The information published in this Undergraduate Calendar outlines the rules, regulations, curricula, programs and fees for the 2016-2017 academic year, including the Summer Semester 2016, the Fall Semester 2016 and the Winter Semester 2017.

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:

• The Association of Universities and Colleges of Canada

Contact Information:

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

Revision Information:

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<tr>
<td>February 1, 2016</td>
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Disclaimer
University of Guelph 2016

The information published in this Undergraduate Calendar outlines the rules, regulations, curricula, programs and fees for the 2016-2017 academic year, including the Summer Semester 2016, the Fall Semester 2016 and the Winter Semester 2017.

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

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

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

Published by: Enrolment Services
Introduction

Collection, Use and Disclosure of Personal Information

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

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

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

Amendments made to the MTCU Act, authorizing the collection and use of personal information from colleges and universities by the Minister of Training Colleges and Universities, which were set out in Schedule 5 of the Childcare Modernization Act, 2014, came into force on March 31, 2015. The amendments strengthen the ability of the Minister to directly or indirectly collect and use personal information about students as required to conduct research and analysis, including longitudinal studies, and statistical activities conducted by or on behalf of the Ministry for purposes that relate to post-secondary education and training, including,

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

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

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

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

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

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

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

viii. developing key performance indicators.

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

Further information on the collection and use of student-level enrolment-related data can be obtained from the Ministry of Training Colleges and Universities website: [http://www.tcu.gov.on.ca](http://www.tcu.gov.on.ca) (English) or [http://www.tcu.gov.on.ca/fr/](http://www.tcu.gov.on.ca/fr/) (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.


Frequently Asked Questions related to the Ministry’s enrolment and OEN data activities are also posted at: [http://www.tcu.gov.on.ca/pepg/publications/FAQs.html](http://www.tcu.gov.on.ca/pepg/publications/FAQs.html)

Authority to Disclose Personal Information to Statistics Canada

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

Notification of Disclosure of Personal Information to Statistics Canada

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

Address for University Communication

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

**Email Address**

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

**Home Address**

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

**Name Changes**

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

Student Confidentiality and Release of Student Information Policy Excerpt

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

Learning Outcomes

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

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

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

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

1. Critical and Creative Thinking

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

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

2. Literacy

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

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

3. Global Understanding

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

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

4. Communicating

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

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

5. Professional and Ethical Behaviour

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

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

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

The Three Semester System

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

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) particularly 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 certain other 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 Physical and Engineering Science dependent upon their primary area(s) of interest. Refer to B.Sc. Program Requirements: Regulation 6 Double-Counting of Credits.

B.Sc. Program Requirements

Regulations 1, 2, 3 and 4 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

In each of the first 2 semesters B.Sc. students must take one (1) of the specified courses in each of biology, chemistry, physics and mathematical science, and 1 other course which is normally an Arts or Social Science elective.

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 (usually 28 courses) with the approval of the program counsellors. Acceptable science courses in the following programs means “acceptable to the B.Sc. Program Committee”. Lists of acceptable courses are available in the offices of the faculty advisors and the program counsellors and on the world wide web at the following address: http://www.bsc.uoguelph.ca/Approved_electives.shtml.

6. 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, from their minor, at the 3000/4000 level towards the 6.00 credits at the 3000/4000 level required for the degree.

7. Continuation of Study

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

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 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.
Recommended Schedule for Students in Biological Science Areas

Semester 1

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

5.00 credits - arts and/or social science electives approved for the B.Sc. degree program.

5.00 credits in electives.

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

**Semester 1**

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

0.50 Arts or Social Science electives

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

**Semester 2**

**BIOL*1070 [0.50]** Discovering Biodiversity *
**CHEM*1050 [0.50]** General Chemistry II
**PHYS*1070 [0.50]** Physics for Life Sciences II

One of:

- **CIS*1000 [0.50]** Introduction to Computer Applications
- **CIS*1200 [0.50]** Introduction to Computing
- **CIS*1500 [0.50]** Introduction to Programming
- **STAT*2040 [0.50]** Statistics I
- **MATH*2080 [0.50]** Elements of Calculus II

0.50 Arts or Social Science electives

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

**Semester 3 to 6**

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

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

**Semester 1**

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

One of:

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

0.50 Arts or Social Science electives

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

**Semester 2**

**CHEM*1050 [0.50]** General Chemistry II
**IPS*1510 [1.00]** Integrated Mathematics and Physics II

One of:

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

0.50 Arts or Social Science electives

**Semester 3 to 6**

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

Honours Program Minors

Minors are available in the following science areas with the particular credit requirements being different (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 - Plant Science (PLSC)
- 5.00 credits - Zoology (ZOO)

**Physical Sciences:**
- 5.00 credits - Chemistry (CHEM)
- 5.00 credits - Physics (PHYS)

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

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

**Additional Disciplines:**
- 5.00 credits - Business Economics (BECN)
- 5.00 credits - Psychology: Brain & Cognition (PBC)

**Continuation of Study**

Students are advised to consult the regulations for continuation of study within the program which are outlined in detail in Section VII-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 2. Application forms can be obtained from the appropriate faculty co-op advisor. In-course students will need to complete successfully an interview in the appropriate department.

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 must consult the Faculty Advisor.

Semester 1

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<tbody>
<tr>
<td>BIOL*1050</td>
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<td>Biology of Plants &amp; Animals in Managed Ecosystems</td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>0.50</td>
<td>General Chemistry I</td>
</tr>
<tr>
<td>MATH*1080</td>
<td>0.50</td>
<td>Elements of Calculus I</td>
</tr>
<tr>
<td>PHYS*1080</td>
<td>0.50</td>
<td>Physics for Life Sciences</td>
</tr>
</tbody>
</table>

0.50 Arts or Social Science electives

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

Semester 2

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<tr>
<td>ANSC*1210</td>
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<td>Principles of Animal Care and Welfare</td>
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<tr>
<td>BIOL*1090</td>
<td>0.50</td>
<td>Introduction to Molecular and Cellular Biology</td>
</tr>
<tr>
<td>CHEM*1050</td>
<td>0.50</td>
<td>General Chemistry II</td>
</tr>
<tr>
<td>PHYS*1070</td>
<td>0.50</td>
<td>Physics for Life Sciences II</td>
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Semester 3

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<th>Credit</th>
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<tr>
<td>AGRO*2350</td>
<td>0.50</td>
<td>Animal Production Systems, Health and Industry</td>
</tr>
<tr>
<td>BIOC*2580</td>
<td>0.50</td>
<td>Introduction to Biochemistry</td>
</tr>
<tr>
<td>MBG*2040</td>
<td>0.50</td>
<td>Foundations in Molecular Biology and Genetics</td>
</tr>
<tr>
<td>MBG*2400</td>
<td>0.50</td>
<td>Fundamentals of Plant and Animal Genetics</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Code</th>
<th>Credit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSC*2340</td>
<td>0.50</td>
<td>Structure of Farm Animals</td>
</tr>
<tr>
<td>MCB*2050</td>
<td>0.50</td>
<td>Molecular Biology of the Cell</td>
</tr>
<tr>
<td>NUTR*3210</td>
<td>0.50</td>
<td>Fundamentals of Nutrition</td>
</tr>
<tr>
<td>STAT*2040</td>
<td>0.50</td>
<td>Statistics I</td>
</tr>
</tbody>
</table>

0.50 electives or restricted electives

Semester 5

<table>
<thead>
<tr>
<th>Code</th>
<th>Credit</th>
<th>Description</th>
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<tbody>
<tr>
<td>ANSC*3080</td>
<td>0.50</td>
<td>Agricultural Animal Physiology</td>
</tr>
<tr>
<td>ANSC*3120</td>
<td>0.50</td>
<td>Introduction to Animal Nutrition</td>
</tr>
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</table>

1.50 electives or restricted electives

Semester 6

<table>
<thead>
<tr>
<th>Code</th>
<th>Credit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSC*3040</td>
<td>0.50</td>
<td>Animal Reproduction</td>
</tr>
<tr>
<td>ANSC*3270</td>
<td>0.50</td>
<td>Animal Disorders</td>
</tr>
<tr>
<td>MBG*3060</td>
<td>0.50</td>
<td>Quantitative Genetics</td>
</tr>
</tbody>
</table>

1.00 electives or restricted electives

Semester 7

<table>
<thead>
<tr>
<th>Code</th>
<th>Credit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.50 electives or restricted electives</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Semester 8

<table>
<thead>
<tr>
<th>Code</th>
<th>Credit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.50 electives or restricted electives</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Restricted Electives

1. Students must complete 2.00 credits from Arts or Social Science courses. ANSC*1210 is an Arts and Social Science 1.00 credit. 1.00 additional credits from Arts or Social Science are required.

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

<table>
<thead>
<tr>
<th>Code</th>
<th>Credit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSC*4050</td>
<td>0.50</td>
<td>Biotechnology in Animal Science</td>
</tr>
<tr>
<td>MBG*4020</td>
<td>0.50</td>
<td>Genetics of Companion Animals</td>
</tr>
<tr>
<td>MBG*4030</td>
<td>0.50</td>
<td>Animal Breeding Methods and Applications</td>
</tr>
</tbody>
</table>

Animal Nutrition [0.50] Required

<table>
<thead>
<tr>
<th>Code</th>
<th>Credit</th>
<th>Description</th>
</tr>
</thead>
<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>
<td>0.50</td>
<td>Dairy Cattle Nutrition</td>
</tr>
<tr>
<td>ANSC*4280</td>
<td>0.50</td>
<td>Poultry Nutrition</td>
</tr>
</tbody>
</table>

Credit Summary (20.00 Total Credits)

3.50 - First year science credits

6.50 - Required science courses semesters 3 - 8

4.50 - Restricted electives (#2 and #3)

1.50 - Approved Science electives

1.00 - Required Arts and/or Social Science course (ANSC 1210)

1.00 - Approved Arts and/or Social Science electives

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

3. 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 postgraduate 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 must consult the Faculty Advisor. The major will require the completion of at least 20.00 credits as indicated below:

Major (Honours Program)

Semester 1

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

0.50 Arts or Social Science electives

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

Semester 2

<table>
<thead>
<tr>
<th>Code</th>
<th>Credit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1070</td>
<td>0.50</td>
<td>Discovering Biodiversity</td>
</tr>
<tr>
<td>BIOL*1080</td>
<td>0.50</td>
<td>Biological Concepts of Health</td>
</tr>
<tr>
<td>CHEM*1050</td>
<td>0.50</td>
<td>General Chemistry II</td>
</tr>
<tr>
<td>MATH*2080</td>
<td>0.50</td>
<td>Elements of Calculus II</td>
</tr>
<tr>
<td>PHYS*1070</td>
<td>0.50</td>
<td>Physics for Life Sciences II</td>
</tr>
</tbody>
</table>

Semester 3

<table>
<thead>
<tr>
<th>Code</th>
<th>Credit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*2580</td>
<td>0.50</td>
<td>Introduction to Biochemistry</td>
</tr>
<tr>
<td>MBG*2040</td>
<td>0.50</td>
<td>Foundations in Molecular Biology and Genetics</td>
</tr>
<tr>
<td>MICR*2420</td>
<td>0.50</td>
<td>Introduction to Microbiology</td>
</tr>
<tr>
<td>STAT*2040</td>
<td>0.50</td>
<td>Statistics I</td>
</tr>
</tbody>
</table>

0.50 Arts or Social Science electives

Semester 4

<table>
<thead>
<tr>
<th>Code</th>
<th>Credit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*3560</td>
<td>0.50</td>
<td>Structure and Function in Biochemistry</td>
</tr>
<tr>
<td>CHEM*2480</td>
<td>0.50</td>
<td>Analytical Chemistry I</td>
</tr>
<tr>
<td>CHEM*2700</td>
<td>0.50</td>
<td>Organic Chemistry I</td>
</tr>
<tr>
<td>MBG*2050</td>
<td>0.50</td>
<td>Molecular Biology of the Cell</td>
</tr>
<tr>
<td>MICR*2430</td>
<td>0.50</td>
<td>Methods in Microbial Culture and Physiology</td>
</tr>
</tbody>
</table>

X. Degree Programs, Bachelor of Science (B.Sc.)
Students must take as part of their program: 0.50 credits from the following list:

- Molecular Genetics *
- Discovering Biodiversity
- Applied Bioinformatics
- Introduction to Co-operative Education
- Topics in Molecular and Cellular Biology
- Methods in Microbial Culture and Physiology
- General Chemistry I
- Membrane Biochemistry
- Protein and Nucleic Acid Structure
- Electricity and Magnetism I
- Laboratory Methods in Molecular Biology I
- Biochemical Toxicology
- Immunology
- Research Project in Molecular & Cellular Biology
- Laboratory Methods in Molecular Biology I

Students must take as part of their program: 4.00 credits from the following list, with

- Statistics I
- Elements of Calculus II
- Introduction to Microbiology
- Biological Concepts of Health
- Advanced Cell Biology
- General Astronomy
- Energy
- Introduction to Microbiology
- Research Project in Molecular & Cellular Biology
- Foundations in Molecular Biology and Genetics
- Biochemical Toxicology
- Molecular Biology of the Cell
- Thermal Physics
- Physics for Life Sciences
- Analytical Chemistry I
- World of Viruses
- Metabolic Processes
- Organic Chemistry II
- Co-op Work Term I
- Statistics II
- Introduction to Molecular and Cellular Biology
- Physical Chemistry
- Foundations in Molecular Biology and Genetics
- Metabolic Processes
- Membrane Biochemistry
- Immunology II
- Organic Chemistry II
- Enzymology
- World of Viruses
- Biophysics of Excitable Cells
- Crop Physiology
- General Chemistry II

In addition, at least 1.50 credits must be chosen from the following courses, with at least

- CHEM*2700
- BIOC*4540
- BIOC*3560

are required:

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

- BIOC*3570 [0.50] 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 5

- BIOC*3570 [0.75] Analytical Biochemistry
- CHEM*2880 [0.50] Physical Chemistry
- CHEM*3750 [0.50] Organic Chemistry II

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

- Metabolic Processes
- Membrane Biochemistry
- Laboratory Methods in Molecular Biology I
- Protein and Nucleic Acid Structure
- Immunology

In addition, at least 1.50 credits must be chosen from the following courses, with at least

- BIOC*4520 [0.50]
- BIOC*4580 [0.50]
- MBG*3350 [0.75]
- MCB*4050 [0.50]
- MCB*3230 [0.50]

Restricted Electives

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

- Metabolic Processes
- Membrane Biochemistry
- Applied Bioinformatics
- Biomedical Physiology
- Bacterial Genetics *
- Molecular Genetics *
- Dynamics of Cell Function and Signaling
- Advanced Cell Biology
- Protein and Nucleic Acid Structure
- Research Project in Molecular & Cellular Biology I
- Research Project in Molecular & Cellular Biology II
- Topics in Molecular and Cellular Biology
- Immunology
- World of Viruses
- Molecular Virology
- Immunology II
- Crop Physiology
- Genetic Engineering of Plants
- Statistics II
- Biochemical Toxicology

*Only one of MBG*3080 and MBG*4080 can be used to meet the restricted elective requirements.

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

- Biophysics of Excitable Cells
- Thermal Physics
- Electricity and Magnetism I
- General Astronomy
- 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 - Approved Arts and/or Social Science 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.

Minors (Honours Program)

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

- BIOC*3570 [0.50] Analytical Biochemistry
- BIOC*4540 [0.75] Enzymology
- CHEM*2480 [0.50] Analytical Chemistry I
- CHEM*2700 [0.50] Organic Chemistry I

One of:

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

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

- Metabolic Processes
- Membrane Biochemistry
- Laboratory Methods in Molecular Biology I
- Protein and Nucleic Acid Structure
- Immunology

Students must take as part of their program: 0.50 credits from the following list, with at least

- World of Viruses
- 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.

Two Streams are available. Stream A is different from Stream B in that Stream A has a double work term following academic semester 5. The course content of semesters 1-4 is the same as that listed above for the regular Honours Program Major. Students in the Co-op program must also take COOP*1100 in the second academic semester. The total program requirements, including the selection of electives are also the same.

Students will be expected to undertake their work terms after semester 3 and completion of course CHEM*2480. Since certain courses must be taken in a different semester from usual, consult your Faculty Co-op Advisor for assistance with course selection.

To graduate from the Co-op program a minimum of 4 successfully completed work terms is normally required.

This major requires the completion of 20.00 credits as indicated below.

Stream A

Semester 1 - Fall

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

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

Semester 2 - Winter

- BIOL*1070 [0.50] Discovering Biodiversity
- BIOL*1080 [0.50] Biological Concepts of Health
- CHEM*1050 [0.50] General Chemistry II
- COOP*1100 [0.00] Introduction to Co-operative Education
- MATH*2080 [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
- 0.50 Arts or Social Science electives

Winter Semester

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

Semester 4 - Summer

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

Students must take as part of their program: 0.50 credits from the following list, with at least

- Structure and Function in Biochemistry
- Organic Chemistry II
- Molecular Biology of the Cell
- Methods in Microbial Culture and Physiology

0.50 electives or restricted electives

Semester 5 - Fall

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

0.50 electives or restricted electives

Winter Semester

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

Summer Semester

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

Semester 6 - Fall

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

Students must take as part of their program: 0.50 credits from the following list, with at least

- World of Viruses
- Enzymology

0.50 electives or restricted electives

Summer Semester

- COOP*4000 [0.00] Co-op Work Term IV
Students must take as part of their program: 4.00 credits from the following list, with at least 1.00 of these credits from BIOC*4520, BIOC*4580, MCB*4050.

