- BOT*3050 [0.50] Plant Functional Ecology

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

Bio-Medical Science (BIOM)

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

This joint program of the Department of Human Health and Nutritional Sciences and the Department of Biomedical Sciences provides students with a broad and integrated foundational overview of human and animal health through the study of function (biochemistry and physiology), structure (anatomy and histology), and 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)

BIOC*2580  [0.50] Introduction to Biochemistry
MBG*2040  [0.50] Foundations in Molecular Biology and Genetics
STAT*2040  [0.50] Statistics I

1.00 electives or restricted electives

Semester 4

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

BIOC*3560  [0.50] Structure and Function in Biochemistry

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

BIOM*3210 is recommended.

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

Semester 6

BIOM*3090  [0.50] Principles of Pharmacology
PATH*3610  [0.50] Principles of Disease
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

Semester 8

2.50 electives or restricted electives

Restricted Electives

1. Anatomy Elective - [1 of (BIOM*3010, BIOM*3040), HK*3401/2, HK*3501/2]
2. Immunology Elective - ANSC*4650 or MICR*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*4411/2, 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.

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

Biomedical Toxicology (BTOX)

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

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

**Major (Honours Program)**

Students must follow the academic work sequence for their program and meet all co-op requirements to be eligible to graduate with co-op certification. For more information on co-operative education policies see the Co-operative Education & Career Services website at: [https://www.recruitguelph.ca](https://www.recruitguelph.ca).

**Semester 1 - Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1090</td>
<td>0.50</td>
<td>Introduction to Molecular and Cellular Biology</td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>0.50</td>
<td>General Chemistry I</td>
</tr>
<tr>
<td>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>
</tbody>
</table>

0.50 Liberal Education electives

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

**Semester 2 - Winter**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1080</td>
<td>0.50</td>
<td>Biological Concepts of Health</td>
</tr>
<tr>
<td>CHEM*1050</td>
<td>0.50</td>
<td>General Chemistry II</td>
</tr>
<tr>
<td>COOP*1100</td>
<td>0.00</td>
<td>Introduction to Co-operative Education</td>
</tr>
<tr>
<td>PHYS*1070</td>
<td>0.50</td>
<td>Physics for Life Sciences II</td>
</tr>
<tr>
<td>STAT*2040</td>
<td>0.50</td>
<td>Statistics I</td>
</tr>
</tbody>
</table>

0.50 Liberal Education electives

**Semester 3 - Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*2580</td>
<td>0.50</td>
<td>Introduction to Biochemistry</td>
</tr>
<tr>
<td>CHEM*2480</td>
<td>0.50</td>
<td>Analytical Chemistry I</td>
</tr>
<tr>
<td>MBG*2040</td>
<td>0.50</td>
<td>Foundations in Molecular Biology and Genetics</td>
</tr>
<tr>
<td>TOX*2000</td>
<td>0.50</td>
<td>Principles of Toxicology</td>
</tr>
</tbody>
</table>

0.50 Liberal Education electives

**Winter Semester**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*1000</td>
<td>0.00</td>
<td>Co-op Work Term I</td>
</tr>
<tr>
<td>COOP*2000</td>
<td>0.00</td>
<td>Co-op Work Term II</td>
</tr>
</tbody>
</table>

**Semester 4 - Fall**

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

0.50 electives or restricted electives

**Semester 5 - Winter**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM*2700</td>
<td>0.50</td>
<td>Organic Chemistry I</td>
</tr>
<tr>
<td>BIOM*3200</td>
<td>1.00</td>
<td>Biomedical Physiology</td>
</tr>
<tr>
<td>TOX*3360</td>
<td>0.50</td>
<td>Environmental Chemistry and Toxicology</td>
</tr>
</tbody>
</table>

0.50 electives or restricted electives*

**Summer Semester**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*3000</td>
<td>0.00</td>
<td>Co-op Work Term III</td>
</tr>
<tr>
<td>COOP*4000</td>
<td>0.00</td>
<td>Co-op Work Term IV</td>
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</tbody>
</table>

**Semester 6 - Winter**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOM*3090</td>
<td>0.50</td>
<td>Principles of Pharmacology</td>
</tr>
<tr>
<td>PATH*3610</td>
<td>0.50</td>
<td>Principles of Disease</td>
</tr>
</tbody>
</table>

One of:

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

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

**Semester 7 - Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUTR*4510</td>
<td>0.50</td>
<td>Toxicology, Nutrition and Food</td>
</tr>
<tr>
<td>TOX*4000</td>
<td>0.50</td>
<td>Medical Toxicology</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOX*4590</td>
<td>[0.50]</td>
<td>Biochemical Toxicology</td>
</tr>
</tbody>
</table>

One of:

- BIOM*4090 [0.50] Pharmacology
- TOX*4900 [1.00] Toxicology Research Project I

1.00 electives or restricted electives*

### Semester 8 - Winter

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOM*4090</td>
<td>0.50</td>
<td>Pharmacology (if not taken in Semester 7)</td>
</tr>
<tr>
<td>TOX*4100</td>
<td>0.50</td>
<td>Toxicological Pathology</td>
</tr>
<tr>
<td>TOX*4200</td>
<td>0.50</td>
<td>Topics in Toxicology</td>
</tr>
</tbody>
</table>

Electives or restricted electives* to 2.50 credits

**Restricted Electives**

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

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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSC*4650</td>
<td>0.50</td>
<td>Comparative Immunology</td>
</tr>
<tr>
<td>BIOM*3040</td>
<td>0.75</td>
<td>Medical Embryology</td>
</tr>
<tr>
<td>BIOM*4050</td>
<td>0.50</td>
<td>Biomedical Aspects of Aging</td>
</tr>
<tr>
<td>BIOM*4070</td>
<td>0.50</td>
<td>Biomedical Histology</td>
</tr>
<tr>
<td>BIOM*4150</td>
<td>0.50</td>
<td>Cancer Biology</td>
</tr>
<tr>
<td>CHEM*3750</td>
<td>0.50</td>
<td>Organic Chemistry II</td>
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<tr>
<td>CHEM*3760</td>
<td>0.50</td>
<td>Organic Chemistry III</td>
</tr>
<tr>
<td>CHEM*4740</td>
<td>0.50</td>
<td>Topics in Bio-Organic Chemistry</td>
</tr>
<tr>
<td>MBG*3040</td>
<td>0.50</td>
<td>Molecular Biology of the Gene</td>
</tr>
<tr>
<td>MBG*3350</td>
<td>0.75</td>
<td>Laboratory Methods in Molecular Biology</td>
</tr>
<tr>
<td>MBG*4270</td>
<td>0.50</td>
<td>DNA Replication, Recombination and Repair</td>
</tr>
<tr>
<td>MCB*4010</td>
<td>0.50</td>
<td>Advanced Cell Biology</td>
</tr>
<tr>
<td>MIRC*3230</td>
<td>0.50</td>
<td>Immunology</td>
</tr>
<tr>
<td>NUTR*4090</td>
<td>0.50</td>
<td>Functional Foods and Nutraceuticals</td>
</tr>
<tr>
<td>NUTR*4320</td>
<td>0.50</td>
<td>Nutrition and Metabolic Control of Disease</td>
</tr>
<tr>
<td>PATH*3040</td>
<td>0.50</td>
<td>Principles of Parasitology</td>
</tr>
<tr>
<td>POPM*3240</td>
<td>0.50</td>
<td>Epidemiology</td>
</tr>
<tr>
<td>POPM*4040</td>
<td>0.50</td>
<td>Epidemiology of Food-borne Diseases</td>
</tr>
<tr>
<td>STAT*2050</td>
<td>0.50</td>
<td>Statistics II</td>
</tr>
<tr>
<td>STAT*3510</td>
<td>0.50</td>
<td>Environmental Risk Assessment</td>
</tr>
<tr>
<td>TOX*4900</td>
<td>[1.00]</td>
<td>Toxicology Research Project I</td>
</tr>
<tr>
<td>TOX*4910</td>
<td>[1.00]</td>
<td>Toxicology Research Project II</td>
</tr>
</tbody>
</table>

### Credit Summary (20.00 Total Credits)

4.00 - First year science credits

10.75 - Required science courses semesters 3 – 8

1.50 - Restricted electives

1.50 -Liberal Education electives

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

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

### Biotechnology (BIOT)

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

**Minor (Honours Program)**

A minimum of 5.00 credits is required including:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*3560</td>
<td>0.50</td>
<td>Structure and Function in Biochemistry</td>
</tr>
<tr>
<td>MCB*2040</td>
<td>0.50</td>
<td>Foundations in Molecular Biology and Genetics</td>
</tr>
<tr>
<td>MIRC*2420</td>
<td>0.50</td>
<td>Introduction to Microbiology</td>
</tr>
<tr>
<td>MIRC*2430</td>
<td>0.50</td>
<td>Methods in Microbial Culture and Physiology</td>
</tr>
</tbody>
</table>

