

# Biology

Requirements for the program Biology and Biotechnology are presented in the Biotechnology program section of this Calendar.

Co-operative Education Option is available (see the Co-operative Education section of this Calendar).

## Graduation Requirements

In addition to the requirements listed below, students must satisfy:

1. the University regulations (see the Academic Regulations of the University in this Calendar),
2. for B.Sc. programs, the common regulations applying to all B.Sc. programs including these relating to Science Continuation and Breadth requirements (see the Academic Regulations for the Bachelor of Science Degree ),
3. for B.A. programs, the common regulations applying to all B.A. programs including those relating to Breadth requirements (see the Academic Regulations for the Bachelor of Arts Degree ).

Students should consult with the Department when planning their program and selecting courses.

## Course Categories for Biology programs

The program descriptions below make use of the following course categories that are defined in the Bachelor of Science Regulations in this Calendar.

- Science Faculty Electives
- Advanced Science Faculty Electives
- Science Continuation
- Science Geography
- Science Psychology
- Approved Arts or Social Sciences
- Free Electives
- Restricted Courses: Biology General, Major, and Honours students (except students in the B.A. General, B.A. Honours and Combined Honours programs) may use Technology, Society, Environment courses TSES 3001, TSES 3002, TSES 3500, TSES 4001, TSES 4002, TSES 4003, TSES 4005, TSES 4006, TSES 4007 to fulfill degree requirements, but only as free electives.

## Program Requirements

### General Note on Programs

Students in Honours Biology programs must complete BIOL 4907 [1.0] or BIOL 4908 [1.0] . BIOL 4908 [1.0] is subject to limited enrolment and requires that students secure a supervisor in the year prior to their honours thesis.

## Bioinformatics

### B.Sc. Honours (20.0 credits)

#### A. Credits included in the Major CGPA (12.5 credits)

<b>1. 4.0 credits in:</b>	4.0
BIOL 1103 [0.5]	Foundations of Biology I
BIOL 1104 [0.5]	Foundations of Biology II
BIOL 2104 [0.5]	Introductory Genetics
BIOL 2200 [0.5]	Cellular Biochemistry
BIOL 3104 [0.5]	Molecular Genetics
BIOL 4106 [0.5]	Advances in Molecular Biology
BIOC 4906 [1.0]	Interdisciplinary Research Project
or BIOL 4907 [1.0]	Honours Essay and Research Proposal
or BIOL 4908 [1.0]	Honours Research Thesis

<b>2. 0.5 credit from:</b>	0.5
BIOL 2001 [0.5]	Animals: Form and Function
BIOL 2002 [0.5]	Plants: Form and Function
BIOL 2303 [0.5]	Microbiology
BIOL 3102 [0.5]	Mycology
BIOL 3305 [0.5]	Human and Comparative Physiology
BIOL 3306 [0.5]	Human Anatomy and Physiology

<b>3. 3.5 credits in:</b>	3.5
BIOC 2300 [0.5]	Physical Biochemistry
BIOC 3008 [0.5]	Bioinformatics
BIOC 3101 [0.5]	General Biochemistry I
BIOC 3102 [0.5]	General Biochemistry II
BIOC 3202 [0.5]	Biophysical Techniques and Applications
BIOC 4008 [0.5]	Computational Systems Biology
BIOC 4202 [0.5]	Mutagenesis and DNA Repair

**4. 1.0 credit in BIOL or BIOC or COMP or MATH or STAT** 1.0  
at the 3000-level or higher

<b>5. 0.5 credit from:</b>	0.5
BIOL 3901 [0.5]	Research Proposal
BIOL 4901 [0.5]	Directed Special Studies
	or 4000-level BIOL

<b>6. 3.0 credits in</b>	3.0
COMP 1005 [0.5]	Introduction to Computer Science I
COMP 1006 [0.5]	Introduction to Computer Science II
COMP 2401 [0.5]	Introduction to Systems Programming
COMP 2402 [0.5]	Abstract Data Types and Algorithms
COMP 2404 [0.5]	Introduction to Software Engineering
COMP 2406 [0.5]	Fundamentals of Web Applications

#### B. Credits not included in the Major CGPA (7.5)

<b>7. 2.0 credits in:</b>	2.0
CHEM 1001 [0.5]	General Chemistry I
& CHEM 1002 [0.5]	and General Chemistry II
CHEM 2203 [0.5]	Organic Chemistry I
& CHEM 2204 [0.5]	and Organic Chemistry II
	See Note: below

<b>8. 1.0 credit from:</b>	1.0
PHYS 1007 [0.5]	Elementary University Physics I
& PHYS 1008 [0.5]	and Elementary University Physics II

PHYS 1003 [0.5]	Introductory Mechanics and	
& PHYS 1004 [0.5]	Thermodynamics	
	and Introductory	
	Electromagnetism and Wave	
	Motion	
<b>9. 2.0 credits in:</b>		<b>2.0</b>
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
STAT 2507 [0.5]	Introduction to Statistical Modeling I	
STAT 2509 [0.5]	Introduction to Statistical Modeling II	
<b>10. 2.0 credits in:</b>		<b>2.0</b>
NSCI 1000 [0.5]	Seminar in Science	
- or Approved Arts or Social Sciences		
<b>11. 0.5 credit in free electives.</b>		<b>0.5</b>
<b>Total Credits</b>		<b>20.0</b>

**Note:** For item 7 above, CHEM 1001 and CHEM 1002 are strongly recommended for this program. Students may substitute CHEM 1001 and CHEM 1002 with CHEM 1005 and CHEM 1006, respectively. Students choosing CHEM 1005 and CHEM 1006 will be required to obtain a grade of B- or higher in CHEM 1006 to take BIOL 2200 and more advanced courses in BIOC and CHEM. Students completing CHEM 1005 with a grade of B- or higher are encouraged to register for CHEM 1002.

## Biology

### B.Sc. Honours (20.0 credits)

#### A. Credits included in the Major CGPA (11.0 credits)

<b>1. 2.0 credits in:</b>		<b>2.0</b>
BIOL 1103 [0.5]	Foundations of Biology I	
BIOL 1104 [0.5]	Foundations of Biology II	
BIOL 4907 [1.0]	Honours Essay and Research Proposal	
or BIOL 4908 [1.0]	Honours Research Thesis	
<b>2. 2.5 credits from:</b>		<b>2.5</b>
BIOL 2001 [0.5]	Animals: Form and Function	
BIOL 2002 [0.5]	Plants: Form and Function	
BIOL 2104 [0.5]	Introductory Genetics	
BIOL 2200 [0.5]	Cellular Biochemistry	
BIOL 2303 [0.5]	Microbiology	
BIOL 2600 [0.5]	Introduction to Ecology	
<b>3. 0.5 credit from:</b>		<b>0.5</b>
BIOL 3201 [0.5]	Cell Biology	
BIOL 3205 [0.5]	Plant Biochemistry and Physiology	
BIOL 3303 [0.5]	Experimental Microbiology	
BIOL 3305 [0.5]	Human and Comparative Physiology	
<b>4. 1.0 credit in BIOL at the 2000-level or higher</b>		<b>1.0</b>
<b>5. 3.5 credits in BIOL or BIOC at the 3000-level or higher</b>		<b>3.5</b>
<b>6. 0.5 credit from</b>		<b>0.5</b>
BIOL 3901 [0.5]	Research Proposal	
BIOL 4901 [0.5]	Directed Special Studies	
or 4000-level BIOL		
<b>7. 1.0 credit in Advanced Science Faculty Electives</b>		<b>1.0</b>
<b>B. Credits not included in the Major CGPA (9.0 credits)</b>		
<b>8. 1.0 credit in</b>		<b>1.0</b>

