2020-2021 Undergraduate Calendar

The information published in this Undergraduate Calendar outlines the rules, regulations, curricula, programs and fees for the 2020-2021 academic year, including the Summer Semester 2020, the Fall Semester 2020 and the Winter Semester 2021.

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:

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<td>February 4, 2020</td>
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The information published in this Undergraduate Calendar outlines the rules, regulations, curricula, programs and fees for the 2020-2021 academic year, including the Summer Semester 2020, the Fall Semester 2020 and the Winter Semester 2021.

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 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/registration/index.cfm?index.

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

The University of Guelph is required to disclose personal information such as characteristics and educational outcomes to the Ministry of 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 Ministry 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 Colleges and Universities website: https://www.ontario.ca/page/ministry-colleges-universities (English) or https://www.ontario.ca/fr/page/ministere-des-colleges-et-universites (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.


Authority to Disclose Personal Information to Statistics Canada

The Ministry of 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 website 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, the student’s 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 the student's record. To this end the University shall refuse to disclose personal information to any person other than the individual to whom the information relates where disclosure would constitute an unjustified invasion of the personal privacy of that person or of any other individual. All members of the University community must respect the confidential nature of the student information which they acquire in the course of their work.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The Three Semester System

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

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

Transfer from One B.Sc. Program to Another

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

Program Information

B.Sc. Program Requirements

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

1. Entry Credits

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

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

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

2. 1st Year Science Core

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

3. 1000 Level Credits

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

4. 3000 and 4000 Level Credits

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

5. Science Credits

A minimum of 16.00 science credits (usually 32 courses) is required for the honours major program. The inclusion of a minor in a non-science area 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 courses electives for the B.Sc. degree program of which 2.50 credits must be at the 3000 or 4000 level. Note: One of: BIOL*1020, CHEM*1060 may be counted towards the degree requirements, counting as 0.50 credits in science.
4. 2.00 credits - Liberal Education electives selected from the B.Sc. list of Liberal Education electives.
5. 1.00 credits in electives.

Recommended Schedule for Students in Biological Science Areas

Semester 1

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<tr>
<th>Course</th>
<th>Credits</th>
<th>Description</th>
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<tr>
<td>BIOL*1090</td>
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<td>Introduction to Molecular and Cellular Biology *</td>
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<tr>
<td>CHEM*1040</td>
<td>[0.50]</td>
<td>General Chemistry I</td>
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<tr>
<td>MATH*1080</td>
<td>[0.50]</td>
<td>Elements of Calculus I</td>
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<tr>
<td>PHYS*1080</td>
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<td>Physics for Life Sciences</td>
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<td>[0.50]</td>
<td>Liberal Education electives</td>
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Recommended Schedule for Students in Physical Science Areas

Semester 1

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
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<tr>
<td>CHEM*1040</td>
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<td>General Chemistry I</td>
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<tr>
<td>IPS*1500</td>
<td>[1.00]</td>
<td>Integrated Mathematics and Physics I</td>
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<td>[0.50]</td>
<td>Liberal Education electives</td>
</tr>
</tbody>
</table>

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 Kinetics (HK)
- 20.00 credits - Marine and Freshwater Biology (MBF)
- 20.00 credits - Microbiology (MICR)
- 20.00 credits - Molecular Biology and Genetics (MBG)
- 20.00 credits - Neuroscience (NEUR)
- 20.00 credits - Nutritional and Nutraceutical Sciences (NANS)
- 20.00 credits - Plant Science (PLSC)
- 20.00 credits - Wildlife Biology and Conservation (WBC)
- 20.00 credits - Zoology (ZOOL)

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

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

Honours Program Minors

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

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

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

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

Additional Disciplines:
5.00 credits - Business Economics (BECN)

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

Conditions for Graduation

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

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

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

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
BIOIL*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.oguelph.ca/bsc/revised_SS

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

Semester 3
AGRI*2350 [0.50] Animal Production Systems, Health and Industry
BIOC*2380 [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
MCB*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.oguelph.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*3900 [0.50] Principles of Animal Behaviour
ANSC*4090 [0.50] Applied Animal Behaviour and Welfare
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
MICR*3230 [0.50] Immunology
PATH*3610 [0.50] Principles of Disease
POPM*3240 [0.50] Epidemiology
POPM*4230 [0.50] Animal Health

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

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

Biochemistry (BIOC)
Department of Molecular and Cellular Biology, College of Biological Science

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

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

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

Semester 2
Biol*1070 [0.50] Discovering Biodiversity
Biol*1080 [0.50] Biological Concepts of Health
Chem*1050 [0.50] General Chemistry II
Math*1090 [0.50] Elements of Calculus II
Phys*1070 [0.50] Physics for Life Sciences II
0.50 Liberal Education electives

Semester 3
Biol*2580 [0.50] Introduction to Biochemistry
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
Mirc*2420 [0.50] Introduction to Microbiology
Stat*2040 [0.50] Statistics I
0.50 Liberal Education electives

Semester 4
Biol*3560 [0.50] Structure and Function in Biochemistry
Chem*2480 [0.50] Analytical Chemistry I
Chem*2700 [0.50] Organic Chemistry I
Mcb*2050 [0.50] Molecular Biology of the Cell
Mirc*2430 [0.50] Methods in Microbial Culture and Physiology

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

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

Semester 7
Biol*4540 [0.75] Enzymology
Electives or restricted electives to a maximum of 2.75 total credits

Restricted Electives
1. Students must take as part of their program: 4.00 credits from the following list, with at least 1.00 of these credits from BIOC*4050, BIOC*4520, BIOC*4580:
   - Biol*4050 [0.50] Protein and Nucleic Acid Structure
   - Biol*4520 [0.50] Metabolic Processes
   - Biol*4580 [0.50] Membrane Biochemistry
   - Biol*3300 [0.50] Applied Bioinformatics
   - Biol*3500 [1.00] Biomedical Physiology
   - Biol*4530 [0.50] Analytical Biochemistry
   - MCB*3010 [0.50] Dynamics of Cell Function and Signaling
   - MCB*4010 [0.50] Advanced Cell Biology
   - MCB*4510 [1.00] Research Project in Molecular & Cellular Biology
   - MCB*4510 [1.00] Research Project in Molecular & Cellular Biology
   - MCB*4600 [0.50] Topics in Molecular and Cellular Biology
   - Micr*3230 [0.50] Immunology
   - Micr*3240 [0.50] Microbial Physiology and Genetics
   - Micr*3330 [0.50] World of Viruses
   - Micr*4330 [0.50] Molecular Virology
   - Micr*4530 [0.50] Immunology II
   - Pbiol*3110 [0.50] Crop Physiology
   - Pbiol*4750 [0.50] Genetic Engineering of Plants
   - Stat*2050 [0.50] Statistics II
   - Toc*4590 [0.50] Biochemical Toxicology
2. Students must take as part of their program: 0.50 credits from the following list:
   - Phys*2030 [0.50] Biophysics of Excitable Cells
   - Phys*2240 [0.50] Thermal Physics
   - Phys*2330 [0.50] Electricity and Magnetism I
   - Phys*2600 [0.50] General Astronomy
   - Phys*3080 [0.50] Energy

Credit Summary (20.00 Total Credits)
4.50 - First year science credits
7.75 - Required science courses semesters 3 - 8
4.50 - Restricted elective (#1 and #2 in restricted elective list)
1.00 - Liberal Education electives
2.25 - Free electives – any approved electives for B.Sc. students
Of the total credits required, students are required to complete 16.00 credits in science of which a minimum of 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Minor (Honours Program)

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

- Biol*5560 [0.50] Structure and Function in Biochemistry
- Biol*5570 [0.75] Analytical Biochemistry
- Biol*5450 [0.50] Enzymology
- Chem*2480 [0.50] Analytical Chemistry I
- Chem*2700 [0.50] Organic Chemistry I

One of:

- MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
- Micr*2420 [0.50] Introduction to Microbiology

Students must take as part of the minor: 1.50 credits from the following list, with at least 1.00 of these credits from BIOC*4050, BIOC*4520, BIOC*4580:

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

Biochemistry (Co-op) (BIOC:C)

Department of Molecular and Cellular Biology, College of Biological Science

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

Program Requirements

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

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

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<th>Year</th>
<th>Fall</th>
<th>Winter</th>
<th>Summer</th>
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<td>Academic Semester 1</td>
<td>Academic Semester 2</td>
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<tr>
<td>2</td>
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<td>Academic Semester 5</td>
<td>COOP*2000 Work Term II</td>
<td>COOP*3000 Work Term III</td>
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<td>Academic Semester 7</td>
<td>COOP*4000 Work Term IV</td>
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Biochemistry Academic and Co-op Work Term Schedule – Sequence B

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<th>Winter</th>
<th>Summer</th>
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<td>Academic Semester 6</td>
<td>Academic Semester 7</td>
<td>COOP*4000 Work Term IV</td>
</tr>
<tr>
<td>5</td>
<td>Academic Semester 8</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

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

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

Revision: 2020-2021 Undergraduate Calendar
Credit Summary (21.50 Total Credits)*

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

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

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

The recommended program sequence is outlined below.

Sequence A

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

Semester 2 - Winter
BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1080 [0.50] Biological Concepts of Health
CHEM*1050 [0.50] General Chemistry II
COOP*1100 [0.50] Introduction to Co-operative Education
MATH*1090 [0.50] Elements of Calculus II
PHYS*1070 [0.50] Physics for Life Sciences II

Summer Semester
No academic semester or work term

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

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

Semester 5 - Fall
BIOC*3560 [0.50] Structure and Function in Biochemistry
CHEM*3750 [0.50] Organic Chemistry II
MIR*2420 [0.50] Molecular Biology of the Cell
MIR*2430 [0.50] Methods in Microbial Culture and Physiology

Semester 6 - Fall
MBG*3350 [0.75] Laboratory Methods in Molecular Biology

Semester 7 - Winter
BIOC*4540 [0.75] Enzymology
MBG*3350 [0.75] Laboratory Methods in Molecular Biology

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*4050, BIOC*4520, BIOC*4580.
   BIOC*4050 [0.50] Protein and Nucleic Acid Structure
   BIOC*4520 [0.50] Metabolic Processes
   BIOC*4580 [0.50] Membrane Biochemistry
   BIOL*3300 [0.50] Applied Bioinformatics
   BIOM*3200 [1.00] Biomedical Physiology
   MBG*3040 [0.50] Molecular Biology of the Gene
   MCB*3010 [0.50] Dynamics of Cell Function and Signaling
   MCB*4010 [0.50] Advanced Cell 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
   MIR*3230 [0.50] Immunology
   MIR*3240 [0.50] Microbial Physiology and Genetics
   MIR*3330 [0.50] World of Viruses
   MIR*4330 [0.50] Molecular Virology
   MIR*4530 [0.50] Immunology II
   PBIO*3110 [0.50] Crop Physiology
   PBIO*4750 [0.50] Genetic Engineering of Plants
   STAT*2050 [0.50] Statistics II
   TOX*4590 [0.50] Biochemical Toxicology

2. Students must take as part of their program: 0.50 credits from the following list:
   PHYS*2030 [0.50] Biophysics of Excitable Cells
   PHYS*2240 [0.50] Thermal Physics
   PHYS*2330 [0.50] Electricity and Magnetism I
   PHYS*2600 [0.50] General Astronomy
   PHYS*3080 [0.50] Energy

Sequence B

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

Semester 2 - Winter
BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1080 [0.50] Biological Concepts of Health
CHEM*1050 [0.50] General Chemistry II
COOP*1100 [0.50] Introduction to Co-operative Education
MATH*1090 [0.50] Elements of Calculus II
PHYS*1070 [0.50] Physics for Life Sciences II

Summer Semester
No academic semester or work term

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

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

Semester 5 - Fall
BIOC*3560 [0.50] Structure and Function in Biochemistry
CHEM*3750 [0.50] Organic Chemistry II
MIR*2420 [0.50] Molecular Biology of the Cell
MIR*2430 [0.50] Methods in Microbial Culture and Physiology

Semester 6 - Fall
MBG*3350 [0.75] Laboratory Methods in Molecular Biology

Semester 7 - Winter
BIOC*4540 [0.75] Enzymology
MBG*3350 [0.75] Laboratory Methods in Molecular Biology

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*4050, BIOC*4520, BIOC*4580.
   BIOC*4050 [0.50] Protein and Nucleic Acid Structure
   BIOC*4520 [0.50] Metabolic Processes
   BIOC*4580 [0.50] Membrane Biochemistry
   BIOL*3300 [0.50] Applied Bioinformatics
   BIOM*3200 [1.00] Biomedical Physiology
   MBG*3040 [0.50] Molecular Biology of the Gene
   MCB*3010 [0.50] Dynamics of Cell Function and Signaling
   MCB*4010 [0.50] Advanced Cell 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
   MIR*3230 [0.50] Immunology
   MIR*3240 [0.50] Microbial Physiology and Genetics
   MIR*3330 [0.50] World of Viruses
   MIR*4330 [0.50] Molecular Virology
   MIR*4530 [0.50] Immunology II
   PBIO*3110 [0.50] Crop Physiology
   PBIO*4750 [0.50] Genetic Engineering of Plants
   STAT*2050 [0.50] Statistics II
   TOX*4590 [0.50] Biochemical Toxicology

2. Students must take as part of their program: 0.50 credits from the following list:
   PHYS*2030 [0.50] Biophysics of Excitable Cells
   PHYS*2240 [0.50] Thermal Physics
   PHYS*2330 [0.50] Electricity and Magnetism I
   PHYS*2600 [0.50] General Astronomy
   PHYS*3080 [0.50] Energy

2020-2021 Undergraduate Calendar
1.00 electives or restricted electives

**Summer Semester**

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

**Semester 8 - Fall**

2.50 electives or restricted electives

**Restricted Electives**

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

- BIOC*4050 [0.50] Protein and Nucleic Acid Structure
- BIOC*4520 [0.50] Metabolic Processes
- BIOC*4580 [0.50] Membrane Biochemistry
- BIOL*3300 [0.50] Applied Bioinformatics
- BIOM*3200 [1.00] Biomedical Physiology
- MBG*3040 [0.50] Molecular Biology of the Gene
- MCB*3010 [0.50] Dynamics of Cell Function and Signaling
- MCB*4010 [0.50] Advanced Cell Biology
- MCB*4500 [1.00] Research Project in Molecular & Cellular Biology
- ACME*3010 [0.25] Advanced Career Management Skills
- SPAN*3010 [0.50] Spanish

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

- PHYS*2300 [0.50] Biophysics of Excitable Cells
- PHYS*2240 [0.50] Thermal Physics
- PHYS*2330 [0.50] Electricity and Magnetism I
- PHYS*2600 [0.50] General Astronomy
- PHYS*3080 [0.50] Energy

**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**

- 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

**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

**Semester 3**

- BIOC*2580 [0.50] Introduction to Biochemistry
- MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
- MCB*2420 [0.50] Introduction to Microbiology
- ZOO*2090 [0.50] Vertebrate Structure and Function

**Biology and Medical Physics (BMPH)**

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

The Major in Biology and Medical Physics 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/education-electives

2. A minimum of 0.50 credits from:

- BOT*2100 [0.50] Life Strategies of Plants
- BIOL*2400 [0.50] Ecology
- BIOL*2400 Evolution
- BIOL*2400 Biostatistics for Integrative Biology
- ZOO*2700 [0.50] Invertebrate Morphology & Evolution

3. A minimum of 0.50 credits from:

- BOT*3710 [0.50] Plant Diversity and Evolution
- ENVS*3090 [0.50] Insect Diversity and Biology
- IBCO*3100 [0.50] Interpreting Biodiversity I

4. A minimum of 0.50 credits from the following list. Biodiversity students are strongly encouraged to take at least one field course. Students should keep in mind that some of these courses have prerequisites that are not required courses for the BIOD major and should plan their programs accordingly.