0.50 credits from:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGG*2660</td>
<td>[0.50]</td>
<td>Biological Engineering Systems I</td>
</tr>
<tr>
<td>ENGG*3830</td>
<td>[0.50]</td>
<td>Bio-Process Engineering</td>
</tr>
<tr>
<td>FOOD*2410</td>
<td>[0.50]</td>
<td>Introduction to Food Processing</td>
</tr>
<tr>
<td>FOOD*2420</td>
<td>[0.50]</td>
<td>Introduction to Food Microbiology</td>
</tr>
<tr>
<td>FOOD*2620</td>
<td>[0.50]</td>
<td>Food Engineering Principles</td>
</tr>
</tbody>
</table>

1.00 credits from:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECON*1050</td>
<td>[0.50]</td>
<td>Introductory Microeconomics</td>
</tr>
<tr>
<td>ECON*1100</td>
<td>[0.50]</td>
<td>Introductory Macroeconomics</td>
</tr>
<tr>
<td>ECON*2100</td>
<td>[0.50]</td>
<td>Economic Growth and Environmental Quality</td>
</tr>
<tr>
<td>ECON*2530</td>
<td>[0.50]</td>
<td>Intermediate Microeconomics</td>
</tr>
<tr>
<td>ECON*2410</td>
<td>[0.50]</td>
<td>Intermediate Macroeconomics</td>
</tr>
<tr>
<td>MCS*1000</td>
<td>[0.50]</td>
<td>Introductory Marketing</td>
</tr>
</tbody>
</table>

A minimum of 1.50 credits from:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>ANSC*4050</td>
<td>[0.50]</td>
<td>Biotechnology in Animal Science</td>
</tr>
<tr>
<td>BIOC*4540</td>
<td>[0.75]</td>
<td>Enzymology</td>
</tr>
<tr>
<td>BIOL*3300</td>
<td>[0.50]</td>
<td>Applied Bioinformatics</td>
</tr>
<tr>
<td>FOOD*3270</td>
<td>[0.50]</td>
<td>Industrial Microbiology</td>
</tr>
<tr>
<td>MBG*3660</td>
<td>[0.50]</td>
<td>Genomics</td>
</tr>
</tbody>
</table>
MBG*4240 [0.50] Applied Molecular Genetics in Medicine and Biotechnology
MCR*4320 [0.50] Protein and Nucleic Acid Structure
MICR*4320 [0.50] Immunology
PBIO*4370 [0.50] Plant Tissue Culture
PBIO*4470 [0.50] Genetic Engineering of Plants

Business Economics (BECN)

Department of Economics and Finance, College of Business and Economics

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

Minor (Honours Program)

A minimum of 5.00 credits is required, including:

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

One of:

- IPS*1500 [1.00] Integrated Mathematics and Physics I
- MATH*1030 [0.50] Business Mathematics
- MATH*1080 [0.50] Elements of Calculus I
- MATH*1200 [0.50] Calculus I

One of:

- ECON*2740 [0.50] Economic Statistics
- PSYC*1010 [0.50] Making Sense of Data in Psychological Research
- SOAN*2120 [0.50] Introductory Methods
- STAT*2040 [0.50] Statistics I
- STAT*2060 [0.50] Statistics for Business Decisions
- STAT*2080 [0.50] Introductory Applied Statistics I
- STAT*2120 [0.50] Probability and Statistics for Engineers

One of:

- ECON*3660 [0.50] Investments
- ECON*4400 [0.50] Managerial Economics
- ENGG*3240 [0.50] Engineering Economics
- FARE*3310 [0.50] Operations Management
- HRPB*2090 [0.50] Individuals and Groups in Organizations
- MCS*1000 [0.50] Introductory Marketing
- MCS*3040 [0.50] Business and Consumer Law
- MGMT*3320 [0.50] Financial Management

* FARE*1040 and FARE*1400 may replace this course if it is required for the major.

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.

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/

Credit Summary (20.00 Total Credits)

5.00 - First year science credits
11.50 - Required science courses semesters 3 – 8
1.00 - Liberal Education electives
2.50 - Free electives - any approved elective for B.Sc. students

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

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

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

Major (Honours Program)

Students must follow the academic work sequence for their program and meet all co-op requirements to be eligible to graduate with co-op certification. For more information on co-operative education policies see the Co-operative Education & Career Services website at: https://www.recruituogelph.ca.
X. Degree Programs, Bachelor of Science (B.Sc.)

PHYS*3000

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.

Credit Summary (20.00 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.

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.

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*2580 [0.50] Introduction to Molecular and Cellular Biology
CHEM*1040 [0.50] General Chemistry I
IPS*1500 [1.00] Integrated Mathematics and Physics I
0.50 Liberal Education electives

Semester 2

CHEM*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 3

CHEM*3330 [0.50] Analytical Chemistry II: Instrumental Analysis
One of:
CHEM*3870 [0.50] Molecular Spectroscopy +
0.50 electives *
One of:
CIS*2500 [0.50] Intermediate Programming
0.50 electives *
1.00 electives*

Semester 4

COOP*3000 [0.00] Co-op Work Term III

Semester 5

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

Winter Semester

COOP*4000 [0.00] Co-op Work Term IV
(8-month work term in conjunction with COOP*5000)

Summer Semester

COOP*5000 [0.00] Co-op Work Term V
(8-month work term in conjunction with COOP*4000)

Semester 7** - Fall

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

Semester 8** - Winter

NANO*3600 [0.50] Computational Methods in Materials Science
PHYS*3000 [0.50] Optics: Fundamentals and Applications

One of:
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.

Credit Summary (20.00 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.

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.
2. Approval of the Faculty Advisor must be obtained for the selection of courses not listed as restrictive electives.

3. Options for an "Area of Focus" or a minor are available. Subject areas include Biochemistry, Computing and Information Science, Earth Sciences, Environmental Sciences, Mathematical Sciences, and Physics. Please consult with your Faculty Advisor for more detail.

**3.00 credits from the 3000/4000 level as follows:**

1. 1.50 comprising of (CHEM*3870 or CHEM*4880), (CHEM*4620 or CHEM*4630), (CHEM*4720 or CHEM*4730)
2. 1.50 chosen from CHEM*3870, CHEM*4010, CHEM*4400, BIOC*4520, BIOC*4540,BIOC*4580, CHEM*4620, CHEM*4630, CHEM*4720, CHEM*4730, CHEM*4740, CHEM*4880, CHEM*4900, CHEM*4910, MCB*4050, MCB*4080 , TOX*4590

Note:
1. Some of these courses may have to be taken in Semester 6.
2. Some of these courses are offered only in alternate years, and some have additional prerequisites for which the student must plan ahead, with the assistance of the Faculty advisor.

Credit Summary (20.00 Total Credits)

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

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

Minor (Honours Program)
A minor in Chemistry consists of at least 5.00 credits including the following courses:
CHEM*1040 [0.50] General Chemistry I
CHEM*1050 [0.50] General Chemistry II

Of the additional 4.00 credits, students will select Chemistry courses (CHEM) at the 2000 level or above including a minimum of 1.00 credits at the 3000 or 4000 level. BIOC*2580 can be counted towards this specialization.

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

Major (Honours Program)
Students must follow the academic work sequence for their program and meet all co-op requirements to be eligible to graduate with co-op certification. For more information on co-operative education policies see the Co-operative Education & Career Services website at: https://www.recruituoguelph.ca.

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 [0.00] 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 [0.00] Co-op Work Term II

Fall Semester
COOP*3000 [0.00] Co-op Work Term III

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

Summer Semester
COOP*4000 [0.00] 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.

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.