- BIOC*4520 [0.50] Metabolic Processes
- BIOC*4580 [0.50] Membrane Biochemistry
- BIOL*3300 [0.50] Applied Bioinformatics
- BIOM*3200 [1.00] Biomedical Physiology
- MBG*3080 [0.50] Bacterial Genetics *
- MBG*4080 [0.50] Molecular Genetics *
- MCB*3010 [0.50] Dynamics of Cell Function and Signaling
- MCB*4010 [0.50] Advanced Cell Biology
- MCB*4050 [0.50] Protein and Nucleic Acid Structure
- MCB*4500 [1.00] Research Project in Molecular & Cellular Biology I
- MCB*4510 [1.00] Research Project in Molecular & Cellular Biology II
- MCB*4600 [0.50] Topics in Molecular and Cellular Biology
- MIRC*3230 [0.50] Immunology
- MIRC*3330 [0.50] World of Viruses
- MIRC*4330 [0.50] Molecular Virology
- MIRC*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

*Only one of MBG*3080 and MBG*4080 can be used to meet the restricted elective requirements.

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

Stream B

Semester 1 - Fall

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

0.50 Arts or Social Science electives

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

Semester 2 - Winter

- BIOL*1070 [0.50] Discovering Biodiversity
- BIOL*1080 [0.50] Biological Concepts of Health
- CHEM*1050 [0.50] General Chemistry II
- COOP*1100 [0.00] Introduction to Co-operative Education
- MATH*2080 [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

0.50 Arts or Social Science electives

Winter Semester

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

Semester 4 - Summer

- BIOC*3570 [0.75] Analytical Biochemistry
- CHEM*2700 [0.50] Organic Chemistry I
- MIRC*2420 [0.50] Introduction to Microbiology
- STAT*2040 [0.50] Statistics I

2.00 electives or restricted electives to a maximum of 2.75 total credits

Fall Semester

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

Semester 5 - Winter

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

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 - Approved Arts and/or Social Science electives
- 2.25 - Free electives – any approved electives for B.Sc. students

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

Biodiversity (BOD)

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.

Major (Honours Program)

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major must consult the Faculty Advisor. A minimum total of 20.00 credits are 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.
X. Degree Programs, Bachelor of Science (B.Sc.)

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 Arts or Social Science electives

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

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 electives or restricted electives*

Semester 3
- BIOL*2580 [0.50] Introduction to Biochemistry
- MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
- ZOO*2090 [0.50] Vertebrate Structure and Function

1.00 electives or restricted electives*

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

0.50 electives or restricted electives*

Semester 5
- MICR*2420 [0.50] Introduction to Microbiology

2.00 electives or restricted electives*

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

1.00 electives or restricted electives*

Semester 7
- IBIO*4100 [1.00] Interpreting Biodiversity II

1.50 electives or restricted electives*

Semester 8
- 2.50 electives or restricted electives*

* Restricted Electives

*The major in Biodiversity is a flexible program that allows students, in consultation with faculty advisors, to 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 Arts and/or Social Science electives are required. The list of approved Arts and Social Science electives for B.Sc. students is available at: http://www.bsc.uoguelph.ca/Approved_electives.shtml#arts.

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

3. A minimum of 0.50 credits from:
   - BOT*3310 [0.50] Plant Growth and Development
   - BOT*3410 [0.50] Plant Anatomy
   - ZOO*3050 [0.50] Developmental Biology

4. A minimum of 0.50 credits from the following list. Biodiversity students are strongly encouraged to take at least one field course. Students should keep in mind that some of these courses have prerequisites that are not required courses for the BIOD major and should plan their programs accordingly.
   - BIOL*4410 [0.75] Field Ecology
   - BIOL*4610 [0.75] Arctic Ecology
   - BIOL*4700 [0.50] Field Biology
   - BIOL*4710 [0.25] Field Biology
   - BIOL*4800 [0.50] Field Biology
   - BIOL*4810 [0.25] Field Biology
   - IBIO*4500 [0.75] Research in Integrative Biology I
   - IBIO*4510 [0.75] Research in Integrative Biology II
   - IBIO*4521/2 [2.00] Thesis in Integrative Biology
   - ZOO*4170 [0.50] Experimental Comparative Animal Physiology
   - ZOO*4300 [0.75] Marine Biology and Oceanography

Other field or research courses with approval of faculty advisor.

Credit Summary (20.00 Total Credits)

4.00 - First year science 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 - Arts and/or Social Science 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 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 Medical Physics (BMPH)

Department of Physics, College of Physical and Engineering Science

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.

Since some of the required courses are not offered every semester, students entering the Major in Biological and Medical Physics should plan their program in consultation with the Department of Physics Faculty Advisor.

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

Semester 1
- BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
- CHEM*1040 [0.50] General Chemistry I
- MATH*1160 [0.50] Linear Algebra I

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: http://www.bsc.uoguelph.ca/reviseeds

Semester 2
- BIOL*2080 [0.50] Biological Concepts of Health
- CHEM*1050 [0.50] General Chemistry II
- CIS*1500 [0.50] Introduction to Programming

1.00 credits from: IPS*1510, or (MATH*2080, PHYS*1070) or (MATH*1210, PHYS*1010)

* IPS*1510 is recommended

Semester 3
- MATH*2200 [0.50] Advanced Calculus I
- MATH*2270 [0.50] Applied Differential Equations
- PHYS*2240 [0.50] Thermal Physics
- PHYS*2330 [0.50] Electricity and Magnetism I

0.50 Arts or Social Science electives

Semester 4
- BIOL*2580 [0.50] Introduction to Biochemistry
- PHYS*2300 [0.50] Biophysics of Excitable Cells
- PHYS*2180 [0.50] Experimental Techniques in Physics
- PHYS*2310 [0.50] Mechanics
- PHYS*2340 [0.50] Electricity and Magnetism II

Semester 5
- NANO*3600 [0.50] Computational Methods in Materials Science
- PHYS*3130 [0.50] Mathematical Physics
- PHYS*3230 [0.50] Quantum Mechanics I

1.00 electives **

Semester 6
- PHYS*3510 [0.50] Intermediate Laboratory
- PHYS*4040 [0.50] Quantum Mechanics II
- PHYS*4300 [0.50] Inquiry in Physics
- PHYS*4540 [0.50] Molecular Biophysics

0.50 electives **

Semester 7
- PHYS*3170 [0.50] Radioactivity and Radiation Interactions
- PHYS*4500 [0.50] Advanced Physics Laboratory

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

0.50 electives

1.00 electives **

Last Revision: January 31, 2017

2016-2017 Undergraduate Calendar
Semester 8

**PHYS*4070** [0.50] Clinical Applications of Physics in Medicine
One of:
**PHYS*4002** [0.50] Research in Physics
0.50 electives **
1.50 electives **
Note: PHYS*4002/1 will be projects in biological or medical physics, some of which may be in areas outside the Department of Physics.

**A minimum of 1.00 credits in Arts/Social Science is 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

- **BIOM*3560** [0.50] Structure and Function in Biochemistry
- **BIOM*4580** [0.50] Membrane Biochemistry
- **MBG*2040** [0.50] Foundations in Molecular Biology and Genetics
- **MCB*2050** [0.50] Molecular Biology of the Cell
- **MCB*4050** [0.50] Protein and Nucleic Acid Structure
- **PHYS*3000** [0.50] Optics: Fundamentals and Applications

### List B: Medical Physics stream

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

**Credit Summary (20.00 Total Credits)**

- 5.00 - First year science credits
- 9.50 - Required science courses semesters 3 – 8
- 1.50 - Restricted electives (from List A OR List B)
- 1.00 - Arts and/or Social Science electives
- 3.00 - Free electives - any approved elective for B.Sc. students.

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

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

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

**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.

Since some of the required courses are not offered every semester, students entering the Major in Biological and Medical Physics (Co-op) should plan their program in consultation with the Department of Physics Faculty Advisor.

To graduate from the Co-op program a minimum of 4 successfully completed work terms is normally required. Students are eligible to participate in a maximum two (2) work terms commencing in the summer and must follow the academic work schedule as outlined by the Co-operative Education & Career Services website: [https://www.recruitsguelph.ca/ccecs/](https://www.recruitsguelph.ca/ccecs/).

This major requires the completion of 20.00 credits as follows:

#### Semester 1 - Fall

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1090</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>[0.50]</td>
</tr>
<tr>
<td>MATH*1160</td>
<td>[0.50]</td>
</tr>
<tr>
<td></td>
<td>1.00 credits from: IPS<em>1500, or (MATH</em>1080, PHYS<em>1080) or (MATH</em>1200, PHYS*1080)</td>
</tr>
</tbody>
</table>

* IPS*1500 is recommended

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

#### Semester 2 - Winter

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1080</td>
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</tr>
<tr>
<td>CHEM*1050</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CIS*1500</td>
<td>[0.50]</td>
</tr>
<tr>
<td></td>
<td>1.00 credits from: IPS<em>1510, or (MATH</em>2080, PHYS<em>1070) or (MATH</em>1210, PHYS*1010)</td>
</tr>
</tbody>
</table>

* IPS*1510 is recommended

#### Semester 3 - Fall

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*1100</td>
<td>[0.00]</td>
</tr>
<tr>
<td>MATH*2200</td>
<td>[0.50]</td>
</tr>
<tr>
<td>MATH*2270</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHYS*2240</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHYS*2330</td>
<td>[0.50]</td>
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</table>

#### Semester 4 - Winter

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*2580</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHYS*2030</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHYS*2180</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHYS*2310</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHYS*2340</td>
<td>[0.50]</td>
</tr>
</tbody>
</table>

#### Summer Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*1100</td>
<td>[0.00]</td>
</tr>
<tr>
<td>COOP*2000</td>
<td>[0.00]</td>
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</tbody>
</table>

#### Semester 5 - Fall

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>NANO*3600</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHYS*3130</td>
<td>[0.50]</td>
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</table>

1.50 electives ***

#### Winter Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*2000</td>
<td>[0.00]</td>
</tr>
</tbody>
</table>

#### Summer Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
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</thead>
<tbody>
<tr>
<td>COOP*3000</td>
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#### Semester 6 - Fall

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td>PHYS*3170</td>
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</tr>
<tr>
<td>PHYS*3230</td>
<td>[0.50]</td>
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</table>

1.50 electives ***

#### Semester 7 - Winter

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS*3510</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHYS*4040</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHYS*4300</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHYS*4540</td>
<td>[0.50]</td>
</tr>
</tbody>
</table>

0.50 electives ***

#### Summer Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*4000</td>
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</tr>
</tbody>
</table>

#### Fall Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*5000</td>
<td>[0.00]</td>
</tr>
</tbody>
</table>

#### Semester 8 - Winter

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS*4070</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PHYS*4500</td>
<td>[0.50]</td>
</tr>
</tbody>
</table>

1.50 electives ***

#### Summer Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>COOP*6000</td>
<td>[0.00]</td>
</tr>
</tbody>
</table>

#### List A: Biological Physics stream

- **BIOC*3560** [0.50] Structure and Function in Biochemistry
- **BIOM*4580** [0.50] Membrane Biochemistry
- **MBG*2040** [0.50] Foundations in Molecular Biology and Genetics
- **MCB*2050** [0.50] Molecular Biology of the Cell
- **MCB*4050** [0.50] Protein and Nucleic Acid Structure
- **PHYS*3000** [0.50] Optics: Fundamentals and Applications

#### List B: Medical Physics stream

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

**Credit Summary (20.00 Total Credits)**

- 5.00 - First year science credits
- 9.50 - Required science courses semesters 3 – 8
- 1.50 - Restricted electives (from List A OR List B)
- 1.00 - Arts and/or Social Science electives
- 3.00 - Free electives - any approved elective for B.Sc. students.

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

**A minimum of 1.00 credits in Arts/Social Science is required. In addition, students are required to complete 1.50 credits from either List A or List B as follows:**

### List A: Biological Physics stream

- **BIOC*3560** [0.50] Structure and Function in Biochemistry
- **BIOM*4580** [0.50] Membrane Biochemistry
- **MBG*2040** [0.50] Foundations in Molecular Biology and Genetics
- **MCB*2050** [0.50] Molecular Biology of the Cell
- **MCB*4050** [0.50] Protein and Nucleic Acid Structure
- **PHYS*3000** [0.50] Optics: Fundamentals and Applications

### List B: Medical Physics stream

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

**Credit Summary (20.00 Total Credits)**

- 5.00 - First year science credits
- 9.50 - Required science courses semesters 3 – 8
- 1.50 - Restricted electives (from List A OR List B)
- 1.00 - Arts and/or Social Science electives
- 3.00 - Free electives - any approved elective for B.Sc. students.

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

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

Semester 1

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1090 Introduction to Molecular and Cellular Biology</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CHEM*1040 General Chemistry I</td>
<td>[0.50]</td>
</tr>
<tr>
<td>IPS*1500 Integrated Mathematics and Physics I</td>
<td>[1.00]</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: [http://www.bsc.uoguelph.ca/revisedss]

Semester 2

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

One of

BIOL*1070 Discovering Biodiversity
BIOL*1080 Biological Concepts of Health

0.50 Arts or Social Science electives

Semester 3

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

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

Semester 4

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM*2070 Structure and Spectroscopy</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CHEM*2700 Organic Chemistry I</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CHEM*3430 Analytical Chemistry II</td>
<td>[0.50]</td>
</tr>
<tr>
<td>MICR*2420 Introduction to Microbiology</td>
<td>[0.50]</td>
</tr>
<tr>
<td>STAT*2040 Statistics I</td>
<td>[0.50]</td>
</tr>
</tbody>
</table>

Semester 5

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*3570 Analytical Biochemistry</td>
<td>[0.75]</td>
</tr>
<tr>
<td>CHEM*3750 Organic Chemistry II</td>
<td>[0.50]</td>
</tr>
</tbody>
</table>

One of:

CHEM*3640 Chemistry of the Elements I **

0.50 electives or restricted electives *

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

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

Semester 6

Select either Option A or Option B

Option A (at Guelph)

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*2560 Structure and Function in Biochemistry</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CHEM*3650 Chemistry of the Elements II</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CHEM*3760 Organic Chemistry III</td>
<td>[0.50]</td>
</tr>
</tbody>
</table>

1.00 electives or restricted electives *

Option B (at Seneca)

2.50 credits from:

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

Note: All XSEN courses are taught at the Seneca@York campus of Seneca College in Toronto. (For more information, go to: [http://www.chemistry.uoguelph.ca/bpch/]

Semester 7

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

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:

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBG*2040 Foundations in Molecular Biology and Genetics</td>
<td>[0.50]</td>
</tr>
<tr>
<td>MCB*2050 Molecular Biology of the Cell</td>
<td>[0.50]</td>
</tr>
<tr>
<td>TOX*2000 Principles of Toxicology</td>
<td>[0.50]</td>
</tr>
</tbody>
</table>

Credit Summary (20.00 Total Credits)

4.00 - First year science credits
6.50 - Required science courses semesters 3 – 8
5.00 - Restricted electives (#1 and 2 in restricted electives list)
0.50 - Approved Science electives
1.00 - Arts and/or Social Science electives
3.00 - Free electives - any approved elective for B.Sc. students. (could be less if restricted electives do not count as science)

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

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

Department of Chemistry, College of Physical and Engineering Science

Major (Honours Program)

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

Semester 1 - Fall

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

0.50 Arts or Social Science 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: [http://www.bsc.uoguelph.ca/revisedss]

Semester 2 - Winter

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

One of

BIOL*1070 Discovering Biodiversity
BIOL*1080 Biological Concepts of Health

0.50 Arts or Social Science electives

Semester 3 - Fall

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*2580 Introduction to Biochemistry</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CHEM*2060 Structure and Bonding</td>
<td>[0.50]</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBG*2040 Foundations in Molecular Biology and Genetics</td>
<td>[0.50]</td>
</tr>
<tr>
<td>MCB*2050 Molecular Biology of the Cell</td>
<td>[0.50]</td>
</tr>
<tr>
<td>TOX*2000 Principles of Toxicology</td>
<td>[0.50]</td>
</tr>
</tbody>
</table>