CHEM 1001 [0.5]	General Chemistry I	
& CHEM 1002 [0.5]	and General Chemistry II (See Note 2, below)	
<b>9. 1.0 credit in:</b>		<b>1.0</b>
PHYS 1007 [0.5]	Elementary University Physics I	
& PHYS 1008 [0.5]	and Elementary University Physics II	
(or PHYS 1003 [0.5] PHYS 1004 [0.5])		
<b>10. 1.0 credit in:</b>		<b>1.0</b>
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
or STAT 2507 [0.5]	Introduction to Statistical Modeling I	
<b>11. 1.0 credit in Science Faculty Electives</b>		<b>1.0</b>
<b>12. 2.0 credits in Science Continuation (not in BIOL)</b>		<b>2.0</b>
<b>13. 0.5 credit in:</b>		<b>0.5</b>
NSCI 1000 [0.5]	Seminar in Science (or Approved Arts or Social Sciences)	
<b>14. 1.5 credits in Approved Arts or Social Sciences</b>		<b>1.5</b>
<b>15. 1.0 credit in free electives.</b>		<b>1.0</b>
<b>Total Credits</b>		<b>20.0</b>

#### Notes:

1. Students should choose their second year courses carefully to ensure that they have the necessary prerequisites for upper year courses in Biology.
2. For item 8 above, CHEM 1001 and CHEM 1002 are strongly recommended for this program. Students may substitute CHEM 1001 and CHEM 1002 with CHEM 1005 and CHEM 1006, respectively. Students choosing CHEM 1005 and CHEM 1006 will be required to obtain a grade of B- or higher in CHEM 1006 to take BIOL 2200 and more advanced courses in BIOC and CHEM. Students completing CHEM 1005 with a grade of B- or higher are encouraged to register for CHEM 1002.
3. Students in the B.Sc. Honours Biology program may elect to focus their studies in one of the following concentrations: 1) Ecology, Evolution and Behaviour, 2) Health Science, 3) Molecular and Cellular Biology, or 4) Physiology.

### Biology with Concentration in Ecology, Evolution and Behaviour

#### B.Sc. Honours (20.0 credits)

<b>A. Credits included in the Major CGPA (11.0 credits)</b>		
<b>1. 2.0 credits in:</b>		<b>2.0</b>
BIOL 1103 [0.5]	Foundations of Biology I	
BIOL 1104 [0.5]	Foundations of Biology II	
BIOL 4907 [1.0]	Honours Essay and Research Proposal	
or BIOL 4908 [1.0]	Honours Research Thesis	
<b>2. 2.5 credits in:</b>		<b>2.5</b>
BIOL 2001 [0.5]	Animals: Form and Function	
BIOL 2002 [0.5]	Plants: Form and Function	
BIOL 2104 [0.5]	Introductory Genetics	
BIOL 2200 [0.5]	Cellular Biochemistry	
BIOL 2600 [0.5]	Introduction to Ecology	
<b>3. 0.5 credit from:</b>		<b>0.5</b>
BIOL 3201 [0.5]	Cell Biology	

BIOL 3205 [0.5]	Plant Biochemistry and Physiology	
BIOL 3303 [0.5]	Experimental Microbiology	
BIOL 3305 [0.5]	Human and Comparative Physiology	
<b>4. 1.0 credit from:</b>		1.0
BIOL 3609 [0.5]	Evolutionary Concepts	
BIOL 3611 [0.5]	Evolutionary Ecology	
BIOL 3802 [0.5]	Animal Behaviour	
<b>5. 2.0 credits from:</b>		2.0
BIOL 3104 [0.5]	Molecular Genetics	
BIOL 3601 [0.5]	Ecosystems and Environmental Change	
BIOL 3602 [0.5]	Conservation Biology	
BIOL 3604 [0.5]	Analysis of Ecological Relationships	
BIOL 3605 [0.5]	Field Course I	
BIOL 3609 [0.5]	Evolutionary Concepts	
BIOL 3608 [0.5]	Principles of Biogeography	
BIOL 3611 [0.5]	Evolutionary Ecology	
BIOL 3612 [0.5]	Computational Methods in Ecology and Evolution	
BIOL 3801 [0.5]	Plants and Herbivores	
BIOL 3802 [0.5]	Animal Behaviour	
BIOL 3804 [0.5]	Social Evolution	
<b>6. 2.0 credits from:</b>		2.0
BIOL 4102 [0.5]	Molecular Ecology	
BIOL 4103 [0.5]	Population Genetics	
BIOL 4104 [0.5]	Evolutionary Genetics	
BIOL 4203 [0.5]	Evolution of Sex	
BIOL 4317 [0.5]	Neuroethology: The Neural Basis of Animal Behaviour	
BIOL 4318 [0.5]	Adaptations to Extreme Environments	
BIOL 4500 [0.5]	Ornithology I	
BIOL 4501 [0.5]	Ornithology II	
BIOL 4503 [0.5]	Fish Ecology, Conservation and Management	
BIOL 4604 [0.5]	Landscape Ecology	
BIOL 4802 [0.5]	Advanced Animal Behaviour	
<b>7. 0.5 credit in BIOL at the 2000-level or higher</b>		0.5
<b>8. 0.5 credit from</b>		0.5
BIOL 3901 [0.5]	Research Proposal	
or BIOL 4901 [0.5]	Directed Special Studies	
or 4000-level BIOL		
<b>B. Credits not included in the Major CGPA (9.0 credits)</b>		
<b>9. 1.0 credit in:</b>		1.0
CHEM 1001 [0.5]	General Chemistry I	
& CHEM 1002 [0.5]	and General Chemistry II (See Note 2, below)	
<b>10. 1.0 credit in:</b>		1.0
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
or STAT 2507 [0.5]	Introduction to Statistical Modeling I	
<b>11. 1.0 credit from:</b>		1.0
PHYS 1007 [0.5]	Elementary University Physics I	
& PHYS 1008 [0.5]	and Elementary University Physics II	
PHYS 1003 [0.5]	Introductory Mechanics and Thermodynamics	

or PHYS 1004 [0.5]	Introductory Electromagnetism and Wave Motion	
<b>12. 1.0 credit in Science Faculty Electives</b>		1.0
<b>13. 2.0 credits in Science Continuation courses (not in BIOL)</b>		2.0
<b>14. 0.5 credit in:</b>		0.5
NSCI 1000 [0.5]	Seminar in Science	
or Approved Arts or Social Sciences		
<b>15. 1.5 credits in Approved Arts or Social Sciences</b>		1.5
<b>16. 1.0 credit in free electives.</b>		1.0
<b>Total Credits</b>		<b>20.0</b>

#### Notes:

1. Students should choose their second year courses carefully to ensure that they have the necessary prerequisites for upper year courses in Biology.
2. For item 9 above, CHEM 1001 and CHEM 1002 are strongly recommended for this program. Students may substitute CHEM 1001 and CHEM 1002 with CHEM 1005 and CHEM 1006, respectively. Students choosing CHEM 1005 and CHEM 1006 will be required to obtain a grade of B- or higher in CHEM 1006 to take BIOL 2200 and more advanced courses in BIOC and CHEM. Students completing CHEM 1005 with a grade of B- or higher are encouraged to register for CHEM 1002.