Computing and Information Science (CIS)
School of Computer Science, College of Engineering and Physical Sciences

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

Minor (Honours Program)

CIS*1300 [0.50] Programming
CIS*1910 [0.50] Discrete Structures in Computing I
CIS*2170 [0.75] User Interface Design
CIS*2430 [0.50] Object Oriented Programming
CIS*2500 [0.50] Intermediate Programming
CIS*2520 [0.50] Data Structures
CIS*2750 [0.75] Software Systems Development and Integration
0.50 additional credits from CIS courses at the 2000 level or above
0.50 additional credits from CIS courses at the 3000 level or above
Ecology (ECOL)

Department of Integrative Biology, College of Biological Science

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

Minor (Honours Program)

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

- BIOL*2060 [0.50] Ecology
- BIOL*3010 [0.50] Laboratory and Field Work in Ecology
- BIOL*3060 [0.50] Populations, Communities & Ecosystems
- BIOL*4110 [1.00] Ecological Methods
- BIOL*4120 [0.50] Evolutionary Ecology

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

At least one of:
- BIOL*2400 [0.50] Evolution
- BIOL*3020 [0.50] Population Genetics

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

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

Environmental Biology (ENVB)

School of Environmental Sciences, Ontario Agricultural College

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

Major (Honours Program)

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

Semester 1

- BIOL*1070 [0.50] Discovering Biodiversity
- CHEM*1040 [0.50] General Chemistry I
- ENVS*1100 [0.50] Fundamentals of Environmental Sciences
- MATH*1080 [0.50] Elements of Calculus I
- PHYS*1080 [0.50] Physics for Life Sciences

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

Semester 2

- BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
- CHEM*1050 [0.50] General Chemistry II
- PHYS*1070 [0.50] Physics for Life Sciences II
- One of:
  - CIS*1200 [0.50] Introduction to Computing
  - CIS*1500 [0.50] Introduction to Programming
- MATH*1090 [0.50] Elements of Calculus II
- STAT*2040 [0.50] Statistics I

0.50 Liberal Education elective

Semester 3

- BIOL*2580 [0.50] Introduction to Biochemistry
- STAT*2040 [0.50] Statistics I (if not taken in semester 2)
- TOX*2060 [0.50] Principles of Toxicology
- 1.00 electives or restricted electives chosen from lists A, B, C and/or D (for Liberal Education elective or 1.50 if STAT*2040 was taken in semester 2).

Semester 4

- BIOL*2060 [0.50] Ecology
- ENVS*2090 [0.50] Problem Solving in Environmental Biology
- MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
- 1.00 electives or restricted electives chosen from lists A, B, C and/or D

Semester 5

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

Semester 6

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

Semester 7

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

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

Restricted Electives

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

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

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

List A - Environmental Processes

Minimum of 2.00 credits from the following list:

- BIOL*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 - Organismal Biology

Minimum of 1.00 credits from the following list:

- BOT*2100 [0.50] Life Strategies of Plants
- BOT*3050 [0.50] Plant Functional Ecology
- ENVS*2080 [0.50] Introduction to Environmental Microbiology
- ENVS*3090 [0.50] Insect Diversity and Biology
- ENVS*4230 [0.50] Biology of Aquatic Insects
- 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*3360 [0.50] Groundwater
- ENVS*3380 [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
- PBIO*4530 [0.50] Plants and Environmental Pollution
- TOX*3360 [0.50] Environmental Chemistry and Toxicology

Conservation of Biodiversity and Plant Protection

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

List D - Independent 4260 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/bsc/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
GEOG*2420 [0.50] The Earth From Space
GEOG*2480 [0.50] Mapping and GIS

0.50 Liberal Education electives*

Semester 4

GEOG*2110 [0.50] Climate and the Biophysical Environment
GEOG*2210 [0.50] Environment and Resources
STAT*2040 [0.50] Statistics I
One of:
CIS*1200 [0.50] Introduction to Computing
CIS*1500 [0.50] Introduction to Programming
MATH*1210 [0.50] Calculus II
MATH*1090 [0.50] Elements of Calculus II
0.50 approved Science electives

Semester 5

GEOG*3000 [0.50] Fluvial Processes
GEOG*3110 [0.50] Biotic and Natural Resources

One of:
GEOG*3020 [0.50] Global Environmental Change
GEOG*3090 [0.50] Gender and Environment
GEOG*3210 [0.50] Management of the Biophysical Environment
1.00 electives, at least 0.50 from approved Science electives*

Semester 6

GEOG*3420 [0.50] Remote Sensing of the Environment
GEOG*3480 [0.50] GIS and Spatial Analysis
GEOG*3610 [0.50] Environmental Hydrology
1.00 electives, at least 0.50 from approved Science electives*

Semester 7

GEOG*4110 [1.00] Environmental Systems Analysis
1.50 electives, at least 0.50 from approved Science electives* (GEOG*4690 is recommended)

Semester 8

GEOG*4150 [0.50] Catchment Processes
GEOG*4480 [1.00] Applied Geomatics
1.00 Approved Science electives*

Credit Summary (20.00 Total Credits)

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

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

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

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

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

Students in the major are required to complete 20.00 credits as indicated below. Their first work term will begin in the summer of their second year, after successfully completing four semesters including a cumulative average of 70% after semester two. Students will undertake four work terms in total. With the exception of a requirement to take an Independent Study course in Semester 6, course requirements are the same for the major program (non-co-op), but students in this program may be required to take those courses during different semesters than their non co-op counterparts. All students are encouraged to consult with their program advisor on a regular basis.

Major (Honours Program)

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

Semester 1 - Fall

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/bsc/revised_SS

Semester 2 - Winter

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 - Fall

GEOG*2110 [0.50] Climate and the Biophysical Environment
GEOG*2210 [0.50] Environment and Resources
STAT*2040 [0.50] Statistics I
One of:
CIS*1200 [0.50] Introduction to Computing
CIS*1500 [0.50] Introduction to Programming
MATH*1210 [0.50] Calculus II
MATH*1090 [0.50] Elements of Calculus II
0.50 approved Science electives*

Semester 4 - Winter

GEOG*2420 [0.50] GIS and Spatial Analysis
GEOG*3480 [0.50] GIS and Spatial Analysis
GEOG*3610 [0.50] Environmental Hydrology
1.00 electives, at least 0.50 from approved Science electives*

Semester 5

GEOG*3000 [0.50] Fluvial Processes
GEOG*3110 [0.50] Biotic and Natural Resources

One of:
GEOG*3020 [0.50] Global Environmental Change
GEOG*3090 [0.50] Gender and Environment
GEOG*3210 [0.50] Management of the Biophysical Environment
1.00 electives, at least 0.50 from approved Science electives*

Semester 6

GEOG*3420 [0.50] Remote Sensing of the Environment
GEOG*3480 [0.50] GIS and Spatial Analysis
GEOG*3610 [0.50] Environmental Hydrology
1.00 electives, at least 0.50 from approved Science electives*

Semester 7

GEOG*4110 [1.00] Environmental Systems Analysis
1.50 electives, at least 0.50 from approved Science electives* (GEOG*4690 is recommended)

Semester 8

GEOG*4150 [0.50] Catchment Processes
GEOG*4480 [1.00] Applied Geomatics
1.00 Approved Science electives*

Credit Summary (20.00 Total Credits)

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

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

Major (Honours Program)

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

Semester 1 - Fall

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

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

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*1090 [0.50] Elements of Calculus II
PHYS*1070 [0.50] Physics for Life Sciences II

0.50 Liberal Education electives

Semester 3 - Fall

BIOC*2580 [0.50] Introduction to Biochemistry
CHEM*2880 [0.50] Physical Chemistry
FOOD*2150 [0.50] Introduction to Nutritional and Food Science

Semester 4 - Winter

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

0.50 electives

Semester 5 - Fall

FOOD*3030 [0.50] Food Chemistry I
FOOD*3160 [0.75] Food Processing I
FOOD*3230 [0.75] Food Microbiology

0.50 electives

Semester 6 - Winter

FOOD*3040 [0.50] Food Chemistry II
FOOD*3170 [0.50] Food Processing II
FOOD*3260 [0.50] Industrial Microbiology
FOOD*3700 [0.50] Sensory Evaluation of Foods

1.50 electives

Semester 7 - Fall

FOOD*4190 [0.50] Advanced Food Analysis
FOOD*4260 [0.50] Food Product Development I

1.50 electives

Semester 8 - Winter

FOOD*4270 [0.50] Food Product Development II

2.00 electives

Notes:

1. ENGL*1200 is recommended for those students needing to improve their English grammar.
2. FOOD*2150 could be replaced by FOOD*2100 with permission of department advisor.
3. Of the 6.50 electives credits:
   a. At least 2.00 credits must be Liberal Education electives.
   b. At least 2.00 must be from list of Restricted electives.
   c. At least 1.00 must be from additional Science electives (1.50 if MCS*3010 is chosen as a Restricted Elective)

Restricted Electives:

FOOD*4070 [0.50] Food Packaging
FOOD*4090 [0.50] Functional Foods and Nutraceuticals
FOOD*4110 [0.50] Meat and Poultry Processing
FOOD*4220 [0.50] Topics in Food Science
FOOD*4230 [0.50] Research in Food Science
FOOD*4310 [0.50] Food Safety Management Systems
FOOD*4400 [0.50] Dairy Processing
FOOD*4520 [0.50] Utilization of Cereal Grains for Human Food
MCS*3010 [0.50] Quality Management
POPM*4040 [0.50] Epidemiology of Food-borne Diseases

Credit Summary (20.00 Total Credits)

4.00 - 1st year science credits
9.00 - Required science courses semesters 3 – 8
1.00 - Required social science courses semesters 3 – 8
2.50 - Approved Science electives
1.00 - Liberal Education electives
2.00 - Free electives - any approved elective for B.Sc. students.