- PHYS*2300 [0.50] Biophysics of Excitable Cells
- PHYS*2240 [0.50] Thermal Physics
- PHYS*2330 [0.50] Electricity and Magnetism I
- PHYS*2600 [0.50] General Astronomy
- PHYS*3080 [0.50] Energy

**Credit Summary (20.00 Total Credits)**

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

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

**Study Abroad**

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/cip/
**Major (Honours Program)**

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

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

### Semester 1

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
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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>CIS*1300</td>
<td>Programming</td>
<td>[0.50]</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](https://www.uoguelph.ca/bsc/revised_SS)

### Semester 2

<table>
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<td>CHEM*1050</td>
<td>General Chemistry II</td>
<td>[0.50]</td>
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<tr>
<td>MATH*1160</td>
<td>Linear Algebra I</td>
<td>[0.50]</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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
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<td>MATH*2200</td>
<td>Advanced Calculus I</td>
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</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>
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</table>

0.50 Liberal Education electives

### Semester 4

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<td>Introduction to Biochemistry</td>
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<td>PHYS*2030</td>
<td>Biophysics of Excitable Cells</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHYS*2180</td>
<td>Experimental Techniques in Physics</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHYS*2310</td>
<td>Mechanics</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHYS*2340</td>
<td>Electricity and Magnetism II</td>
<td>[0.50]</td>
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</table>

1.00 electives **

### Semester 5

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<tbody>
<tr>
<td>IPS*3000</td>
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<tr>
<td>PHYS*3130</td>
<td>Mathematical Physics</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHYS*3230</td>
<td>Quantum Mechanics I</td>
<td>[0.50]</td>
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</table>

1.00 electives **

### Semester 6

<table>
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<tr>
<td>NANO*3600</td>
<td>Computational Methods in Materials Science</td>
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<td>PHYS*3510</td>
<td>Intermediate Laboratory</td>
<td>[0.50]</td>
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<tr>
<td>PHYS*4040</td>
<td>Quantum Mechanics II</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHYS*4540</td>
<td>Molecular Biophysics</td>
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</table>

0.50 electives **

### Semester 7

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<tbody>
<tr>
<td>PHYS*3170</td>
<td>Radioactivity and Radiation Interactions</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHYS*4500</td>
<td>Advanced Physics Laboratory</td>
<td>[0.50]</td>
</tr>
</tbody>
</table>

One of:

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

0.50 electives

One of:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGG*4040</td>
<td>Medical Imaging Modalities</td>
<td>[0.50]</td>
</tr>
</tbody>
</table>

0.50 electives **

### Semester 8

<table>
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<tr>
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<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>PHYS*4002</td>
<td>Research in Physics</td>
<td>[0.50]</td>
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</table>

0.50 electives **

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS*4070</td>
<td>Clinical Applications of Physics in Medicine</td>
<td>[0.50]</td>
</tr>
</tbody>
</table>

1.50 electives **

Note: PHYS*4001 and PHYS*4002 will be projects in biological or medical physics, some of which may be in areas outside the Department of Physics.

Either ENGG*4040 or PHYS*4070 must be completed.

** 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>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>BIOC*3560</td>
<td>Structure and Function in Biochemistry</td>
<td>[0.50]</td>
</tr>
<tr>
<td>BIOC*4050</td>
<td>Protein and Nucleic Acid Structure</td>
<td>[0.50]</td>
</tr>
</tbody>
</table>

### List B: Medical Physics stream

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>BIOM*2000</td>
<td>Concepts in Human Physiology</td>
<td>[0.50]</td>
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<td>BIOM*3200</td>
<td>Biomedical Physiology</td>
<td>[1.00]</td>
</tr>
<tr>
<td>MBG*2040</td>
<td>Foundations in Molecular Biology and Genetics</td>
<td>[0.50]</td>
</tr>
<tr>
<td>MIRC*3230</td>
<td>Immunology</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PATH*3610</td>
<td>Principles of Disease</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHYS*3000</td>
<td>Optics: Fundamentals and Applications</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHYS*4130</td>
<td>Subatomic Physics</td>
<td>[0.50]</td>
</tr>
<tr>
<td>ZOO*2090</td>
<td>Vertebrate Structure and Function</td>
<td>[0.50]</td>
</tr>
</tbody>
</table>

**Note:** The recommended program sequence is outlined below.

---

**Credit Summary (20.00 Total Credits)**

5.00 - First year science credits

9.50 - Required science courses semesters 3 – 8

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

1.00 - Liberal Education electives

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

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

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

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

The 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.

#### Program Requirements

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

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

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Winter</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Academic Semester 1</td>
<td>Academic Semester 2</td>
<td>Off</td>
</tr>
<tr>
<td>2</td>
<td>Academic Semester 3</td>
<td>COOP*1100</td>
<td>COOP*1000 Work Term I</td>
</tr>
<tr>
<td>3</td>
<td>Academic Semester 5</td>
<td>COOP*2000 Work Term II</td>
<td>COOP*3000 Work Term III</td>
</tr>
<tr>
<td>4</td>
<td>Academic Semester 6</td>
<td>Academic Semester 7</td>
<td>COOP*4000 Work Term IV</td>
</tr>
<tr>
<td>5</td>
<td>COOP*5000 Work Term V</td>
<td>Academic Semester 8</td>
<td>N/A</td>
</tr>
</tbody>
</table>

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

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

### Credit Summary (22.00 Total Credits)*

5.00 - First year science credits

9.50 - Required science courses semesters 3 – 8

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

1.00 - Liberal Education electives

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

2.00 - Co-op Work Terms

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

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

---

**Revision:**

2020-2021 Undergraduate Calendar
**Major (Honours Program)**

**Semester 1 - Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*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>CITS*1300</td>
<td>0.50</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](https://www.uoguelph.ca/bsc/revised_SS)

**Semester 2 - Winter**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>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>MATH*1160</td>
<td>0.50</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>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*1100</td>
<td>0.00</td>
<td>Introduction to Co-operative Education</td>
</tr>
<tr>
<td>MATH*2200</td>
<td>0.50</td>
<td>Advanced Calculus I</td>
</tr>
<tr>
<td>MATH*2270</td>
<td>0.50</td>
<td>Applied Differential Equations</td>
</tr>
<tr>
<td>PHYS*2240</td>
<td>0.50</td>
<td>Thermal Physics</td>
</tr>
<tr>
<td>PHYS*2330</td>
<td>0.50</td>
<td>Electricity and Magnetism I</td>
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</table>

0.50 Liberal Education electives

**Semester 4 - Winter**

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

<table>
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<tr>
<th>Course Code</th>
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<th>Course Title</th>
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<tbody>
<tr>
<td>COOP*1000</td>
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**Semester 5 - Fall**

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<tbody>
<tr>
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<td>Mathematical Physics</td>
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<tr>
<td>PHYS*3230</td>
<td>0.50</td>
<td>Quantum Mechanics I</td>
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</table>

1.50 electives ***

**Winter Semester**

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

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

**Summer Semester**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>COOP*3000</td>
<td>0.50</td>
<td>Co-op Work Term III</td>
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(8-month work term in conjunction with COOP*2000)

**Semester 6 - Fall**

<table>
<thead>
<tr>
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<th>Credits</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>IPS*3000</td>
<td>0.50</td>
<td>Science Communication</td>
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<tr>
<td>PHYS*3170</td>
<td>0.50</td>
<td>Radioactivity and Radiation Interactions</td>
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</table>

One of:

- ENGG*4040  | 0.50 | Medical Imaging Modalities

0.50 electives

1.00 electives ***

**Semester 7 - Winter**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>NANO*3600</td>
<td>0.50</td>
<td>Computational Methods in Materials Science</td>
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<td>PHYS*3510</td>
<td>0.50</td>
<td>Intermediate Laboratory</td>
</tr>
<tr>
<td>PHYS*4040</td>
<td>0.50</td>
<td>Quantum Mechanics II</td>
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<tr>
<td>PHYS*4540</td>
<td>0.50</td>
<td>Molecular Biophysics</td>
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0.50 electives ***

**Summer Semester**

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<tr>
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**Fall Semester**

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<tbody>
<tr>
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<td>Co-op Work Term V</td>
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**Semester 8 - Winter**

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<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>PHYS*4500</td>
<td>0.50</td>
<td>Advanced Physics Laboratory</td>
</tr>
</tbody>
</table>

One of:

- PHYS*4070 | 0.50 | Clinical Applications of Physics in Medicine

0.50 electives

1.50 electives ***

Either ENGG*4040 or PHYS*4070 must be completed.

*** 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>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>BIOC*4050</td>
<td>0.50</td>
<td>Protein and Nucleic Acid Structure</td>
</tr>
<tr>
<td>BIOC*4580</td>
<td>0.50</td>
<td>Membrane Biochemistry</td>
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</tbody>
</table>

**List B: Medical Physics stream**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOM*2000</td>
<td>0.50</td>
<td>Concepts in Human Physiology</td>
</tr>
<tr>
<td>BIOM*3200</td>
<td>1.00</td>
<td>Biomedical Physiology</td>
</tr>
<tr>
<td>MGB*2040</td>
<td>0.50</td>
<td>Foundations in Molecular Biology and Genetics</td>
</tr>
<tr>
<td>MCR*3230</td>
<td>0.50</td>
<td>Immunology</td>
</tr>
<tr>
<td>PATH*3610</td>
<td>0.50</td>
<td>Principles of Disease</td>
</tr>
<tr>
<td>PHYS*3000</td>
<td>0.50</td>
<td>Optics: Fundamentals and Applications</td>
</tr>
<tr>
<td>PHYS*4130</td>
<td>0.50</td>
<td>Subatomic Physics</td>
</tr>
<tr>
<td>ZOO*2090</td>
<td>0.50</td>
<td>Vertebrate Structure and Function</td>
</tr>
</tbody>
</table>

**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**

<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

**Semester 2**

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

One of:

- BIOL*1070 | 0.50 | Discovering Biodiversity
- BIOL*1080 | 0.50 | Biological Concepts of Health

0.50 Liberal Education electives

**Semester 3**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*2580</td>
<td>0.50</td>
<td>Introduction to Biochemistry</td>
</tr>
<tr>
<td>CHEM*2060</td>
<td>0.50</td>
<td>Structure and Bonding</td>
</tr>
<tr>
<td>CHEM*2880</td>
<td>0.50</td>
<td>Physical Chemistry</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 4**

<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*2400</td>
<td>0.75</td>
<td>Analytical Chemistry I</td>
</tr>
<tr>
<td>MCR*2420</td>
<td>0.50</td>
<td>Introduction to Microbiology</td>
</tr>
</tbody>
</table>

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

**Semester 5**

<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>
</tr>
</tbody>
</table>

One of:

- CHEM*3640 | 0.50 | Chemistry of the Elements I **

0.50 electives or restricted electives *

One of:

- CHEM*3430 | 0.50 | Analytical Chemistry II: Instrumental Analysis ***

0.50 electives or restricted electives *

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

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

*** CHEM*3430 can be taken in Semester 5 or 6 (Option A)

**Semester 6**

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*3430</td>
<td>0.50</td>
<td>Analytical Chemistry II: Instrumental Analysis</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>
</tbody>
</table>

0.50 electives or restricted electives *

**Option B (at Seneca)**

2.50 credits from:

<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>
</tbody>
</table>
**Structured and Bonding**

**Laboratory Methods in Molecular Biology **

**Synthetic Organic Chemistry **

**Chemistry of the Elements II **

**Chemistry of the Elements I**

**Pharmaceutical Organic Chemistry**

**Structural Bonding and Organic Chemistry**

**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. 1.00 credits from the following:
- **MBG*2040** [0.50] Foundations in Molecular Biology and Genetics
- **MCB*2050** [0.50] Molecular Biology of the Cell
- **MICR*2430** [0.50] Methods in Microbial Culture and Physiology
- **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*4050** [0.50] Protein and Nucleic Acid Structure **
- **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*3460** [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*3330** [0.75] Laboratory Methods in Molecular Biology **
- **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*3070** [0.50] Pharmacology and Applied Toxicology
- **XSEN*3090** [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 (21.50 Total Credits)**

4.00 - First year science credits

6.00 - Required science courses semesters 3 – 8

5.50 - Restricted electives (#1 and #2 in restricted electives list)

0.50 - Approved Science electives

1.00 - Liberal Education electives

3.00 - Free electives - any approved elective for B.Sc. students. (could be less if restricted electives do not count as science)

1.50 - Co-op Work Terms

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

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

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

**Program Requirements**

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

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

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

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

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

**Credit Summary (21.50 Total Credits)**

4.00 - First year science credits

6.00 - Required science courses semesters 3 – 8

5.50 - Restricted electives (#1 and #2 in restricted electives list)

0.50 - Approved Science electives

1.00 - Liberal Education electives

3.00 - Free electives - any approved elective for B.Sc. students. (could be less if restricted electives do not count as science)

1.50 - Co-op Work Terms

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

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

The recommended program sequence is outlined below.