### Biology with Concentration in Health Science B.Sc. Honours (20.0 credits)

#### A. Credits included in the Major CGPA (11.0 credits)

<b>1. 2.0 credits in:</b>		2.0
BIOL 1103 [0.5]	Foundations of Biology I	
BIOL 1104 [0.5]	Foundations of Biology II	
BIOL 4907 [1.0]	Honours Essay and Research Proposal	
or BIOL 4908 [1.0]	Honours Research Thesis	
<b>2. 2.0 credits in:</b>		2.0
BIOL 2001 [0.5]	Animals: Form and Function	
BIOL 2104 [0.5]	Introductory Genetics	
BIOL 2200 [0.5]	Cellular Biochemistry	
BIOL 2303 [0.5]	Microbiology	
<b>3. 1.0 credit in:</b>		1.0
BIOL 3305 [0.5]	Human and Comparative Physiology	
BIOL 3307 [0.5]	Advanced Human Anatomy and Physiology	
<b>4. 1.0 credit in:</b>		1.0
BIOC 3101 [0.5]	General Biochemistry I	
BIOC 3102 [0.5]	General Biochemistry II	
<b>5. 1.0 credit from:</b>		1.0
BIOL 3104 [0.5]	Molecular Genetics	
BIOL 3201 [0.5]	Cell Biology	
BIOL 3202 [0.5]	Principles of Developmental Biology	
BIOL 3303 [0.5]	Experimental Microbiology	
BIOL 3501 [0.5]	Biomechanics	
BIOL 4318 [0.5]	Adaptations to Extreme Environments	

BIOL 4201 [0.5]	Advanced Cell Culture and Tissue Engineering	
<b>6. 1.0 credit from:</b>		1.0
BIOC 4009 [0.5]	Biochemistry of Disease	
BIOL 4106 [0.5]	Advances in Molecular Biology	
BIOC 4708 [0.5]	Principles of Toxicology	
BIOL 4200 [0.5]	Immunology	
BIOL 4202 [0.5]	Mutagenesis and DNA Repair	
BIOL 4306 [0.5]	Animal Neurophysiology	
<b>7. 1.0 credit from BIOL or BIOC at the 3000-level or higher</b>		1.0
<b>8. 0.5 credit from:</b>		0.5
BIOL 3901 [0.5]	Research Proposal	
BIOL 4901 [0.5]	Directed Special Studies	
or 4000-level BIOL		
<b>9. 1.0 credit from:</b>		1.0
NEUR 3204 [0.5]	Principles of Psychopharmacology: From Drugs to Behaviour	
NEUR 2200 [0.5]	Biological Foundations of Behaviour	
PSYC 2301 [0.5]	Introduction to Health Psychology	
<b>10. 0.5 credit from:</b>		0.5
PHIL 2408 [0.5]	Bioethics	
GEOG 3206 [0.5]	Health, Environment, and Society	
ANTH 3310 [0.5]	Studies in Medical Anthropology	
SOCI 3050 [0.5]	Studies in the Sociology of Health	
SOCI 3056 [0.5]	Women and Health	
<b>B. Credits not included in the Major CGPA (9.0 credits)</b>		
<b>11. 2.0 credits from:</b>		2.0
CHEM 1001 [0.5]	General Chemistry I	
& CHEM 1002 [0.5]	and General Chemistry II	
CHEM 2203 [0.5]	Organic Chemistry I	
& CHEM 2204 [0.5]	and Organic Chemistry II	
CHEM 2207 [0.5]	Introduction to Organic Chemistry I	
& CHEM 2208 [0.5]	and Introduction to Organic Chemistry II	
See Note 2, below		
<b>12. 1.0 credit in:</b>		1.0
PHYS 1007 [0.5]	Elementary University Physics I	
& PHYS 1008 [0.5]	and Elementary University Physics II	
or PHYS 1003	Introductory Mechanics and	
& PHYS 1004 [1.0]	Thermodynamics and Introductory Electromagnetism and Wave Motion	
<b>13. 1.0 credit in:</b>		1.0
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
or STAT 2507 [0.5]	Introduction to Statistical Modeling I	
<b>14. 1.0 credit in:</b>		1.0
PSYC 1001 [0.5]	Introduction to Psychology I	
PSYC 1002 [0.5]	Introduction to Psychology II	
<b>15. 1.0 credit in Science Faculty Electives</b>		1.0
<b>16. 1.0 credit in Science Continuation courses (not in BIOL)</b>		1.0
<b>17. 0.5 credit in:</b>		0.5
NSCI 1000 [0.5]	Seminar in Science (or Approved Arts and Social Sciences)	

<b>18. 0.5 credit in Approved Arts and Social Sciences</b>	0.5
<b>19. 1.0 credit in free electives.</b>	1.0
<b>Total Credits</b>	<b>20.0</b>

#### Notes:

1. Students should choose their second year courses carefully to ensure that they have the necessary prerequisites for upper year courses in Biology.
2. For item 11 above, CHEM 1001 and CHEM 1002 are strongly recommended for this program. Students may substitute CHEM 1001 and CHEM 1002 with CHEM 1005 and CHEM 1006, respectively. Students choosing CHEM 1005 and CHEM 1006 will be required to obtain a grade of B- or higher in CHEM 1006 to take BIOL 2200 and more advanced courses in BIOC and CHEM. Students completing CHEM 1005 with a grade of B- or higher are encouraged to register for CHEM 1002.
3. In order to meet the prerequisite requirements for courses in Items 9 and 10, students should ensure that they have chosen appropriate courses in Items 15, 16, 17, 18 and 19.
4. Students intending to apply to medical schools should be aware of the requirements of different medical schools for chemistry courses with laboratories, and for English courses. This may influence the choice of courses chosen to meet the requirements in Items 11, 17, 18, and 19.

### Biology with Concentration in Molecular and Cellular Biology

#### B.Sc. Honours (20.0 credits)

<b>A. Credits included in the Major CGPA (11.0 credits)</b>		
<b>1. 2.0 credits in:</b>		2.0
BIOL 1103 [0.5]	Foundations of Biology I	
BIOL 1104 [0.5]	Foundations of Biology II	
BIOL 4907 [1.0]	Honours Essay and Research Proposal	
or BIOL 4908 [1.0]	Honours Research Thesis	
<b>2. 2.5 credits in:</b>		2.5
BIOL 2001 [0.5]	Animals: Form and Function	
BIOL 2002 [0.5]	Plants: Form and Function	
BIOL 2104 [0.5]	Introductory Genetics	
BIOL 2200 [0.5]	Cellular Biochemistry	
BIOL 2303 [0.5]	Microbiology	
<b>3. 0.5 credit from:</b>		0.5
BIOL 3205 [0.5]	Plant Biochemistry and Physiology	
BIOL 3303 [0.5]	Experimental Microbiology	
BIOL 3305 [0.5]	Human and Comparative Physiology	
<b>4. 1.0 credit in:</b>		1.0
BIOC 3101 [0.5]	General Biochemistry I	
BIOC 3102 [0.5]	General Biochemistry II	
<b>5. 1.0 credit in:</b>		1.0
BIOL 3104 [0.5]	Molecular Genetics	
BIOL 3201 [0.5]	Cell Biology	
<b>6. 2.0 credits from:</b>		2.0
BIOL 4106 [0.5]	Advances in Molecular Biology	