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.

Credit Summary (20.00 Total Credits)

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

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

Department of Food Science, Ontario Agricultural College

Major (Honours Program)

Students must follow the academic work sequence for their program and meet all co-op requirements to be eligible to graduate with co-op certification. For more information on co-operative education policies see the Co-operative Education & Career Services website at: https://www.recruitguelph.ca.

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

Semester 2 - Winter

BIOL*1080 [0.50] Biological Concepts of Health
CHEM*1050 [0.50] General Chemistry II
MATH*1090 [0.50] Elements of Calculus II
PHYS*1070 [0.50] Physics for Life Sciences II

0.50 Liberal Education electives

Semester 3 - Fall

BIOC*2580 [0.50] Introduction to Biochemistry
CHEM*2880 [0.50] Physical Chemistry
FOOD*2150 [0.50] Introduction to Nutritional and Food Science

Semester 4 - Winter

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

0.50 electives

Semester 5 - Fall

FOOD*3030 [0.50] Food Chemistry I
FOOD*3160 [0.75] Food Processing I
FOOD*3230 [0.75] Food Microbiology

0.50 electives

Semester 6 - Winter

FOOD*3040 [0.50] Food Chemistry II
FOOD*3170 [0.50] Food Processing II
FOOD*3260 [0.50] Industrial Microbiology
FOOD*3700 [0.50] Sensory Evaluation of Foods

1.50 electives

Semester 7 - Fall

FOOD*4190 [0.50] Advanced Food Analysis
FOOD*4260 [0.50] Food Product Development I

1.50 electives

Semester 8 - Winter

FOOD*4270 [0.50] Food Product Development II

2.00 electives

Notes:

1. ENGL*1200 is recommended for those students needing to improve their English grammar.
2. FOOD*2150 could be replaced by FOOD*2100 with permission of department advisor.
3. Of the 6.50 electives credits:
   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)
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 CJS*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*1080, BIOL*1080 and BIOL*1090. For students with a 65-69.9% average in these three courses, admission to the major will be competitive based on available spaces.

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

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

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

**Semester 1**

BIOL*1080 [0.50] Biological Concepts of Health
CHEM*1050 [0.50] General Chemistry I
MATH*1090 [0.50] Elements of Calculus II
PHYS*1070 [0.50] Physics for Life Sciences I

0.50 Liberal Education electives

**Semester 2**

BIOL*1080 [0.50] Introduction to Biochemistry
CHEM*2880 [0.50] Physical Chemistry
COOP*1100 [0.00] Introduction to Co-operative Education
FOOD*2150 [0.50] Introduction to Nutritional and Food Science
MICR*2420 [0.50] Introduction to Microbiology

0.50 electives

**Semester 3**

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

0.50 electives

**Semester 4**

FOOD*3040 [0.50] Food Chemistry I
FOOD*3160 [0.75] Food Processing I
FOOD*3230 [0.75] Food Microbiology

0.50 electives

**Semester 5**

FOOD*3030 [0.50] Fundamentals of Nutrition
FOOD*3170 [0.62] Food Chemistry II
FOOD*3260 [0.50] Industrial Microbiology

0.50 electives

**Semester 6**

FOOD*3230 [0.50] Food Microbiology
FOOD*3700 [0.50] Sensory Evaluation of Foods

0.50 electives

**Summer Semester**

COOP*1000 [0.00] Co-op Work Term I

**Fall Semester**

COOP*2000 [0.00] Co-op Work Term II

**Winter Semester**

COOP*3000 [0.00] Co-op Work Term III

**Semester 7**

FOOD*4190 [0.50] Advanced Food Analysis
FOOD*4260 [0.50] Food Product Development I

1.50 electives

**Semester 8**

FOOD*4270 [0.50] Food Product Development II

2.00 electives

**Notes:**
See Notes and Credit Summary in Food Science Major.

Geographic Information Systems (GIS) and Environmental Analysis
Department of Geography, Environment and Geomatics, College of Social and Applied Human Sciences

Minor (Honours Program)
A minimum of 5.00 credits is required, including the following 3.50 credits:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
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<tbody>
<tr>
<td>GEOG*1300</td>
<td>Introduction to the Biophysical Environment</td>
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<tr>
<td>GEOG*2420</td>
<td>The Earth From Space</td>
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<td>GEOG*2480</td>
<td>Mapping and GIS</td>
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<tr>
<td>GEOG*3420</td>
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<td>GIS and Spatial Analysis</td>
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<tr>
<td>GEOG*4480</td>
<td>Applied Geomatics</td>
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And at least 1.50 credits from:

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<tr>
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<td>Climate and the Biophysical Environment</td>
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<tr>
<td>GEOG*2210</td>
<td>Environment and Resources</td>
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<tr>
<td>GEOG*3110</td>
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</tr>
<tr>
<td>GEOG*3210</td>
<td>Management of the Biophysical Environment</td>
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<tr>
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<td>Physics for Life Sciences I</td>
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<td>STAT*2040</td>
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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 electives list)
2.00 - Free electives - any approved electives for B.Sc. students.

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

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*1080 [0.50] | Biological Concepts of Health |
| BIOL*1090 [0.50] | Introduction to Molecular and Cellular Biology |
| CHEM*1050 [0.50] | General Chemistry II |
| PHYS*1070 [0.50] | Physics for Life Sciences II |
| 0.50 Liberal Education electives |

Semester 3

| BIOL*2060 [0.50] | Ecology |
| BIOL*2400 [0.50] | Evolution |
| ZOO*2090 [0.50] | Vertebrate Structure and Function |
| 1.00 electives* |

Semester 4

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

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] | Adaptional 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/bsc/]

Credit Summary (20.00 Total Credits)

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

Students must follow the academic work sequence for their program and meet all co-op requirements to be eligible to graduate with co-op certification. For more information on co-operative education policies see the Co-operative Education & Career Services website at: [https://www.recruitguelph.ca]

Major (Honours Program)

Students may wish to plan their program in consultation with the faculty advisor. A total of 20.00 credits are required to complete the major.

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/bsc/revised_SS]

Semester 2 - Winter

| BIOL*1080 [0.50] | Biological Concepts of Health |
| BIOL*1090 [0.50] | Introduction to Molecular and Cellular Biology |
| CHEM*1050 [0.50] | General Chemistry II |
| PHYS*1070 [0.50] | Physics for Life Sciences II |
| 0.50 Liberal Education electives |

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

Semester 3 - Fall

| BIOL*2060 [0.50] | Ecology |
| BIOL*2400 [0.50] | Evolution |
| ZOO*2090 [0.50] | Vertebrate Structure and Function |
| 1.00 electives or restricted electives* |

Semester 4 - Winter

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

Last Revision: February 6, 2019

2019-2020 Undergraduate Calendar
Summer Semester
COOP*1000 [0.00] Co-op Work Term I

Semester 5 - Fall
BIOL*3450 [0.50] Introduction to Aquatic Environments
ZOO*3600 [0.50] Comparative Animal Physiology I
ZOO*3610 [0.25] Lab Studies in Animal Physiology I
ZOO*3700 [0.50] Integrative Biology of Invertebrates

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

Winter Semester
COOP*2000 [0.00] Co-op Work Term II

Summer Semester
COOP*3000 [0.00] Co-op Work Term III

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

1.00 electives or restricted electives

Semester 7 - Winter
BIOL*3060 [0.50] Populations, Communities & Ecosystems
ZOO*3050 [0.50] Developmental Biology
ZOO*3620 [0.50] Comparative Animal Physiology II
ZOO*3630 [0.25] Lab Studies in Animal Physiology II

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

Summer Semester
COOP*4000 [0.00] Co-op Work Term IV

Fall Semester
COOP*5000 [0.00] Co-op Work Term V

Semester 8 - Winter
BIOL*4010 [0.50] Adapational 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/

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.

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 credits from: IPS*1500, or (PHYS*1010 and 0.50 credits from: 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 credits 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 II
STAT*3240 [0.50] Applied Regression Analysis

0.50 additional credits in MATH at 2000 level or above

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

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

AREAS OF EMPHASIS

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

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:
Minor (Honours Program)

This requires 1.00 calculus credits and 4.00 other credits chosen from mathematics, statistics, and computing and information science. For these 4.00 credits students will choose at least 0.50 from each discipline. At least 1.00 credits must be at the 3000 level or above. CIS*2050 and CIS*5000 cannot be counted toward this minor. This minor cannot be combined with a major in Mathematics, Statistics, or Bachelor of Computing program.