2. A minimum of 1.50 credits at the 4000 level and 2.50 credits at the 3000/4000 level from the following list:

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*3560 Structure and Function in Biochemistry</td>
<td>[0.50]</td>
</tr>
<tr>
<td>BIOC*4520 Metabolic Processes</td>
<td>[0.50]</td>
</tr>
<tr>
<td>BIOC*4540 Enzymology **</td>
<td>[0.75]</td>
</tr>
<tr>
<td>BIOC*4580 Membrane Biochemistry</td>
<td>[0.50]</td>
</tr>
<tr>
<td>BIOM*3090 Principles of Pharmacology **</td>
<td>[0.50]</td>
</tr>
<tr>
<td>BIOM*3200 Biomedical Physiology</td>
<td>[1.00]</td>
</tr>
<tr>
<td>BIOM*4090 Pharmacology **</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CHEM*3360 Environmental Chemistry and Toxicology</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CHEM*3440 Analytical Chemistry III: Analytical Instrumentation</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CHEM*3640 Chemistry of the Elements I</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CHEM*3650 Chemistry of the Elements II **</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CHEM*3760 Organic Chemistry III</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CHEM*4010 Chemistry and Industry</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CHEM*4040 Advanced Topics in Analytical Chemistry</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CHEM*4630 Bioinorganic Chemistry **</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CHEM*4720 Organic Reactivity **</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CHEM*4730 Synthetic Organic Chemistry **</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CHEM*4740 Topics in Bio-Organic Chemistry</td>
<td>[0.50]</td>
</tr>
<tr>
<td>CHEM*4900 Chemistry Research Project I **</td>
<td>[1.00]</td>
</tr>
<tr>
<td>CHEM*4910 Chemistry Research Project II **</td>
<td>[1.00]</td>
</tr>
<tr>
<td>MCB*4050 Protein and Nucleic Acid Structure **</td>
<td>[0.50]</td>
</tr>
<tr>
<td>MICR*3230 Immunology</td>
<td>[0.50]</td>
</tr>
<tr>
<td>NUTR*3210 Fundamentals of Nutrition</td>
<td>[0.50]</td>
</tr>
<tr>
<td>PATH*3610 Principles of Disease</td>
<td>[0.50]</td>
</tr>
<tr>
<td>TOX*4590 Biochemical Toxicology **</td>
<td>[0.50]</td>
</tr>
<tr>
<td>XSEN*3030 Pharmacology and Applied Toxicology</td>
<td>[0.50]</td>
</tr>
<tr>
<td>XSEN*3040 Occupational Health and Chemistry</td>
<td>[0.50]</td>
</tr>
<tr>
<td>XSEN*3060 Pharmaceutical Analysis - Advanced</td>
<td>[0.50]</td>
</tr>
<tr>
<td>XSEN*3070 Pharmaceutical Product Formulations</td>
<td>[0.50]</td>
</tr>
<tr>
<td>XSEN*3090 Biopharmaceuticals</td>
<td>[0.50]</td>
</tr>
<tr>
<td>XSEN*3200 Pharmaceutical Organic Chemistry</td>
<td>[0.50]</td>
</tr>
<tr>
<td>XSEN*3210 Introduction to Pharmaceutical Manufacturing</td>
<td>[0.50]</td>
</tr>
</tbody>
</table>
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 [0.00] Co-op Work Term I

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

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

Semester 6 - Winter
Select either Option A or Option B

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

Option B (at Seneca)
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. (For more information, go to: http://www.chemistry.uoguelph.ca/bpsc/)

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

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

Semester 7 - Winter
2.50 electives or restricted electives *

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

Semester 8 - Fall
One of:
CHEM*4730 [0.50] Synthetic Organic Chemistry
CHEM*4740 [0.50] Topics in Bio-Organic Chemistry
2.00 electives or restricted electives *

* Restricted Electives
**Students are advised to pay particular attention to pre-requisite requirements when choosing individual courses, and seek advice as needed.
1. MICR*2420 [0.50] Introduction to Microbiology
2. 1.00 credits from the following:
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
MCB*2050 [0.50] Molecular Biology of the Cell
TOX*2000 [0.50] Principles of Toxicology
3. A minimum of 1.50 credits at the 4000 level and 2.50 credits at the 3000/4000 level from the following list:
BIOC*3560 [0.50] Structure and Function in Biochemistry
BIOC*4520 [0.50] Metabolic Processes
BIOC*4540 [0.75] Enzymology **
BIOC*4580 [0.50] Membrane Biochemistry
BIOM*3090 [0.50] Principles of Pharmacology **
BIOM*3200 [1.00] Biomedical Physiology
BIOM*4090 [0.50] Pharmacology **
CHEM*3360 [0.50] Environmental Chemistry and Toxicology
CHEM*3440 [0.50] Analytical Chemistry III: Analytical Instrumentation
CHEM*3640 [0.50] Chemistry of the Elements I
CHEM*3650 [0.50] Chemistry of the Elements II **
CHEM*3760 [0.50] Organic Chemistry III
CHEM*4010 [0.50] Chemistry and Industry
CHEM*4100 [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*3350 [0.75] Laboratory Methods in Molecular Biology I **
MBG*4080 [0.50] Molecular Genetics **
MCB*4080 [0.50] Protein and Nucleic Acid Structure **
MICR*3230 [0.50] Immunology
NUTR*3210 [0.50] Fundamentals of Nutrition
PATH*3610 [0.50] Principles of Disease
TOX*4590 [0.50] Biochemical Toxicology **
XSEN*3030 [0.50] Pharmacology and Applied Toxicology
XSEN*3040 [0.50] Occupational Health and Chemistry
XSEN*3060 [0.50] Pharmaceutical Analysis - Advanced
XSEN*3070 [0.50] Pharmaceutical Product Formulations
XSEN*3090 [0.50] Biopharmaceuticals
XSEN*3200 [0.50] Pharmaceutical Organic Chemistry
XSEN*3210 [0.50] Introduction to Pharmaceutical Manufacturing

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

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

Biological Science (BIOS)

College of Biological Science

Major (Honours Program)

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

Schedule of Studies

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

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

Semester 2
BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1080 [0.50] Biological Concepts of Health
CHEM*1050 [0.50] General Chemistry II
PHYS*1070 [0.50] Physics for Life Sciences II
0.50 Arts or Social Science electives

Semester 3
BIOL*2100 [0.50] Evolution
One of:
BIOC*2580 [0.50] Introduction to Biochemistry
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
1.00 electives or restricted electives *
0.50 Arts or Social Science elective

Semester 4
STAT*2040 [0.50] Statistics I
One of:
BIOC*2580 [0.50] Introduction to Biochemistry
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
1.00 electives or restricted electives *
0.50 Arts or Social Science elective

Semester 5 to 8
2.50 in each semester*

* Restricted Electives
** Note: some courses may require additional prerequisites.
1. A minimum of 2.00 credits of Arts and/or Social Science electives are required. The list of approved Arts and Social Science electives for B.Sc. students is available at: http://www.bsc.uoguelph.ca/Approved_electives.shtml#arts

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

3. A minimum of 0.50 credits in Mathematical or Computational Science:
   - CIS*1000 [0.50] Introduction to Computer Applications
   - CIS*1200 [0.50] Introduction to Computing
   - MATH*2080 [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
   - BIOL*2100 [0.50] Life Strategies of Plants
   - HK*2810 [0.50] Human Physiology I - Concepts and Principles
   - ZOO*3600 [0.50] Comparative Animal Physiology I **

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

Credit Summary (20.00 Total Credits)

4.00 - First year science core

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

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

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

2.00 - Approved Arts and/or Social Science 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.

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**Animal Care Policies**

All animals are protected under the Animals for Research Act of Ontario (1980), the Standards 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% will be guaranteed continuation in this major. For students with a 70-74.9% average, continuation will be competitive based on available spaces. Students with an average below 70% will be changed to the Biological Science major. Students may subsequently change to another B.Sc. major of their choice. B.Sc. students who wish to declare the specialization at the end of or beyond first year must apply directly to the Department of Biomedical Sciences by the last day of classes in the winter semester and meet the same requirements specified above.

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

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Major (Honours Program)

A minimum of 20.00 credits is required.

Note: Students are required to complete 16.00 credits in science of which a minimum of 2.00 credits must be at the 4000 level.

**Semester 1**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1080</td>
<td>0.50</td>
<td>Biological Concepts of Health</td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>0.50</td>
<td>General Chemistry I</td>
</tr>
<tr>
<td>MATH*1080</td>
<td>0.50</td>
<td>Elements of Calculus I</td>
</tr>
<tr>
<td>PHYS*1080</td>
<td>0.50</td>
<td>Physics for Life Sciences</td>
</tr>
</tbody>
</table>

5.00 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: http://www.bsc.uoguelph.ca/revisedss.

**Semester 2**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1070</td>
<td>0.50</td>
<td>Discovering Biodiversity</td>
</tr>
<tr>
<td>BIOL*1090</td>
<td>0.50</td>
<td>Introduction to Molecular and Cellular Biology</td>
</tr>
<tr>
<td>CHEM*1050</td>
<td>0.50</td>
<td>General Chemistry II</td>
</tr>
<tr>
<td>PHYS*1070</td>
<td>0.50</td>
<td>Physics for Life Sciences II</td>
</tr>
</tbody>
</table>

0.50 electives or restricted electives

**Semester 3 (see admission statement above)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*2500</td>
<td>0.50</td>
<td>Introduction to Molecular and Cellular Biology</td>
</tr>
<tr>
<td>MBG*2040</td>
<td>0.50</td>
<td>Foundations in Molecular Biology and Genetics</td>
</tr>
<tr>
<td>STAT*2040</td>
<td>0.50</td>
<td>Statistics I</td>
</tr>
</tbody>
</table>

1.00 electives or restricted electives

**Semester 4**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCB*2050</td>
<td>0.50</td>
<td>Molecular Biology of the Cell</td>
</tr>
<tr>
<td>NUTR*3210</td>
<td>0.50</td>
<td>Fundamentals of Nutrition</td>
</tr>
</tbody>
</table>

One of:

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

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**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOM*3560</td>
<td>0.50</td>
<td>Structure and Function in Biochemistry</td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOM*3090</td>
<td>0.50</td>
<td>Principles of Pharmacology</td>
</tr>
<tr>
<td>PATH*3610</td>
<td>0.50</td>
<td>Principles of Disease</td>
</tr>
<tr>
<td>POP*3240</td>
<td>0.50</td>
<td>Epidemiology</td>
</tr>
</tbody>
</table>

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

**Semester 7**

2.50 electives or restricted electives

**Semester 8**

2.50 electives or restricted electives*

**Restricted Electives**

1. Anatomy Elective - [1 of (BIOM*3010, BIOM*3040), HK*3401/2, HK*3501/2]
2. Immunology Elective - ANSC*4650 or MICR*3230
3. Advance Study Electives - 2.00 credits from BIOM*4030, BIOM*4050, BIOM*4070, BIOM*4090, BIOM*4110, BIOM*4150, BIOM*4180, BIOM*4300, BIOM*4500, BIOM*4510, BIOM*4521/2, HK*4070, HK*4230, HK*4340, HK*4360, HK*4371/2, HK*4441/2, HK*4460, NUTR*4320, NUTR*4360, NUTR*4510, TOX*4000

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Last Revision: January 31, 2017
2016-2017 Undergraduate Calendar
At least 2.00 credits of Arts and/or Social Science Electives are required. The approved list of Arts and Social Science Electives for B.Sc. students is available at: http://www.bsc.uoguelph.ca/Approved_electives.shtml.

Credit Summary (20.00 Total Credits)

4.00 - First year science credits
5.75 - Required science courses semesters 3 – 8 (with HK 2810,3810) or 5.50 (with BIOM 3200)
4.00 - Restricted elective (with HK 3401/2 or HK 3501/2) 3.75 (with BIOM 3010, BIOM 3040) (Restricted elective #1, #2 and #3)
2.25 – 2.75 Approved Science electives depending on which anatomy and physiology courses are completed above.
2.00 - Arts and/or Social Science electives (# 4 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 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Biomedical Toxicology (BTOX)

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

Major (Honours Program)

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

Semester 1

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

0.50 Arts or Social Science electives

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

Semester 2

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

0.50 Arts or Social Science electives

Semester 3

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 Arts or Social Science electives

Semester 4

Chem*2700 0.50 Organic Chemistry I
Mcb*2050 0.50 Molecular Biology of the Cell
Nutr*3210 0.50 Fundamentals of Nutrition
Tox*3360 0.50 Environmental Chemistry and Toxicology

0.50 electives or restricted electives*

Semester 5

BioC*3560 0.50 Structure and Function in Biochemistry
BioM*3200 0.50 Biomedical Physiology
Tox*3300 0.50 Analytical Toxicology

0.50 electives or restricted electives*

Semester 6

BioM*3090 0.50 Principles of Pharmacology
Path*3610 0.50 Principles of Disease

One of:
BioM*3040 0.75 Medical Embryology
Mbg*3350 0.75 Laboratory Methods in Molecular Biology I *

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

Semester 7

Nutr*4510 0.50 Toxicology, Nutrition and Food
Tox*4000 0.50 Medical Toxicology
Tox*4590 0.50 Biochemical Toxicology

1.00 electives or restricted electives*

Semester 8

BioM*4090 0.50 Pharmacology
Tox*4100 0.50 Toxicological Pathology
Tox*4200 0.50 Topics in Toxicology

1.00 electives or restricted electives*

* Restricted Electives

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

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

Ansc*4650 0.50 Comparative Immunology
Biom*3040 0.75 Medical Embryology
Biom*4050 0.50 Biomedical Aspects of Aging
Biom*4070 0.50 Biomedical Histology
Biom*4150 0.50 Cancer Biology
Chem*3750 0.50 Organic Chemistry II
Chem*3760 0.50 Organic Chemistry III
Chem*4740 0.50 Topics in Bio-Orgnic Chemistry
Mbg*3350 0.75 Laboratory Methods in Molecular Biology I
Mbg*4080 0.50 Molecular Genetics
Mbg*4270 0.50 DNA Replication, Recombination and Repair
Mcb*4010 0.50 Advanced Cell Biology
Mirc*3230 0.50 Immunology
Nutr*4090 0.50 Functional Foods and Nutraceuticals
Nutr*4320 0.50 Nutrition and Metabolic Control of Disease
Path*3040 0.50 Principles of Parasitology
Popm*3240 0.50 Epidemiology
Popm*4040 0.50 Epidemiology of Food-borne Diseases
Stat*2050 0.50 Statistics II
Stat*3510 0.50 Environmental Risk Assessment
Tox*4900 1.00 Toxicology Research Project I
Tox*4910 1.00 Toxicology Research Project II

Credit Summary (20.00 Total Credits)

4.00 - First year science credits
10.75 - Required science courses semesters 3 – 8
1.50 - Restricted electives
1.50 - Arts and/or Social Science electives
2.25 - Free electives - any approved elective for B.Sc. students.

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

Biomedical Toxicology (Co-op) (BTOX:C)

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

To graduate from the Co-op program a minimum of 3 successfully completed work terms (Coop*1000, Coop*2000, Coop*3000) is normally required.

Major (Honours Program)

A minimum of 20.00 credits are required for graduation.

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 Arts or Social Science electives

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

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 Arts or Social Science 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 Arts or Social Science electives

Winter Semester

Coop*1000 0.00 Co-op Work Term I

Summer Semester

Coop*2000 0.00 Co-op Work Term II

Semester 4 - Fall

BioC*3560 0.50 Structure and Function in Biochemistry
Mbg*2050 0.50 Molecular Biology of the Cell
Nutr*3210 0.50 Fundamentals of Nutrition
Tox*3300 0.50 Analytical Toxicology

Last Revision: January 31, 2017
Major (Honours Program)

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major must consult the Faculty Advisor. A minimum of 20.00 credits is required. At least 1.00 credits must be from Arts and/or Social Science courses.

Minor (Honours Program)

A minimum of 5.00 credits is required, including:

- ACCT*1220 [0.50] Introductory Financial Accounting
- ACCT*2220 [0.50] Management Accounting
- ECON*1050 [0.50] Introductory Microeconomics
- ECON*1100 [0.50] Introductory Macroeconomics
- ECON*2100 [0.50] Economic Growth and Environmental Quality
- ECON*2310 [0.50] Intermediate Microeconomics
- ECON*2410 [0.50] Intermediate Macroeconomics
- MATH*1080 [0.50] Elements of Calculus I
- MATH*1100 [0.50] Business Mathematics
- MATH*1200 [0.50] Calculus I

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
- MATH*1250 [0.50] Probability and Statistics for Engineers
- MATH*2120 [0.50] Probability and Statistics for Engineers

One of:

- ECON*2410 [0.50] Intermediate Macroeconomics
- ECON*2560 [0.50] Theory of Finance
- ECON*2740 [0.50] Economic Statistics
- ECON*3660 [0.50] Economics of Equity Markets
- ECON*4400 [0.50] Economics of Organizations and Corporate Governance
- ENG*3240 [0.50] Engineering Economics
- FARE*3310 [0.50] Operations Management
- HROB*2090 [0.50] Individuals and Groups in Organizations
- MATH*1100 [0.50] Business and Consumer Law
- MATH*3340 [0.50] Financial Management
- MGMT*4330 [0.50] Financial Management
- MGMT*4340 [0.50] Business and Consumer Law

* 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 Physical and Engineering Science 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 must consult the Faculty Advisor. A minimum of 20.00 credits is required. At least 1.00 credits must be from Arts and/or Social Science courses.