BIOL 4109 [0.5]	Laboratory Techniques in Molecular Genetics	
BIOL 4200 [0.5]	Immunology	
BIOL 4202 [0.5]	Mutagenesis and DNA Repair	
BIOL 4201 [0.5]	Advanced Cell Culture and Tissue Engineering	
BIOL 4400 [0.5]	Nuclear Dynamics and The Cell Cycle	
<b>7. 0.5 credit in</b>	BIOL or BIOC at the 2000-level or higher	0.5
<b>8. 1.0 credit in</b>	BIOL or BIOC at the 3000-level or higher	1.0
<b>9. 0.5 credit from:</b>		0.5
BIOL 3901 [0.5]	Research Proposal	
BIOL 4901 [0.5]	Directed Special Studies or 4000-level BIOL	
<b>B. Credits Not Included in the Major CGPA (9.0 credits)</b>		
<b>10. 2.0 credits in:</b>		2.0
CHEM 1001 [0.5]	General Chemistry I & CHEM 1002 [0.5] and General Chemistry II	
CHEM 2203 [0.5]	Organic Chemistry I & CHEM 2204 [0.5] and Organic Chemistry II	
See Note 2, below		
<b>11. 1.0 credit in:</b>		1.0
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
or STAT 2507 [0.5]	Introduction to Statistical Modeling I	
<b>12. 1.0 credit from:</b>		1.0
PHYS 1007 [0.5]	Elementary University Physics I & PHYS 1008 [0.5] and Elementary University Physics II	
PHYS 1003 [0.5]	Introductory Mechanics and Thermodynamics	
or PHYS 1004 [0.5]	Introductory Electromagnetism and Wave Motion	
<b>13. 1.0 credit in</b>	Science Faculty Electives	1.0
<b>14. 1.0 credit in</b>	Science Continuation courses (not in BIOL)	1.0
<b>15. 0.5 credit in:</b>		0.5
NSCI 1000 [0.5]	Seminar in Science (or Approved Arts or Social Sciences)	
<b>16. 1.5 credits in</b>	Approved Arts or Social Sciences	1.5
<b>17. 1.0 credit in</b>	free electives.	1.0
<b>Total Credits</b>		<b>20.0</b>

**Notes:**

- Students should choose their second year courses carefully to ensure that they have the necessary prerequisites for upper year courses in Biology.
- For Item 10 above, CHEM 1001 and CHEM 1002 are strongly recommended for this program. Students may substitute CHEM 1001 and CHEM 1002 with CHEM 1005 and CHEM 1006, respectively. Students choosing CHEM 1005 and CHEM 1006 will be required to obtain a grade of B- or higher in CHEM 1006 to take BIOL 2200 and more advanced courses in BIOC and CHEM. Students completing CHEM 1005 with a grade of B- or higher are encouraged to register for CHEM 1002.

**Biology with Concentration in Physiology  
B.Sc. Honours (20.0 credits)**

**A. Credits Included in the Major CGPA (11.0 credits)**

<b>1. 2.0 credits in:</b>		2.0
BIOL 1103 [0.5]	Foundations of Biology I	
BIOL 1104 [0.5]	Foundations of Biology II	
BIOL 4907 [1.0]	Honours Essay and Research Proposal	
or BIOL 4908 [1.0]	Honours Research Thesis	
<b>2. 2.0 credits in:</b>		2.0
BIOL 2001 [0.5]	Animals: Form and Function	
BIOL 2002 [0.5]	Plants: Form and Function	
BIOL 2104 [0.5]	Introductory Genetics	
BIOL 2200 [0.5]	Cellular Biochemistry	
<b>3. 1.5 credits in:</b>		1.5
BIOL 3205 [0.5]	Plant Biochemistry and Physiology	
BIOL 3305 [0.5]	Human and Comparative Physiology	
BIOL 3307 [0.5]	Advanced Human Anatomy and Physiology	
<b>4. 1.5 credits in:</b>		1.5
BIOC 2300 [0.5]	Physical Biochemistry	
BIOC 3101 [0.5]	General Biochemistry I	
BIOC 3102 [0.5]	General Biochemistry II	
<b>5. 2.0 credits from:</b>		2.0
BIOL 3201 [0.5]	Cell Biology	
BIOL 3202 [0.5]	Principles of Developmental Biology	
BIOL 3501 [0.5]	Biomechanics	
BIOL 3802 [0.5]	Animal Behaviour	
BIOL 4317 [0.5]	Neuroethology: The Neural Basis of Animal Behaviour	
BIOL 4318 [0.5]	Adaptations to Extreme Environments	
BIOL 4201 [0.5]	Advanced Cell Culture and Tissue Engineering	
BIOL 4008 [0.5]	Molecular Plant Development	
BIOC 4203 [0.5]	Advanced Metabolism	
BIOL 4209 [0.5]	Advanced Plant Physiology	
BIOL 4306 [0.5]	Animal Neurophysiology	
<b>6. 1.0 credit in</b>	BIOL at the 2000-level or higher	1.0
<b>7. 0.5 credit in</b>	BIOL or BIOC at the 3000-level or higher	0.5
<b>8. 0.5 credit from:</b>		0.5
BIOL 3901 [0.5]	Research Proposal	
BIOL 4901 [0.5]	Directed Special Studies or 4000-level BIOL	
<b>B. Credits not included in the Major CGPA (9.0 credits)</b>		
<b>9. 2.0 credits from:</b>		2.0
CHEM 1001 [0.5]	General Chemistry I & CHEM 1002 [0.5] and General Chemistry II	
CHEM 2203 [0.5]	Organic Chemistry I & CHEM 2204 [0.5] and Organic Chemistry II (or)	
CHEM 2207 [0.5]	Introduction to Organic Chemistry I & CHEM 2208 [0.5] and Introduction to Organic Chemistry II	
See Note 2, below		
<b>10. 1.0 credit in:</b>		1.0
MATH 1007 [0.5]	Elementary Calculus I	

MATH 1107 [0.5]	Linear Algebra I	
or STAT 2507 [0.5]	Introduction to Statistical Modeling I	
<b>11. 1.0 credit from:</b>		1.0
PHYS 1007 [0.5]	Elementary University Physics I	
& PHYS 1008 [0.5]	and Elementary University Physics II	
PHYS 1003 [0.5]	Introductory Mechanics and	
& PHYS 1004 [0.5]	Thermodynamics and Introductory Electromagnetism and Wave Motion	
<b>12. 1.0 credit in</b>	Science Faculty electives	1.0
<b>13. 1.0 credit in</b>	Science Continuation courses (not in BIOL)	1.0
<b>14. 0.5 credit in:</b>		0.5
NSCI 1000 [0.5]	Seminar in Science (or Approved Arts or Social Sciences)	
<b>15. 1.5 credits in</b>	Approved Arts or Social Sciences	1.5
<b>16. 1.0 credit in</b>	free electives.	1.0
<b>Total Credits</b>		<b>20.0</b>

#### Notes:

- Students should choose their second year courses carefully to ensure that they have the necessary prerequisites for upper year courses in Biology.
- For Item 9 above, CHEM 1001 and CHEM 1002 are strongly recommended for this program. Students may substitute CHEM 1001 and CHEM 1002 with CHEM 1005 and CHEM 1006, respectively. Students choosing CHEM 1005 and CHEM 1006 will be required to obtain a grade of B- or higher in CHEM 1006 to take BIOL 2200 and more advanced courses in BIOC and CHEM. Students completing CHEM 1005 with a grade of B- or higher are encouraged to register for CHEM 1002.