Mathematics (MATH)

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

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

Minor (Honours Program)

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

(MATH*1080 or MATH*1200)*

(MATH*1090 or MATH*1210)**

MATH*1160 [0.50] Linear Algebra I
MATH*2000 [0.50] Proofs, Sets, and Numbers
MATH*2200 [0.50] Advanced Calculus I
STAT*2040 [0.50] Statistics I
0.50 additional Mathematics credits at the 2000 level or above.
1.50 additional Mathematics credits at the 3000 or 4000 level.

* IPS*1500 can count toward this 0.50 credit
** IPS*1510 can count toward this 0.50 credit

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

Microbiology (MICR)

Department of Molecular and Cellular Biology, College of Biological Science

Microbiology programs are designed to give students a good understanding of microorganisms, including diversity, ecology, physiology, molecular genetics, current approaches in bacterial genomics/proteomics, and microbial associations with animal hosts and the environments. Such knowledge will provide the basis for further work with microbes in medicine, agricultural industries (including biotechnology, pharmaceuticals, food and beverage) and the environment (surveillance and bioremediation). Students can take the B.Sc. program with a Major in Microbiology, or combine the minor with another major. Students should plan their programs in consultation with the microbiology faculty advisor. As course offerings may change during the program, students are strongly encouraged to review their plans at least once a year with their advisors, and to check the departmental website for program news.

Major (Honours Program)

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

Semester 1

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.queensph.com/bsc/revised_SS

Semester 2

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

Semester 3

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

Semester 4

BIOL*3560 [0.50] Structure and Function in Biochemistry
MCP*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
Semester 5
MBG*3080 [0.50] Bacterial Genetics
MICR*3420 [0.50] Microbial Diversity and Ecology
1.50 electives or restricted electives

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

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
MCB*3010 [0.50] Dynamics of Cell Function and Signaling
MCB*4500 [1.00] Research Project in Molecular & Cellular Biology I
MCB*4510 [1.00] Research Project in Molecular & Cellular Biology II
MCB*4600 [0.50] Topics in Molecular and Cellular Biology
MICR*3090 [0.50] Mycology
MICR*3220 [0.50] Plant Microbiology
MICR*3230 [0.50] Immunology
MICR*3330 [0.50] World of Viruses
MICR*4010 [0.50] Pathogenic Microbiology
MICR*4330 [0.50] Molecular Virology
MICR*4430 [0.50] Medical Virology
MICR*4520 [0.50] Microbial Cell Biology
MICR*4530 [0.50] Immunology II
PATH*3040 [0.50] Principles of Parasitology

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.

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

Minor (Honours Program)
The minor in Microbiology consists of the following 5.00 credits including:
BIOC*3560 [0.50] Structure and Function in Biochemistry
MICR*2420 [0.50] Introduction to Microbiology
MICR*2430 [0.50] Methods in Microbial Culture and Physiology
A minimum of 2.50 credits from:
FOOD*3230 [0.75] Food Microbiology
FOOD*3240 [0.50] Food Microbiology
FOOD*3260 [0.50] Industrial Microbiology
FOOD*3270 [0.50] Industrial Microbiology
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
MBG*3080 [0.50] Bacterial Genetics
MBG*3350 [0.75] Laboratory Methods in Molecular Biology
MICR*3090 [0.50] Mycology
MICR*3220 [0.50] Plant Microbiology
MICR*3230 [0.50] Immunology
MICR*3260 [0.50] Microbial Adaptation
MICR*3330 [0.50] World of Viruses
MICR*3420 [0.50] Microbial Diversity and Ecology
MICR*3430 [0.75] Advanced Methods in Microbiology
1.00 credits from:
MICR*4010 [0.50] Pathogenic Microbiology

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

Microbiology (Co-op) (MICR:C)
Department of Molecular and Cellular Biology, College of Biological Science

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

Students must follow the academic work sequence for their program and meet all co-op requirements to be eligible to graduate with co-op certification. For more information on co-operative education policies see the Co-operative Education & Career Services website at: https://www.recruituogelph.ca

Major (Honours Program)

Semester 1 - Fall
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
CHEM*1040 [0.50] General Chemistry I
STAT*1010 [0.50] Introduction to Statistics
PHYS*1080 [0.50] Physics for Life Sciences
0.50 Liberal Education electives

Semester 2 - Winter
BIOL*1070 [0.50] Discovering Biodiversity
CHEM*1030 [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*2420 [0.50] General Microbiology
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
MICR*2420 [0.50] Introduction to Microbiology
2.50 electives or restricted electives which can include MCB*4500

Semester 4 - Winter
BIOC*3560 [0.50] Structure and Function in Biochemistry
MICR*2430 [0.50] Methods in Microbial Culture and Physiology
0.50 electives
0.50 Liberal Education electives

Summer Semester
COOP*1000 [0.00] Co-op Work Term I

Semester 5 - Fall
MBG*3080 [0.50] Bacterial Genetics
MICR*3420 [0.50] Microbial Diversity and Ecology
1.50 electives or restricted electives

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

Summer - Semester
COOP*2000 [0.00] Co-op Work Term II

Fall Semester
COOP*3000 [0.00] Co-op Work Term III

Winter Semester
COOP*4000 [0.00] Co-op Work Term IV

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.

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<thead>
<tr>
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<td>BIOL*1090</td>
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<td>Introduction to Molecular and Cellular Biology</td>
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<td>BIOL*1070</td>
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<td>Structure and Function in Biochemistry</td>
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<td>CHEM*2700</td>
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<td>Organic Chemistry I</td>
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<tr>
<td>MCB*2050</td>
<td>0.50</td>
<td>Molecular Biology of the Cell</td>
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<tr>
<td>MICR*2430</td>
<td>0.50</td>
<td>Methods in Microbial Culture and Physiology</td>
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</table>

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.

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.

Molecular Biology and Genetics (MBG)

Department of Molecular and Cellular Biology, College of Biological Science

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

Major (Honours Program)

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

Semester 1

<table>
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Semester 2

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<tr>
<td>BIOL*1070</td>
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<td>Discovering Biodiversity</td>
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Semester 3

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<td>BIOC*2580</td>
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<tr>
<td>MBG*2040</td>
<td>0.50</td>
<td>Foundations in Molecular Biology and Genetics</td>
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<tr>
<td>MICR*2420</td>
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<td>Introduction to Microbiology</td>
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<tr>
<td>STAT*2040</td>
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Semester 4

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<td>Structure and Function in Biochemistry</td>
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<td>CHEM*2700</td>
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<td>Organic Chemistry I</td>
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<tr>
<td>MCB*2050</td>
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<td>Molecular Biology of the Cell</td>
</tr>
<tr>
<td>MICR*2430</td>
<td>0.50</td>
<td>Methods in Microbial Culture and Physiology</td>
</tr>
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</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>
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<tr>
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<td>Foundations in Molecular Biology and Genetics</td>
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<tr>
<td>MCB*2050</td>
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<td>Molecular Biology of the Cell</td>
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A minimum of 4.00 credits from:

<table>
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<tr>
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<td>BIOL*3030</td>
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<td>Applied Bioinformatics</td>
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<tr>
<td>MBG*2040</td>
<td>0.50</td>
<td>Fundamentals of Plant and Animal Genetics</td>
</tr>
<tr>
<td>MBG*3040</td>
<td>0.50</td>
<td>Molecular Biology of the Gene</td>
</tr>
<tr>
<td>MBG*3050</td>
<td>0.50</td>
<td>Human Genetics</td>
</tr>
<tr>
<td>MBG*3060</td>
<td>0.50</td>
<td>Quantitative Genetics</td>
</tr>
<tr>
<td>MBG*3080</td>
<td>0.50</td>
<td>Bacterial Genetics</td>
</tr>
</tbody>
</table>
### Nanoscience (NANO)

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

**Major (Honours Program)**

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

#### Semester 1

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

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

#### Semester 2

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

#### Semester 3

<table>
<thead>
<tr>
<th>Code</th>
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<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM*2060</td>
<td>Structure and Bonding</td>
<td>0.50</td>
</tr>
<tr>
<td>MATH*2270</td>
<td>Applied Differential Equations</td>
<td>0.50</td>
</tr>
<tr>
<td>NANO*2000</td>
<td>Synthesis and Characterization of Nanomaterials I</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*2330</td>
<td>Electricity and Magnetism I</td>
<td>0.50</td>
</tr>
<tr>
<td>One of:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHEM*2820</td>
<td>Thermodynamics and Kinetics</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*2240</td>
<td>Thermal Physics</td>
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</tbody>
</table>

#### Semester 4

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

#### Semester 5

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>NANO*3200</td>
<td>Nanolithographic Techniques</td>
<td>0.50</td>
</tr>
<tr>
<td>NANO*3500</td>
<td>Thin Film Science</td>
<td>0.50</td>
</tr>
<tr>
<td>One of:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHEM*3860</td>
<td>Quantum Chemistry</td>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*3230</td>
<td>Quantum Mechanics I</td>
<td>0.50</td>
</tr>
<tr>
<td>1.00 electives</td>
<td></td>
<td></td>
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</table>

#### Semester 6

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

#### Semester 7

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

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>NANO*4200</td>
<td>Topics in Nanomaterials</td>
<td>0.50</td>
</tr>
<tr>
<td>2.00 electives</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

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

### Areas of Focus

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

**Chemistry: Inorganic**

- Semester 4: CHEM*2480
- Semester 5: CHEM*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**

**Major (Honours Program)**

Students must follow the academic work sequence for their program and meet all co-op requirements to be eligible to graduate with co-op certification. For more information on co-operative education policies see the Co-operative Education & Career Services website at: [https://www.recruitguelph.ca](https://www.recruitguelph.ca).