Semester 1

- CHEM*1040 [0.50] General Chemistry I
- IPS*1500 [1.00] Integrated Mathematics and Physics I
- MATH*1160 [0.50] Linear Algebra I
<table>
<thead>
<tr>
<th>Semester</th>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
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<tbody>
<tr>
<td>Semester 2</td>
<td>BIOL*1070</td>
<td>Discovering Biodiversity</td>
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<tr>
<td></td>
<td>BIOL*1080</td>
<td>Biological Concepts of Health</td>
<td>0.50</td>
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<td>BIOL*1090</td>
<td>Introduction to Molecular and Cellular Biology</td>
<td>0.50</td>
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<td>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: <a href="http://www.bsc.uoguelph.ca/revisedss">http://www.bsc.uoguelph.ca/revisedss</a></td>
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<td>Semester 3</td>
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<td>General Chemistry II</td>
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<td></td>
<td>IPS*1510</td>
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<td>BIOL*1070</td>
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<td>BIOL*1080</td>
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<td>Semester 4</td>
<td>CHEM*2060</td>
<td>Structure and Bonding</td>
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<td>MATH*2270</td>
<td>Applied Differential Equations</td>
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<td>PHYS*2330</td>
<td>Electricity and Magnetism</td>
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<td>0.50 Arts or Social Science electives</td>
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<td>Semester 5</td>
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<td>PHYS*2240</td>
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<td>Semester 6</td>
<td>CHEM*3430</td>
<td>Analytical Chemistry II: Instrumental Analysis</td>
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<td>PHYS*3000</td>
<td>Optics: Fundamentals and Applications</td>
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<td>PHYS*4040</td>
<td>Quantum Mechanics II</td>
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<td>PHYS*3230</td>
<td>Quantum Mechanics I</td>
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<td></td>
<td>CHEM*2820</td>
<td>Thermodynamics and Kinetics</td>
<td>0.50</td>
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<tr>
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<td>PHYS*2240</td>
<td>Thermal Physics</td>
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<td>Semester 7</td>
<td>CHEM*3440</td>
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<td>PHYS*4120</td>
<td>Atomic and Molecular Physics</td>
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<td>PHYS*4240</td>
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<td>0.50 electives</td>
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<td>Semester 8</td>
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<td>CHEM*4880</td>
<td>Topics in Advanced Physical Chemistry</td>
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<td>CHEM*4900</td>
<td>Chemistry Research Project I +</td>
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<td>PHYS*4002</td>
<td>and 0.50 electives</td>
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<td></td>
<td>PHYS*4300</td>
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<td>0.50 electives +</td>
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<td>+ Students must complete either (PHYS<em>4001, PHYS</em>4002 in semester 7 and 8) or (CHEM*4900 in semester 8).</td>
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<td>Credit Summary (20.00 Total Credits)</td>
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<td>11.50 - Required science courses semesters 3 – 8</td>
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<td>1.00 - Arts and/or Social Science electives</td>
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<td>2.50 - Free electives - any approved elective for B.Sc. students</td>
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Of the total credits required, students are required to complete 16.00 credits in science of which 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

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

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

**Major (Honours Program)**

A minimum of 20.00 credits is required. At least 1.00 credits must be from Arts and/or Social Science courses. Students are eligible to participate in a maximum two (2) work terms commencing in the summer and must follow the academic work schedule as outlined in the Co-operative Education & Career Services website: [https://www.recruituoguelph.ca/cecs/](https://www.recruituoguelph.ca/cecs/)

**Semester 1 - Fall**

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<td>CHEM*1040</td>
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<td>Discovering Biodiversity</td>
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<td>BIOL*1080</td>
<td>Biological Concepts of Health</td>
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**Semester 2 - Winter**

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<td>IPS*1510</td>
<td>Integrated Mathematics and Physics I</td>
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<td>Discovering Biodiversity</td>
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<td>BIOL*1080</td>
<td>Biological Concepts of Health</td>
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<td>BIOL*1090</td>
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**Semester 3 - Fall**

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<td>CHEM*2060</td>
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<td>MATH*2200</td>
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<td>MATH*2270</td>
<td>Applied Differential Equations</td>
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<td>Electricity and Magnetism</td>
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**Semester 4 - Winter**

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<tr>
<td>CHEM*2070</td>
<td>Structure and Spectroscopy</td>
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<td>CHEM*2480</td>
<td>Analytical Chemistry I</td>
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<td>PHYS*2180</td>
<td>Experimental Techniques in Physics</td>
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<td>PHYS*2310</td>
<td>Mechanics</td>
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<td>PHYS*4300</td>
<td>Inquiry in Physics</td>
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<td>CHEM*3870</td>
<td>Molecular Spectroscopy</td>
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<tr>
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<td>CHEM*4880</td>
<td>Topics in Advanced Physical Chemistry</td>
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**Semester 5 - Winter**

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<td>Optics: Fundamentals and Applications</td>
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<td>Quantum Mechanics II</td>
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<td>PHYS*4300</td>
<td>Research in Physics</td>
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<td>0.50 electives +</td>
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**Semester 6 - Fall**

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<td>CHEM*3440</td>
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<td>PHYS*4120</td>
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<td>Statistical Physics</td>
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<td>PHYS*4001</td>
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**Semester 7 - Winter**

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<td>CHEM*3870</td>
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<td>CHEM*4880</td>
<td>Topics in Advanced Physical Chemistry</td>
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<td>CHEM*4900</td>
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<td>PHYS*4300</td>
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<td>Credit Summary (20.00 Total Credits)</td>
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<td>11.50 - Required science courses semesters 3 – 8</td>
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<td>2.50 - Free electives - any approved elective for B.Sc. students</td>
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2016-2017 Undergraduate Calendar  Last Revision: January 31, 2017
X. Degree Programs, Bachelor of Science (B.Sc.)

Co-op Work Term V ++
Integrated Mathematics and Physics I
General Chemistry I
1.50 chosen from CHEM*3870, CHEM*4010, CHEM*4400, BIOC*4520, Quantum Chemistry
Organic Chemistry II
Analytical Chemistry I
Introduction to Molecular and Cellular Biology
Integrated Mathematics and Physics II
Optics: Fundamentals and Applications
Linear Algebra I
Organic Chemistry II
Structure and Bonding
Options for an "Area of Focus" or a minor are available. Subject areas include
Introduction to Biochemistry
Organic Chemistry III
General Chemistry II
General Chemistry I
Topics in Advanced Physical Chemistry +
Statistical Physics II
Chemistry of the Elements II
Analytical Chemistry II: Instrumental Analysis
Biological Concepts of Health
Thermodynamics and Kinetics
Analytical Chemistry III: Analytical Instrumentation
Analytical Chemistry III: Analytical Instrumentation
At least 1.00 credits must be in the Arts & Social Sciences.
Structure and Spectroscopy
Introduction to Molecular and Cellular Biology
Analytical Chemistry III: Analytical Instrumentation

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

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

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

*selection of electives is subject to the following:
1. At least 1.00 credits must be in the Arts & Social Sciences.
2. Approval of the Faculty Advisor must be obtained for the selection of courses not listed as restrictive electives.
3. Options for an "Area of Focus" or a minor are available. Subject areas include Biochemistry, Computing and Information Science, Earth Sciences, Environmental Sciences, Mathematical Sciences, and Physics. Please consult with your Faculty Advisor for more details.

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

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)
5.00 - First year science credits
10.50 - Required science courses semesters 3 – 8
0.50 – Approved science electives
3.00 - Free electives - any approved elective for B.Sc. students.
Of the total credits required, students are required to complete 16.00 credits in science of which 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Chemistry (CHEM)
Department of Chemistry, College of Physical and Engineering Science
Major (Honours Program)
Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major must 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 Arts or Social Science electives

Students who are lacking one 4U /grade 12 course in Biology, Chemistry or Physics must plan ahead, with the assistance of the faculty advisor.

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
BIOC*2580 [0.50] Introduction to Biochemistry
CHEM*2060 [0.50] Structure and Bonding
CHEM*2400 [0.75] Analytical Chemistry I
MATH*2270 [0.50] Applied Differential Equations
Electives to a maximum of 2.75 total credits in this semester *

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

Credit Summary (20.00 Total Credits)
5.00 - First year science credits
10.50 - Required science courses semesters 3 – 8
0.50 – Approved science electives
3.00 - Free electives - any approved elective for B.Sc. students.
Of the total credits required, students are required to complete 16.00 credits in science of which 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

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

Chemistry (Co-op) (CHEM:C)
Department of Chemistry, College of Physical and Engineering Science
Major (Honours Program)
The major will require the completion of 20.00 credits as indicated below.
The course content of semesters 1 to 3 is the same as listed in the regular Honours Program Major.
To graduate from the Co-op program a minimum of 4 successfully completed work terms is normally required.

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 Arts or Social Science electives

Students who are lacking one 4U /grade 12 course in Biology, Chemistry or Physics must plan ahead, with the assistance of the faculty advisor.

Semester 2 - Winter
CHEM*1050 [0.50] General Chemistry II

Last Revision: January 31, 2017
2016-2017 Undergraduate Calendar
Computing and Information Science (CIS)

School of Computer Science, College of Physical and Engineering Science

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)

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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO*1040</td>
<td>0.50</td>
<td>Discovering Biodiversity</td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>0.50</td>
<td>General Chemistry I</td>
</tr>
<tr>
<td>PHYS*1040</td>
<td>0.50</td>
<td>Physics for Life Sciences</td>
</tr>
</tbody>
</table>

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

At least one of:

- BIO*1040
- CHEM*1040
- PHYS*1040

At least one of:

- BIO*1040
- CHEM*1040
- PHYS*1040

Environmental Biology (ENVB)

School of Environmental Sciences, Ontario Agricultural College

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

Major (Honours Program)

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major must 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. Of these 16.00 science credits, a minimum of 6.00 must be at the 3000 - 4000-levels with a minimum of 2.00 credits at the 4000-level.

Semester 1

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO*1040</td>
<td>0.50</td>
<td>Discovering Biodiversity</td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>0.50</td>
<td>General Chemistry I</td>
</tr>
<tr>
<td>PHYS*1040</td>
<td>0.50</td>
<td>Physics for Life Sciences</td>
</tr>
</tbody>
</table>

Semester 2

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO*1040</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 II</td>
</tr>
<tr>
<td>PHYS*1040</td>
<td>0.50</td>
<td>Physics for Life Sciences II</td>
</tr>
</tbody>
</table>

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.
X. Degree Programs, Bachelor of Science (B.Sc.)

Semester 3
BIOC*2580 [0.50] Introduction to Biochemistry
ENVS*2330 [0.50] Current Issues in Ecosystem Science and Biodiversity
STAT*2040 [0.50] Statistics I (if not taken in semester 2)
TOX*2000 [0.50] Principles of Toxicology
0.50 electives or restricted electives chosen from lists A, B, C and/or D (or 1.00 if STAT*2040 was taken in semester 2)

Semester 4
BIOL*2060 [0.50] Ecology
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
1.50 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 (at least 1.00 restricted electives must be selected, including at least one ENVS course)
Students are encouraged to take (ENVS*3410 and ENVS*3420) or ENVS*3430 in Semesters 5 and 6.

Semester 6
BIOL*2400 [0.50] Evolution
2.00 electives or restricted electives chosen from lists A, B, C and/or D

Semester 7
2.50 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 in semester 8, or ENVS*4430 in either semester 7 or 8.

Semester 8
2.50 electives or restricted electives chosen from lists A, B, C and/or D

Restricted Electives
1. A minimum of 1.00 credits of Approved Arts and Social Science electives
2. Select 4.50 credits from the following lists of restricted electives during Semesters 3-8. 1.00 credits must be completed in each of lists A, B and C. Of the total 4.50 credits at least 1.00 of these credits must be from ENVS courses.

List A - Environment & Agriculture
Minimum of 1.00 credits from the following list:
AGR*2050 [0.50] Agroecology
ENVS*2040 [0.50] Plant Health and the Environment
ENVS*2340 [0.50] Current Issues in Agriculture and Landscape Mgmt
ENVS*3040 [0.50] Natural Chemicals in the Environment
ENVS*3210 [0.50] Plant Pathology
ENVS*3310 [0.50] Soil Biodiversity and Ecosystem Function **
ENVS*4100 [0.50] Integrated Management of Invasive Insect Pests **
ENVS*4130 [0.50] Chemical Ecology: Principles & Practice **
MCIR*3220 [0.50] Plant Microbiology
PBIO*4750 [0.50] Genetic Engineering of Plants **

List B - Impacts of Pollution on Living Organisms
Minimum of 1.00 credits from the following list:
BIOL*3450 [0.50] Introduction to Aquatic Environments
BIOL*4350 [0.50] Limnology of Natural and Polluted Waters **
BIOL*4610 [0.75] Arctic Ecology
ENVS*3010 [0.50] Climate Change Biology
ENVS*3020 [0.50] Pesticides and the Environment
ENVS*3290 [0.50] Waterborne Disease Ecology
ENVS*4180 [0.50] Insecticide Biological Activity and Resistance
ENVS*4190 [0.50] Biological Activity of Herbicides
GEOG*3020 [0.50] Global Environmental Change
MBG*4270 [0.50] DNA Replication, Recombination and Repair **
PBIO*4530 [0.50] Plants and Environmental Pollution **
STAT*3510 [0.50] Environmental Risk Assessment
TOX*3360 [0.50] Environmental Chemistry and Toxicology

List C - Conservation of Biodiversity & Natural Resources
Minimum of 1.00 credits from the following list:
BIOL*3060 [0.50] Populations, Communities & Ecosystems
BIOL*3130 [0.50] Conservation Biology
BIOL*4150 [0.50] Wildlife Conservation and Management
BIOL*4500 [0.50] Natural Resource Policy Analysis
ENVS*2120 [0.50] Introduction to Environmental Stewardship
ENVS*3080 [0.50] Soil and Water Conservation **
ENVS*3090 [0.50] Insect Diversity and Biology
ENVS*3150 [0.50] Aquatic Systems
ENVS*3230 [0.50] Agroforestry Systems **
ENVS*3250 [0.50] Forest Health and Disease
ENVS*3270 [0.50] Forest Biodiversity **
ENVS*3370 [0.50] Terrestrial Ecosystem Ecology
ENVS*4230 [0.50] Biology of Aquatic Insects **
ENVS*4260 [0.50] Field Entomology **
ENVS*4350 [0.50] Forest Ecology **
ENVS*4390 [1.00] Soil Variability and Land Evaluation

List D - Supporting Courses
ENVS*3410 [0.50] Independent Research I
ENVS*3420 [0.50] Independent Research II
ENVS*3430 [1.00] Independent Research
ENVS*3510 [0.50] Independent Study I
ENVS*3520 [0.50] Independent Study II
ENVS*3530 [1.00] Independent Study
ENVS*4410 [1.00] Advanced Independent Research I
ENVS*4420 [1.00] Advanced Independent Research II
ENVS*4430 [2.00] Advanced Independent Research
ENVS*4510 [0.50] Advanced Independent Study I
ENVS*4520 [0.50] Advanced Independent Study II
ENVS*4530 [1.00] Advanced Independent Study

The following restricted elective courses are required as prerequisites for some courses in lists A, B and C:
BIOL*3060 [0.50] Populations, Communities & Ecosystems
BOT*2100 [0.50] Life Strategies of Plants
ENVS*2060 [0.50] Soil Science
MCIR*2050 [0.50] Molecular Biology of the Cell

Credit Summary (20.00 Total Credits)
4.00 - First year science credits
3.50 - Required science courses semesters 3 – 8 (3.00 if STAT 2040 is taken in Semester 2)
4.50 - Restricted electives (some restricted electives do not count as science electives towards degree therefore additional science electives may be required)
4.00 - Approved Science electives (4.50 if STAT 2040 is taken in semester 2, in place of CIS)
1.00 - Arts and/or Social Science electives (# 1 in restricted elective list)
3.00 - Free electives - any approved elective for B.Sc. students. (could be less if restricted electives do not count as science)

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

Environmental Geoscience and Geomatics (EGG)

Department of Geography, 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 that select courses required for a 'Professional Geoscientist' will meet the academic requirements for eligibility for membership as an Environmental Geoscientist in the Association of Professional Geoscientists of Ontario (APGO), allowing for use of the designation P. Geo. Ontario’s legislation under the Professional Geoscientists Act, 2000 (the Act), requires registration with the APGO of anyone wishing to practice geoscience in Ontario. Details on the course requirements for APGO membership can be found on the Department of Geography website:

Major (Honours Program)
Students must enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major must consult with a B.Sc. Faculty Advisor in the Department of Geography. All students are encouraged to consult with the advisor on a regular basis.