## Biology

### B.Sc. Major (20.0 credits)

#### A. Credits included in the Major CGPA (9.0 credits)

<b>1. 1.0 credit in:</b>		1.0
BIOL 1003 [0.5]	Introductory Biology I	
BIOL 1004 [0.5]	Introductory Biology II	
<b>2. 2.5 credits from:</b>		2.5
BIOL 2001 [0.5]	Animals: Form and Function	
BIOL 2002 [0.5]	Plants: Form and Function	
BIOL 2104 [0.5]	Introductory Genetics	
or BIOL 2107 [0.5]	Fundamentals of Genetics	
BIOL 2200 [0.5]	Cellular Biochemistry	
or BIOL 2201 [0.5]	Cell Biology and Biochemistry	
BIOL 2303 [0.5]	Microbiology	
BIOL 2600 [0.5]	Introduction to Ecology	
<b>3. 0.5 credit from:</b>		0.5
BIOL 3205 [0.5]	Plant Biochemistry and Physiology	
BIOL 3306 [0.5]	Human Anatomy and Physiology	
<b>4. 3.0 credits in</b>	BIOL at the 3000-level or higher	3.0
<b>5. 2.0 credits in</b>	Advanced Science Faculty electives	2.0

#### B. Credits Not Included in the Major CGPA (11.0 credits)

<b>6. 1.0 credit from:</b>		1.0
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CHEM 1001 [0.5]	General Chemistry I	
& CHEM 1002 [0.5]	and General Chemistry II	
CHEM 1005 [0.5]	Elementary Chemistry I	
& CHEM 1006 [0.5]	and Elementary Chemistry II (See Note 2, below)	
<b>7. 1.0 credit from:</b>		1.0
PHYS 1007 [0.5]	Elementary University Physics I	
& PHYS 1008 [0.5]	and Elementary University Physics II	
PHYS 1003 [0.5]	Introductory Mechanics and Thermodynamics	
or PHYS 1004 [0.5]	Introductory Electromagnetism and Wave Motion	
<b>8. 1.0 credit in:</b>		1.0
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
or STAT 2507 [0.5]	Introduction to Statistical Modeling I	
<b>9. 1.0 credit in</b>	Science Faculty Electives	1.0
<b>10. 2.0 credits in</b>	Advanced Science Faculty Electives	2.0
<b>11. 2.0 credits in</b>	Science Continuation courses (not in BIOL)	2.0
<b>12. 0.5 credit in:</b>		0.5
NSCI 1000 [0.5]	Seminar in Science (or Approved Arts or Social Sciences)	
<b>13. 1.5 credits in</b>	Approved Arts or Social Sciences	1.5
<b>14. 1.0 credit in</b>	free electives.	1.0
<b>Total Credits</b>		<b>20.0</b>

#### Notes:

- Students should choose their second year courses carefully to ensure that they have the necessary prerequisites for upper year courses in Biology.
- For item 6 above, students choosing CHEM 1005 and CHEM 1006 will be required to obtain a grade of B- or higher in CHEM 1006 to take BIOL 2200 and more advanced courses in BIOC and CHEM.

## Biology

### B.Sc. General (15.0 credits)

**Note:** some advanced Biology courses with laboratory components will not be available to students enrolling in the B.Sc. General program.

#### A. Credits included in the Major CGPA (6.0 credits)

<b>1. 1.0 credit in:</b>		1.0
BIOL 1003 [0.5]	Introductory Biology I	
BIOL 1004 [0.5]	Introductory Biology II	
<b>2. 2.0 credits from:</b>		2.0
BIOL 2001 [0.5]	Animals: Form and Function	
BIOL 2002 [0.5]	Plants: Form and Function	
BIOL 2107 [0.5]	Fundamentals of Genetics	
BIOL 2201 [0.5]	Cell Biology and Biochemistry	
BIOL 2303 [0.5]	Microbiology	
BIOL 2600 [0.5]	Introduction to Ecology	
<b>3. 0.5 credit in:</b>		0.5
BIOL 3306 [0.5]	Human Anatomy and Physiology	
<b>4. 2.5 credits from</b>	BIOL at the 2000-level and 3000-level or higher	2.5
<b>B. Credits Not Included in the Major CGPA (9.0 credits)</b>		
<b>5. 1.0 credit from:</b>		1.0

CHEM 1001 [0.5]	General Chemistry I	
& CHEM 1002 [0.5]	and General Chemistry II	
CHEM 1005 [0.5]	Elementary Chemistry I	
& CHEM 1006 [0.5]	and Elementary Chemistry II (See Note 2, below)	
<b>6. 1.0 credit from:</b>		<b>1.0</b>
PHYS 1007 [0.5]	Elementary University Physics I	
& PHYS 1008 [0.5]	and Elementary University Physics II	
PHYS 1003 [0.5]	Introductory Mechanics and	
& PHYS 1004 [0.5]	Thermodynamics and Introductory Electromagnetism and Wave Motion	
<b>7. 1.0 credit in:</b>		<b>1.0</b>
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
or STAT 2507 [0.5]	Introduction to Statistical Modeling I	
<b>8. 2.0 credits in</b>	Science Continuation (not in BIOL)	<b>2.0</b>
<b>9. 1.0 credit in</b>	Science Faculty Electives	<b>1.0</b>
<b>10. 0.5 credit in:</b>		<b>0.5</b>
NSCI 1000 [0.5]	Seminar in Science (or Approved Arts or Social Sciences)	
<b>11. 1.5 credits in</b>	Approved Arts or Social Sciences	<b>1.5</b>
<b>12. 1.0 credit free</b>	electives.	<b>1.0</b>
<b>Total Credits</b>		<b>15.0</b>

#### Notes:

- Students should choose their second year courses carefully to ensure that they have the necessary prerequisites for upper year courses in Biology.
- Students choosing CHEM 1005 and CHEM 1006 will be required to obtain a grade of B- or higher in CHEM 1006 to take advanced courses in BIOC and CHEM.

### Biology and Earth Sciences

#### B.Sc. Combined Honours (20.0 credits)

##### A. Credits Included in the Major CGPA (13.0 credits)

<b>1. 1.0 credit in:</b>		<b>1.0</b>
BIOL 1103 [0.5]	Foundations of Biology I	
BIOL 1104 [0.5]	Foundations of Biology II	
<b>2. 1.0 credit in:</b>		<b>1.0</b>
ERTH 1006 [0.5]	Exploring Planet Earth	
ERTH 1009 [0.5]	The Earth System Through Time	
<b>3. 10.0 credits in:</b>	BIOL (or BIOC) and EARTH at the 2000-level or above, collectively satisfying:	<b>10.0</b>
a. 1.0 credit in:		
BIOL 3605 [0.5]	Field Course I	
ERTH 2314 [0.5]	Sedimentation and Stratigraphy	
or EARTH 3206 [0.5]	Oceanography: Its Modern and Geologic Records	
b. at least 4.0 credits in	BIOC	
c. at least 4.0 credits in	ERTH	
d. at least 4.0 credits at the	3000-level or above	
<b>4. 1.0 credit from:</b>		<b>1.0</b>
BIOL 4908 [1.0]	Honours Research Thesis	
ERTH 4908 [1.0]	Honours Thesis	
ERTH 4909 [0.5]	Research in Earth Sciences (and 0.5 credit in EARTH at the 4000-level)	

#### B. Credits Not Included in the Major CGPA (7.0 credits)

<b>5. 1.0 credit in:</b>		<b>1.0</b>
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
<b>6. 1.0 credit from:</b>		<b>1.0</b>
CHEM 1001 [0.5]	General Chemistry I	
& CHEM 1002 [0.5]	and General Chemistry II	
CHEM 1005 [0.5]	Elementary Chemistry I	
& CHEM 1006 [0.5]	and Elementary Chemistry II	
PHYS 1003 [0.5]	Introductory Mechanics and	
& PHYS 1004 [0.5]	Thermodynamics and Introductory Electromagnetism and Wave Motion	
PHYS 1007 [0.5]	Elementary University Physics I	
& PHYS 1008 [0.5]	and Elementary University Physics II (The omitted subject, i.e. Chemistry or Physics, must have been taken at the 4U/M level)	
<b>7. 0.5 credit in</b>	STAT	<b>0.5</b>
STAT 2507 [0.5]	Introduction to Statistical Modeling I (recommended)	
<b>8. 0.5 credit in</b>	COMP	<b>0.5</b>
COMP 1004 [0.5]	Introduction to Computers for the Sciences (recommended)	
<b>9. 1.0 credit in</b>	Science Faculty Electives	<b>1.0</b>
<b>10. 0.5 credit in:</b>		<b>0.5</b>
NSCI 1000 [0.5]	Seminar in Science (or Approved Arts or Social Sciences)	
<b>11. 1.5 credits in</b>	Approved Arts or Social Sciences	<b>1.5</b>
<b>12. 1.0 credit in</b>	free electives.	<b>1.0</b>
<b>Total Credits</b>		<b>20.0</b>

Note: Students choosing CHEM 1005 and CHEM 1006 will be required to obtain a grade of B- or higher in CHEM 1006 to take BIOL 2200 and more advanced courses in BIOC and CHEM.