#### Semester 1 - Fall

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

Students who are lacking one 4U/grade 12 course in Biology, Chemistry or Physics must take the equivalent introductory course in first semester. The required first-year science courses in that subject should be completed according to the revised schedule of studies available at: [https://www.uoguelph.ca/bsc/revised_SS](https://www.uoguelph.ca/bsc/revised_SS).
### 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 1 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

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

#### Semester 2
- **BIOL*1070** [0.50] Discovering Biodiversity
- **BIOL*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
- **PSYC*1000** [0.50] Introduction to Psychology

0.50 Liberal Education elective

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

#### Semester 5
- **PSYC*1010** [0.50] Making Sense of Data in Psychological Research

0.50 Liberal Education elective

#### Semester 6
- **PSYC*3410** [0.50] Behavioural Neuroscience II

1.00 electives or restricted electives

#### Semester 7
- **MCR*2050** [0.50] Molecular Biology of the Cell
- **PHYS*2030** [0.50] Biophysics of Excitable Cells
- **PSYC*3270** [0.50] Cognitive Neuroscience

1.00 electives or restricted electives

#### Semester 8
- **PSYC*4270** [0.50] Current Issues in Neuroscience
- **NEUR*4100** [0.50] Neuropharmacology

1.50 electives or restricted electives

### Neuroscience (NEUR)

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

#### Credit Summary (20.00 Total Credits)

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOM*3210</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHIL*2100</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHIL*2110</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHIL*2120</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHIL*2180</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHIL*2240</td>
<td>[0.50]</td>
</tr>
</tbody>
</table>

#### Ethics from:

- **Critical Thinking in the Health Sciences**
- **Formal Logic**
- **Ethics**
- **Philosophy of Science**
- **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 meet the minimum requirement specified.

2. A minimum of 0.50 credits of Developmental Biology
   BIOM*3040 [0.75] Medical Embryology *
   MBG*3040 [0.50] Molecular Biology of the Gene
   ZOO*3050 [0.50] Developmental Biology

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

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

4. A minimum of 0.50 credits of additional statistics or experimental design
   PSYC*2360 [0.50] Psychological Methods and Statistics
   STAT*2050 [0.50] Statistics II

5. A minimum of 1.00 credits of Independent Study

For students who are interested in graduate studies, a research course is recommended.

* Indicates courses that have additional prerequisites.

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

BIOM*4500 [0.50] Literature-based Research in Biomedical Sciences
BIOM*4510 [1.00] Research in Biomedical Sciences
BIOM*4521/2 [2.00] Research in Biomedical Sciences
HK*4230 [0.50] Advanced Study in Human Health and Nutritional Sciences
HK*4360 [1.00] Research in Human Health and Nutritional Sciences
HK*4371/2 [1.00] Research in Human Health and Nutritional Sciences II
IBIO*4500 [1.00] Research in Integrative Biology I
IBIO*4510 [1.00] Research in Integrative Biology II
IIBIO*4521/2 [2.00] Thesis in Integrative Biology
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 *
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 [0.50] 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 II - Integrated Systems *
HK*4070 [0.50] Clinical Biomechanics *
TOX*4000 [0.50] Medical Toxicology

Credit Summary (20.00 Total Credits)

4.00 – First year science core
7.00 – Required science courses semester 3-8
3.00 – Restricted elective (#1,2,3,4,5 in restricted electives list)
2.00 – Approved Science elective*
0.50 - Required Liberal Education elective (PSYC*1000)
1.00 – Liberal Education electives
2.50 – Free electives

Of the 20 total credits required, students must complete 16.00 credits in science of which a minimum of 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

*2.50 Approved Science Electives if a PHIL*XXXX course is selected for restricted electives #1

Minor (Honours Program)

A minor in Neuroscience requires a minimum of 5.00 credits including:

BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
PSYC*1010 [0.50] Introduction to Psychology
PSYC*2330 [0.50] Principles of Learning

One of:
NEUR*2000 [0.50] Introduction to Neuroscience
PSYC*2410 [0.50] Behavioural Neuroscience I

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

A minimum of 0.50 credits from:

BIOM*2000 [0.50] Concepts in Human Physiology
BIOM*3200 [1.00] Biomedical Physiology
HK*2810 [0.50] Human Physiology I - Concepts and Principles
ZOO*3600 [0.50] Comparative Animal Physiology I

A minimum of 2.00 credits from:

BIOM*3000 [0.50] Functional Mammalian Neuroanatomy
BIOM*3090 [0.50] Principles of Pharmacology
BIOM*4030 [0.50] Endocrine Physiology
HK*3100 [0.50] Neuromuscular Physiology
MBG*3050 [0.50] Human Genetics
MCB*2050 [0.50] Molecular Biology of the Cell
NEUR*3100 [0.50] Molecular Biology of Neurodevelopmental and Degenerative Disease
NEUR*4000 [0.50] Current Issues in Neuroscience
NEUR*4100 [0.50] Neuropharmacology
PHYS*2030 [0.50] Biophysics of Excitable Cells
PHYS*2330 [0.50] Electricity and Magnetism I
PSYC*2390 [0.50] Sensation and Perception
PSYC*2650 [0.50] Cognitive Psychology
PSYC*3030 [0.50] Neurochemical Basis of Behaviour
PSYC*3270 [0.50] Cognitive Neuroscience
PSYC*3330 [0.50] Memory and Attention
PSYC*3410 [0.50] Behavioural Neuroscience II
PSYC*4750 [0.50] Seminar in Motivation and Emotion

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

BIOM*3040 [0.75] Medical Embryology
MBG*4040 [0.50] Genetics and Molecular Biology of Development
ZOO*3050 [0.50] Developmental Biology

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

Nutritional and Nutraceutical Sciences (NANS)

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

The Nutritional and Nutraceutical Sciences major is concerned with understanding the contribution of food, beverage and nutritional supplement consumption to growth, development of optimal biological function, maintenance of health, and treatment of disease.

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

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

**Semester 1**
- BIOC*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](https://www.uoguelph.ca/bsc/revised_SS).

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

0.50 Liberal Education electives

**Semester 3**
- BIOC*2580 0.50 Introduction to Biochemistry
- MBG*2040 0.50 Foundations in Molecular Biology and Genetics
- STAT*2040 0.50 Statistics I

0.50 electives or restricted electives 0.50 Liberal Education electives

**Semester 4**
- BIOC*3560 0.50 Structure and Function in Biochemistry
- 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 Liberal Education electives

**Semester 5**
- HK*3810 0.75 Human Physiology II - Integrated Systems
- NUTR*3330 0.50 Micronutrients, Phytochemicals and Health
- NUTR*3360 0.50 Lifestyle Genomics
- NUTR*3390 0.75 Applied Nutritional and Nutraceutical Sciences I

**Semester 6**
- BIOM*3090 0.50 Principles of Pharmacology
- NUTR*4090 0.50 Functional Foods and Nutraceuticals
- NUTR*4320 0.50 Nutrition and Metabolic Control of Disease
- NUTR*4330 0.75 Applied Nutritional and Nutraceutical Sciences II

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

**Semester 7**
- NUTR*4210 0.50 Nutrition, Exercise and Energy Metabolism
- NUTR*4510 0.50 Toxicology, Nutrition and Food

1.50 electives or restricted electives

**Semester 8**
- 2.50 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/](https://www.uoguelph.ca/bsc/)

2. 1.00 credits from the following:
   - HK*4230 0.50 Advanced Study in Human Health and Nutritional Sciences
   - HK*4340 0.50 Genomics: Exercise and Disease
   - HK*4360 0.50 Research in Human Health and Nutritional Sciences
   - HK*4371/2 1.00 Research in Human Health and Nutritional Sciences II
   - HK*4510 1.00 Teaching, Learning & Knowledge Transfer
   - HK*4511/2 1.00 Teaching, Learning & Knowledge Transfer II
   - HK*4720 0.50 Genomics: Exercise and Disease
   - NUTR*4360 0.50 Nutritional and Metabolic Control of Disease
   - NUTR*4390 0.50 Current Issues in Nutrigenomics
   - PATH*3610 0.50 Principles of Disease