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

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

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

Semester 2
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
CHEM*1050 [0.50] General Chemistry II

Last Revision: January 31, 2017
2016-2017 Undergraduate Calendar
<table>
<thead>
<tr>
<th>Semester 3</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOS*1300</td>
<td>[0.50] Introduction to the Biophysical Environment</td>
</tr>
<tr>
<td>PHYS*1130</td>
<td>[0.50] Physics with Applications</td>
</tr>
<tr>
<td>0.50 Arts or Social Science electives* (GEOG*1220 is recommended)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 4</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOS*2110</td>
<td>[0.50] Climate and the Biophysical Environment</td>
</tr>
<tr>
<td>GEOS*2210</td>
<td>[0.50] Environment and Resources</td>
</tr>
<tr>
<td>STAT*2040</td>
<td>[0.50] Statistics I</td>
</tr>
<tr>
<td>One of:</td>
<td></td>
</tr>
<tr>
<td>CIS*1200</td>
<td>[0.50] Introduction to Computing</td>
</tr>
<tr>
<td>CIS*1500</td>
<td>[0.50] Introduction to Programming</td>
</tr>
<tr>
<td>MATH*1210</td>
<td>[0.50] Calculus II</td>
</tr>
<tr>
<td>MATH*2080</td>
<td>[0.50] Elements of Calculus II</td>
</tr>
<tr>
<td>0.50 approved Science electives*</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 5</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOS*3000</td>
<td>[0.50] Fluvial Processes</td>
</tr>
<tr>
<td>GEOS*3110</td>
<td>[0.50] Biotic and Natural Resources</td>
</tr>
<tr>
<td>One of:</td>
<td></td>
</tr>
<tr>
<td>GEOG*3020</td>
<td>[0.50] Global Environmental Change</td>
</tr>
<tr>
<td>GEOG*3090</td>
<td>[0.50] Gender and Environment</td>
</tr>
<tr>
<td>GEOG*3210</td>
<td>[0.50] Management of the Biophysical Environment</td>
</tr>
<tr>
<td>1.00 electives, at least 0.50 from approved Science electives*</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 6</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOS*3420</td>
<td>[0.50] Remote Sensing of the Environment</td>
</tr>
<tr>
<td>GEOS*3480</td>
<td>[0.50] GIS and Spatial Analysis</td>
</tr>
<tr>
<td>GEOS*3610</td>
<td>[0.50] Environmental Hydrology</td>
</tr>
<tr>
<td>1.00 electives, at least 0.50 from approved Science electives*</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semester 7</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOS*4110</td>
<td>[0.50] Environmental Systems Analysis</td>
</tr>
<tr>
<td>GEOS*4150</td>
<td>[0.50] Catchment Processes</td>
</tr>
<tr>
<td>GEOS*4480</td>
<td>[1.00] Applied Geomatics</td>
</tr>
<tr>
<td>1.00 Approved Science electives*</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Credit Summary (20.00 Total Credits)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.50 - First year science credits</td>
</tr>
<tr>
<td>8.50 - Required science courses semesters 3 – 8</td>
</tr>
<tr>
<td>1.00 - Required social science courses semesters 3 – 8</td>
</tr>
<tr>
<td>3.00 - Approved Science electives</td>
</tr>
<tr>
<td>1.00 - Arts and/or Social Science electives</td>
</tr>
<tr>
<td>2.00 - Free electives - any approved elective for B.Sc. students.</td>
</tr>
</tbody>
</table>

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

### 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 must consult the Faculty Advisor.

**Semester 1 - Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1090</td>
<td>Introduction to Molecular and Cellular Biology</td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>General Chemistry I</td>
</tr>
<tr>
<td>MATH*1080</td>
<td>Elements of Calculus I</td>
</tr>
<tr>
<td>PHYS*1080</td>
<td>Physics for Life Sciences</td>
</tr>
<tr>
<td>0.50 Arts or Social Science electives</td>
<td></td>
</tr>
</tbody>
</table>

Note: CIS*1200, rather than an Arts or Social Science 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: [http://www.bsc.uoguelph.ca/degreq/index.html](http://www.bsc.uoguelph.ca/degreq/index.html)

**Semester 2 - Winter**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1080</td>
<td>Biological Concepts of Health</td>
</tr>
<tr>
<td>CHEM*1050</td>
<td>General Chemistry II</td>
</tr>
<tr>
<td>MATH*2080</td>
<td>Elements of Calculus II</td>
</tr>
<tr>
<td>PHYS*1070</td>
<td>Physics for Life Sciences</td>
</tr>
<tr>
<td>0.50 Arts or Social Science electives</td>
<td></td>
</tr>
</tbody>
</table>

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### Semester 3 - Fall

<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>CHEM*2880</td>
<td>Physical Chemistry</td>
</tr>
<tr>
<td>FOOD*2150</td>
<td>Introduction to Nutritional and Food Science</td>
</tr>
<tr>
<td>MIRC*2420</td>
<td>Introduction to Microbiology</td>
</tr>
<tr>
<td>0.50 electives</td>
<td></td>
</tr>
</tbody>
</table>

### Semester 4 - Winter

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOOD*2100</td>
<td>Communication in Food Science</td>
</tr>
<tr>
<td>FOOD*2620</td>
<td>Food Engineering Principles</td>
</tr>
<tr>
<td>NUTR*3210</td>
<td>Fundamentals of Nutrition</td>
</tr>
<tr>
<td>STAT*2040</td>
<td>Statistics I</td>
</tr>
<tr>
<td>0.50 electives</td>
<td></td>
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</tbody>
</table>

### Semester 5 - Fall

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>FOOD*3030</td>
<td>Food Chemistry I</td>
</tr>
<tr>
<td>FOOD*3160</td>
<td>Food Processing I</td>
</tr>
<tr>
<td>FOOD*3230</td>
<td>Food Microbiology</td>
</tr>
<tr>
<td>0.50 electives</td>
<td></td>
</tr>
</tbody>
</table>

### Semester 6 - Winter

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOOD*3040</td>
<td>Food Chemistry II</td>
</tr>
<tr>
<td>FOOD*3170</td>
<td>Food Processing II</td>
</tr>
<tr>
<td>FOOD*3260</td>
<td>Industrial Microbiology</td>
</tr>
<tr>
<td>FOOD*3700</td>
<td>Sensory Evaluation of Foods</td>
</tr>
<tr>
<td>0.50 electives</td>
<td></td>
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</tbody>
</table>

### Semester 7 - Fall

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOOD*4190</td>
<td>Advanced Food Analysis</td>
</tr>
<tr>
<td>FOOD*4260</td>
<td>Food Product Development I</td>
</tr>
<tr>
<td>1.50 electives</td>
<td></td>
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</tbody>
</table>

### Semester 8 - Winter

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOOD*4270</td>
<td>Food Product Development II</td>
</tr>
<tr>
<td>2.00 electives</td>
<td></td>
</tr>
</tbody>
</table>

**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:
   - At least 2.00 must be Arts or Social Sciences.
   - At least 2.00 must be from list of Restricted Electives.
   - At least 1.00 must be from additional science electives (1.50 if MCS*3010 is chosen as a Restricted Elective)

**Restricted Electives:**

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

**Credit Summary (20.00 Total Credits)**

1.00 or 1.50 - Additional Science electives (See Note 3 above)

1.00 or 1.50 - Free electives (See Note 3 above)

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

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

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

##### Major (Honours Program)

**Semester 1 - Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>BIOL*1090</td>
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<td>Elements of Calculus I</td>
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<tr>
<td>PHYS*1080</td>
<td>Physics for Life Sciences</td>
</tr>
<tr>
<td>0.50 Arts or Social Science electives</td>
<td></td>
</tr>
</tbody>
</table>

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2016-2017 Undergraduate Calendar  
Last Revision: January 31, 2017
Note: CIS*1200, rather than an Arts or Social Science 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: http://www.bsc.uoguelph.ca/revisedss

### Semester 2 - Winter

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>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*2080</td>
<td>0.50</td>
<td>Elements of Calculus II</td>
</tr>
<tr>
<td>PHYS*1070</td>
<td>0.50</td>
<td>Physics for Life Sciences II</td>
</tr>
</tbody>
</table>

0.50 Arts or Social Science electives

### Summer Semester

Optional

### Semester 3 - Fall

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*2580</td>
<td>0.50</td>
<td>Introduction to Biochemistry</td>
</tr>
<tr>
<td>CHEM*2880</td>
<td>0.50</td>
<td>Physical Chemistry</td>
</tr>
<tr>
<td>COOP*1100</td>
<td>0.00</td>
<td>Introduction to Co-operative Education</td>
</tr>
<tr>
<td>FOOD*2150</td>
<td>0.50</td>
<td>Introduction to Nutritional and Food Science</td>
</tr>
<tr>
<td>MICR*2420</td>
<td>0.50</td>
<td>Introduction to Microbiology</td>
</tr>
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0.50 electives

### Semester 4 - Winter

<table>
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<tr>
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<tbody>
<tr>
<td>FOOD*2100</td>
<td>0.50</td>
<td>Communication in Food Science</td>
</tr>
<tr>
<td>FOOD*2620</td>
<td>0.50</td>
<td>Food Engineering Principles</td>
</tr>
<tr>
<td>NUTR*3210</td>
<td>0.50</td>
<td>Fundamentals of Nutrition</td>
</tr>
<tr>
<td>STAT*2040</td>
<td>0.50</td>
<td>Statistics I</td>
</tr>
</tbody>
</table>

0.50 electives

### Summer Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
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</tr>
</thead>
<tbody>
<tr>
<td>COOP*1000</td>
<td>0.00</td>
<td>Co-op Work Term I</td>
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### Semester 5 - Fall

<table>
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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>FOOD*3030</td>
<td>0.50</td>
<td>Food Chemistry I</td>
</tr>
<tr>
<td>FOOD*3160</td>
<td>0.75</td>
<td>Food Processing I</td>
</tr>
<tr>
<td>FOOD*3230</td>
<td>0.75</td>
<td>Food Microbiology</td>
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</table>

0.50 electives

### Semester 6 - Winter

<table>
<thead>
<tr>
<th>Course Code</th>
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</thead>
<tbody>
<tr>
<td>FOOD*3040</td>
<td>0.50</td>
<td>Food Chemistry II</td>
</tr>
<tr>
<td>FOOD*3170</td>
<td>0.50</td>
<td>Food Processing II</td>
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<tr>
<td>FOOD*3260</td>
<td>0.50</td>
<td>Industrial Microbiology</td>
</tr>
<tr>
<td>FOOD*3700</td>
<td>0.50</td>
<td>Sensory Evaluation of Foods</td>
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</table>

0.50 electives

### Summer Semester

Optional

### Fall Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
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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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### Winter Semester

<table>
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<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>COOP*3000</td>
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<td>Co-op Work Term III</td>
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### Semester 7 - Fall

<table>
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<tr>
<th>Course Code</th>
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</thead>
<tbody>
<tr>
<td>FOOD*4190</td>
<td>0.50</td>
<td>Advanced Food Analysis</td>
</tr>
<tr>
<td>FOOD*4260</td>
<td>0.50</td>
<td>Food Product Development I</td>
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1.50 electives

### Semester 8 - Winter

<table>
<thead>
<tr>
<th>Course Code</th>
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</thead>
<tbody>
<tr>
<td>FOOD*4270</td>
<td>0.50</td>
<td>Food Product Development II</td>
</tr>
</tbody>
</table>

2.00 electives

Notes:

See Notes and Credit Summary in Food Science Major.

### Geographic Information Systems (GIS) and Environmental Analysis

#### Department of Geography, College of Social and Applied Human Sciences

#### Minor (Honours Program)

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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOG*1300</td>
<td>0.50</td>
<td>Introduction to the Biophysical Environment</td>
</tr>
<tr>
<td>GEOG*2420</td>
<td>0.50</td>
<td>The Earth From Space</td>
</tr>
<tr>
<td>GEOG*2480</td>
<td>0.50</td>
<td>Mapping and GIS</td>
</tr>
<tr>
<td>GEOG*3420</td>
<td>0.50</td>
<td>Remote Sensing of the Environment</td>
</tr>
<tr>
<td>GEOG*3480</td>
<td>0.50</td>
<td>GIS and Spatial Analysis</td>
</tr>
<tr>
<td>GEOG*4480</td>
<td>1.00</td>
<td>Applied Geomatics</td>
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</table>

And at least 1.50 credits from:

<table>
<thead>
<tr>
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<th>Credits</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOG*2110</td>
<td>0.50</td>
<td>Climate and the Biophysical Environment</td>
</tr>
<tr>
<td>GEOG*2210</td>
<td>0.50</td>
<td>Environment and Resources</td>
</tr>
<tr>
<td>GEOG*3110</td>
<td>0.50</td>
<td>Biotic and Natural Resources</td>
</tr>
<tr>
<td>GEOG*3210</td>
<td>0.50</td>
<td>Management of the Biophysical Environment</td>
</tr>
<tr>
<td>GEOG*4110</td>
<td>1.00</td>
<td>Environmental Systems Analysis</td>
</tr>
<tr>
<td>GEOG*4210</td>
<td>0.50</td>
<td>Environmental Governance</td>
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</table>

### Human Kinetics (HK)

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

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

If lacking the fundamentals of word processing, 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 with 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, of which 16.00 must be from the list of acceptable science courses, are required.

#### Semester 1

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*1080</td>
<td>0.50</td>
<td>Biological Concepts of Health</td>
</tr>
<tr>
<td>CHEM*1040</td>
<td>0.50</td>
<td>General Chemistry I</td>
</tr>
<tr>
<td>MATH*1080</td>
<td>0.50</td>
<td>Elements of Calculus II</td>
</tr>
<tr>
<td>PHYS*1080</td>
<td>0.50</td>
<td>Physics for Life Sciences II</td>
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</table>

0.50 Arts or Social Science electives

#### Semester 2

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

0.50 arts or social science electives

#### Semester 3

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC*2580</td>
<td>0.50</td>
<td>Introduction to Biochemistry</td>
</tr>
<tr>
<td>HK*2270</td>
<td>0.50</td>
<td>Principles of Human Biomechanics</td>
</tr>
<tr>
<td>MCB*2040</td>
<td>0.50</td>
<td>Foundations in Molecular Biology and Genetics</td>
</tr>
<tr>
<td>STAT*2040</td>
<td>0.50</td>
<td>Statistics I</td>
</tr>
</tbody>
</table>

0.50 Arts or Social Science electives

#### Semester 4

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

0.50 electives

0.50 Arts or Social Science electives

#### Semester 5

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

One of:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Title</th>
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<tbody>
<tr>
<td>HK*3401</td>
<td>0.75</td>
<td>Human Anatomy: Dissection</td>
</tr>
<tr>
<td>HK*3501</td>
<td>0.75</td>
<td>Human Anatomy: Prosection</td>
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#### Semester 6

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BIOC*3560</td>
<td>0.50</td>
<td>Structure and Function in Biochemistry</td>
</tr>
<tr>
<td>HK*3100</td>
<td>0.50</td>
<td>Neuromuscular Physiology</td>
</tr>
<tr>
<td>HK*4600</td>
<td>0.75</td>
<td>Applied Human Kinetics II</td>
</tr>
</tbody>
</table>

One of:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Title</th>
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<tbody>
<tr>
<td>HK*3402</td>
<td>0.75</td>
<td>Human Anatomy: Dissection (if registered in HK*3401 in semester 5)</td>
</tr>
<tr>
<td>HK*3502</td>
<td>0.75</td>
<td>Human Anatomy (if registered in HK*3501 in semester 5)</td>
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#### Semester 7

<table>
<thead>
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<th>Course Code</th>
<th>Credits</th>
<th>Title</th>
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<tbody>
<tr>
<td>HK*4550</td>
<td>0.50</td>
<td>Human Cardio-respiratory Physiology</td>
</tr>
<tr>
<td>NUTR*4210</td>
<td>0.50</td>
<td>Nutrition, Exercise and Energy Metabolism</td>
</tr>
</tbody>
</table>

1.50 electives or restricted electives

#### Semester 8

2.25 electives or restricted electives
Restricted Electives
1. 2.00 credits of Approved Arts and Social Science electives.
2. A minimum of 2.00 credits of restricted electives are required which must be selected from HK*4XXX, NUR*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 - Approved Arts and/or Social Science electives (#1 in restricted electives list)
2.00 - Free electives - any approved electives for B.Sc. students.

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

Marine and Freshwater Biology (MFB)

Department of Integrative Biology, College of Biological Science

The Marine and Freshwater Biology major capitalizes on Guelph’s recognized excellence in aquatic research. In this major, you will build upon core courses in ecology, evolution, genetics, physiology and zoology 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. This program prepares students for post-graduate work in the aquatic sciences, and provides a sound scientific background for students wishing to pursue careers in biology, management and conservation, aquaculture, biotechnology, education, and research either in government or the private sectors.

Major (Honours Program)

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

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

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

Semester 2
BIOL*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 Arts or Social Science 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
BIOL*3450 [0.50] Introduction to Aquatic Environments
ZOO*3600 [0.50] Comparative Animal Physiology I
ZOO*3610 [0.25] Lab Studies in Animal Physiology I
ZOO*3700 [0.50] Integrative Biology of Invertebrates
Electives or restricted electives to a maximum of 2.75 total credits in this semester.

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 2.25 total credits in this semester.

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

Semester 8
BIOL*4010 [0.50] Adaptational Physiology
ZOO*4330 [0.50] Biology of Fishes
ZOO*4570 [0.50] Marine Ecological Processes
1.00 electives or restricted electives

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

Restricted Electives
At least 1.00 credits of Arts or Social Science electives are required. The list of approved Arts and Social Science electives for B.Sc. students is available at: http://www.bsc.uoguelph.ca/Approved_electives.shtml\#Arts

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 - Arts and/or Social Science 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.

Mathematical Science (MSCI)

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

Major (Honours Program)

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

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major must consult the Faculty Advisor. A total of 20.00 credits is required to complete the Major which includes at least 10.00 credits in Mathematics & Statistics, 0.50 credits in Computing and Information Science, and an additional 2.50 credits in an area of emphasis.