### Biology and Physics

#### B.Sc. Combined Honours (20.0 credits)

##### A. Credits Included in the Major CGPA (12.0 credits)

<b>1. 1.0 credit from:</b>		<b>1.0</b>
PHYS 1001 [0.5]	Foundations of Physics I	
& PHYS 1002 [0.5]	and Foundations of Physics II (recommended)	
PHYS 1003 [0.5]	Introductory Mechanics and	
& PHYS 1004 [0.5]	Thermodynamics and Introductory Electromagnetism and Wave Motion	
PHYS 1007 [0.5]	Elementary University Physics I	
& PHYS 1008 [0.5]	and Elementary University Physics II (with an average grade of B- or higher)	
<b>2. 2.0 credits in:</b>		<b>2.0</b>
PHYS 2604 [0.5]	Modern Physics I	
PHYS 2202 [0.5]	Wave Motion and Optics	
PHYS 2305 [0.5]	Electricity and Magnetism	
PHYS 2401 [0.5]	Thermal Physics	
<b>3. 2.0 credits in:</b>		<b>2.0</b>

PHYS 3007 [0.5]	Third Year Physics Laboratory: Selected Experiments and Seminars	
PHYS 3207 [0.5]	Topics in Biophysics	
PHYS 3606 [0.5]	Modern Physics II	
PHYS 3701 [0.5]	Elements of Quantum Mechanics	
<b>4. 1.0 credit from:</b>		<b>1.0</b>
PHYS 3308 [0.5]	Electromagnetism	
PHYS 3802 [0.5]	Advanced Dynamics	
PHYS 3807 [0.5]	Mathematical Physics I	
PHYS 4008 [0.5]	Fourth-Year Physics Laboratory: Selected Experiments and Workshop	
PHYS 4203 [0.5]	Physical Applications of Fourier Analysis	
PHYS 4409 [0.5]	Thermodynamics and Statistical Physics	
PHYS 4608 [0.5]	Nuclear Physics	
PHYS 4707 [0.5]	Introduction to Quantum Mechanics I	
<b>5. 4.0 credits in:</b>		<b>4.0</b>
BIOL 1103 [0.5]	Foundations of Biology I	
BIOL 1104 [0.5]	Foundations of Biology II	
BIOL 2200 [0.5]	Cellular Biochemistry	
BIOL 2104 [0.5]	Introductory Genetics	
BIOL 2001 [0.5]	Animals: Form and Function	
BIOL 3201 [0.5]	Cell Biology	
BIOL 3104 [0.5]	Molecular Genetics	
BIOL 3305 [0.5]	Human and Comparative Physiology	
<b>6. 1.0 credit from:</b>		<b>1.0</b>
BIOL 4106 [0.5]	Advances in Molecular Biology	
BIOL 4109 [0.5]	Laboratory Techniques in Molecular Genetics	
BIOL 4202 [0.5]	Mutagenesis and DNA Repair	
BIOL 4301 [0.5]	Current Topics in Biotechnology	
BIOL 4306 [0.5]	Animal Neurophysiology	
<b>7. 1.0 credit from:</b>		<b>1.0</b>
a. BIOL 4907 [1.0]		
b. BIOL 4908 [1.0]		
c. PHYS 4909 [1.0]		
d. PHYS 4907 [0.5] plus 0.5 credit 4000-level PHYS		
e. PHYS 4908 plus 0.5 credit 4000-level PHYS		
<b>B. Credits Not Included in the Major CGPA (8.0 credits)</b>		
<b>8. 1.0 credit in:</b>		<b>1.0</b>
CHEM 1001 [0.5]	General Chemistry I	
& CHEM 1002 [0.5]	and General Chemistry II (See Note, below)	
<b>9. 1.5 credit from:</b>		<b>1.5</b>
MATH 1004 [0.5]	Calculus for Engineering or Physics	
MATH 1005 [0.5]	Differential Equations and Infinite Series for Engineering or Physics	
MATH 1104 [0.5]	Linear Algebra for Engineering or Science	
<b>10. 2.0 credits in:</b>		<b>2.0</b>
STAT 2507 [0.5]	Introduction to Statistical Modeling I	
MATH 2004 [0.5]	Multivariable Calculus for Engineering or Physics	
MATH 3705 [0.5]	Mathematical Methods I	

MATH 3806 [0.5]	Numerical Analysis (Honours)	
<b>11. 0.5 credit from:</b>		<b>0.5</b>
COMP 1005 [0.5]	Introduction to Computer Science I	
<b>12. 0.5 credit from:</b>		<b>0.5</b>
NSCI 1000 [0.5]	Seminar in Science	
Approved Arts or Social Sciences Elective		
<b>13. 1.5 credits in</b>	Approved Arts or Social Sciences	<b>1.5</b>
<b>14. 1.0 credit in</b>	free electives	<b>1.0</b>
<b>Total Credits</b>		<b>20.0</b>

Note: For **Item 8** above, CHEM 1001 and CHEM 1002 are strongly recommended for this program. Students may substitute CHEM 1001 and CHEM 1002 with CHEM 1005 and CHEM 1006, respectively. Students choosing CHEM 1005 and CHEM 1006 will be required to obtain a grade of B- or higher in CHEM 1006 to take BIOL 2200 and more advanced courses in BIOC and CHEM. Students completing CHEM 1005 with a grade of B- or higher are encouraged to register for CHEM 1002.

## Neuroscience

### B.Sc. Combined Honours (20.0 credits)

#### A. Credits Included in the Major CGPA (12.5 credits)

<b>1. 3.0 credits in:</b>		<b>3.0</b>
BIOL 1103 [0.5]	Foundations of Biology I	
BIOL 1104 [0.5]	Foundations of Biology II	
BIOL 2001 [0.5]	Animals: Form and Function	
BIOL 2200 [0.5]	Cellular Biochemistry	
BIOL 2104 [0.5]	Introductory Genetics	
BIOL 3305 [0.5]	Human and Comparative Physiology	
<b>2. 1.0 credit in</b>	BIOL, BIOC, or CHEM	<b>1.0</b>
<b>3. 1.5 credits in</b>	BIOL, BIOC, or CHEM at the 3000-level or above	<b>1.5</b>
<b>4. 4.5 credits in:</b>		<b>4.5</b>
PSYC 1001 [0.5]	Introduction to Psychology I	
PSYC 1002 [0.5]	Introduction to Psychology II	
NEUR 2001 [0.5]	Introduction to Research Methods in Psychology	
NEUR 2002 [0.5]	Introduction to Statistics in Psychology	
NEUR 2200 [0.5]	Biological Foundations of Behaviour	
PSYC 2700 [0.5]	Introduction to Cognitive Psychology	
NEUR 3200 [1.0]	Principles of Neuroscience	
NEUR 4200 [0.5]	Seminar on Current Research in Neuroscience	
<b>5. 1.0 credit from:</b>		<b>1.0</b>
NEUR 3202 [0.5]	Sensory Processes	
NEUR 3203 [0.5]	Field Course in Animal Behaviour	
or BIOL 3605 [0.5]	Field Course I	
NEUR 3204 [0.5]	Principles of Psychopharmacology: From Drugs to Behaviour	
PSYC 3700 [1.0]	Cognition (Honours Seminar)	
NEUR 4001 [0.5]	Special Topics in Neuroscience (with permission)	
NEUR 4207 [0.5]	Neuropsychology of Memory Disorders	
<b>6. 0.5 credit from:</b>		<b>0.5</b>