### Credit Summary (20.00 Total Credits)

- 4.00 - First year science core
- 1.25 - Restricted electives (2 credits)
- 1.75 - Approved science electives
- 2.00 - Liberal Education electives
- 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:

**Semester 1**
- BIOC*2580 0.50 Introduction to Biochemistry
- NUTR*3310 0.50 Fundamentals of Nutrition
- NUTR*3330 0.50 Micronutrients, Phytochemicals and Health
- NUTR*4090 0.50 Functional Foods and Nutraceuticals
- STAT*2040 0.50 Statistics I

At least 0.50 credits from:
- ANSC*3080 0.50 Agricultural Animal Physiology (restricted to ABIO majors)
- BIOM*3200 1.00 Biomedical Physiology
- HK*2810 0.50 Human Physiology I - Concepts and Principles
- ZOO*3560 0.50 Comparative Animal Physiology I

and 2.00 credits from:
- ANSC*3170 0.50 Nutrition of Fish and Crustacea
- ANSC*3180 0.50 Wildlife Nutrition
- ANSC*4260 0.50 Beef Cattle Nutrition
- ANSC*4270 0.50 Dairy Cattle Nutrition
- ANSC*4280 0.50 Poultry Nutrition
- ANSC*4290 0.50 Swine Nutrition
- ANSC*4560 0.50 Pet Nutrition
- EQN*4020 0.50 Advanced Equine Nutrition
- FOOD*2010 0.50 Principles of Food Science
- HK*3810 0.75 Human Physiology II - Integrated Systems
- HK*4230 0.50 Advanced Study in Human Health and Nutritional Sciences
- HK*4340 0.50 Genomics: Exercise and Disease
- HK*4360 1.00 Research in Human Health and Nutritional Sciences
- HK*4371/2 1.00 Research in Human Health and Nutritional Sciences II
- HK*4510 1.00 Teaching, Learning & Knowledge Transfer
- HK*4511/2 1.00 Teaching, Learning & Knowledge Transfer II
- NUTR*2150 0.50 Introduction to Nutritional and Food Sciences
- NUTR*3360 0.50 Lifestyle Genomics
- NUTR*3390 0.75 Applied Nutritional and Nutraceutical Sciences I
- NUTR*4210 0.50 Nutrition, Exercise and Energy Metabolism
- NUTR*4320 0.50 Nutrition and Metabolic Control of Disease
- NUTR*4330 0.75 Applied Nutritional and Nutraceutical Sciences II
- NUTR*4360 0.50 Current Issues in Nutrigenomics
- NUTR*4510 0.50 Toxicology, Nutrition and Food

### Physical Science (PSCI)

#### College of Engineering and Physical Sciences

#### Major (Honours Program)

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

1. **Basic Science Core - 4.00 credits**
   - 1.00 - Biology (BIOL*1070, BIOL*1080, BIOL*1090)
   - 1.00 - Chemistry (CHEM*1040, CHEM*1050)*
   - 1.00 - Physics (PHYS*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

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Last Revision: February 6, 2019

2019-2020 Undergraduate Calendar
Major (Honours Program)

This major requires the completion of 20.00 credits. At least 1.00 credits must be from Arts and/or Social Science courses.

Semester 1*

CHEM*1040 [0.50] General Chemistry I  
CIS*1300 [0.50] Programming  
IPS*1500 [1.00] Integrated Mathematics and Physics I  
One of:  
Biol*1070 [0.50] Discovering Biodiversity  
Biol*1080 [0.50] Biological Concepts of Health  
Biol*1090 [0.50] Introduction to Molecular and Cellular Biology  

0.50 Liberal Education electives

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

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.
Credit Summary (20.00 Total Credits)
5.00 - First year science credits
8.50 - Required science courses semesters 3 – 8
1.00 - Restricted electives
1.50 - Approved Science electives
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 Physics requires 5.00 credits in interdisciplinary physical science or physics courses including:
PHYS*2180 [0.50] Experimental Techniques in Physics
PHYS*2310 [0.50] Mechanics
PHYS*2330 [0.50] Electricity and Magnetism I
PHYS*2340 [0.50] Electricity and Magnetism II
A maximum of 1.00 credits from the following courses may be used towards the minor:
PHYS*1010 [0.50] Introductory Electricity and Magnetism
PHYS*1070 [0.50] Physics for Life Sciences II
PHYS*1080 [0.50] Physics for Life Sciences
PHYS*1130 [0.50] Physics with Applications
IPS*1510 [1.00] Integrated Mathematics and Physics II
A minimum of 1.00 credits are required at the 3000 or 4000 level.

NOTE: PHYS*1300, PHYS*1600 and PHYS*1810 may not be taken for credit toward this minor.

Physics (Co-op) (PHYS:C)
Department of Physics, College of Engineering and Physical Sciences
Students must follow the academic work sequence for their program and meet all co-op requirements to be eligible to graduate with co-op certification. For more information on co-operative education policies see the Co-operative Education & Career Services website at: https://www.recruituqueph.ca.

Major (Honours Program)
This major requires the completion of 20.00 credits.

Semester 1 - Fall
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 - Winter
CHEM*1050 [0.50] General Chemistry II
IPS*1510 [1.00] Integrated Mathematics and Physics II
MATH*1160 [0.50] Linear Algebra I
One of:
BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1080 [0.50] Biological Concepts of Health
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology

Semester 3 - Fall
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
PHYS*2180 [0.50] Experimental Techniques in Physics
PHYS*2310 [0.50] Mechanics
PHYS*2340 [0.50] Electricity and Magnetism II
One of:
CIS*2500 [0.50] Intermediate Programming
0.50 electives
0.50 electives

Summer Semester
COOP*1000 [0.00] Co-op Work Term I ++

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 [0.00] Co-op Work Term II ++
(8-month work term in conjunction with COOP*3000)

Summer Semester
COOP*3000 [0.00] 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 [0.00] Co-op Work Term IV ++

Fall Semester
COOP*5000 [0.00] 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

Credit Summary (20.00 Total Credits)
5.00 - First year science credits
8.50 - Required science courses semesters 3 – 8
1.00 - Restricted electives
1.50 - Approved Science electives
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.

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

Last Revision: February 6, 2019
2019-2020 Undergraduate Calendar
### 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 (#2) (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
- 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
- ENV*3020 [0.50] Pesticides and the Environment
- ENV*3080 [0.50] Soil and Water Conservation **
- ENV*3140 [0.50] Management of Turfgrass Diseases **
- ENV*3310 [0.50] Soil Biodiversity and Ecosystem Function **
- ENV*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*3340 [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*2220 [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 **
### 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>
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<tr>
<td>MATH*1080</td>
<td>Elements of Calculus</td>
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<tr>
<td>PHYS*1080</td>
<td>Physics for Life Sciences</td>
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<tr>
<td>0.50 Liberal Education electives</td>
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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 [https://www.uoguelph.ca/bsc/revised_SS](https://www.uoguelph.ca/bsc/revised_SS).

#### Semester 2

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<tr>
<td>BIOL*1080</td>
<td>Biological Concepts of Health</td>
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<tr>
<td>BIOL*1090</td>
<td>Introduction to Molecular and Cellular Biology</td>
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</tr>
<tr>
<td>CHEM*1050</td>
<td>General Chemistry II</td>
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<tr>
<td>PHYS*1070</td>
<td>Physics for Life Sciences II</td>
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<td>0.50 Liberal Education electives</td>
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#### Semester 3

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<tbody>
<tr>
<td>BIOL*2580</td>
<td>Introduction to Biochemistry</td>
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<td>MBG*2040</td>
<td>Foundations in Molecular Biology and Genetics</td>
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#### Semester 4

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<tr>
<td>BIOL*2060</td>
<td>Ecology</td>
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<td>BIOL*2400</td>
<td>Evolution</td>
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<td>STAT*2230</td>
<td>Biostatistics for Integrative Biology</td>
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<td>1.00 electives or restricted electives</td>
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#### Semester 5

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<th>Course Code</th>
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<tbody>
<tr>
<td>BIOL*3010</td>
<td>Laboratory and Field Work in Ecology</td>
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<td>2.00 electives or restricted electives</td>
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#### Semester 6

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

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

#### RestRICTed Electives

Note: For students considering graduate research programs, BIOL*4110 may be substituted by an independent research course (1.00 credits minimum). Course options include: (IBIO*4500 and IBIO*4510), IBIO*4521/IBIO*4522.