**Major (Honours Program)**

### Semester 1 - Fall

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

**0.50 Liberal Education electives**

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

### Semester 2 - Winter

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

**One of**

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

**0.50 Liberal Education electives**

### Semester 3 - Fall

- **BIOC*2580** [0.50] Introduction to Biochemistry
- **CHEM*2060** [0.50] Structure and Bonding
- **CHEM*2400** [0.75] Analytical Chemistry I
- **CHEM*2880** [0.50] Physical Chemistry

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

### Winter Semester

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

### Semester 4 - Summer

- **CHEM*2070** [0.50] Structure and Spectroscopy
- **CHEM*2700** [0.50] Organic Chemistry I
- **CHEM*3430** [0.50] Analytical Chemistry II: Instrumental Analysis
- **STAT*2040** [0.50] Statistics I
CHEM 3750 [0.50] Organic Chemistry II
One of:
CHEM 3640 [0.50] Chemistry of the Elements I
**
0.50 electives or restricted electives *

** CHEM 3640 is a prerequisite for CHEM 3650

Semester 6 - Winter
Select either Option A or Option B

Option A (at Guelph)

BIOL*3560 [0.50] Structure and Function in Biochemistry
CHEM*3650 [0.50] Chemistry of the Elements II
CHEM*3760 [0.50] Organic Chemistry III

1.00 electives or restricted electives *

Option B (at Seneca)

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.

Summer Semester

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

Fall Semester

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

Semester 7 - Winter

2.50 electives or restricted electives *

Summer Semester

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

Semester 8 - Fall

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

2.00 electives or restricted electives *

* Restricted Electives

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

1. 1.00 credits from the following:
   MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
   MCB*2050 [0.50] Molecular Biology of the Cell
   MIRC*2430 [0.50] Methods in Microbial Culture and Physiology

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*4050 [0.50] Protein and Nucleic Acid Structure **
   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*3460 [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 **
   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

Revised: 2020-2021 Undergraduate Calendar
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/

A minimum of 0.50 credits in Ecological Sciences:

- **BOT*2100**  [0.50]  Introduction to Mammalian Biology
- **HK*2810**  [0.50]  Human Physiology I - Concepts and Principles

3. A minimum of 0.50 credits in Mathematical or Computational Science:

- **CIS*1000**  [0.50]  Introduction to Computer Applications
- **CIS*1200**  [0.50]  Introduction to Computing
- **MATH*1090**  [0.50]  Elements of Calculus II
- **STAT*2050**  [0.50]  Statistics II

4. A minimum of 0.50 credits in Physiology:

- **BIOM*3200**  [1.00]  Biomedical Physiology
- **BOT*2100**  [0.50]  Life Strategies of Plants
- **HK*2810**  [0.50]  Human Physiology I - Concepts and Principles
- **ZOO*3600**  [0.50]  Comparative Animal Physiology I **

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

Credit Summary (20.00 Total Credits)

4.00 - First year science core

3.50 - Required science courses (semesters 3 - 8 (# 2, 3 and 4 in restricted elective list))

5.50 - Approved Biological Science electives of which 4.00 must be at the 3000 or 4000 level (# 5 in restricted elective list)

3.00 - Approved Science electives of which 2.00 credits must be at the 3000 or 4000 level* May include 1 of BIOL*1020, CHEM*1060

2.00 - Liberal Education electives

2.00 - Electives

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

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

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

3.00 additional Biological Science credits of which 1.50 must be at the 3000 or 4000 level. The list of approved biological science electives is posted at http://www.uoguelph.ca/bsc.

Students registered in B.Sc. majors in biological science may not declare this minor.

Bio-Medical Science (BIOM)

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

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

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

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

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

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

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*1090**  [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

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*3402, HK*3502)
2. Immunology Elective - ANSC*4650 or MIRC*3230
3. Advanced Study Electives - 2.00 credits from BIOM*4030, BIOM*4050, BIOM*4070, BIOM*4090, BIOM*4110, BIOM*4130, BIOM*4180, BIOM*4300, BIOM*4500, BIOM*4510, BIOM*4522, HK*4070, HK*4230, HK*4340, HK*4360, HK*4372, HK*4442, 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
Biomedical Toxicology (BTOX)

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

Major (Honours Program)

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

Semester 1

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1090</td>
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<td>Introduction to Molecular and Cellular Biology</td>
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<tr>
<td>CHEM*1040</td>
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<td>General Chemistry I</td>
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<td>Elements of Calculus I</td>
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<td>PHYS*1080</td>
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Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at: https://www.uoguelph.ca/bsc/revised_SS

Semester 2

<table>
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<td>BIOL*1080</td>
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<td>Biological Concepts of Health</td>
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Semester 3

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<td>BIOC*2580</td>
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<td>Introduction to Biochemistry</td>
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<td>MBG*2040</td>
<td>0.50</td>
<td>Foundations in Molecular Biology and Genetics</td>
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<tr>
<td>TOX*2000</td>
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<td>Principles of Toxicology</td>
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Semester 4

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<td>CHEM*2480</td>
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<td>CHEM*2700</td>
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<td>Organic Chemistry I</td>
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Semester 5

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<td>BIOC*3560</td>
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<td>Structure and Function in Biochemistry</td>
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<tr>
<td>CHEM*3430</td>
<td>0.50</td>
<td>Analytical Chemistry II: Instrumental Analysis</td>
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<tr>
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<td>Fundamentals of Nutrition</td>
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Semester 6

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<tr>
<td>BIOM*3090</td>
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<td>Principles of Pharmacology</td>
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<tr>
<td>BIOM*3040</td>
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<td>MBG*3350</td>
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<td>Laboratory Methods in Molecular Biology *</td>
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Electives or restricted electives to a maximum of 2.75 total credits in this semester

Semester 7

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<td>NUTR*4510</td>
<td>0.50</td>
<td>Toxicology, Nutrition and Food</td>
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<tr>
<td>TOX*4000</td>
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<td>TOX*4590</td>
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<td>elective or restricted electives*</td>
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One of:

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<tr>
<td>TOX*4900</td>
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<td>elective or restricted electives*</td>
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* Restricted Electives

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

**Note:** Students are advised to pay particular attention to pre-requisite requirements when choosing individual courses, and seek advice as needed.
Note: A minimum of three Co-op work terms including a Summer, Fall, and Winter are necessary to complete the Co-op requirement. *A fourth Co-op work term is optional and if completed, the total number of credits will equal 22.00.

The recommended program sequence is outlined below.

**Major (Honours Program)**

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

0.50 Liberal Education electives

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

**Semester 2 - Winter**
- BIOL*1080 [0.50] Biological Concepts of Health
- CHEM*1050 [0.50] General Chemistry II
- COOP*1100 [0.00] Introduction to Co-operative Education
- PHYS*1070 [0.50] Physics for Life Sciences II
- STAT*2040 [0.50] Statistics I

0.50 Liberal Education electives

**Semester 3 - Fall**
- BIOC*2580 [0.50] Introduction to Biochemistry
- CHEM*2480 [0.50] Analytical Chemistry I
- MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
- TOX*2000 [0.50] Principles of Toxicology

0.50 Liberal Education electives

**Winter Semester**
- COOP*1000 [0.50] Co-op Work Term I
- COOP*2000 [0.50] Co-op Work Term II

**Semester 4 - Fall**
- BIOC*3560 [0.50] Structure and Function in Biochemistry
- MCB*2050 [0.50] Molecular Biology of the Cell
- NUTR*3210 [0.50] Fundamentals of Nutrition
- TOX*3300 [0.50] Analytical Toxicology

0.50 electives or restricted electives

**Semester 5 - Winter**
- CHEM*2700 [0.50] Organic Chemistry I
- CHEM*3430 [0.50] Analytical Chemistry II: Instrumental Analysis
- BIOM*3200 [1.00] Biomedical Physiology

0.50 electives or restricted electives

**Summer Semester**
- COOP*3000 [0.50] Co-op Work Term III
- COOP*4000 [0.50] Co-op Work Term IV

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

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

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

**Semester 7 - Fall**
- NUTR*4510 [0.50] Toxicology, Nutrition and Food
- TOX*4090 [0.50] Medical Toxicology
- TOX*4590 [0.50] Biochemical Toxicology

One of:
- TOX*4900 [1.00] Toxicology Research Project I

1.00 electives or restricted electives

**Semester 8- Winter**
- ENVS*4000 [0.50] Toxicological Risk Assessment
- TOX*4100 [0.50] Toxicological Pathology
- TOX*4200 [0.50] Topics in Toxicology

1.00 electives or restricted electives

* Restricted Electives

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

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

- ANSC*4650 [0.50] Comparative Immunology
- BIOM*3040 [0.75] Medical Embryology
- BIOM*4050 [0.50] Biomedical Aspects of Aging
- BIOM*4070 [0.50] Biomedical Histology

**Biotechnology (BIOT)**

Department of Molecular and Cellular Biology, College of Biological Science

**Minor (Honours Program)**

A minimum of 5.00 credits is required including:

- BIOC*3560 [0.50] Structure and Function in Biochemistry
- MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
- MCB*2420 [0.50] Introduction to Microbiology
- MCB*2430 [0.50] Methods in Microbial Culture and Physiology

0.50 credits from:

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<thead>
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<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
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<tr>
<td>ENGG*2660</td>
<td>Biological Engineering Systems I</td>
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<tr>
<td>ENGG*3830</td>
<td>Bio-Process Engineering</td>
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</tr>
<tr>
<td>FOOD*2410</td>
<td>Introduction to Food Processing</td>
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<tr>
<td>FOOD*2420</td>
<td>Introduction to Food Microbiology</td>
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<tr>
<td>FOOD*2620</td>
<td>Food Engineering Principles</td>
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<tr>
<td>ECON*1050</td>
<td>Introductory Microeconomics</td>
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<tr>
<td>ECON*1100</td>
<td>Introductory Macroeconomics</td>
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<tr>
<td>ECON*2100</td>
<td>Economic Growth and Environmental Quality</td>
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<td>ECON*2310</td>
<td>Intermediate Microeconomics</td>
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<tr>
<td>ECON*2410</td>
<td>Intermediate Macroeconomics</td>
<td>0.50</td>
</tr>
<tr>
<td>MCS*1000</td>
<td>Introductory Marketing</td>
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<tr>
<td>ANSC*4050</td>
<td>Biotechnology in Animal Science</td>
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<tr>
<td>BIOC*4050</td>
<td>Protein and Nucleic Acid Structure</td>
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<td>BIOC*4540</td>
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<td>BIOC*3300</td>
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<td>FOOD*3270</td>
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<td>MBG*3660</td>
<td>Genomics</td>
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<td>MBG*4240</td>
<td>Applied Molecular Genetics in Medicine and Biotechnology</td>
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<td>MCB*3230</td>
<td>Immunology</td>
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<td>PFBIO*3750</td>
<td>Plant Tissue Culture</td>
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<tr>
<td>PFBIO*4750</td>
<td>Genetic Engineering of Plants</td>
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**Business Economics (BECN)**

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

Interdisciplinary study in Business Economics is offered as a minor in the honours program. Students in this program can 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
- FIN*2000 [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:
FIN*3000 [0.50] Investments
ENGG*3240 [0.50] Engineering Economics
FARE*3310 [0.50] Operations Management
HROB*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
CIS*1300 [0.50] Programming
IPS*1500 [1.00] Integrated Mathematics and Physics I
One of:
BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1080 [0.50] Biological Concepts of Health
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology

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

Semester 2

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

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

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

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

Program Requirements

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

Chemical Physics Academic and Co-op Work Term Schedule

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<th>Summer</th>
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<td>Academic Semester 4</td>
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<td>Academic Semester 7</td>
<td>Academic Semester 8</td>
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To be eligible to continue in the Co-op program, students must meet a minimum 70% cumulative average requirement after second semester, as well as meet all work term requirements. Please refer to the Co-operative Education program policy with respect to work term performance grading, work term report grading and program completion requirements.

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

Credit Summary (22.00 Total Credits)*

5.00 - First year science credits
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.

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

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

The recommended program sequence is outlined below.