Semester 1
CHEM*1040 [0.50] General Chemistry I
MATH*1160 [0.50] Linear Algebra I
One of ***
BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1080 [0.50] Biological Concepts of Health
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
1.00 credits from: IPS*1500, or (MATH*1080, PHYS*1080) or (MATH*1200, PHYS*1080)*

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

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*1500, or (MATH*1080, PHYS*1080) or (MATH*1200, PHYS*1080)**

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

Semester 3
MATH*2130 [0.50] Numerical Methods
STAT*2050 [0.50] Statistics II
1.50 electives or restricted electives (CIS*2500 recommended)

Semester 4
MATH*2130 [0.50] Numerical Methods
STAT*2050 [0.50] Statistics II
1.50 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. 1.00 credits of Approved Arts and/or Social Science electives
2. 5.50 credits from either the Mathematics Stream or the Statistics Stream as follows:
   3. 2.50 credits from an Area of Emphasis

#### Mathematics Stream:

- MATH*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
- 0.50 additional credits in MATH at 3000 level or above
- 3.00 additional credits in MATH or STAT at 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 3000 level or above
- 1.00 additional credits in MATH or STAT at 2000 level or above
- 3.00 additional credits in MATH or STAT at 3000 level or above of which at least 1.50 credits must be STAT at the 4000 level

### AREAS OF EMPHASIS

#### 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
- MBC*2040 [0.50] Foundations in Molecular Biology and Genetics

#### BIOMATHEMATICAL OR BIOSTATISTICAL MODELLING (BBM)

The following credits must be taken:

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

### COMPUTER SCIENCE (CS)

The following credits must be taken:

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

at least 1.00 credits from:

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

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

### ECONOMICS (ECON)

The following credits must be taken:

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

at least 1.00 credits from:

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

**Note:** ECON*1050 and ECON*1100 are approved Arts or Social Science electives for B.Sc. students

### ENERGY AND MASS TRANSFER (EMT)

The following credits must be taken:

- ENGG*1210 [0.50] Engineering Mechanics I
- ENGG*2230 [0.50] Fluid Mechanics
- ENGG*2400 [0.50] Engineering Systems Analysis
- ENGG*3260 [0.50] Thermodynamics
- ENGG*3430 [0.50] Heat and Mass Transfer

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

### ELECTRICITY AND SYSTEMS (EAS)

The following credits must be taken:

- ENGG*1210 [0.50] Engineering Mechanics I
- ENGG*2400 [0.50] Engineering Systems Analysis
- ENGG*2450 [0.50] Electric Circuits

at least 1.00 credits from:

- ENGG*3410 [0.50] Systems and Control Theory
- ENGG*3450 [0.50] Electrical Devices
- ENGG*4460 [0.50] Robotic Systems

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

### SIGNAL PROCESSING (SP)

The following credits must be taken:

- ENGG*1210 [0.50] Engineering Mechanics I
- ENGG*2400 [0.50] Engineering Systems Analysis
- ENGG*2450 [0.50] Electric Circuits
- ENGG*3390 [0.50] Signal Processing
- ENGG*4660 [0.50] Medical Image Processing

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

### INDIVIDUALIZED (IN)

It is required that 2.5 credits are taken from approved Science electives for B.Sc. students where 1.00 credits must be at the 3000 level or above.

### Credit Summary (20.00 Total Credits)

- 5.00 - First year science credits
- 3.00 - Required science courses (semesters 3 – 8)
- 8.00 - Restricted electives (Stream and Area of Emphasis)
- 1.00 - Arts and/or Social Science electives (#1 in restricted elective list)
- 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.

### 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. This minor cannot be combined with a major in Mathematical Science or Computing and Information Science.

### Mathematics (MATH)

#### Department of Mathematics and Statistics, College of Physical and Engineering Science

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*1210 or MATH*2080)**
- MATH*1160 [0.50] Linear Algebra I
- MATH*2200 [0.50] Advanced Calculus I
- STAT*2040 [0.50] Statistics I
- 1.00 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

### 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 or a Minor 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.
**PATH**3040 [0.50] Principles of Parasitology

**Credit Summary (20.00 Total Credits)**
4.00 - First year science core
6.25 - Required science courses semesters 3 - 8
3.50 - Restricted electives (#2 in restricted electives list)
2.25 - Approved Science electives
2.00 - Approved Arts and/or Social Science electives (#1 in restricted electives list)
2.00 - Free electives - any approved electives for B.Sc. students.

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

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

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

A minimum of 2.50 credits from:

- FOOD*3230 [0.75] Food Microbiology
- FOOD*3240 [0.50] Food Microbiology
- FOOD*3260 [0.50] Industrial Microbiology
- FOOD*3270 [0.50] Industrial Microbiology
- MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
- MBG*3080 [0.50] Bacterial Genetics
- MBG*3350 [0.75] Laboratory Methods in Molecular Biology I
- MICR*3090 [0.50] Mycology
- MICR*3220 [0.50] Plant Microbiology
- MICR*3230 [0.50] Immunology
- MICR*3260 [0.50] Microbial Adaptation
- MICR*3330 [0.50] World of Viruses
- MICR*3420 [0.50] Microbial Diversity
- MICR*3430 [0.50] Microbiology Methods II
- MICR*4520 [0.50] Microbial Cell Biology

1.00 credits from:

- MICR*4010 [0.50] Pathogenic Bacteriology
- MICR*4280 [0.50] Microbial Ecology
- MICR*4330 [0.50] Molecular Virology
- MICR*4430 [0.50] Medical Virology
- MICR*4530 [0.50] Immunology II

**Microbiology (Co-op) (MICR:C)**

Department of Molecular and Cellular Biology, College of Biological Science

Students in the Major in Microbiology program may take the Co-op option. Students do not begin their first work term until they have completed semester 3 and courses BIOL*1070, BIOL*1080, BIOL*1090 and MICR*2430. Students in the co-op program must also complete COOP*1100 in the second academic semester. At least 3 work terms (COOP*1000, COOP*2000, COOP*3000) are required in the co-op program, and the course requirements are the same as shown for the major program. Some courses must be taken during a different semester than usual, and Co-op students generally require an additional semester to meet all the program requirements. Students should plan their programs in consultation with the faculty advisor. A total of 20.00 credits are required to major. A minimum of 6.00 science credits must be at the 3000/4000 level of which at least 2.00 credits must be at the 4000 level (including the 1.00 from the restricted elective credits).

**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 Arts or Social Science electives

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

### Semester 2 - Winter

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

### Semester 4

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

### Semester 5

- MBG*3080 [0.50] Bacterial Genetics
- MICR*3420 [0.50] Microbial Diversity
- 1.50 electives or restricted electives

### Semester 6

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

### Semester 7

- 2.50 electives or restricted electives which can include MCB*4500

### Semester 8

- 2.50 electives or restricted electives which can include MCB*4510

**Restricted Electives**

1. A minimum of 2.00 credits of Arts and/or Social Science electives are required. The list of approved Arts and Social Science electives for B.Sc. students is available at [http://www.bsc.uoguelph.ca/Approved_electives.shtml#arts](http://www.bsc.uoguelph.ca/Approved_electives.shtml#arts).

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

- BIOC*4540 [0.75] Enzymology
- BIOC*4580 [0.50] Membrane Biochemistry
- ENVS*3290 [0.50] Waterborne Disease Ecology
- FOOD*3230 [0.75] Food Microbiology
- FOOD*3240 [0.50] Food Microbiology
- FOOD*3260 [0.50] Industrial Microbiology
- FOOD*3270 [0.50] Industrial Microbiology
- FOOD*4000 [0.50] Dairy Processing
- MCB*3010 [0.50] Dynamics of Cell Function and Signaling
- MCB*4500 [1.00] Research Project in Molecular & Cellular Biology I
- MCB*4510 [1.00] Research Project in Molecular & Cellular Biology II
- MCB*4600 [0.50] Topics in Molecular and Cellular Biology
- MICR*3090 [0.50] Mycology
- MICR*3220 [0.50] Plant Microbiology
- MICR*3230 [0.50] Immunology
- MICR*3330 [0.50] World of Viruses
- MICR*4010 [0.50] Pathogenic Bacteriology
- MICR*4280 [0.50] Microbial Ecology
- MICR*4330 [0.50] Molecular Virology
- MICR*4430 [0.50] Medical Virology
- MICR*4520 [0.50] Microbial Cell Biology
- MICR*4530 [0.50] Immunology II

**Summer Semester**

No academic semester or work term

**Semester 3 - Fall**

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

2016-2017 Undergraduate Calendar

Last Revision: January 31, 2017
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 must 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 Arts or Social Science electives

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

Semester 2
- BIOL*1070 [0.50] Discovering Biodiversity
- BIOL*1080 [0.50] Biological Concepts of Health
- CHEM*1050 [0.50] General Chemistry II
- PHYS*1070 [0.50] Physics for Life Sciences II
- 0.50 Arts or Social Science electives

Semester 3
- BIOL*2580 [0.50] Introduction to Biochemistry
- MBG*2400 [0.50] Foundations in Molecular Biology and Genetics
- MBG*3420 [0.50] Introduction to Microbiology
- MCB*3540 [0.50] Statistics I
- 0.50 Arts or Social Science electives

Semester 4
- BIOL*3560 [0.50] Structure and Function in Biochemistry
- MCB*2050 [0.50] Molecular Biology of the Cell
- MCB*3530 [0.50] Methods in Microbial Culture and Physiology
- STAT*2050 [0.50] Statistics II
- 0.50 Arts or Social Science electives

Semester 5
- MCB*3440 [0.50] Fundamentals of Plant and Animal Genetics
- MBG*3350 [0.75] Laboratory Methods in Molecular Biology I
- 1.50 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
- MCB*4510 [1.00] Research Project in Molecular & Cellular Biology II
- 1.50 Electives or restricted electives

Semester 8
- MCB*4500 [1.00] Research Project in Molecular & Cellular Biology I
- MCB*4510 [1.00] Research Project in Molecular & Cellular Biology II
- 1.50 Electives or restricted electives

Restricted Electives

1. At least 2.00 Arts and/or Social Science electives are required. The list of approved Arts and Social Science electives for B.Sc. students is available at: [http://www.bsc.uoguelph.ca/Approved_electives.shtml#arts](http://www.bsc.uoguelph.ca/Approved_electives.shtml#arts)

2. Medical science electives for students majoring in Molecular Biology and Genetics are directed by the Department of Biology.

3. Subject Area Electives - 3.00 credits (4.50 if MCB*4600 and MCB*4510 are taken instead of MCB*4500 and MCB*4510)

- BIOL*3020 [0.50] Population Genetics
- BIOL*3300 [0.50] Applied Bioinformatics
- MBG*3050 [0.50] Human Genetics
- MBG*3060 [0.50] Quantitative Genetics
- MBG*3080 [0.50] Bacterial Genetics
- MBG*3100 [0.50] Plant Genetics
- MBG*3360 [0.75] Laboratory Methods in Molecular Biology II
- MBG*3660 [0.50] Genomics

Credit Summary (20.00 Total Credits)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>MBG*2040</td>
<td>Foundations in Molecular Biology and Genetics</td>
<td>0.50</td>
</tr>
<tr>
<td>MCB*2420</td>
<td>Introduction to Microbiology</td>
<td>0.50</td>
</tr>
<tr>
<td>STAT*2040</td>
<td>Statistics I</td>
<td>0.50</td>
</tr>
<tr>
<td>0.50 Arts or Social Science electives</td>
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Semester 4 - Winter

- BIOL*3560 [0.50] Structure and Function in Biochemistry
- MCB*2050 [0.50] Molecular Biology of the Cell
- MCB*2430 [0.50] Methods in Microbial Culture and Physiology
- 0.50 Electives
- 0.50 Arts or Social Science electives

Summer Semester

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

Semester 5 - Fall

- MBG*3080 [0.50] Bacterial Genetics
- MCB*3420 [0.50] Microbial Diversity
- 1.50 Electives or restricted electives

Semester 6 - Winter

- MBG*3350 [0.75] Laboratory Methods in Molecular Biology I
- MCB*3260 [0.50] Microbial Adaptation
- MCB*3430 [0.50] Microbiology Methods II
- A minimum of 0.75 Electives or restricted electives

Summer - Semester

Optional

Fall Semester

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

Winter Semester

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

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 Arts or Social Science electives are required. The list of approved Arts and Social Science electives for B.Sc. students is available at: [http://www.bsc.uoguelph.ca/Approved_electives.shtml#arts](http://www.bsc.uoguelph.ca/Approved_electives.shtml#arts)

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

   - BIOL*4540 [0.75] Enzymology
   - BIOL*4580 [0.50] Membrane Biochemistry
   - ENVS*3290 [0.50] Waterborne Disease Ecology
   - FOOD*3230 [0.75] Food Microbiology
   - FOOD*3240 [0.50] Food Microbiology
   - FOOD*3260 [0.50] Industrial Microbiology
   - FOOD*3270 [0.50] Industrial Microbiology
   - FOOD*4400 [0.50] Dairy Processing
   - MCB*3010 [0.50] Dynamics of Cell Function and Signaling
   - MCB*4500 [1.00] Research Project in Molecular & Cellular Biology I
   - MCB*4510 [1.00] Research Project in Molecular & Cellular Biology II
   - MCB*4600 [0.50] Topics in Molecular and Cellular Biology
   - MCB*3090 [0.50] Mycology
   - MCB*3220 [0.50] Plant Microbiology
   - MCB*3230 [0.50] Immunology
   - MCB*3330 [0.50] World of Viruses
   - MCB*4010 [0.50] Pathogenic Bacteriology
   - MCB*4280 [0.50] Microbial Ecology
   - MCB*4330 [0.50] Molecular Virology
   - MCB*4430 [0.50] Medical Virology
   - MCB*4520 [0.50] Microbial Cell Biology
   - MCB*4530 [0.50] Immunology II
   - PATH*3040 [0.50] Principles of Parasitology

Credit Summary (20.00 Total Credits)

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<tr>
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<tr>
<td>MCB*2420</td>
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<td>Statistics I</td>
<td>0.50</td>
</tr>
<tr>
<td>0.50 Arts or Social Science electives</td>
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</tbody>
</table>

Last Revision: January 31, 2017

2016-2017 Undergraduate Calendar
MBG*4030 [0.50] Animal Breeding Methods and Applications
MBG*4040 [0.50] Genetics and Molecular Biology of Development
MBG*4080 [0.50] Molecular Genetics
MBG*4110 [0.50] Advanced Concepts in Genetics
MBG*4160 [0.50] Plant Breeding
MBG*4240 [0.50] Advanced Molecular Biology Techniques
MBG*4270 [0.50] DNA Replication, Recombination and Repair
MBG*4300 [0.50] Plant Molecular Genetics
MCB*3010 [0.50] Dynamics of Cell Function and Signaling
MCB*4010 [0.50] Advanced Cell Biology
MICR*3330 [0.50] World of Viruses
MICR*4330 [0.50] Molecular Virology

Credit Summary (20.00 Total Credits)
4.00 - First year science core
7.25 - Required science courses semesters 3 - 8
3.50 - Restricted electives (#2 and 3 in restricted electives list)
1.25 - Approved science electives
2.00 - Arts and/or Social Science electives (#1 in the restricted electives list)
2.00 - Free electives - any approved elective for B.Sc. Students

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

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

MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
MCB*2050 [0.50] Molecular Biology of the Cell

A minimum of 4.00 credits from:

BIOL*3560 [0.50] Structure and Function in Biochemistry
BIOL*3020 [0.50] Population Genetics
BIOL*3300 [0.50] Applied Bioinformatics
MBG*2400 [0.50] Fundamentals of Plant and Animal Genetics
MBG*3050 [0.50] Human Genetics
MBG*3060 [0.50] Quantitative Genetics
MBG*3080 [0.50] Bacterial Genetics
MBG*3100 [0.50] Plant Genetics
MBG*3350 [0.75] Laboratory Methods in Molecular Biology I
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*4080 [0.50] Molecular Genetics
MBG*4110 [0.50] Advanced Concepts in Genetics
MBG*4160 [0.50] Plant Breeding
MBG*4240 [0.50] Advanced Molecular Biology Techniques
MBG*4270 [0.50] DNA Replication, Recombination and Repair
MBG*4300 [0.50] Plant Molecular Genetics
MCB*3010 [0.50] Dynamics of Cell Function and Signaling
MCB*4010 [0.50] Advanced Cell Biology
MCB*4050 [0.50] Protein and Nucleic Acid Structure
MICR*3330 [0.50] World of Viruses
MICR*4330 [0.50] Molecular Virology

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

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: http://www.bsc.uoguelph.ca/revisedssd

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
One of:
CHEM*3860 [0.50] Quantum Chemistry
PHYS*3230 [0.50] Quantum Mechanics I
NANO*3500 [0.50] Thin Film Science
NANO*3600 [0.50] Computational Methods in Materials Science
1.00 electives

Semester 6
NANO*3200 [0.50] Nanolithographic Techniques
NANO*3300 [0.50] Spectroscopy of Nanomaterials
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*3660
Semester 6: CHEM*3430 or CHEM*3870
Semester 7: CHEM*3440
Semester 8: CHEM*3430 or CHEM*3870

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

Mathematics and Statistics
Semester 4: STAT*2040
Semester 5: STAT*3100
Semester 6: MATH*2130
Semester 8: MATH*3160, MATH*4240

Physics
Semester 4: PHYS*2340
Semester 5: MATH*2200, PHYS*3130
Semester 6: PHYS*3000
NANO*4700 [0.50] Concepts in Quantum Computing
1.50 electives

**Semester 7 - Winter**

NANO*3200 [0.50] Nanolithographic Techniques
NANO*3300 [0.50] Spectroscopy of Nanomaterials
1.50 electives

**Summer Semester**

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

**Fall Semester**

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

**Semester 8 – Winter**

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:** Four work terms are required for the completion of the co-op degree. It is also necessary that there be at least one work term in each of Winter, Fall, and Summer semesters. Therefore, one of the summer work terms could be missed and the student would still graduate successfully. It is only required to complete 4 of the 5 listed work terms. A report is required for each work term completed, even when all 5 are done. Contact the co-op faculty advisor for further details.