#### Semester 8

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
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<tr>
<td>BIOL*4500</td>
<td>Natural Resource Policy Analysis</td>
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</tr>
<tr>
<td>2.00 electives or restricted electives</td>
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### Credit Summary (20.00 Total Credits)

- 5.00 - First year science credits
- 11.00 - Required science courses semesters 3 – 8
- 2.00 - Restricted electives
- 1.00 - Liberal Education electives
- 1.00 - Free electives - any approved elective for B.Sc. students, could be less if restricted electives do not count as science

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

### Wildlife Biology and Conservation (WBC)

The core of this major will provide students with an integrated foundation in three disciplines necessary to understand the origins, interactions, and protection of biological diversity: evolution, ecology, and conservation biology. After the second semester, the student has the opportunity to take a wide variety of electives, including courses that meet his/her specific interests within one or two of these disciplines. The program offers a sound scientific background in preparation for careers in resource management, conservation, ecological consulting, teaching, and government service. This major also qualifies students for post-graduate work in ecology, evolutionary biology, environmental sciences, or wildlife management.
BOT*3710 [0.50] Plant Diversity and Evolution
ENVS*3090 [0.50] Insect Diversity and Biology
ENVS*3180 [0.50] Sedimentary Environments *
MBG*3040 [0.50] Molecular Biology of the Gene
MBG*4110 [0.50] Epigenetics *
MBG*4270 [0.50] DNA Replication, Recombination and Repair *
ZOO*2700 [0.50] Invertebrate Morphology & Evolution
ZOO*3050 [0.50] Developmental Biology

Ecology
ANSC*3180 [0.50] Wildlife Nutrition *
BIOL*3450 [0.50] Introduction to Aquatic Environments
ENVS*3000 [0.50] Nature Interpretation
ENVS*3270 [0.50] Forest Biodiversity *
ENVS*4350 [0.50] Forest Ecology *
NUTR*3210 [0.50] Fundamentals of Nutrition
ZOO*4300 [0.75] Marine Biology and Oceanography *
ZOO*4570 [0.50] Marine Ecological Processes *

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

Integrative/Cross-Disciplinary
IBIO*4500 [1.00] Research in Integrative Biology I
IBIO*4510 [1.00] Research in Integrative Biology II
IBIO*4521/2 [2.00] Thesis in Integrative Biology
MCB*2050 [0.50] Molecular Biology of the Cell
ZOO*3610 [0.25] Lab Studies in Animal Physiology I
ZOO*3620 [0.50] Comparative Animal Physiology II
ZOO*3630 [0.25] Lab Studies in Animal Physiology II
ZOO*3700 [0.50] Integrative Biology of Invertebrates *
ZOO*4070 [0.50] Animal Behaviour
ZOO*4910 [0.50] Integrative Vertebrate Biology *
ZOO*4920 [0.25] Lab Studies in Ornithology
ZOO*4940 [0.25] Lab Studies in Herpetology
ZOO*4950 [0.25] Lab Studies in Mammalogy

Field Courses
BIOL*4410 [0.75] Field Ecology
BIOL*4610 [0.75] Arctic Ecology
BIOL*4700 [0.50] Field Biology
BIOL*4710 [0.25] Field Ecology
BIOL*4800 [0.50] Field Ecology
BIOL*4810 [0.25] Field Ecology
BIOL*4900 [0.50] Field Biology

Credit Summary (20.00 Total Credits)
4.00 - First year science core
6.50 - Required science courses semesters 3 - 8
4.50 - Restricted electives (# 2, 3, 4 and 5 in restricted electives list)**
1.00 - Approved Science electives
1.00 - Liberal Education electives (#1 in restricted electives list)
3.00 - Free electives - any approved elective for B.Sc. students

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

Zoology (ZOO)
Department of Integrative Biology, College of Biological Science
The major in zoology offers a broad education in the life sciences while providing a more specialized understanding of the structure, function and ecology of animals. This major qualifies students for post-graduate work in zoology and other life sciences and provides a sound science background for students wishing to pursue careers in teaching, government service or the private sector.

Major (Honours Program)
Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. A minimum total of 20.00 credits is required to complete the major. At least 6.00 science credits must be at the 3000 or 4000 level, 2.00 of which must be at the 4000 level.

Semester 1
BIOL*1070 [0.50] Discovering Biodiversity
CHEM*1040 [0.50] General Chemistry I
MATH*1080 [0.50] Elements of Calculus I
PHYS*1080 [0.50] Physics for Life Sciences

0.50 Liberal Education electives

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

Semester 2
BIOL*1080 [0.50] Biological Concepts of Health
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
CHEM*1050 [0.50] General Chemistry II
PHYS*1070 [0.50] Physics for Life Sciences II

0.50 Liberal Education electives

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

1.00 electives or restricted electives *

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

0.50 electives or restricted electives *

Semester 5
ZOO*3000 [0.50] Comparative Histology
ZOO*3600 [0.50] Comparative Animal Physiology I
ZOO*3610 [0.25] Lab Studies in Animal Physiology I
ZOO*3700 [0.50] Integrative Biology of Vertebrates

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

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

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

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

1.50 electives or restricted electives

Semester 8
2.50 electives or restricted electives

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

Restricted Electives must include:
1. A minimum of 1.00 credits of Liberal Education electives is required. The list of Liberal Education electives for B.Sc. students can be found at: [https://www.uoguelph.ca/bsc/](https://www.uoguelph.ca/bsc/)
2. A minimum of 0.50 credits from:
   - ZOO*4330 [0.50] Biology of Fishes
   - ZOO*4920 [0.25] Lab Studies in Ornithology
   - ZOO*4940 [0.25] Lab Studies in Herpetology
   - ZOO*4950 [0.25] Lab Studies in Mammalogy
3. A minimum of 0.50 credits from:
   - BIOL*4410 [0.75] Field Ecology
   - BIOL*4610 [0.75] Arctic Ecology
   - BIOL*4700 [0.50] Field Biology
   - BIOL*4710 [0.25] Field Biology
   - BIOL*4800 [0.50] Field Biology
   - BIOL*4810 [0.25] Field Biology
   - BIOL*4900 [0.50] Field Biology
   - BIOL*4910 [0.50] Integrative Vertebrate Biology
   - BIOL*4920 [0.25] Lab Studies in Ornithology
   - BIOL*4940 [0.25] Lab Studies in Herpetology
   - BIOL*4950 [0.25] Lab Studies in Mammalogy
   - BIOL*4970 [0.50] Animal Behaviour
   - BIOL*4980 [0.50] Field Biology
   - BIOL*4990 [0.25] Field Biology
   - BIOL*5000 [1.00] Research in Integrative Biology I
   - BIOL*5010 [1.00] Research in Integrative Biology II
   - BIOL*5020 [2.00] Thesis in Integrative Biology
   - ZOO*4170 [0.50] Experimental Comparative Animal Physiology
   - ZOO*4330 [0.75] Marine Biology and Oceanography

Other field or research courses with approval of faculty advisor.

Credit Summary (20.00 Total Credits)
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6.00 - Required science courses semesters 3 - 8
4.00 - Restricted electives (# 2, 3, 4 and 5 in restricted electives list)**
1.00 - Approved Science electives
1.00 - Liberal Education electives (#1 in restricted electives list)
3.00 - Free electives - any approved elective for B.Sc. students

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Major (Honours Program)
Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. A minimum total of 20.00 credits is required to complete the major. At least 6.00 science credits must be at the 3000 or 4000 level, 2.00 of which must be at the 4000 level.
3.00 - Free electives - any approved elective for B.Sc. students

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

**Minor (Honours Program)**

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

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

- BIOL*2060 [0.50] Ecology
- BIOL*2400 [0.50] Evolution
- BIOL*3060 [0.50] Populations, Communities & Ecosystems
- ZOO*2090 [0.50] Vertebrate Structure and Function
- ZOO*2700 [0.50] Invertebrate Morphology & Evolution
- ZOO*3000 [0.50] Comparative Histology
- ZOO*3050 [0.50] Developmental Biology
- ZOO*3600 [0.50] Comparative Animal Physiology I
- ZOO*3610 [0.25] Lab Studies in Animal Physiology I
- ZOO*3620 [0.50] Comparative Animal Physiology II
- ZOO*3630 [0.25] Lab Studies in Animal Physiology II
- ZOO*3700 [0.50] Integrative Biology of Invertebrates
- ZOO*4070 [0.50] Animal Behaviour
- ZOO*4330 [0.50] Biology of Fishes
- ZOO*4910 [0.50] Integrative Vertebrate Biology
- ZOO*4920 [0.25] Lab Studies in Ornithology
- ZOO*4940 [0.25] Lab Studies in Herpetology
- ZOO*4950 [0.25] Lab Studies in Mammalogy

The remaining 1.00 credits may also come from this list or from outside this list, in consultation with a faculty advisor.