### Major (Honours Program)

#### Semester 1 - Fall

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

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

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

#### Semester 2 - Winter

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

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

#### Semester 3 - Fall

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

0.50 Liberal Education electives

#### Semester 4 - Winter

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

#### Fall Semester

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

#### Semester 5 - Winter

- **CHEM*3430** [0.50] Analytical Chemistry II: Instrumental Analysis

One of:
- **CHEM*3870** [0.50] Molecular Spectroscopy +

0.50 electives *

One of:
- **CIS*2500** [0.50] Intermediate Programming

0.50 electives *

1.00 electives*

#### Summer Semester

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

#### Semester 6 - Fall

- **CHEM*3860** [0.50] Quantum Chemistry
- **IPS*3000** [0.50] Science Communication
- **PHYS*3130** [0.50] Mathematical Physics
- **PHYS*3230** [0.50] Quantum Mechanics I

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

#### Winter Semester

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

(8-month work term in conjunction with COOP*5000)

#### Summer Semester

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

(8-month work term in conjunction with COOP*4000)

#### Semester 7** - Fall

- **CHEM*3440** [0.50] Analytical Chemistry III: Analytical Instrumentation

- **PHYS*4240** [0.50] Statistical Physics II

One of:
- **CHEM*3640** [0.50] Chemistry of the Elements I
- **CHEM*3750** [0.50] Organic Chemistry II

0.50 electives *

1.00 electives *

#### Semester 8** - Winter

- **NANO*3600** [0.50] Computational Methods in Materials Science
- **PHYS*3000** [0.50] Optics: Fundamentals and Applications
- **PHYS*4040** [0.50] Quantum Mechanics II

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

0.50 electives *

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

** A minimum of 2.00 credits in science courses at the 4000 level is required for graduation.

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

### Chemistry (CHEM)

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

#### Major (Honours Program)

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

#### Semester 1

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

0.50 Liberal Education electives

#### Semester 2

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

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

#### Semester 3

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

#### Fall Semester

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

#### Semester 4

- **CHEM*2070** [0.50] Structure and Spectroscopy
- **CHEM*2400** [0.75] Analytical Chemistry I
- **CHEM*2700** [0.50] Organic Chemistry I

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

#### Semester 5

- **CHEM*2820** [0.50] Thermodynamics and Kinetics
- **CHEM*3640** [0.50] Chemistry of the Elements I
- **CHEM*3750** [0.50] Organic Chemistry II
- **CHEM*3860** [0.50] Quantum Chemistry

0.50 electives or restricted electives *

#### Semester 6

- **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

1.00 electives or restricted electives **

#### Semester 7 and 8

- **CHEM*3440** [0.50] Analytical Chemistry III: Analytical Instrumentation

3.00 Chemistry or Biochemistry**

1.50 electives *

* selection of electives is subject to the following:

1. At least 1.00 credits of Liberal Education electives are required. The list of Liberal Education electives for B.Sc. students can be found at: [https://www.uoguelph.ca/bsc/](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, BIOL*4520, BIOL*4540, BIOL*4580, CHEM*4620, CHEM*4630, CHEM*4720, CHEM*4730, CHEM*4740, CHEM*4880, CHEM*4900, CHEM*4910, (BIOL*4050 or 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
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.

**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. BIOL*2580 can be counted towards this specialization.

**Chemistry (Co-op) (CHEM:C)**

Department of Chemistry, College of Engineering and Physical Sciences

Program Requirements

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

Chemistry Academic and Co-op Work Term Schedule

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

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

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

**Credit Summary (21.50 Total Credits)**

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

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

**Major (Honours Program)**

**Semester 1 - Fall**

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

**Semester 2 - Winter**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM*1050</td>
<td>[0.50]</td>
<td>General Chemistry II</td>
</tr>
<tr>
<td>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>
<tr>
<td>MATH*1160</td>
<td>[0.50]</td>
<td>Linear Algebra I</td>
</tr>
<tr>
<td>One of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIOL*1070</td>
<td>[0.50]</td>
<td>Discovering Biodiversity</td>
</tr>
<tr>
<td>BIOL*1080</td>
<td>[0.50]</td>
<td>Biological Concepts of Health</td>
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**Semester 3 - Fall**

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

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

**Winter Semester**

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

**Semester 4 - Summer**

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

1.00 electives *

**Semester 5 - Fall**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>CHEM*2820</td>
<td>[0.50]</td>
<td>Thermodynamics and Kinetics</td>
</tr>
<tr>
<td>CHEM*3640</td>
<td>[0.50]</td>
<td>Chemistry of the Elements I</td>
</tr>
<tr>
<td>CHEM*3750</td>
<td>[0.50]</td>
<td>Organic Chemistry II</td>
</tr>
<tr>
<td>CHEM*3860</td>
<td>[0.50]</td>
<td>Quantum Chemistry</td>
</tr>
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</table>

0.50 electives *

**Semester 6 - Winter**

<table>
<thead>
<tr>
<th>Course</th>
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<th>Description</th>
</tr>
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<tbody>
<tr>
<td>CHEM*3650</td>
<td>[0.50]</td>
<td>Chemistry of the Elements II</td>
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<tr>
<td>CHEM*3760</td>
<td>[0.50]</td>
<td>Organic Chemistry III</td>
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</table>

1.50 electives* or restricted electives**

**Summer Semester**

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

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
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<tbody>
<tr>
<td>COOP*3000</td>
<td>[0.50]</td>
<td>Co-op Work Term III</td>
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**Semester 7 - Winter**

<table>
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<tr>
<th>Course</th>
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<tbody>
<tr>
<td>COOP*4000</td>
<td>[0.50]</td>
<td>Co-op Work Term IV</td>
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**Semester 8 - Fall**

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<tr>
<th>Course</th>
<th>Credits</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>CHEM*3440</td>
<td>[0.50]</td>
<td>Analytical Chemistry III: Analytical Instrumentation</td>
</tr>
</tbody>
</table>

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/](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*4630, CHEM*4720, CHEM*4730, CHEM*4740, CHEM*4880, CHEM*4900, CHEM*4910, MCB*4050, MCB*4080, TOX*4590

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

Computing and Information Science (CIS)

School of Computer Science, College of Engineering and Physical Sciences

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

Minor (Honours Program)

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

0.50 additional credits from CIS courses at the 2000 level or above
0.50 additional credits from CIS courses at the 3000 level or above

Ecology (ECOL)

Department of Integrative Biology, College of Biological Science

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

Minor (Honours Program)

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

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

Or 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 I or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor. This major requires the completion of 20.00 credits. A minimum of 16.00 of these 20.00 must be science credits.

Semester 1

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

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

Semester 2

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

One of:
CIS*1200 [0.50] Introduction to Computing
CIS*1500 [0.50] Introduction to Programming
MATH*1090 [0.50] Elements of Calculus II
STAT*2040 [0.50] Statistics I

0.50 Liberal Education elective

Semester 3

BIOC*2580 [0.50] Introduction to Biochemistry
STAT*2040 [0.50] Statistics I (if not taken in semester 2)
TOX*2000 [0.50] Principles of Toxicology

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

Semester 4

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

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

Semester 5

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

Semester 6

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

Semester 7

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

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

Semester 8

ENVS*4000 [0.50] Toxicological Risk Assessment
ENVS*4002 [0.50] Project in Environmental Sciences

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

Restricted Electives

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

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] Environmental Data Analysis
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*3060 [0.50] Groundwater
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

**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)**
- 4.00 - 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 (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.

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.

**Program Requirements**

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

**Credit Summary (20.00 Total Credits)**
- 4.50 - First year science credits
- 8.50 - Required science courses semesters 3 – 8
- 1.00 - Required social science courses semesters 3 – 8
- 3.00 - Approved Science electives
- 1.00 - Liberal Education electives
- 2.00 - Free electives - any approved elective for B.Sc. students.

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

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

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

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

**Program Requirements**

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

<table>
<thead>
<tr>
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<th>Winter</th>
<th>Summer</th>
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</table>

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

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

Credit Summary (21.50 Total Credits)*

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

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

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

The recommended program sequence is outlined below.

**Major (Honours Program)**

**Semester 1 - Fall**

BIOL*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](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

**Semester 3 - Fall**

COOP*1100  [0.00]  Introduction to Co-operative Education
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
STAT*2040  [0.50]  Statistics I

**Semester 4 - Winter**

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

**Summer Semester**

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

**Semester 5 - Fall**

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

**Winter Semester**

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

**Semester 6 - Summer**

GEOG*3610  [0.50]  Environmental Hydrology
GEOG*4990  [0.50]  Independent Study in Geography
One of:
    GEOG*3202  [0.50]  Global Environmental Change
    GEOG*3210  [0.50]  Management of the Biophysical Environment
1.00 electives

**Fall Semester**

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

**Winter Semester**

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

**Semester 7 - Fall**

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

**Semester 8 - Winter**

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

**Food Science (FOOD)**

Department of Food Science, Ontario Agricultural College

Major (Honours Program)

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

**Semester 1 - Fall**

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 computer skills.

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

**Semester 2 - Winter**

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

**Semester 3 - Fall**

BIOL*2580  [0.50]  Introduction to Biochemistry
CHEM*2880  [0.50]  Physical Chemistry
FOOD*2150  [0.50]  Introduction to Nutritional and Food Science
MICR*2420  [0.50]  Introduction to Microbiology
0.50 electives

**Semester 4 - Winter**

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

**Semester 5 - Fall**

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

**Semester 6 - Winter**

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

**Semester 7 - Fall**

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

**Semester 8 - Winter**

FOOD*4270 [0.50] Food Product Development II
2.00 electives

**Notes:**
1. ENGL*1200 is recommended for those students needing to improve their English grammar.
2. FOOD*2150 could be replaced by FOOD*2010 with permission of department advisor.
3. Of the 6.50 electives credits:
   a. A least 2.00 credits must be Liberal Education electives.
   b. At least 2.00 must be from list of Restricted electives.
   c. At least 1.00 must be from additional Science electives (1.50 if MCS*3010 is chosen as a Restricted Elective)

**Restricted Electives:**

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

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

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

The recommended program sequence is outlined below.

**Major (Honours Program)**

**Semester 1 - Fall**

- BIO*1100 [0.50] Introduction to Molecular and Cellular Biology
- CHEM*1040 [0.50] General Chemistry I
- MATH*1090 [0.50] Elements of Calculus I
- PHYS*1080 [0.50] Physics for Life Sciences
- 0.50 Liberal Education electives

**Semester 2 - Winter**

- BIO*1100 [0.50] Introduction to Molecular and Cellular Biology
- CHEM*1040 [0.50] General Chemistry I
- MATH*1090 [0.50] Elements of Calculus I
- PHYS*1080 [0.50] Physics for Life Sciences
- 0.50 Liberal Education electives

**Semester 3 - Fall**

- BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
- CHEM*1040 [0.50] General Chemistry I
- MATH*1090 [0.50] Elements of Calculus I
- PHYS*1080 [0.50] Physics for Life Sciences
- ENGL*1200 [0.50] College Writing
- 0.50 Liberal Education electives

**Semester 4 - Winter**

- BIO*1100 [0.50] Introduction to Molecular and Cellular Biology
- CHEM*1040 [0.50] General Chemistry I
- MATH*1090 [0.50] Elements of Calculus I
- PHYS*1080 [0.50] Physics for Life Sciences
- 0.50 Liberal Education electives

**Summer Semester**

- Off

**Semester 5 - Fall**

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

**Semester 6 - Winter**

- BIO*1100 [0.50] Introduction to Molecular and Cellular Biology
- CHEM*1040 [0.50] General Chemistry I
- MATH*1090 [0.50] Elements of Calculus I
- PHYS*1080 [0.50] Physics for Life Sciences
- 0.50 Liberal Education electives

**Semester 7 - Fall**

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

**Semester 8 - Winter**

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

**Credit Summary (21.50 Total Credits)**

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

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

Students not in the Food Science Major who are seeking further study in Food Science are encouraged to consider the Certificate in Food Science. See Special Study Opportunities, Chapter XI of the Calendar.
2. FOOD*2150 could be replaced by FOOD*2010 with permission of department advisor.

**Restricted Electives**

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<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Title</th>
</tr>
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<tr>
<td>FOOD*4070</td>
<td>[0.50]</td>
<td>Food Packaging</td>
</tr>
<tr>
<td>FOOD*4090</td>
<td>[0.50]</td>
<td>Functional Foods and Nutraceuticals</td>
</tr>
<tr>
<td>FOOD*4110</td>
<td>[0.50]</td>
<td>Meat and Poultry Processing</td>
</tr>
<tr>
<td>FOOD*4220</td>
<td>[0.50]</td>
<td>Topics in Food Science</td>
</tr>
<tr>
<td>FOOD*4230</td>
<td>[0.50]</td>
<td>Research in Food Science</td>
</tr>
<tr>
<td>FOOD*4310</td>
<td>[0.50]</td>
<td>Food Safety Management Systems</td>
</tr>
<tr>
<td>FOOD*4400</td>
<td>[0.50]</td>
<td>Dairy Processing</td>
</tr>
<tr>
<td>FOOD*4520</td>
<td>[0.50]</td>
<td>Utilization of Cereal Grains for Human Food</td>
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<tr>
<td>MCS*3010</td>
<td>[0.50]</td>
<td>Quality Management</td>
</tr>
<tr>
<td>POPM*4040</td>
<td>[0.50]</td>
<td>Epidemiology of Food-borne Diseases</td>
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**Geographic Information Systems (GIS) and Environmental Analysis**

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

The minor in Applied Geomatics offers students with expertise in the science and application of geospatial tools including Geographic Information Systems (GIS) (e.g., ArcGIS, GoogleEarth), remote sensing (e.g., extracting information from satellite images), and Geographic Positioning Systems (GPS). Although students learn fundamental underlying science, the focus of the minor is on the application of these spatial technologies. The program of studies has been designed to be complementary with a wide range of Majors and disciplines on campus, including the ability to select from a wide range of restricted electives, so that students can learn how to apply geomatics to their primary area of expertise.

**Minor (Honours Program)**

A minimum of 5.00 credits is required, including the following 3.00 credits:

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

One of:

- GEOG*1200 [0.50] Society and Space
- GEOG*1220 [0.50] Human Impact on the Environment
- GEOG*1300 [0.50] Introduction to the Biophysical Environment
- GEOG*1350 [0.50] Earth: Hazards and Global Change

One of:

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

One of:

- ECON*2740 [0.50] Economic Statistics
- GEOG*2460 [0.50] Analysis in Geography
- POLS*3650 [0.50] Quantitative Methods of Data Analysis
- SOAN*3120 [0.50] Quantitative 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
- STAT*2230 [0.50] Biostatistics for Integrative Biology

- GEOG*3430 [0.50] Geomatics for Environmental Analysis
- GEOG*3440 [0.50] GIS for Decision-Making

**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, spread sheet use and data management, the student should select CIS*1200 as early in the program as possible.

**Major (Honours Program)**

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

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

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

All decisions regarding transfers will be made by the end of June. To complete the major, a minimum of 20.00 credits are required.