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

**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 - Arts and/or Social Science 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 Physical and Engineering Science

**Major (Honours Program)**

The major will require the completion of 20.00 credits as indicated below. To graduate from the co-op program, a minimum of 4 successfully completed work terms is normally required. Students are eligible to participate in a maximum two (2) work terms commencing in the summer and must follow the academic work schedule as outlined in the Co-operative Education & Career Services website: https://www.recruitguelph.ca/cces/

**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/garde 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: http://www.bsc.uoguelph.ca/revisedss

One of:

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

**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

**Semester 3 - Fall**

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

One of:

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

**Semester 4 - Winter**

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

1.00 electives*

**Summer Semester**

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

**Semester 5 - Fall**

NANO*3600 [0.50] Computational Methods in Materials Science
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 [0.00] Co-op Work Term II

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

**Summer Semester**

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

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

**Semester 6 - Fall**

NANO*4100 [0.50] Biological Nanomaterials
### Nutritional and Nutraceutical Sciences (NANS)

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

The Nutritional and Nutraceutical Sciences major is concerned with understanding the contribution of food, beverage and nutritional supplement consumption to growth, development of optimal biological function, maintenance of health, and treatment of disease. If lacking the fundamentals of word processing, spreadsheet use and data management, the student should select CSIS*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 must consult the Faculty Advisor. A total of 20.00 credits is required, including 2.00 credits from Arts and Social Sciences courses.

**Semester 1**

<table>
<thead>
<tr>
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<tr>
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**Semester 8**

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</table>

**Credit Summary (20.00 Total Credits)**

- 2.00 electives or restricted electives
- **3.50** - Science core
- **2.00** - Restricted electives
- **1.50** - Restricted electives
- **6.00** - Restricted electives
- **1.50** - Restricted electives
- **3.00** - Restricted electives
- **1.50** - Restricted electives
- **3.00** - Restricted electives

**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>Credit Hours</th>
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</thead>
<tbody>
<tr>
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</table>

**Physical Science (PSCI)**

**College of Physical and Engineering Science**

**Major (Honours Program)**

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

1. **Basic Science Core - 4.00 credits**
   - 1.00 - Biology (BIOL*1070, BIOL*1080, BIOL*1090)
X. Degree Programs, Bachelor of Science (B.Sc.)

1.00 - Chemistry [CHEM*1040, CHEM*1050]*
1.00 - Physics [PHYS*1080, (1 of PHYS*1010, PHYS*1070, PHYS*1130)]*
1.00 - Mathematical Science [(MATH*1080, MATH*2080) or (MATH*1200, MATH*1210)]*
* IPS*1500 can be taken instead of PHYS*1080 and MATH*1200, and IPS*1510 can be taken instead of PHYS*1010 and MATH*1210.

2. Subject Area Core - 8.00 credits
0.50 STAT*2040
0.50 (CIS*1200 or CIS*1500)
7.00 physical science credits, including at least 4.00 credits at the 3000 or 4000 level of which 2.00 credits must be at the 4000 level.

3. Science Electives - 4.00 credits
4.00 science credits from the List of Approved Science Electives for B.Sc. Students*

4. Arts and Social Science Electives - 2.00
2.00 acceptable Arts or Social Science credits selected from the List of Approved B.Sc. Electives*

5. Free Electives - 2.00 credits
Note: the program must include a total of 6.00 science credits at the 3000 or 4000 level. Of these, at least 2.00 credits must be physical science at the 4000 level.

Semester 1
CHEM*1040 [0.50] General Chemistry I
PHYS*1080 [0.50] Physics for Life Sciences
One of:
MATH*1080 [0.50] Elements of Calculus I
MATH*1200 [0.50] Calculus I
* IPS*1500 can be taken instead of PHYS*1000 and MATH*1200.
One of:
BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1080 [0.50] Biological Concepts of Health
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
0.50 Arts or Social Science electives
Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at: [http://www.bsc.uoguelph.ca/revisedss](http://www.bsc.uoguelph.ca/revisedss)

Semester 2
CHEM*1050 [0.50] General Chemistry II
PHYS*1010 [0.50] Introductory Electricity and Magnetism
PHYS*1080 [0.50] Physics for Life Sciences
PHYS*1130 [0.50] Physics with Applications
One of:
MATH*1210 [0.50] Calculus II
MATH*2080 [0.50] Elements of Calculus II
IPS*1510 can be taken instead of PHYS*1010 and MATH*1210.
One of:
BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1080 [0.50] Biological Concepts of Health
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology
0.50 Arts or Social Science electives

Semester 3
1.50 science electives from the approved list of acceptable B.Sc. science electives* 0.50 electives
One of:
CIS*1200 [0.50] Introduction to Computing
CIS*1500 [0.50] Introduction to Programming
OR STAT*2040 [0.50] Statistics I

Semester 4
1.50 science electives from the approved list of B.Sc. science electives* 0.50 electives
One of:
CIS*1200 [0.50] Introduction to Computing
CIS*1500 [0.50] Introduction to Programming
(if a statistics course is chosen in Semester 3)
OR STAT*2040 [0.50] Statistics I
(if a computing course is chosen in Semester 3)

Semester 5 to 8
Total of 2.50 credits per semester including at least 2.00 science electives.
Sufficient courses at the 3000 or 4000 level must be selected in Semesters 5 through 8 to total 6.00 credits in science at the 3000 or 4000 level with at least 2.00 physical science at the 4000 level.

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

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 - Arts and/or Social Science 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 Physical and Engineering Science

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

Major (Honours Program)

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

Semester 1*
CHEM*1040 [0.50] General Chemistry I
IPS*1500 [1.00] Integrated Mathematics and Physics I
MATH*1160 [0.50] Linear Algebra I
One of:
BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1080 [0.50] Biological Concepts of Health
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology

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: [http://www.bsc.uoguelph.ca/revisedss](http://www.bsc.uoguelph.ca/revisedss)

Semester 2*
CHEM*1050 [0.50] General Chemistry II
CIS*1500 [0.50] Introduction to Programming
IPS*1510 [1.00] Integrated Mathematics and Physics II
One of:
BIOL*1070 [0.50] Discovering Biodiversity
BIOL*1080 [0.50] Biological Concepts of Health
BIOL*1090 [0.50] Introduction to Molecular and Cellular Biology

* students who have taken physics courses other than IPS*1500 or PHYS*1000 in Semester 1 and IPS*1510 or PHYS*1010 in Semester 2, may proceed to semester 3 with the permission of the Department of Physics.

Semester 3
MATH*2200 [0.50] Advanced Calculus I
MATH*2270 [0.50] Applied Differential Equations
PHYS*2240 [0.50] Thermal Physics
PHYS*2330 [0.50] Electricity and Magnetism I
0.50 Arts or Social Science electives

Semester 4
PHYS*2180 [0.50] Experimental Techniques in Physics
PHYS*2310 [0.50] Mechanics
PHYS*2340 [0.50] Electricity and Magnetism II
1.00 electives

Semester 5
NANO*3600 [0.50] Computational Methods in Materials Science
PHYS*3130 [0.50] Mathematical Physics
PHYS*3230 [0.50] Quantum Mechanics I
PHYS*3400 [0.50] Advanced Mechanics
0.50 electives

Semester 6
PHYS*3000 [0.50] Optics: Fundamentals and Applications
PHYS*3510 [0.50] Intermediate Laboratory
PHYS*4040 [0.50] Quantum Mechanics II
PHYS*4300 [0.50] Inquiry in Physics

One of:

Last Revision: January 31, 2017

2016-2017 Undergraduate Calendar
### Credit Summary (20.00 Total Credits)

<table>
<thead>
<tr>
<th>Semester</th>
<th>Courses</th>
<th>Credits</th>
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<td>First year science credits</td>
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<td>Required science courses semesters 3 – 8</td>
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<td>1.00</td>
<td>Restricted electives (1.00 credits from List A and 0.50 credits from List B, some restricted electives from List B do not count as science electives towards degree therefore may need additional science electives)</td>
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<td>1.00</td>
<td>Approved science electives (depending on restricted electives chosen)</td>
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<td>Arts and/or Social Science electives</td>
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<td>Students 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.</td>
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<td>Minor (Honours Program)</td>
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<tr>
<td></td>
<td>A minor in Physics requires 5.00 credits in interdisciplinary physical science or physics courses including:</td>
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<tr>
<td></td>
<td>PHYS*2180 [0.50] Experimental Techniques in Physics</td>
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<td>PHYS*2310 [0.50] Mechanics</td>
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<td>PHYS*2330 [0.50] Electricity and Magnetism I</td>
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<td>A maximum of 1.00 credits from the following courses may be used towards the minor:</td>
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<td>PHYS*1010 [0.50] Introductory Electricity and Magnetism</td>
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<td>PHYS*1070 [0.50] Physics for Life Sciences II</td>
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<td>PHYS*1080 [0.50] Physics for Life Sciences</td>
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<td>PHYS*1130 [0.50] Physics with Applications</td>
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<td>IPS*1510.00 [1.00] Integrated Mathematics and Physics II</td>
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<td>A minimum of 1.00 credits are required at the 3000 or 4000 level.</td>
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<td><strong>NOTE:</strong> PHYS<em>1300, PHYS</em>1600 and PHYS*1810 may not be taken for credit toward this minor.</td>
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### Major (Honours Program)

This major requires the completion of 20.00 credits.

#### Semester 1 - Fall

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<td>PHYS*4190</td>
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<td><strong>Introduction to Molecular and Cellular Biology</strong></td>
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#### Semester 3 - Fall

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<td>MATH*2200</td>
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<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><strong>Thermal Physics</strong></td>
</tr>
<tr>
<td>PHYS*2330</td>
<td>0.50</td>
<td><strong>Electricity and Magnetism I</strong></td>
</tr>
<tr>
<td>PHYS*2340</td>
<td>0.50</td>
<td><strong>Electricity and Magnetism II</strong></td>
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</table>

#### Semester 4 - Winter

<table>
<thead>
<tr>
<th>Course</th>
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<tbody>
<tr>
<td>PHYS*2180</td>
<td>0.50</td>
<td>Experimental Techniques in Physics</td>
</tr>
<tr>
<td>PHYS*2310</td>
<td>0.50</td>
<td>Mechanics</td>
</tr>
<tr>
<td>PHYS*2340</td>
<td>0.50</td>
<td><strong>Electricity and Magnetism II</strong></td>
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#### Summer Semester

<table>
<thead>
<tr>
<th>Course</th>
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</tr>
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<tbody>
<tr>
<td>COOP*1000</td>
<td>0.00</td>
<td>Co-op Work Term I ++</td>
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#### Semester 5 - Fall

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<tr>
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<tbody>
<tr>
<td>NANO*3600</td>
<td>0.50</td>
<td>Computational Methods in Materials Science</td>
</tr>
<tr>
<td>PHYS*3130</td>
<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 I</td>
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#### Winter Semester

<table>
<thead>
<tr>
<th>Course</th>
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</tr>
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<tbody>
<tr>
<td>COOP*2000</td>
<td>0.00</td>
<td>Co-op Work Term II ++</td>
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### Summer Semester

<table>
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<tr>
<th>Course</th>
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<tbody>
<tr>
<td>COOP*3000</td>
<td>0.00</td>
<td>Co-op Work Term III ++</td>
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#### Semester 6 - Fall +

<table>
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<tr>
<th>Course</th>
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<tbody>
<tr>
<td>PHYS*4180</td>
<td>0.50</td>
<td>Advanced Electromagnetic Theory</td>
</tr>
<tr>
<td>PHYS*2310</td>
<td>0.50</td>
<td><strong>Data Structures</strong></td>
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#### Semester 7 - Winter +

<table>
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<tr>
<th>Course</th>
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<tbody>
<tr>
<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>
</tr>
<tr>
<td>PHYS*4300</td>
<td>0.50</td>
<td>Inquiry in Physics</td>
</tr>
</tbody>
</table>
One of:

MATH*3260 [0.50] Complex Analysis
0.50 electives**

Summer Semester

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

Fall Semester

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

Semester 8 - Winter +

PHYS*4500 [0.50] Advanced Physics Laboratory

One of:

PHYS*4130 [0.50] Subatomic Physics
0.50 electives**

One of:

PHYS*4150 [0.50] Solid State Physics
0.50 electives**

1.00 electives**

* 1.00 credits must be taken as Arts or Social Science electives in this Major
+ students going on to graduate school in physics should take PHYS*4130, PHYS*4150, and PHYS*4240
++At least 1.50 credits must be from lists A and B below. At least 1.00 credits must be from list A. Substitutions of courses in list B by other 3000 or 4000 level courses must be approved by the Physics Faculty Advisor.
+++Four work terms are required for the completion of the co-op degree. It is also necessary that there be at least one work term in each of Fall, Winter and Summer semesters. Therefore, one of the summer work terms could be missed and the student would still graduate successfully. Whether the student completes four or five work terms, a report is required for each work term completed. Contact the co-op faculty advisor for further details.

List A

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

List B

EDRD*3120 [0.50] Educational Communication
ENVS*3060 [0.50] Groundwater
GEOG*3420 [0.50] Remote Sensing of the Environment
MATH*3200 [0.50] Real Analysis
PHYS*3170 [0.50] Radioactivity and Radiation Interactions
PHYS*4070 [0.50] Clinical Applications of Physics in Medicine
PHYS*4540 [0.50] Molecular Biophysics
PHYS*4910 [0.50] Advanced Topics in Physics I
PHYS*4920 [0.50] Advanced Topics in Physics II
PHYS*4930 [0.50] Advanced Topics in Physics III
POLS*3370 [0.50] Environmental Politics and Governance
STAT*3240 [0.50] Applied Regression Analysis
STAT*3510 [0.50] Environmental Risk Assessment

Credit Summary (20.00 Total Credits)

5.00 - First year science credits
8.50 - Required science courses semesters 3 – 8
1.50 - Restricted electives (1.00 credits from List A and 0.50 credits from List B, some restricted electives from List B do not count as science electives towards degree therefore may need additional science electives)
1.00 or 1.50 - Approved Science electives (depending on restricted electives chosen)
1.00 - Arts and/or Social Science electives
2.50 - 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.

Particulars:

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 must consult the Faculty Advisor. The major requires the completion of 20.00 credits and students must declare one of the following areas of emphasis: Applied Plant Science, Botany, Plant Biotechnology, Plant Environmental Science or Unspecialized.

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 Arts or Social Science electives

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

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*2080 [0.50] Elements of Calculus II

0.50 Arts or Social Science 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 Arts and Social Science electives

Semester 4

MCB*2050 [0.50] Molecular Biology of the Cell
STAT*2040 [0.50] Statistics I
One of:

AGD*2050 [0.50] Agroecology
BIOC*2060 [0.50] Ecology

1.00 electives or restricted electives

Semester 5

BOT*3410 [0.50] Plant Anatomy

2.00 electives or restricted electives

Semester 6

BOT*3310 [0.50] Plant Growth and Development
BOT*3710 [0.50] Plant Diversity and Evolution

1.50 electives or restricted electives

Semester 7

2.50 electives or restricted electives

Semester 8

BOT*4380 [0.50] Metabolism in the Whole Life of Plants

2.00 electives or restricted electives

Program Requirements

1. Students must declare an area of emphasis in one of the following areas: Applied Plant Science, Botany, Plant Biotechnology, Plant Environmental Science or Unspecialized.
2. Students must complete at least 5.00 credits from within their area of emphasis.

Restricted Electives

1. A minimum of 1.50 credits of Arts and Social Science electives
2. 5.00 credits from within their areas of emphasis from the lists below

Note: Restricted electives, indicated with †, are non-science electives.