BIOL 3802 [0.5]	Animal Behaviour	
BIOL 4317 [0.5]	Neuroethology: The Neural Basis of Animal Behaviour	
BIOC 4007 [0.5]	Membrane Biochemistry	
<b>7. 1.0 credit from:</b>		<b>1.0</b>
NEUR 4907 [1.0]	Honours Essay and Research Proposal	
NEUR 4908 [1.0]	Honours Research Thesis	
BIOL 4907 [1.0]	Honours Essay and Research Proposal	
BIOL 4908 [1.0]	Honours Research Thesis	
<b>B. Credits Not Included in the Major CGPA (7.5 credits)</b>		
<b>8. 1.0 credit in:</b>		<b>1.0</b>
MATH 1007 [0.5]	Elementary Calculus I	
or MATH 1004 [0.5]	Calculus for Engineering or Physics	
MATH 1107 [0.5]	Linear Algebra I	
<b>9. 1.0 credit in:</b>		<b>1.0</b>
PSYC 3000 [1.0]	Design and Analysis in Psychological Research	
<b>10. 1.5 credits in:</b>		<b>1.5</b>
CHEM 1001 [0.5]	General Chemistry I	
& CHEM 1002 [0.5]	and General Chemistry II	
CHEM 2203 [0.5]	Organic Chemistry I (See Note 2, below)	
<b>11. 1.0 credit from:</b>		<b>1.0</b>
PHYS 1007 [0.5]	Elementary University Physics I	
& PHYS 1008 [0.5]	and Elementary University Physics II	
or PHYS 1001	Foundations of Physics I	
& PHYS 1002 [1.0]	and Foundations of Physics II	
<b>12. 0.5 credit in:</b>		<b>0.5</b>
NSCI 1000 [0.5]	Seminar in Science	
or in the Faculty of Arts and Social Sciences or Faculty of Public Affairs, not in Psychology		
<b>13. 1.5 credits in</b>	Approved Arts or Social Sciences, not in PSYC or BIOL	<b>1.5</b>
<b>14. 1.0 credits in</b>	free electives.	<b>1.0</b>
<b>Total Credits</b>		<b>20.0</b>

#### Notes:

- The topic for Item 7 above must be in neurophysiology, animal behaviour, neuropsychology or a related topic.
- For item 10 above, CHEM 1001 and CHEM 1002 are strongly recommended for this program. Students may substitute CHEM 1001 and CHEM 1002 with CHEM 1005 and CHEM 1006, respectively. Students choosing CHEM 1005 and CHEM 1006 will be required to obtain a grade of B- or higher in CHEM 1006 to take BIOL 2200 and more advanced courses in BIOC and CHEM. Students completing CHEM 1005 with a grade of B- or higher are encouraged to register in CHEM 1002.
- For Item 11 above, students who enrol in PHYS 1001/PHYS 1002 must have completed MATH 1004 for Item 8.

## Biology

### B.A. Honours (20.0 credits)

#### A. Credits included in the Major CGPA (8.0 credits)

<b>1. 1.0 credit in:</b>		<b>1.0</b>
BIOL 1003 [0.5]	Introductory Biology I	
BIOL 1004 [0.5]	Introductory Biology II	
<b>2. 2.5 credits from:</b>		<b>2.5</b>
BIOL 2001 [0.5]	Animals: Form and Function	
BIOL 2002 [0.5]	Plants: Form and Function	
BIOL 2104 [0.5]	Introductory Genetics	
or BIOL 2107 [0.5]	Fundamentals of Genetics	
BIOL 2200 [0.5]	Cellular Biochemistry	
or BIOL 2201 [0.5]	Cell Biology and Biochemistry	
BIOL 2303 [0.5]	Microbiology	
BIOL 2600 [0.5]	Introduction to Ecology	
<b>3. 0.5 credit from:</b>		<b>0.5</b>
BIOL 3205 [0.5]	Plant Biochemistry and Physiology	
BIOL 3303 [0.5]	Experimental Microbiology	
BIOL 3305 [0.5]	Human and Comparative Physiology	
BIOL 3306 [0.5]	Human Anatomy and Physiology	
<b>4. 1.0 credit in</b>	BIOL at the 3000-level or higher	<b>1.0</b>
<b>5. 2.0 credits in</b>	BIOL	<b>2.0</b>
<b>6. 1.0 credit in:</b>		<b>1.0</b>
BIOL 4907 [1.0]	Honours Essay and Research Proposal	
or BIOL 4908 [1.0]	Honours Research Thesis	

#### B. Credits not included in the Major CGPA (12.0 credits)

<b>7. 1.0 credit from:</b>		<b>1.0</b>
CHEM 1001 [0.5]	General Chemistry I	
& CHEM 1002 [0.5]	and General Chemistry II	
CHEM 1005 [0.5]	Elementary Chemistry I	
& CHEM 1006 [0.5]	and Elementary Chemistry II	
(see Note 2 below)		
<b>8. 1.0 credit in</b>	Science Faculty Electives at the 2000-level or higher, not in BIOL	<b>1.0</b>
<b>9. 1.0 credit in</b>	Science Faculty Electives not in BIOL	<b>1.0</b>
<b>10. 2.0 credits in</b>	Approved Arts or Social Sciences at the 2000-level or higher	<b>2.0</b>
<b>11. 4.0 credits in</b>	Approved Arts or Social Sciences	<b>4.0</b>
<b>12. 1.0 credit at</b>	the 3000- or 4000-level	<b>1.0</b>
<b>13. 2.0 credits in</b>	free electives.	<b>2.0</b>
<b>Total Credits</b>		<b>20.0</b>

#### Notes:

- Students should choose their second year courses carefully to ensure that they have the necessary prerequisites for upper year courses in Biology
- For Item 7 above, students choosing CHEM 1005 and CHEM 1006 will be required to obtain a grade of B- or higher in CHEM 1006 to take BIOL 2200 and more advanced courses in BIOC and CHEM.

## Biology

### B.A. General (15.0 credits)

**Note: Some advanced Biology courses with laboratory components will not be available to students enrolling in the B.A. General program.**

#### A. Credits included in the Major CGPA (6.0 credits)

<b>1. 1.0 credit in:</b>	1.0
BIOL 1003 [0.5]	Introductory Biology I
BIOL 1004 [0.5]	Introductory Biology II
<b>2. 2.0 credits from:</b>	2.0
BIOL 2001 [0.5]	Animals: Form and Function
BIOL 2002 [0.5]	Plants: Form and Function
BIOL 2107 [0.5]	Fundamentals of Genetics
BIOL 2201 [0.5]	Cell Biology and Biochemistry
BIOL 2303 [0.5]	Microbiology
BIOL 2600 [0.5]	Introduction to Ecology

<b>3. 3.0 credits in BIOL</b>	3.0
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#### B. Credits not included in the Major CGPA (9.0 credits)

<b>4. 1.0 credit from:</b>	1.0
CHEM 1001 [0.5]	General Chemistry I
& CHEM 1002 [0.5]	and General Chemistry II
CHEM 1005 [0.5]	Elementary Chemistry I
& CHEM 1006 [0.5]	and Elementary Chemistry II
( see Note 2, below)	
<b>5. 1.0 credit in Science Faculty Electives, not in BIOL</b>	1.0
<b>6. 4.0 credits in Approved Arts or Social Sciences</b>	4.0
<b>7. 1.0 credit at the 2000-level or higher</b>	1.0
<b>8. 1.0 credit in electives not in BIOL</b>	1.0
<b>9. 1.0 credit in free electives.</b>	1.0
<b>Total Credits</b>	15.0

#### Notes:

1. Students should choose their second year courses carefully to ensure that they have the necessary prerequisites for upper year courses in Biology.
2. For Item 4 above, students choosing CHEM 1005 and CHEM 1006 will be required to obtain a grade of B- or higher in CHEM 1006 to take more advanced courses in BIOC and CHEM.