**Semester 1**

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

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

**Semester 3**

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

**Semester 4**

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

**Semester 5**

- HK*3600 [0.75] Applied Human Kinetics I
- HK*3810 [0.75] Human Physiology II - Integrated Systems
- NUTR*3360 [0.50] Lifestyle Genomics
- One of
  - HK*3401 [0.75] Human Anatomy: Dissection
  - HK*3501 [0.75] Human Anatomy: Prospection

**Semester 6**

- BIOC*3560 [0.50] Structure and Function in Biochemistry
- HK*3100 [0.50] Neuromuscular Physiology
- HK*4600 [0.75] Applied Human Kinetics II
- One of
  - HK*3402 [0.75] Human Anatomy: Dissection (if registered in HK*3401 in semester 5)
  - HK*3502 [0.75] Human Anatomy (if registered in HK*3501 in semester 5)

**Semester 7**

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

**Semester 8**

2.25 electives or restricted electives

**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. 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

[Credit Summary (20.00 Total Credits)](https://www.uoguelph.ca/bsc/)

2020-2021 Undergraduate Calendar

Revision.
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 postgraduate 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

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<thead>
<tr>
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<th>Title</th>
<th>Credits</th>
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<td>Discovering Biodiversity</td>
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</tr>
<tr>
<td>CHEM*1040</td>
<td>General Chemistry I</td>
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</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>
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</tr>
<tr>
<td>0.50 Liberal Education electives</td>
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Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at https://www.uoguelph.ca/bsc/revised SS

Semester 2

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<td>BIOL*1080</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>
<td>0.50</td>
</tr>
<tr>
<td>PHYS*1070</td>
<td>Physics for Life Sciences</td>
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Semester 3

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<tbody>
<tr>
<td>BIOL*2060</td>
<td>Ecology</td>
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<tr>
<td>BIOL*2400</td>
<td>Evolution</td>
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<tr>
<td>ZOO*2090</td>
<td>Vertebrate Structure and Function</td>
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Semester 4

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<td>BIOC*2580</td>
<td>Introduction to Biochemistry</td>
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</tr>
<tr>
<td>MBG*2040</td>
<td>Foundations in Molecular Biology and Genetics</td>
<td>0.50</td>
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<tr>
<td>STAT*2230</td>
<td>Biostatistics for Integrative Biology</td>
<td>0.50</td>
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<tr>
<td>ZOO*2700</td>
<td>Invertebrate Morphology &amp; Evolution</td>
<td>0.50</td>
</tr>
<tr>
<td>0.50 electives*</td>
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Semester 5

<table>
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<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>BIOL*2350</td>
<td>Introduction to Aquatic Environments</td>
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<td>ZOO*3560</td>
<td>Comparative Animal Physiology I</td>
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<td>ZOO*3610</td>
<td>Lab Studies in Animal Physiology I</td>
<td>0.25</td>
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<tr>
<td>ZOO*3700</td>
<td>Integrative Biology of Invertebrates</td>
<td>0.50</td>
</tr>
<tr>
<td>Electives to a maximum of 2.75 total credits in this semester.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Semester 6

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*3060</td>
<td>Populations, Communities &amp; Ecosystems</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*3050</td>
<td>Developmental Biology</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*3620</td>
<td>Comparative Animal Physiology II</td>
<td>0.50</td>
</tr>
<tr>
<td>ZOO*3630</td>
<td>Lab Studies in Animal Physiology II</td>
<td>0.25</td>
</tr>
<tr>
<td>Electives to a maximum of 2.75 total credits in this semester.</td>
<td></td>
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</tr>
</tbody>
</table>

Semester 7

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

Semester 8

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

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
2.00 - Co-op Work Terms

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

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 postgraduate work in the aquatic sciences, and provides a sound scientific background for students wishing to pursue careers in academia, government service, private sector (e.g., NGOs, fisheries, aquaculture, biotechnology, consulting), conservation, education and research.

Program Requirements

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

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

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Winter</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Academic Semester 1</td>
<td>Academic Semester 2</td>
<td>Off</td>
</tr>
<tr>
<td>2</td>
<td>Academic Semester 3</td>
<td>Academic Semester 4</td>
<td>COOP*1000 Work Term I</td>
</tr>
<tr>
<td>3</td>
<td>Academic Semester 5</td>
<td>COOP*2000 Work Term II</td>
<td>COOP*3000 Work Term III</td>
</tr>
<tr>
<td>4</td>
<td>Academic Semester 6</td>
<td>COOP*4000 Work Term IV</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>COOP*5000 Work Term V</td>
<td>Academic Semester 7</td>
<td>N/A</td>
</tr>
</tbody>
</table>

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

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

Credit Summary (22.00 Total Credits)*

4.00 - First year science core
10.00 - Required science courses semesters 3 - 8
2.00 - Approved science electives
1.00 - Liberal Education electives
3.00 - Free electives - any approved elective for B.Sc. Students
2.00 - Co-op Work Terms

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

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

The recommended program sequence is outlined below.

Major (Honours Program)

Semester 1 - Fall

<table>
<thead>
<tr>
<th>Course</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>0.50 Liberal Education electives</td>
<td></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/revised SS

Semester 2 - Winter

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

Revision: 2020-2021 Undergraduate Calendar
Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at: https://www.uoguelph.ca/bsc/revised_SS

Semester 2

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. 2.50 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

Note: a major in Mathematical Science cannot be combined with a minor in Mathematical Science, Mathematics, or Statistics.

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

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

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

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

RESTRICTED ELECTIVES

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

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

   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

Note: a major in Mathematical Science cannot be combined with a minor in Mathematical Science, Mathematics, or Statistics.
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*1000, CIS*2050, and CIS*3000 cannot be counted toward this minor. This minor cannot be combined with a major in Mathematical Science or with any Bachelor of Computing program, or with a minor in Mathematics or Statistics.

Mathematics (MATH)

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

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

Minor (Honours Program)

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

(MATH*1080 or MATH*1200)*

(MATH*1090 or MATH*1210)**

(CIS*1910 or MATH*2000)***

MATH*1160 [0.50] Linear Algebra I

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

*** MATH*2000 is recommended. It is required for students wishing to take MATH*3200, MATH*3130, or MATH*4310.

Note: Students majoring or minoring 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

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

0.50 Liberal Education electives

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

Semester 2

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

0.50 Liberal Education electives

Semester 3

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

0.50 Liberal Education electives

Semester 4

<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>MCB*2050</td>
<td>Molecular Biology of the Cell</td>
</tr>
<tr>
<td>MICR*2430</td>
<td>Methods in Microbial Culture and Physiology</td>
</tr>
</tbody>
</table>
The recommended program sequence is outlined below.

**Major (Honours Program)**

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

**Semester 2 - Winter**
- BIOL*2420 [0.50] Advanced Topics in Molecular Biology
- BIOL*2430 [0.50] Advanced Work in Molecular Biology
- MBG*3040 [0.50] Analytical Methods in Microbiology
- MICR*2410 [0.50] Pathogen Microbiology
- MICR*2430 [0.50] Medical Virology
- 0.50 Liberal Education electives

**Semester 3 - Fall**
- MICR*3240 [0.50] Microbial Cell Biology
- MICR*3250 [0.50] Molecular Biology of the Gene
- MBG*3040 [0.50] Advanced Topics in Microbiology
- MBG*4010 [0.50] Advanced Methods in Microbiology
- 0.50 Liberal Education electives

**Semester 4 - Winter**
- MICR*3240 [0.50] Microbial Cell Biology
- MICR*3250 [0.50] Molecular Biology of the Gene
- MBG*3040 [0.50] Advanced Topics in Microbiology
- MBG*4010 [0.50] Advanced Methods in Microbiology
- 0.50 Liberal Education electives

**Semester 5 - Fall**
- MICR*3240 [0.50] Microbial Cell Biology
- MICR*3250 [0.50] Molecular Biology of the Gene
- MBG*3040 [0.50] Advanced Topics in Microbiology
- MBG*4010 [0.50] Advanced Methods in Microbiology
- 0.50 Liberal Education electives

**Semester 6 - Winter**
- MICR*3240 [0.50] Microbial Cell Biology
- MICR*3250 [0.50] Molecular Biology of the Gene
- MBG*3040 [0.50] Advanced Topics in Microbiology
- MBG*4010 [0.50] Advanced Methods in Microbiology
- 0.50 Liberal Education electives

**Semester 7 - Fall**
- MICR*3240 [0.50] Microbial Cell Biology
- MICR*3250 [0.50] Molecular Biology of the Gene
- MBG*3040 [0.50] Advanced Topics in Microbiology
- MBG*4010 [0.50] Advanced Methods in Microbiology
- 0.50 Liberal Education electives

**Semester 8 - Winter**
- MICR*3240 [0.50] Microbial Cell Biology
- MICR*3250 [0.50] Molecular Biology of the Gene
- MBG*3040 [0.50] Advanced Topics in Microbiology
- MBG*4010 [0.50] Advanced Methods in Microbiology
- 0.50 Liberal Education electives
Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at https://www.uoguelph.ca/bsc/revised_SS

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

 Semester 3 - Fall
BIOC*2580 [0.50] Introduction to Biochemistry
COOP*1100 [0.00] Introduction to Co-operative Education
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
MICR*2420 [0.50] Introduction to Microbiology
STAT*2040 [0.50] Statistics I
0.50 Liberal Education electives

 Semester 4 - Winter
BIOC*3560 [0.50] Structure and Function in Biochemistry
MBG*2050 [0.50] Molecular Biology of the Cell
MICR*2430 [0.50] Methods in Microbial Culture and Physiology
0.50 electives
0.50 Liberal Education electives

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

 Semester 5 - Fall
MICR*3240 [0.50] Microbial Physiology and Genetics
MICR*3280 [0.50] Microbial Cell Biology
MICR*3420 [0.50] Microbial Diversity and Ecology
1.00 electives or restricted electives

 Semester 6 - Winter
MBG*3350 [0.75] Laboratory Methods in Molecular Biology
MICR*3430 [0.75] Advanced Methods in Microbiology
A minimum of 1.00 electives or restricted electives

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

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

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

 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/bse/
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
   - ENV*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
   - MBG*3040 [0.50] Molecular Biology of the Gene
   - MBG*4040 [0.50] Genetics and Molecular Biology of Development
   - MBG*4110 [0.50] Epigenetics
   - MBG*4240 [0.50] Applied Molecular Genetics in Medicine and Biotechnology
   - 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*3320 [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*4530 [0.50] Immunology II
   - PATH*3040 [0.50] Principles of Parasitology

 Molecular Biology and Genetics (MBG)

 Department of Molecular and Cellular Biology, College of Biological Science

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

 Major (Honours Program)

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

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

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

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

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

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

 Semester 5
MBG*3040 [0.50] Molecular Biology of the Gene
MBG*3350 [0.75] Laboratory Methods in Molecular Biology
0.50 Liberal Education electives

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

 Semester 6
2.50 electives or restricted electives

 Semester 7
MCB*4500 [1.00] Research Project in Molecular & Cellular Biology I
1.50 electives or restricted electives

 Semester 8
MCB*4510 [1.00] Research Project in Molecular & Cellular Biology I
1.50 electives or restricted electives

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

 Restricted Electives

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

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

 2. 2.50 electives or restricted electives

 3. Subject Area Electives - 2.50 credits (4.00 if MCB*4600 is taken instead of MCB*4500 and MCB*4510)
   - BIOC*4050 [0.50] Protein and Nucleic Acid Structure
   - BIOL*3020 [0.50] Population Genetics
   - BIOL*3300 [0.50]Applied Bioinformatics
MBG*2400 [0.50] Fundamentals of Plant and Animal Genetics
MBG*3050 [0.50] Human Genetics
MBG*3060 [0.50] Quantitative Genetics
MBG*3110 [0.50] Plant Genetics
MBG*3660 [0.50] Genomics
MBG*4030 [0.50] Animal Breeding Methods and Applications
MBG*4040 [0.50] Genetics and Molecular Biology of Development
MBG*4110 [0.50] Epigenetics
MBG*4160 [0.50] Plant Breeding
MBG*4240 [0.50] Applied Molecular Genetics in Medicine and Biotechnology
MBG*4270 [0.50] DNA Replication, Recombination and Repair
MBG*4300 [0.50] Plant Molecular Genetics
MCM*3010 [0.50] Dynamics of Cell Function and Signaling
MCM*4010 [0.50] Advanced Cell Biology
MCR*3240 [0.50] Microbial Physiology and Genetics
MCR*3280 [0.50] Microbial Cell Biology
MCR*3330 [0.50] World of Viruses
MCR*4330 [0.50] Molecular Virology
STAT*2050 [0.50] Statistics II

Credit Summary (20.00 Total Credits)
4.00 - First year science core
7.25 - Required science courses semesters 3 - 8
3.00 - Restricted electives (#2 and 3 in restricted electives list)
1.75 - Approved science electives
2.00 - Liberal Education electives (# 1 in restricted elective list)
2.00 - Free electives - any approved elective for B.Sc. Students

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

Minor (Honours Program)
A minor in Molecular Biology and Genetics requires 5.00 credits in Molecular Biology and Genetics chosen in consultation with the faculty advisor, and will include:
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
MCR*2050 [0.50] Molecular Biology of the Cell

A minimum of 4.00 credits from:
BIOC*3560 [0.50] Structure and Function in Biochemistry
BIOC*4050 [0.50] Protein and Nucleic Acid Structure
BIOL*3020 [0.50] Population Genetics
BIOL*3030 [0.50] Applied Bioinformatics
MBG*2400 [0.50] Fundamentals of Plant and Animal Genetics
MBG*3040 [0.50] Molecular Biology of the Gene
MBG*3050 [0.50] Human Genetics
MBG*3060 [0.50] Quantitative Genetics
MBG*3100 [0.50] Plant Genetics
MBG*3350 [0.75] Laboratory Methods in Molecular Biology
MBG*3660 [0.50] Genomics
MBG*4030 [0.50] Animal Breeding Methods and Applications
MBG*4040 [0.50] Genetics and Molecular Biology of Development
MBG*4110 [0.50] Epigenetics
MBG*4160 [0.50] Plant Breeding
MBG*4240 [0.50] Applied Molecular Genetics in Medicine and Biotechnology
MBG*4270 [0.50] DNA Replication, Recombination and Repair
MBG*4300 [0.50] Plant Molecular Genetics
MCM*3010 [0.50] Dynamics of Cell Function and Signaling
MCM*4010 [0.50] Advanced Cell Biology
MCR*3240 [0.50] Microbial Physiology and Genetics
MCR*3280 [0.50] Microbial Cell Biology
MCR*3330 [0.50] World of Viruses
MCR*4330 [0.50] Molecular Virology

Nanoscience (NANO)
Administered jointly by the Department of Chemistry and the Department of Physics, College of Engineering and Physical Sciences

Major (Honours Program)
The major will require the completion of 20.00 credits as indicated below.