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

Students interested in graduate studies are encouraged to take two semesters of research projects which will count towards the restricted elective requirements in their area of emphasis. The following combinations of courses are examples of such combinations:

AGR*4450 [1.00] Research Project I
AGR*4460 [1.00] Research Project II

or

IBIO*4500 [0.75] Research in Integrative Biology I
IBIO*4510 [0.75] Research in Integrative Biology II

or

MCB*4500 [1.00] Research Project in Molecular & Cellular Biology I

MCB*4510 [1.00] Research Project in Molecular & Cellular Biology II

Credit Summary (20.00 Total Credits)

4.00 - First year science core
5.50 - 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 may need additional science electives)
1.50 - Approved science electives, if all restricted electives chosen are approved science electives.
Area of Emphasis

Applied Plant Science (APSC)

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

‡ 3.00 credits from:

CROP*3300 [0.50] Grain Crops
CROP*3310 [0.50] Protein and Oilsed Crops
CROP*3340 [0.50] Managed Grasslands
CROP*4220 [0.50] Cropping Systems **
ENVS*2040 [0.50] Plant Health and the Environment
ENVS*2340 [0.50] Current Issues in Agriculture and Landscape Mgmt
ENVS*3020 [0.50] Pesticides and the Environment
ENVS*3080 [0.50] Soil and Water Conservation
ENVS*3140 [0.50] Management of Turfgrass Diseases **
ENVS*3310 [0.50] Soil Biodiversity and Ecosystem Function
ENVS*4090 [0.50] Soil Management
HORT*2450 [0.50] Introduction to Turfgrass Science
HORT*3010 [0.50] Annual, Perennial and Indoor Plants - Identification and Use

‡ 3.00 credits from:

HORT*3050 [0.50] Management of Turfgrass Insect Pests and Weeds **
HORT*3150 [0.50] Principles and Applications of Plant Propagation
HORT*3270 [0.50] Medicinal Plants
HORT*3280 [0.50] Greenhouse Production
HORT*3430 [0.50] Wine-Grape Culture
HORT*3510 [0.50] Vegetable Production
HORT*4200 [0.50] Plants, the Environment and Society **
HORT*4300 [0.50] Postharvest Physiology
HORT*4420 [0.50] Fruit Crops
HORT*4450 [0.50] Advanced Turfgrass Science **
LARC*2240 [0.50] Plants in the Landscape

Botany (BOT)

BOT*3050 [0.50] Plant Functional Ecology **
MBG*3100 [0.50] Plant Genetics
MBG*4160 [0.50] Plant Breeding
OAGR*2070 [1.00] Introduction to Organic Agriculture
OAGR*4050 [1.00] Design of Organic Production Systems
PBIO*3110 [0.50] Crop Physiology
PBIO*3750 [0.50] Plant Tissue Culture
PBIO*4750 [0.50] Genetic Engineering of Plants
PBIO*4150 [0.50] Molecular and Cellular Aspects of Plant Development

‡ 3.00 credits from:

MBG*4300 [0.50] Plant Molecular Genetics
MICR*2420 [0.50] Introduction to Microbiology
MICR*3090 [0.50] Mycology
MICR*3220 [0.50] Plant Microbiology
PBIO*3110 [0.50] Crop Physiology
PBIO*3750 [0.50] Plant Tissue Culture
PBIO*4750 [0.50] Genetic Engineering of Plants

Plant Biotechnology (PBTC)

MBG*3110 [0.50] Plant Genetics
MBG*3350 [0.75] Laboratory Methods in Molecular Biology I
PBIO*3750 [0.50] Plant Tissue Culture
PBIO*4750 [0.50] Genetic Engineering of Plants

‡ minimum of 2.75 credits from:

BIOL*3300 [0.50] Applied Bioinformatics
MBG*2400 [0.50] Fundamentals of Plant and Animal Genetics
MBG*3660 [0.50] Genomics
MBG*4160 [0.50] Plant Breeding
MBG*4300 [0.50] Plant Molecular Genetics
MCP*4010 [0.50] Advanced Cell Biology
MICR*2420 [0.50] Introduction to Microbiology
MICR*3220 [0.50] Plant Microbiology
MICR*3230 [0.50] Immunology
MICR*3330 [0.50] World of Viruses
PBIO*3110 [0.50] Molecular and Cellular Aspects of Plant Development
PBIO*4150 [0.50] Molecular and Cellular Aspects of Plant Development

Plant Environmental Science (PESC)

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

‡ 3.00 credits from:

BIOL*3010 [0.50] Laboratory and Field Work in Ecology
BIOL*3060 [0.50] Populations, Communities & Ecosystems
BIOL*3130 [0.50] Conservation Biology
BIOL*4500 [0.50] Natural Resource Policy Analysis
ENVS*2060 [0.50] Soil Science
ENVS*2120 [0.50] Introduction to Environmental Stewardship **
ENVS*2330 [0.50] Current Issues in Ecosystem Science and Biodiversity
ENVS*3000 [0.50] Nature Interpretation **
ENVS*3020 [0.50] Pesticides and the Environment
ENVS*3040 [0.50] Natural Chemicals in the Environment
ENVS*3090 [0.50] Insect Diversity and Biology
ENVS*3210 [0.50] Plant Pathology
ENVS*3250 [0.50] Forest Health and Disease
ENVS*4100 [0.50] Integrated Management of Invasive Insect Pests **
GEOG*2210 [0.50] Environment and Resources
GEOG*3210 [0.50] Management of the Biophysical Environment **
GEOG*4210 [0.50] Environmental Governance **
GEOG*4220 [0.50] Local Environmental Management
LARC*3320 [0.50] Principles of Landscape Ecology **
PHIL*2070 [0.50] Philosophy of the Environment
POLS*3370 [0.50] Environmental Politics and Governance

Unspecialized (UNSP)

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

Minor (Honours Program)

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

AGR*2470 [0.50] Introduction to Plant Agriculture
BOT*2100 [0.50] Life Strategies of Plants
BOT*3310 [0.50] Plant Growth and Development
BOT*3410 [0.50] Plant Anatomy
BOT*3710 [0.50] Plant Diversity and Evolution
BOT*4380 [0.50] Metabolism in the Whole Life of Plants

2.00 credits from any courses listed in the areas of emphasis.

Restricted electives, indicated with **, are non-science electives. Restricted electives, indicated with **, require other restricted electives as prerequisites.

Psychology: Brain & Cognition (PBC)

Department of Psychology, College of Social and Applied Human Sciences

The B.Sc. Major in Psychology: Brain and Cognition offers an opportunity for students to develop interests within learning, perception, cognition, and biopsychology from a sound base in physical and biological sciences. Students primarily interested in other areas within psychology should consult the schedule of studies for the Bachelor of Arts program.

Psychology courses in the above focuses may also be studied via the B.A. program.

Note on Honours Courses

Honours Courses: courses designated with (H) are designed for students in a psychology honours specialization. This includes B.A. Honours Psychology (PYSCh) major or minor, B.A. Information Systems and Human Behaviour (ISHB) major, B.Sc. Psychology, Brain and Cognition (PBC), major or minor, and the Neuroscience (NEUR) minor. (H) courses are Honours level requiring for registration a cumulative average of at least 70% in all course attempts in Psychology or registration in the ISHB major, NEUR minor, or PBC major or minor. Unless otherwise specified, all other courses may be taken by students in a general or honours program, providing the prerequisites are met.

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
PSYCH*1000 [0.50] Introduction to Psychology

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

Semester 2

CHEM*1050 [0.50] General Chemistry II
PHYS*1070 [0.50] Physics for Life Sciences II

One of:

BIOL*1070 [0.50] Discovering Biodiversity
Credit Summary (20.00 Total Credits)

4.50 - First year science core
3.00 - Required science courses semesters 3 - 8
3.00 - Restricted electives (#2)
5.50 - Approved Science electives
1.00 - Required Arts and Social Science courses, semesters 1 - 8
1.00 - Approved Non-Psychology Arts and/or Social Science electives (#1)
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.

Minor (Honours Program)
A minor in Psychology: Brain and Cognition requires a minimum of 5.00 psychology credits as follows:

PSYC*1000 [0.50] Introduction to Psychology
PSYC*2360 [0.50] Introductory Research Methods
2.00 credits from 2000 level psychology core courses selected as follows:
   a. 1.50 credits from:
      PSYC*2330 [0.50] Principles of Learning
      PSYC*2390 [0.50] Principles of Sensation and Perception
      PSYC*2410 [0.50] Behavioural Neuroscience I
      PSYC*2650 [0.50] Cognitive Psychology
   b. 0.50 credits from:
      PSYC*2310 [0.50] Introduction to Social Psychology
      PSYC*2450 [0.50] Introduction to Developmental Psychology
      PSYC*2740 [0.50] Personality

1.50 credits from courses in Restricted Electives list above

One of:
   PSYC*1010 [0.50] Quantification in Psychology
   STAT*2040 [0.50] Statistics I

Statistics (STAT)

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

Statistics (STAT)

Minor (Honours Program)
A total of 5.00 credits is required to complete the minor, including:

(MATH*1080 or MATH*1200)*
(MATH*1210 or MATH*2080)**
MATH*1160 [0.50] Linear Algebra I
STAT*2040 [0.50] Statistics I
STAT*2050 [0.50] Statistics II
STAT*3100 [0.50] Introductory Mathematical Statistics I
STAT*3110 [0.50] Introductory Mathematical Statistics II
STAT*3240 [0.50] Applied Regression Analysis

0.50 additional credits in Statistics
0.50 additional credits in Statistics or Mathematics
* IPS*1500 can count toward this 0.50 credit
** IPS*1510 can count toward this 0.50 credit

Theoretical Physics (THPY)

Department of Physics, College of Physical and Engineering Science

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major must consult 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 Arts and/or Social Science courses.

Semester 1
CHEM*1040 [0.50] General Chemistry I
IPS*2100 [1.00] Integrated Mathematics and Physics I
MATH*1160 [0.50] Linear Algebra I
One of:
   BIOL*1070 [0.50] Discovering Biodiversity
   BIOL*1080 [0.50] Biological Concepts of Health
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: http://www.bsc.uoguelph.ca/revisedss

Semester 2
CHEM*1050 [0.50] General Chemistry II
CIS*1500 [0.50] Introduction to Programming
IPS*1510 [1.00] Integrated Mathematics and Physics II

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

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

Semester 3
MATH*2200 [0.50] Advanced Calculus I
MATH*2270 [0.50] Applied Differential Equations
PHYS*2240 [0.50] Thermal Physics
PHYS*2330 [0.50] Electricity and Magnetism I
0.50 Arts or Social Science 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
NANO*3600 [0.50] Computational Methods in Materials Science
PHYS*3130 [0.50] Mathematical Physics
PHYS*3230 [0.50] Quantum Mechanics I
PHYS*3400 [0.50] Advanced Mechanics
0.50 electives*

Semester 6
PHYS*3000 [0.50] Optics: Fundamentals and Applications
PHYS*3510 [0.50] Intermediate Laboratory
PHYS*4040 [0.50] Quantum Mechanics II
PHYS*4300 [0.50] Inquiry in Physics
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
PHYS*4300 [0.50] Inquiry in Physics
0.50 electives*

*Restricted Electives
Students must complete 2.00 credits from the following list:
CIS*2500 [0.50] Intermediate Programming
MATH*2130 [0.50] Numerical Methods
MATH*3100 [0.50] Differential Equations II
MATH*3130 [0.50] Abstract Algebra
MATH*3160 [0.50] Linear Algebra II
MATH*3200 [0.50] Real Analysis
MATH*3240 [0.50] Operations Research

Credit Summary (20.00 Total Credits)
5.00 - First year science credits
11.00 - Required science courses semesters 3 – 8
2.00 - Restricted electives
1.00 - Arts and/or Social Science electives
1.00 - Free electives - any approved elective for B.Sc. students. could be less if restricted electives do not count as science

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

Wildlife Biology and Conservation (WBC)
Department of Integrative Biology, College of Biological Science

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

Major (Honours Program)

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major must 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 Arts or Social Science electives

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

Semester 2
BIOL*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 Arts or Social Science electives

Semester 3
BIOL*2580 [0.50] Introduction to Biochemistry
MBG*2040 [0.50] Foundations in Molecular Biology and Genetics
1.50 electives or restricted electives

Semester 4
BIOL*2060 [0.50] Ecology
BIOL*2400 [0.50] Evolution
STAT*2230 [0.50] Biostatistics for Integrative Biology
1.00 electives or restricted electives

Semester 5
BIOL*3010 [0.50] Laboratory and Field Work in Ecology
2.00 electives or restricted electives

Semester 6
BIOL*3040 [0.50] Methods in Evolutionary Biology
BIOL*3060 [0.50] Populations, Communities & Ecosystems
BIOL*3130 [0.50] Conservation Biology
1.00 electives or restricted electives

Semester 7
BIOL*4110 [1.00] Ecological Methods
BIOL*4150 [0.50] Wildlife Conservation and Management
1.00 electives or restricted electives

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

Semester 8
BIOL*4500 [0.50] Natural Resource Policy Analysis
2.00 electives or restricted electives

Restricted Electives

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

1. A minimum of 1.00 credits of Arts and/or Social Science electives are required. The list of approved Arts and Social Science electives for B.Sc. students is available at: http://www.bsc.uoguelph.ca/Approved_electives.shtml#Arts

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

3. A minimum of 0.50 credits from:
   - BOT*3050 [0.50] Plant Functional Ecology
   - ZOO*3600 [0.50] Comparative Animal Physiology I
4. A minimum of 0.50 credits from:
   - BIOL*3020 [0.50] Population Genetics
   - BIOL*4120 [0.50] Evolutionary Ecology

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

   *Some of the restricted electives will require additional courses outside of the required courses listed in Semesters 3-8

   **Please note not all restricted electives are considered science electives for B.Sc. students. If the non-science restricted electives are chosen, students are reminded that they will still be responsible for meeting the minimum of 16.00 credits in science and that the credit summary may vary from what is specified below.

### Evolution
- BIOL*3020 [0.50] Population Genetics
- BIOL*3300 [0.50] Applied Bioinformatics
- BOT*3710 [0.50] Plant Diversity and Evolution
- ENVS*3090 [0.50] Insect Diversity and Biology
- ENVS*3180 [0.50] Sedimentary Environments *
- MBG*4080 [0.50] Molecular Genetics *
- MBG*4110 [0.50] Advanced Concepts in Genetics *
- MBG*4270 [0.50] DNA Replication, Recombination and Repair *
- ZOO*2700 [0.50] Invertebrate Morphology & Evolution
- ZOO*3050 [0.50] Developmental Biology

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

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

### Integrative/Cross-Disciplinary
- IIBI*4500 [0.75] Research in Integrative Biology I
- IIBI*4510 [0.75] Research in Integrative Biology II
- IIBI*4521/2 [2.00] Thesis in Integrative Biology
- MCB*2050 [0.50] Molecular Biology of the Cell
- ZOO*3610 [0.25] Lab Studies in Animal Physiology I
- ZOO*3620 [0.50] Comparative Animal Physiology II
- ZOO*3630 [0.25] Lab Studies in Animal Physiology II
- ZOO*3700 [0.50] Integrative Biology of Invertebrates *
- ZOO*4070 [0.50] Animal Behaviour
- ZOO*4910 [0.50] Integrative Vertebrate Biology *
- ZOO*4920 [0.25] Lab Studies in Ornithology
- ZOO*4940 [0.25] Lab Studies in Herpetology
- ZOO*4950 [0.25] Lab Studies in Mammalogy

### Field Courses
- BIOL*4410 [0.75] Field Ecology
- BIOL*4610 [0.75] Arctic Ecology
- BIOL*4700 [0.75] Field Biology
- BIOL*4710 [0.25] Field Biology
- BIOL*4800 [0.50] Field Biology
- BIOL*4810 [0.50] 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 and 4 in restricted electives list)**
- **1.00** - Approved Science electives
- **1.00** - Approved Arts and/or Social Science 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 must 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 Arts or Social Science electives

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

**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 Arts or Social Science 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 Arts and/or Social Science electives are required. The list of approved Arts and Social Science electives for B.Sc. students is available at: [http://www.bsc.uoguelph.ca/Approved_electives.shtml#arts](http://www.bsc.uoguelph.ca/Approved_electives.shtml#arts)

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

Last Revision: January 31, 2017

- 2016-2017 Undergraduate Calendar
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credit</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL*4710</td>
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<td>Field Biology</td>
</tr>
<tr>
<td>BIOL*4800</td>
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<td>Field Biology</td>
</tr>
<tr>
<td>BIOL*4810</td>
<td>0.25</td>
<td>Field Biology</td>
</tr>
<tr>
<td>IBIO*4500</td>
<td>0.75</td>
<td>Research in Integrative Biology I</td>
</tr>
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<td>IBIO*4510</td>
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<td>Research in Integrative Biology II</td>
</tr>
<tr>
<td>IBIO*4521/2</td>
<td>2.00</td>
<td>Thesis in Integrative Biology</td>
</tr>
<tr>
<td>ZOO*4170</td>
<td>0.50</td>
<td>Experimental Comparative Animal Physiology</td>
</tr>
<tr>
<td>ZOO*4300</td>
<td>0.75</td>
<td>Marine Biology and Oceanography</td>
</tr>
</tbody>
</table>

Other field or research courses with approval of faculty advisor.

**Credit Summary (20.00 Total Credits)**

4.00 - First year science core
8.00 - Required science courses semesters 3 - 8
1.00 - Restricted electives (# 2, and 3 in restricted electives list)
3.00 - Approved Science electives
1.00 - Arts and/or Social Science electives (#1 in restricted electives)
3.00 - Free electives - any approved elective for B.Sc. students

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

**Minor (Honours Program)**

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

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

<table>
<thead>
<tr>
<th>Course Code</th>
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</thead>
<tbody>
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<td>BIOL*2060</td>
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<td>0.50</td>
<td>Populations, Communities &amp; Ecosystems</td>
</tr>
<tr>
<td>ZOO*2090</td>
<td>0.50</td>
<td>Vertebrate Structure and Function</td>
</tr>
<tr>
<td>ZOO*2700</td>
<td>0.50</td>
<td>Invertebrate Morphology &amp; Evolution</td>
</tr>
<tr>
<td>ZOO*3000</td>
<td>0.50</td>
<td>Comparative Histology</td>
</tr>
<tr>
<td>ZOO*3050</td>
<td>0.50</td>
<td>Developmental Biology</td>
</tr>
<tr>
<td>ZOO*3600</td>
<td>0.50</td>
<td>Comparative Animal Physiology I</td>
</tr>
<tr>
<td>ZOO*3610</td>
<td>0.25</td>
<td>Lab Studies in Animal Physiology I</td>
</tr>
<tr>
<td>ZOO*3620</td>
<td>0.50</td>
<td>Comparative Animal Physiology II</td>
</tr>
<tr>
<td>ZOO*3630</td>
<td>0.25</td>
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</tbody>
</table>

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