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

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

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

Semester 3
CHEM*2060 [0.50] Structure and Bonding
MATH*2270 [0.50] Applied Differential Equations
NANO*2000 [0.50] Synthesis and Characterization of Nanomaterials I
PHYS*2330 [0.50] Electricity and Magnetism I
One of
CHEM*2820 [0.50] Thermodynamics and Kinetics
PHYS*2240 [0.50] Thermal Physics

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

Semester 5
NANO*3200 [0.50] Nanolithographic Techniques
NANO*3500 [0.50] Thin Film Science
One of
CHEM*3860 [0.50] Quantum Chemistry
PHYS*3230 [0.50] Quantum Mechanics I
1.00 electives

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

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

Semester 8
NANO*4200 [0.50] Topics in Nanomaterials
2.00 electives
* To take PHYS*3230 in semester 5, PHYS*2340 must be selected as an elective in semester 4.

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

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

Chemistry: Inorganic
Semester 4: CHEM*2480
Semester 5: CHEM*3640
Semester 6: CHEM*3650
Semester 7: CHEM*4620
Semester 8: CHEM*2700

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

Chemistry: Physical/Analytical
Semester 4: CHEM*2480
Semester 5: CHEM*3860
Semester 6: CHEM*3430 or CHEM*3870
Semester 7: CHEM*3440
Semester 8: CHEM*3430 or CHEM*3870

Engineering
Semester 2: CIS*1500
Semester 4: ENGG*2450
Semester 5: ENGG*2410, ENGG*3450
Semester 6: ENGG*4550
Semester 7: ENGG*4080
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Mathematics and Statistics
Semester 4: STAT*2040
Semester 5: STAT*3100
Semester 6: MATH*2130
Semester 7: MATH*4240
Semester 8: MATH*3160

Physics
Semester 4: PHYS*2340
Semester 5: MATH*2200, PHYS*3130
Semester 6: PHYS*3000
Semester 7: PHYS*4180, PHYS*4240
Semester 8: PHYS*4040, PHYS*4150
*Note: Courses marked with an asterisk may require additional prerequisites. Students should consult the relevant course descriptions for further information.

Credit Summary (20.00 Total Credits)
4.50 - First year science credits
8.00 - Required science courses semesters 3 - 8
0.50 or 1.00- Restricted electives (either NANO 4900 (1.00) or NANO 4910 (0.50) )
2.50 to 3.00 - Approved Science electives (depending on restricted elective chosen above)
1.00 - Liberal Education electives
3.00 - Free electives - any approved elective for B.Sc. students. (could be less if restricted electives do not count as science)

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

Nanoscience (NANO:C)
Administered jointly by the Department of Chemistry and the Department of Physics, College of Engineering and Physical Sciences

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

Nanoscience Academic and Co-op Work Term Schedule

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<th>Year</th>
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<th>Winter</th>
<th>Summer</th>
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<td>Academic Semester 3</td>
<td>Academic Semester 4</td>
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<tr>
<td></td>
<td>COOP*2000 Work Term II</td>
<td>COOP*3000 Work Term III</td>
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<tr>
<td>3</td>
<td>Academic Semester 5</td>
<td>COOP*4000 Work Term IV</td>
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<td>Academic Semester 6</td>
<td>COOP*5000 Work Term V</td>
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</tr>
<tr>
<td>5</td>
<td>Academic Semester 8</td>
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<td></td>
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</table>

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

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

Credit Summary (22.00 Total Credits)*
4.50 - First year science core
8.00 - Required science courses semesters 3 - 8
0.50 or 1.00 - Restricted electives (either NANO 4900 (1.00) or NANO 4910 (0.50))
2.50 to 3.00 - Approved Science electives (depending on restricted elective chosen above)
1.00 - Liberal Education electives
3.00 - Free electives - any approved elective for B.Sc. students. (could be less if restricted electives do not count as science)
2.00 - Co-op Work Terms

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

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

The recommended program sequence is outlined below.

Major (Honours Program)

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

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

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

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

**Semester 3 - Fall**
CHEM*2060 [0.50] Structure and Bonding
COOP*1100 [0.50] Work Term
MATH*2270 [0.50] Applied Differential Equations
NANO*2000 [0.50] Synthesis and Characterization of Nanomaterials I
PHYS*2330 [0.50] Electricity and Magnetism I

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

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

1.00 electives*

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

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

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

1.00 electives*

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

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

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

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

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

1.50 electives

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

1.50 electives

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

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

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

2.00 electives

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

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

Neuroscience (NEUR)

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

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

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

Students may enter this major in Semester 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

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<th>Credit Hours</th>
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<td>MATH*1080</td>
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<tr>
<td>PHYS*1080</td>
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</table>

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.auguepulh.ca/bc/reviced_SS](https://www.auguepulh.ca/bc/reviced_SS)

Semester 2

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<td>BIOL*1090</td>
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<td>CHEM*1050</td>
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<td>PHYS*1070</td>
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<tr>
<td>PSYC*1000</td>
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0.50 Liberal Education elective

Semester 3

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<td>MBG*2040</td>
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<td>NEUR*2000</td>
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One of:

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<td>PSYC*1010</td>
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0.50 Liberal Education elective

Semester 4

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<td>MCB*2050</td>
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<td>PHYS*2030</td>
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<td>PSYC*3410</td>
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</table>

1.00 electives or restricted electives

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

Semester 5

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<th>Course Code</th>
<th>Credit Hours</th>
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<td>NEUR*3100</td>
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<td>PSYC*3270</td>
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</table>

1.00 electives or restricted electives

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

Semester 6

<table>
<thead>
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<th>Credit Hours</th>
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<tbody>
<tr>
<td>BIOM*3090</td>
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<td>NEUR*3500</td>
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<td>NEUR*4000</td>
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<tr>
<td>NEUR*4100</td>
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</table>

1.00 electives or restricted electives

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

Semester 7

<table>
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<th>Course Code</th>
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<td>NEUR*4000</td>
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</table>

1.50 electives or restricted electives

Semester 8

2.50 electives or restricted electives

Restricted Electives

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

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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>BIOM*3210</td>
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<td>PHIL*2100</td>
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<td>PHIL*2110</td>
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<tr>
<td>PHIL*2120</td>
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<tr>
<td>PHIL*2180</td>
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<tr>
<td>PHIL*2240</td>
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</tbody>
</table>

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

2. A minimum of 0.50 credits of Developmental Biology

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>BIOM*3040</td>
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<td>MBG*3040</td>
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<td>ZOO*3050</td>
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3. A minimum of 0.50 credits of Physiology

<table>
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<th>Course Code</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>BIOM*3200</td>
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<td>HK*2810</td>
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<tr>
<td>ZOO*3600</td>
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</table>

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

<table>
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<th>Credit Hours</th>
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<tr>
<td>PSYC*2360</td>
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<td>STAT*2050</td>
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</table>

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.

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

Psychology

<table>
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Statistics

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Biology

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Health & Disease

<table>
<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
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<tr>
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<tr>
<td>BIOM*4050</td>
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</tr>
<tr>
<td>HK*3100</td>
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<tr>
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<tr>
<td>HK*4070</td>
<td>0.50</td>
</tr>
<tr>
<td>TOX*4000</td>
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</table>

Research Based

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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>BIOM*4500</td>
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<tr>
<td>BIOM*4510</td>
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</tr>
<tr>
<td>BIOM*4521</td>
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<td>BIOM*4522</td>
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</tr>
<tr>
<td>HK*4230</td>
<td>0.50</td>
</tr>
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</table>

2020-2021 Undergraduate Calendar
Topics in Molecular and Cellular Biology
Research in Neurosciences
Research in Neurosciences
Research in Neurosciences
Independent Research Project
Advanced Independent Research Project
Honours Thesis I
Honours Thesis II

Credit Summary (20.00 Total Credits)

4.00 – First year science core
7.50 – Required science courses semester 3-8
2.00 – Restricted elective (#1,2,3,4,5 in restricted electives list)
2.50 – 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.

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

Minor (Honours Program)
A minor in Neuroscience requires a minimum of 5.00 credits including:

BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
PSYC*1000 [0.50] Introduction to Psychology
PSYC*2330 [0.50] Principles of Learning

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

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

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

A minimum of 2.00 credits from:
BIOM*3000 [0.50] Functional Mammalian Neuroanatomy
BIOM*3090 [0.50] Principles of Pharmacology
BIOM*4030 [0.50] Endocrine Physiology
HK*3100 [0.50] Neurumascular Physiology
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
MBG*3050 [0.50] Human Genetics
MBG*2050 [0.50] Molecular Biology of the Cell
NEUR*3100 [0.50] Molecular Mechanisms of Neurological Disorders
NEUR*4000 [0.50] Current Issues in Neuroscience
NEUR*4100 [0.50] Neuropsychopharmacology
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

Or 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)

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, spread sheet 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

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

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

Semester 2

BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
CHEM*1050 [0.50] General Chemistry II
PHYS*1070 [0.50] Physics for Life Sciences 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
STAT*2040 [0.50] Statistics I
0.50 electives or restricted electives
0.50 Liberal Education electives

Semester 4

BIOL*3560 [0.50] Structure and Function in Biochemistry
HK*2810 [0.50] Human Physiology I - Concepts and Principles
MBG*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/

2. A minimum of 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 [1.00] Research in Human Health and Nutritional Sciences
HK*4371 [0.50] Research in Human Health and Nutritional Sciences II
HK*4372 [0.50] Research in Human Health and Nutritional Sciences II
HK*4510 [1.00] Teaching, Learning & Knowledge Transfer
HK*4511 [0.50] Teaching, Learning & Knowledge Transfer II
HK*4512 [0.50] Teaching, Learning & Knowledge Transfer II
HK*4460 [0.50] Regulation of Human Metabolism
NUTR*4360 [0.50] Current Issues in Nutrigenomics
PATH*5610 [0.50] Principles of Disease

Credit Summary (20.00 Total Credits)

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

Revision:

2020-2021 Undergraduate Calendar
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:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>BIOL*2560</td>
<td>[0.50]</td>
<td>Introduction to Biochemistry</td>
</tr>
<tr>
<td>NUTR*3210</td>
<td>[0.50]</td>
<td>Fundamentals of Nutrition</td>
</tr>
<tr>
<td>NUTR*3330</td>
<td>[0.50]</td>
<td>Micronutrients, Phytochemicals and Health</td>
</tr>
<tr>
<td>NUTR*4090</td>
<td>[0.50]</td>
<td>Functional Foods and Nutraeuticals</td>
</tr>
<tr>
<td>STAT*2040</td>
<td>[0.50]</td>
<td>Statistics I</td>
</tr>
</tbody>
</table>

At least 0.50 credits from:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSC*3080</td>
<td>[0.50]</td>
<td>Agricultural Animal Physiology (restricted to ABIO majors)</td>
</tr>
<tr>
<td>BIOM*3200</td>
<td>[1.00]</td>
<td>Biomedical Physiology</td>
</tr>
<tr>
<td>HK*2810</td>
<td>[0.50]</td>
<td>Human Physiology I - Concepts and Principles</td>
</tr>
<tr>
<td>ZOO*3600</td>
<td>[0.50]</td>
<td>Comparative Animal Physiology I</td>
</tr>
</tbody>
</table>

and 2.00 credits from:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Title</th>
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<tbody>
<tr>
<td>ANSC*3170</td>
<td>[0.50]</td>
<td>Nutrition of Fish and Crustacea</td>
</tr>
<tr>
<td>ANSC*3180</td>
<td>[0.50]</td>
<td>Wildlife Nutrition</td>
</tr>
<tr>
<td>ANSC*4260</td>
<td>[0.50]</td>
<td>Beef Cattle Nutrition</td>
</tr>
<tr>
<td>ANSC*4270</td>
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<td>Dairy Cattle Nutrition</td>
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<td>ANSC*4280</td>
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<td>Poultry Nutrition</td>
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<td>ANSC*4290</td>
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<td>Swine Nutrition</td>
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<td>ANSC*4560</td>
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<td>Pet Nutrition</td>
</tr>
<tr>
<td>EQN*4020</td>
<td>[0.50]</td>
<td>Advanced Equine Nutrition</td>
</tr>
<tr>
<td>FOOD*2010</td>
<td>[0.50]</td>
<td>Principles of Food Science</td>
</tr>
<tr>
<td>HK*3810</td>
<td>[0.75]</td>
<td>Human Physiology II - Integrated Systems</td>
</tr>
<tr>
<td>HK*4230</td>
<td>[0.50]</td>
<td>Advanced Study in Human Health and Nutritional Sciences</td>
</tr>
<tr>
<td>HK*4340</td>
<td>[0.50]</td>
<td>Genomics: Exercise and Disease</td>
</tr>
<tr>
<td>HK*4360</td>
<td>[1.00]</td>
<td>Research in Human Health and Nutritional Sciences</td>
</tr>
<tr>
<td>HK*4372</td>
<td>[0.50]</td>
<td>Research in Human Health and Nutritional Sciences II</td>
</tr>
<tr>
<td>HK*4510</td>
<td>[1.00]</td>
<td>Teaching, Learning &amp; Knowledge Transfer</td>
</tr>
<tr>
<td>HK*4512</td>
<td>[0.50]</td>
<td>Teaching, Learning &amp; Knowledge Transfer II</td>
</tr>
<tr>
<td>NUTR*2150</td>
<td>[0.50]</td>
<td>Introduction to Nutritional and Food Sciences</td>
</tr>
<tr>
<td>NUTR*3360</td>
<td>[0.50]</td>
<td>Lifestyle Genomics</td>
</tr>
<tr>
<td>NUTR*3390</td>
<td>[0.75]</td>
<td>Applied Nutritional and Nutraceutical Sciences I</td>
</tr>
<tr>
<td>NUTR*4210</td>
<td>[0.50]</td>
<td>Nutrition, Exercise and Energy Metabolism</td>
</tr>
<tr>
<td>NUTR*4320</td>
<td>[0.50]</td>
<td>Nutrition and Metabolic Control of Disease</td>
</tr>
<tr>
<td>NUTR*4330</td>
<td>[0.75]</td>
<td>Applied Nutritional and Nutraceutical Sciences II</td>
</tr>
<tr>
<td>NUTR*4360</td>
<td>[0.50]</td>
<td>Current Issues in Nutrigenomics</td>
</tr>
<tr>
<td>NUTR*4510</td>
<td>[0.50]</td>
<td>Toxicology, Nutrition and Food</td>
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<tr>
<td>PHYS*1080</td>
<td>[0.50]</td>
<td>Physics for Life Sciences</td>
</tr>
<tr>
<td>PHYS*1130</td>
<td>[0.50]</td>
<td>Physics with Applications</td>
</tr>
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</table>

Note: at least 2.00 credits must be at the 4000 level.

Semester 1

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Title</th>
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<tbody>
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One of:

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<thead>
<tr>
<th>Course Code</th>
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<th>Title</th>
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<tbody>
<tr>
<td>CHEM*1040</td>
<td>[0.50]</td>
<td>General Chemistry I</td>
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<thead>
<tr>
<th>Course Code</th>
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<th>Title</th>
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</thead>
<tbody>
<tr>
<td>PHYS*1080</td>
<td>[0.50]</td>
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</tr>
<tr>
<td>PHYS*1130</td>
<td>[0.50]</td>
<td>Physics with Applications</td>
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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 2

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</thead>
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<tr>
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<td>Introductory Electricity and Magnetism</td>
</tr>
<tr>
<td>PHYS*1080</td>
<td>[0.50]</td>
<td>Physics for Life Sciences</td>
</tr>
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One of:

<table>
<thead>
<tr>
<th>Course Code</th>
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<tr>
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<tr>
<td>MATH*1090</td>
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<td>Elements of Calculus II</td>
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</tbody>
</table>

0.50 Liberal Education electives

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

Semester 3

1.50 science electives from the approved list of acceptable B.Sc. science electives*

0.50 electives

One of:

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<th>Credits</th>
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<tbody>
<tr>
<td>CIS*1200</td>
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<tr>
<td>CIS*1300</td>
<td>[0.50]</td>
<td>Programming</td>
</tr>
<tr>
<td>CIS*1500</td>
<td>[0.50]</td>
<td>Introduction to Programming</td>
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</table>

OR

<table>
<thead>
<tr>
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<th>Credits</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>STAT*2040</td>
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<td>Statistics I</td>
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</tbody>
</table>

Semester 4

1.50 science electives from the approved list of B.Sc. science electives*

0.50 electives

One of:

<table>
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<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIS*1200</td>
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<td>Introduction to Computing</td>
</tr>
<tr>
<td>CIS*1300</td>
<td>[0.50]</td>
<td>Programming</td>
</tr>
<tr>
<td>CIS*1500</td>
<td>[0.50]</td>
<td>Introduction to Programming</td>
</tr>
</tbody>
</table>

OR

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT*2040</td>
<td>[0.50]</td>
<td>Statistics I</td>
</tr>
</tbody>
</table>

Semester 5 to 8

Total of 2.50 credits per semester including at least 2.00 science electives.

Sufficient courses at the 3000 or 4000 level must be selected in Semesters 5 through 8 to total 6.00 credits in science at the 3000 or 4000 level with at least 2.00 physical science at the 4000 level.

*approved course lists are available in the B.Sc. Academic Counselling Office or at: [https://www.uoguelph.ca/bsc/Approved_electives](https://www.uoguelph.ca/bsc/Approved_electives)

Credit Summary (20.00 Total Credits)

4.00 - First year science credits
8.00 - Subject area core semesters 3 – 8 (including STAT 2040 and CIS 1200 or CIS 1500)
4.00 - Approved Science electives
2.00 - Liberal Education electives (# 1 in restricted elective list)
2.00 - Free electives - any approved elective for B.Sc. students. (could be less if restricted electives do not count as science)

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

Honours Physical Science (With a Minor)

The requirements and schedules are the same as for Honours Physical Science. Available Minor subjects are listed at the beginning of the B.Sc. Program section under the heading Honours Program Minors.

Physics (PHYS)

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

**Major (Honours Program)**

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

### Semester 1*

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM*1040</td>
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<td>General Chemistry I</td>
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<tr>
<td>CTS*1300</td>
<td>0.50</td>
<td>Programming</td>
</tr>
<tr>
<td>IPS*1500</td>
<td>1.00</td>
<td>Integrated Mathematics and Physics I</td>
</tr>
<tr>
<td>One of:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIOL*1070</td>
<td>0.50</td>
<td>Discovering Biodiversity</td>
</tr>
<tr>
<td>BIOL*1080</td>
<td>0.50</td>
<td>Biological Concepts of Health</td>
</tr>
<tr>
<td>BIOL*1090</td>
<td>0.50</td>
<td>Introduction to Molecular and Cellular Biology</td>
</tr>
</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>
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<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
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<td>General Chemistry II</td>
</tr>
<tr>
<td>IPS*1510</td>
<td>1.00</td>
<td>Integrated Mathematics and Physics II</td>
</tr>
<tr>
<td>MATH*1160</td>
<td>0.50</td>
<td>Linear Algebra I</td>
</tr>
<tr>
<td>One of:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIOL*1070</td>
<td>0.50</td>
<td>Discovering Biodiversity</td>
</tr>
<tr>
<td>BIOL*1080</td>
<td>0.50</td>
<td>Biological Concepts of Health</td>
</tr>
<tr>
<td>BIOL*1090</td>
<td>0.50</td>
<td>Introduction to Molecular and Cellular Biology</td>
</tr>
</tbody>
</table>

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

### Semester 3

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
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<td>MATH*2200</td>
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<td>Advanced Calculus I</td>
</tr>
<tr>
<td>MATH*2270</td>
<td>0.50</td>
<td>Applied Differential Equations</td>
</tr>
<tr>
<td>PHYS*2240</td>
<td>0.50</td>
<td>Thermal Physics</td>
</tr>
<tr>
<td>PHYS*2330</td>
<td>0.50</td>
<td>Electricity and Magnetism I</td>
</tr>
<tr>
<td>0.50 Liberal Education electives</td>
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</tr>
</tbody>
</table>

### Semester 4

<table>
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<th>Credits</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
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<tr>
<td>PHYS*2310</td>
<td>0.50</td>
<td>Mechanics</td>
</tr>
<tr>
<td>PHYS*2340</td>
<td>0.50</td>
<td>Electricity and Magnetism II</td>
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<tr>
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### Semester 5

<table>
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<tr>
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<td>Science Communication</td>
</tr>
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<td>0.50</td>
<td>Mathematical Physics</td>
</tr>
<tr>
<td>PHYS*3230</td>
<td>0.50</td>
<td>Quantum Mechanics I</td>
</tr>
<tr>
<td>PHYS*3400</td>
<td>0.50</td>
<td>Advanced Mechanics</td>
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### Semester 6

<table>
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<tr>
<td>NANO*3600</td>
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<td>Computational Methods in Materials Science</td>
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<td>PHYS*3000</td>
<td>0.50</td>
<td>Optics: Fundamentals and Applications</td>
</tr>
<tr>
<td>PHYS*3510</td>
<td>0.50</td>
<td>Intermediate Laboratory</td>
</tr>
<tr>
<td>PHYS*4040</td>
<td>0.50</td>
<td>Quantum Mechanics II</td>
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<tr>
<td>MATH*3260</td>
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<td>Complex Analysis</td>
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### Semester 7+

<table>
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<tr>
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<tbody>
<tr>
<td>PHYS*4500</td>
<td>0.50</td>
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<tr>
<td>PHYS*4180</td>
<td>0.50</td>
<td>Advanced Electromagnetic Theory</td>
</tr>
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<td>PHYS*4240</td>
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<tr>
<td>PHYS*4001</td>
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<td>Research in Physics</td>
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### Semester 8+

<table>
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<tr>
<td>PHYS*4002</td>
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<tr>
<td>PHYS*4120</td>
<td>0.50</td>
<td>Atomic and Molecular Physics</td>
</tr>
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<td>PHYS*4130</td>
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<td>Subatomic Physics</td>
</tr>
<tr>
<td>PHYS*4150</td>
<td>0.50</td>
<td>Solid State Physics</td>
</tr>
</tbody>
</table>
| ** At least 1.00 credits must be from the restricted electives listed below.**

**Restricted Electives**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>PHYS*4130</td>
<td>0.50</td>
<td>Atomic and Molecular Physics</td>
</tr>
<tr>
<td>PHYS*4130</td>
<td>0.50</td>
<td>Subatomic Physics</td>
</tr>
<tr>
<td>PHYS*4150</td>
<td>0.50</td>
<td>Solid State Physics</td>
</tr>
</tbody>
</table>

**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:

<table>
<thead>
<tr>
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<th>Credits</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>PHYS*2180</td>
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<td>Experimental Techniques in Physics</td>
</tr>
<tr>
<td>PHYS*2310</td>
<td>0.50</td>
<td>Mechanics</td>
</tr>
<tr>
<td>PHYS*2330</td>
<td>0.50</td>
<td>Electricity and Magnetism I</td>
</tr>
<tr>
<td>PHYS*2340</td>
<td>0.50</td>
<td>Electricity and Magnetism II</td>
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</tbody>
</table>

A maximum of1.00 credits from the following courses may be used towards the minor:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
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<tbody>
<tr>
<td>PHYS*1010</td>
<td>0.50</td>
<td>Introductory Electricity and Magnetism</td>
</tr>
<tr>
<td>PHYS*1070</td>
<td>0.50</td>
<td>Physics for Life Sciences II</td>
</tr>
<tr>
<td>PHYS*1080</td>
<td>0.50</td>
<td>Physics for Life Sciences</td>
</tr>
<tr>
<td>PHYS*1130</td>
<td>0.50</td>
<td>Physics with Applications</td>
</tr>
<tr>
<td>IPS*1510</td>
<td>1.00</td>
<td>Integrated Mathematics and Physics II</td>
</tr>
</tbody>
</table>

A minimum of 1.00 credits are required at the 3000 or 4000 level.

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

**Physics (Co-op) (PHYS:C)**

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

**Program Requirements**

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

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

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Winter</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Academic Semester 1</td>
<td>Academic Semester 2</td>
<td>Off</td>
</tr>
<tr>
<td>2</td>
<td>Academic Semester 3</td>
<td>COOP*1100</td>
<td>Academic Semester 4</td>
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<tr>
<td>3</td>
<td>Academic Semester 5</td>
<td>COOP*2000 Work Term II</td>
<td>COOP*3000 Work Term III</td>
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<tr>
<td>4</td>
<td>Academic Semester 6</td>
<td>Academic Semester 7</td>
<td>COOP*4000 Work Term IV</td>
</tr>
<tr>
<td>5</td>
<td>COOP*5000 Work Term V</td>
<td>Academic Semester 8</td>
<td>N/A</td>
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</tbody>
</table>

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

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

**Credit Summary (22.00 Total Credits)**

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

Of the total credits required, students are required to complete 16.00 credits in science of which a minimum of 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.
Note: A minimum of four Co-op work terms including a Summer, Fall, and Winter are necessary to complete the Co-op requirement. *A fifth Co-op work term is optional and if completed, the total number of credits will equal 22.50
The recommended program sequence is outlined below.

**Major (Honours Program)**

**Semester 1 - Fall**

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

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

**Semester 2 - 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*2230 [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 [0.50] 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 [0.50] Co-op Work Term II ++ (8-month work term in conjunction with COOP*3000)

**Summer Semester**

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

**Semester 6 - Fall +**

- PHYS*4180 [0.50] Advanced Electromagnetic Theory
- One of:
  - CIS*2520 [0.50] Data Structures
  - 0.50 electives**
- One of:
  - PHYS*4240 [0.50] Statistical Physics II
  - 0.50 electives**
  - 1.00 electives **

**Semester 7 - Winter +**

- NANO*3600 [0.50] Computational Methods in Materials Science
- PHYS*3000 [0.50] Optics: Fundamentals and Applications
- PHYS*3510 [0.50] Intermediate Laboratory
- PHYS*4040 [0.50] Quantum Mechanics II
- One of:
  - MATH*3260 [0.50] Complex Analysis
  - 0.50 electives**

**Summer Semester**

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

**Fall Semester**

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

**Semester 8 - Winter +**

- PHYS*4500 [0.50] Advanced Physics Laboratory
  - One of:
    - PHYS*4130 [0.50] Subatomic Physics
    - 0.50 electives**
  - One of:
    - PHYS*4150 [0.50] Solid State Physics
    - 0.50 electives**
    - 1.00 electives**
  - + students going on to graduate school in physics should take PHYS*4130, PHYS*4150, and PHYS*4240
  - ** At least 1.00 credits must be from the restricted electives listed below.

** Restricted Electives **

- PHYS*4130 [0.50] Subatomic Physics
- PHYS*4150 [0.50] Solid State Physics
- PHYS*4240 [0.50] Statistical Physics II

**Plant Science (PLSC)**

Department of Plant Agriculture, Ontario Agricultural College
School of Environmental Sciences, Ontario Agricultural College
Department of Integrative Biology, College of Biological Science
Department of Molecular and Cellular Biology, College of Biological Science

**Major (Honours Program)**

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

**Semester 1**

- BIOL*1070 [0.50] Discovering Biodiversity
- CHEM*1040 [0.50] General Chemistry I
- ENGL*1030 [0.50] Effective Writing
- MATH*1080 [0.50] Elements of Calculus I
- PHYS*1080 [0.50] Physics for Life Sciences

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

**Semester 2**

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

**Semester 3**

- AGR*2470 [0.50] Introduction to Plant Agriculture
- BIOC*2580 [0.50] Introduction to Biochemistry
- BOT*2100 [0.50] Life Strategies of Plants
- MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
- 0.50 Liberal Education

**Semester 4**

- MCB*2050 [0.50] Molecular Biology of the Cell
- STAT*2040 [0.50] Statistics I
- One of:
  - AGR*2050 [0.50] Agroecology
  - BIOL*2060 [0.50] Ecology
- 1.00 electives or restricted electives

**Semester 5**

- BOT*3410 [0.50] Plant Anatomy
- 2.00 electives or restricted electives

**Semester 6**

- BOT*3310 [0.50] Plant Growth and Development
- 2.00 electives or restricted electives

**Option A**

**Semester 7**

- One of:
  - AGR*4450 [1.00] Research Project I
  - IBIO*4500 [1.00] Research in Integrative Biology I
  - MCB*4500 [1.00] Research Project in Molecular & Cellular Biology I
  - 1.50 electives or restricted electives
### Semester 8

**BOT*4380 [0.50]**  
Metabolism in the Whole Life of Plants  
2.00 electives or restricted electives  

**Option B**

**Semester 7**

2.50 electives or restricted electives

**Semester 8**

**AGR*4600 [1.00]**  
Agriculture and Food Issues Problem Solving  
**BOT*4380 [0.50]**  
Metabolism in the Whole Life of Plants

1.00 electives or restricted electives

#### Restricted Electives

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

2. 5.00 credits from within their area of emphasis from the lists below

Note: Restricted electives indicated with † are non-science electives. If non-science restricted electives are chosen students are reminded that they will still be responsible for meeting the minimum requirement of 16.00 credits in science and that the credit requirement may vary from what is specified below.

Note: Restricted electives indicated with ** require other restricted electives as prerequisites. Students should consult the most recent undergraduate calendar for specific requirements.

‡ Students are required to take one of (AGR*4450 or IBIO*4500 or MCB*4500) in semester 7 OR AGR*4600 in semester 8. For those choosing (AGR*4450 or IBIO*4500 or MCB*4500), one of the following may count towards restricted elective requirements in an area of emphasis.

**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)

<table>
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<tr>
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<th>Credits</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>CROP*4240</td>
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<td>Weed Science</td>
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<tr>
<td>ENV<em>S</em>2060</td>
<td>0.50</td>
<td>Soil Science</td>
</tr>
<tr>
<td>ENV<em>S</em>3210</td>
<td>0.50</td>
<td>Plant Pathology</td>
</tr>
</tbody>
</table>

### Integrated Management of Invasive Insect Pests **

‡ 3.00 credits from:

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGR*3450</td>
<td>0.50</td>
<td>Research Methods in Agricultural Science</td>
</tr>
<tr>
<td>BOT*3710</td>
<td>0.50</td>
<td>Plant Diversity and Evolution</td>
</tr>
<tr>
<td>CROP*3300</td>
<td>0.50</td>
<td>Grain Crops</td>
</tr>
<tr>
<td>CROP*3310</td>
<td>0.50</td>
<td>Protein and Oilseed Crops</td>
</tr>
<tr>
<td>CROP*3340</td>
<td>0.50</td>
<td>Managed Grasslands</td>
</tr>
<tr>
<td>CROP*4220</td>
<td>0.50</td>
<td>Cropping Systems</td>
</tr>
<tr>
<td>ENV<em>S</em>2040</td>
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<td>Pesticides and the Environment</td>
</tr>
<tr>
<td>ENV<em>S</em>3020</td>
<td>0.50</td>
<td>Water and the Environment</td>
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<tr>
<td>ENV<em>S</em>3080</td>
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<td>Soil and Water Conservation</td>
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<tr>
<td>ENV<em>S</em>3140</td>
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<td>Management of Turfgrass Diseases</td>
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<tr>
<td>ENV<em>S</em>3310</td>
<td>0.50</td>
<td>Soil Biodiversity and Ecosystem Function</td>
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<td>Soil Management</td>
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<td>Introduction to Turfgrass Science</td>
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<td>HORT*3010</td>
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<td>Annual, Perennial and Indoor Plants - Identification and Use</td>
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<td>HORT*3050</td>
<td>0.50</td>
<td>Management of Turfgrass Insect Pests and Weeds</td>
</tr>
<tr>
<td>HORT*3150</td>
<td>0.50</td>
<td>Principles and Applications of Plant Propagation</td>
</tr>
<tr>
<td>HORT*3270</td>
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<td>HORT*3280</td>
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<td>Greenhouse Production</td>
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<td>Plants, Food and Health</td>
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<td>HORT*3340</td>
<td>0.50</td>
<td>Wine-Grape Culture</td>
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<td>HORT*3510</td>
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<td>Vegetable Production</td>
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<tr>
<td>HORT*4200</td>
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<td>Plants, the Environment and Society</td>
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<td>HORT*4300</td>
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<td>Postharvest Physiology</td>
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<td>HORT*4420</td>
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<td>Advanced Turfgrass Science</td>
</tr>
<tr>
<td>LARC*2240</td>
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<td>Plants in the Landscape</td>
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<tr>
<td>MBG*2400</td>
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<td>Fundamentals of Plant and Animal Genetics</td>
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<td>MBG*3100</td>
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<td>MBG*4160</td>
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<td>Plant Breeding</td>
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<td>OAGR*2070</td>
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<td>Introduction to Organic Agriculture</td>
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<td>OAGR*4050</td>
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<td>Design of Organic Production Systems</td>
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<td>PBIO*3110</td>
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<td>Crop Physiology</td>
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<tr>
<td>PBIO*3750</td>
<td>0.50</td>
<td>Plant Tissue Culture</td>
</tr>
<tr>
<td>PBIO*4750</td>
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<td>STAT*2050</td>
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</tr>
<tr>
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<td>0.50</td>
<td>Experimental Design</td>
</tr>
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### Botany (BOT)

**BOT*3050 [0.50]**  
Plant Functional Ecology

**MBG*3100 [0.50]**  
Plant Genetics

**PBIO*4000 [0.50]**  
Molecular and Cellular Aspects of Plant-Microbe Interactions

**PBIO*4150 [0.50]**  
Molecular and Cellular Aspects of Plant Development

‡ 3.00 credits from:

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<td>0.50</td>
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<td>0.50</td>
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### Plant Biotechnology (PBTC)

**MBG*3100 [0.50]**  
Plant Genetics

**MBG*3350 [0.75]**  
Laboratory Methods in Molecular Biology

**PBIO*3750 [0.50]**  
Plant Tissue Culture

**PBIO*4750 [0.50]**  
Genetic Engineering of Plants

‡ minimum of 2.75 credits from:

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</thead>
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<tr>
<td>BOT*3710</td>
<td>0.50</td>
<td>Plant Diversity and Evolution</td>
</tr>
<tr>
<td>BIOL*3300</td>
<td>0.50</td>
<td>Applied Bioinformatics</td>
</tr>
<tr>
<td>MBG*2400</td>
<td>0.50</td>
<td>Fundamentals of Plant and Animal Genetics</td>
</tr>
<tr>
<td>MBG*3660</td>
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<td>Genomics</td>
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<td>MBG*4160</td>
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<td>PBIO*3110</td>
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<td>Crop Physiology</td>
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<tr>
<td>PBIO*4150</td>
<td>0.50</td>
<td>Molecular and Cellular Aspects of Plant Development</td>
</tr>
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</table>
**Unspecialized (UNSP)**
Choose 5.00 credits from any courses listed in the other areas of emphasis.

**Minor (Honours Program)**
A minor in Plant Science requires a minimum of 5.00 credits in the Plant Science Program chosen in consultation with the Faculty Advisor. The courses include:

- BOT*2470 [0.50] Introduction to Plant Agriculture
- BOT*2100 [0.50] Life Strategies of Plants
- BOT*3610 [0.50] Plant Diversity and Evolution
- BOT*3410 [0.50] Plant Anatomy
- BOT*3410 [0.50] Metabolism in the Whole Life of Plants
- HORT*3310 [0.50] Plants, Food and Health
- LARC*3320 [0.50] Principles of Landscape Ecology
- PBIO*4530 [0.50] Plants and Environmental Pollution
- PHIL*2070 [0.50] Philosophy of the Environment
- POLS*3370 [0.50] Environmental Politics and Governance
- STAT*2050 [0.50] Statistics II
- STAT*3210 [0.50] Experimental Design

**Statistics (STAT)**

**Theoretical Physics (THPY)**

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

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

**Major (Honours Program)**

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

**Semester 1**

- CHEM*3200 [0.50] General Chemistry I
- CIS*3200 [0.50] Programming
- IPS*3200 [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

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

**Semester 2**

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

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

Note: Students who 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 3**

- MATH*2200 [0.50] Advanced Calculus I
- MATH*2270 [0.50] Applied Differential Equations
- PHYS*2240 [0.50] Thermal Physics
- PHYS*2330 [0.50] Electricity and Magnetism I

0.50 Liberal Education electives

**Semester 4**

- MATH*2210 [0.50] Advanced Calculus II
- PHYS*2180 [0.50] Experimental Techniques in Physics
- PHYS*2310 [0.50] Mechanics
- PHYS*2340 [0.50] Electricity and Magnetism II

0.50 electives*

**Semester 5**

- IPS*3000 [0.50] Science Communication
- PHYS*3130 [0.50] Mathematical Physics
- PHYS*3230 [0.50] Quantum Mechanics I
- PHYS*3400 [0.50] Advanced Mechanics

0.50 electives*

**Semester 6**

- NANO*3600 [0.50] Computational Methods in Materials Science
- PHYS*3000 [0.50] Optics: Fundamentals and Applications
- PHYS*3510 [0.50] Intermediate Laboratory
- PHYS*4040 [0.50] Quantum Mechanics II

0.50 electives*

**Semester 7**

- PHYS*4120 [0.50] Atomic and Molecular Physics
- PHYS*4180 [0.50] Advanced Electromagnetic Theory
- PHYS*4240 [0.50] Statistical Physics II

Two of:
- PHYS*4001 [0.50] Research in Physics
- PHYS*4500 [0.50] Advanced Physics Laboratory

0.50 electives*

**Semester 8**

- MATH*3260 [0.50] Complex Analysis
- PHYS*4130 [0.50] Subatomic Physics
- PHYS*4150 [0.50] Solid State Physics

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

**Revision:**
*Restricted Electives
Students must complete 2.00 credits from the following list:

<table>
<thead>
<tr>
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<th>Credits</th>
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<tbody>
<tr>
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<tr>
<td>MATH*2000</td>
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<td>MATH*2130</td>
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<td>MATH*3100</td>
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**Survey of Natural Resource Economics**

**Evolutionary Ecology**

**Integrative Biology of Invertebrates**

**Introduction to Wildlife Rehabilitation**

**Molecular Biology of the Cell**

**Evolution**

**Wildlife Rehabilitation: Caring for Sick, Injured, and Orphaned Wildlife**

**DNA Replication, Recombination and Repair**

**Lab Studies in Animal Physiology II**

**Environmental Impact Assessment**

**Natural Resource Policy Analysis**

**Credit Summary (20.00 Total Credits)**

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

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

**Wildlife Biology and Conservation (WBC)**

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

The core of this major will provide students with an integrated foundation in three disciplines necessary to understand the origins, interactions, and protection of biological diversity: evolution, ecology, and conservation biology. After the second semester, the student has the opportunity to take a wide variety of electives, including courses that meet their specific interests within one or two of these disciplines. The program offers a sound scientific background in preparation for careers in resource management, conservation, ecological consulting, teaching, and government service. This major also qualifies students for post-graduate work in ecology, evolutionary biology, environmental sciences, or wildlife management.

**Major (Honours Program)**

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

**Semester 1**

<table>
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<tr>
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<th>Credits</th>
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**Semester 3**

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**Semester 7**

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<tr>
<td>BIOL*4150</td>
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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</th>
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</thead>
<tbody>
<tr>
<td>BIOL*4500</td>
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</tbody>
</table>

**Natural Resource Policy Analysis**

**Restricted Electives**

Note that some courses have prerequisites, so be sure to consult the undergraduate calendar.

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

2. A minimum of 0.50 credits from:
   - BOT*2100 [0.50] Life Strategies of Plants
   - ZOO*2090 [0.50] Vertebrate Structure and Function
   - ZOO*2700 [0.50] Invertebrate Morphology & Evolution

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

4. A minimum of 0.50 credits from:
   - BIOL*3020 [0.50] Population Genetics
   - BIOL*4120 [0.50] Evolutionary Ecology

5. A minimum of 3.00 credits from any of the following lists of courses. The courses are broken into disciplines for which they are most suitable to help students tailor their electives towards a specific field if desired.

**Evolution**

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**Ecology**

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**Integrative/Cross-Disciplinary**

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**2020-2021 Undergraduate Calendar**

Revision: X. Degree Programs, Bachelor of Science (B.Sc.)
ZOO*4070 [0.50] Animal Behaviour
ZOO*4910 [0.50] Integrative Vertebrate Biology *
ZOO*4920 [0.25] Lab Studies in Ornithology
ZOO*4940 [0.25] Lab Studies in Herpetology
ZOO*4950 [0.25] Lab Studies in Mammalogy

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

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

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

Zoology (ZOO)
Department of Integrative Biology, College of Biological Science

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

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

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

0.50 Liberal Education electives

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

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

0.50 Liberal Education electives

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

1.00 electives or restricted electives *

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

0.50 electives or restricted electives *

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

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

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

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

Semester 7
ZOO*4070 [0.50] Animal Behaviour
ZOO*4910 [0.50] Integrative Vertebrate Biology
1.50 electives or restricted electives

Semester 8
2.50 electives or restricted electives

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

Restricted Electives must include:
1. A minimum of 1.00 credits of Liberal Education electives is required. The list of Liberal Education electives for B.Sc. students can be found at: https://www.uoguelph.ca/bsc/
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*4910 [0.50] Field Ecology
   IBIO*4500 [1.00] Research in Integrative Biology I
   IBIO*4510 [1.00] Research in Integrative Biology II
   IBIO*4521 [1.00] Thesis in Integrative Biology
   IBIO*4522 [1.00] Thesis in Integrative Biology
   ZOO*4170 [0.50] Experimental Comparative Animal Physiology
   ZOO*4300 [0.75] Marine Biology and Oceanography

Other field or research courses with approval of faculty advisor.

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

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

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

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

BIOL*2060 [0.50] Ecology
BIOL*2400 [0.50] Evolution
BIOL*3060 [0.50] Populations, Communities & Ecosystems
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.

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