## Biology

### B.A. Combined Honours (20.0 credits)

#### A. Credits included in the Biology Major CGPA (6.0 credits)

<b>1. 1.0 credit in:</b>	1.0
BIOL 1003 [0.5]	Introductory Biology I
BIOL 1004 [0.5]	Introductory Biology II
<b>2. 2.5 credits from:</b>	2.5
BIOL 2001 [0.5]	Animals: Form and Function
BIOL 2002 [0.5]	Plants: Form and Function
BIOL 2104 [0.5]	Introductory Genetics
or BIOL 2107 [0.5]	Fundamentals of Genetics
BIOL 2200 [0.5]	Cellular Biochemistry
or BIOL 2201 [0.5]	Cell Biology and Biochemistry
BIOL 2303 [0.5]	Microbiology
BIOL 2600 [0.5]	Introduction to Ecology
<b>3. 1.0 credit in BIOL at the 3000-level or higher</b>	1.0
<b>4. 1.5 credits from BIOL</b>	1.5

<b>B. Additional Requirements (14.0 credits)</b>	
<b>5. 1.0 credit from:</b>	1.0
CHEM 1001 [0.5]	General Chemistry I
& CHEM 1002 [0.5]	and General Chemistry II
CHEM 1005 [0.5]	Elementary Chemistry I
& CHEM 1006 [0.5]	and Elementary Chemistry II
( see Note 2, below)	
<b>6. 1.0 credit from:</b>	1.0
BIOL 4907 [1.0]	Honours Essay and Research Proposal
BIOL 4908 [1.0]	Honours Research Thesis
or equivalent from the other Honours department	
<b>7. 1.0 credit in Science Faculty Electives, not in BIOL, at the 2000-level or higher</b>	1.0
<b>8. 1.0 credit in Science Faculty Electives, not in BIOL</b>	1.0
<b>9. 7.0 credits in Approved Arts or Social Sciences to include the requirements for the other discipline</b>	7.0
<b>10. 2.0 credits in free electives not in BIOL or the other discipline</b>	2.0
<b>11. 1.0 credit in free electives.</b>	1.0
<b>Total Credits</b>	20.0

#### Notes:

1. Students should choose their second year courses carefully to ensure that they have the necessary prerequisites for upper year courses in Biology.
2. For item 5 above, students choosing CHEM 1005 and CHEM 1006 will be required to obtain a grade of B- or higher in CHEM 1006 to take BIOL 2200 and more advanced courses in BIOC and CHEM.

### Minor in Biology (4.0 credits)

The Minor in Biology is available to students registered in degree programs other than those offered by the Department of Biology. Consultation with the undergraduate advisor is required.

#### Requirements (4.0 credits)

<b>1. 1.0 credit in:</b>	1.0
BIOL 1003 [0.5]	Introductory Biology I
BIOL 1004 [0.5]	Introductory Biology II
<b>2. 1.5 credits from:</b>	1.5
BIOL 2001 [0.5]	Animals: Form and Function
BIOL 2002 [0.5]	Plants: Form and Function
BIOL 2107 [0.5]	Fundamentals of Genetics
BIOL 2201 [0.5]	Cell Biology and Biochemistry
BIOL 2303 [0.5]	Microbiology
BIOL 2600 [0.5]	Introduction to Ecology
<b>3. 0.5 credit in BIOL at the 2000-level or higher</b>	0.5
<b>4. 1.0 credit in BIOL at the 3000-level or higher</b>	1.0
<b>Total Credits</b>	4.0

**Note:** At least 2.0 of these credits must be taken at Carleton University.

### Biology (BIOL) Courses

#### Department of Biology

#### Faculty of Science

**BIOL 1003 [0.5 credit]****Introductory Biology I**

A concepts and applications course focusing on cell organization, metabolism, genetics, and reproduction. Normally for students interested in understanding the fundamental processes that underlie cellular biology and their relationship to organism function, who are not registered in a B.Sc. Honours program.

Precludes additional credit for BIOL 1103.

Prerequisite(s): Ontario 4U/M in Biology (or equivalent), or Ontario 4U/M in Chemistry (or equivalent).

Lectures three hours a week, laboratory or tutorial three hours a week.

**BIOL 1004 [0.5 credit]****Introductory Biology II**

A concepts and applications course focusing on evolution, diversity of life, and ecological relationships. Normally for students interested in understanding larger scale biological processes that impact our lives on the global scale, who are not registered in a B.Sc. Honours program.

Precludes additional credit for BIOL 1104.

Prerequisite(s): Ontario 4U/M in Biology (or equivalent) or BIOL 1003.

Lectures three hours a week, laboratory or tutorial three hours a week.

**BIOL 1010 [0.5 credit]****Biotechnology and Society**

A course for students interested in the science behind recent advances in biotechnology. The different ways in which biotechnology is being applied in agriculture, health care, and the environment will be examined. Preclusion: credit will not be given if taken concurrently with, or after BIOL 2200 or BIOC 2200 or BIOL 2201. Students in Biology and Biochemistry programs may only take this course as a free elective.

Lectures three hours a week.

**BIOL 1103 [0.5 credit]****Foundations of Biology I**

A research-oriented course focusing on the scientific process of biological exploration at the cellular level. Topics include cell organization, metabolism, genetics, and reproduction. This course is for students registered in one of the B.Sc. Honours programs.

Precludes additional credit for BIOL 1003

Prerequisite(s): Ontario 4U/M in Biology (or equivalent), or Ontario 4U/M in Chemistry (or equivalent).

Lectures three hours a week, laboratory or tutorial three hours a week.

**BIOL 1104 [0.5 credit]****Foundations of Biology II**

A research-oriented course focusing on the scientific process of biological exploration at the macroscale. Topics include evolution, diversity of life, and ecological relationships. This course is for students registered in one of the B.Sc. Honours programs.

Precludes additional credit for BIOL 1004.

Prerequisite(s): Ontario 4U/M in Biology (or equivalent) or BIOL 1103.

Lectures three hours a week, laboratory or tutorial three hours a week.

**BIOL 1902 [0.5 credit]****Natural History**

A course designed primarily for students in non-biology programs to investigate the natural history of plants and animals, and the communities in which they occur.

Particular attention is paid to the Ottawa region, but appropriate examples from other locales are also included. Lectures three hours a week.

**BIOL 2001 [0.5 credit]****Animals: Form and Function**

An introduction to the diverse structures of animals (both invertebrates and vertebrates) in relationship to their functions, discussed within an evolutionary framework.

Prerequisite(s): (BIOL 1003 and BIOL 1004) or (BIOL 1103 and BIOL 1104) or permission of the Department.

Lectures three hours a week, laboratory or tutorial three hours a week.

**BIOL 2002 [0.5 credit]****Plants: Form and Function**

An introduction to the structure and development of higher plants (at cellular, morphological and organism levels) discussed in relation to their function.

Prerequisite(s): (BIOL 1003 and BIOL 1004) or (BIOL 1103 and BIOL 1104) or permission of the Department.

Lectures three hours a week, laboratory or tutorial three hours a week.

**BIOL 2005 [0.5 credit]****Human Physiology**

Topics may include: neurophysiology, sensory reception, the skeletal system, muscular contraction, the cardiovascular system, the respiratory system, and the gastrointestinal system. Preclusion: credit will not be given if taken concurrently with, or after BIOL 3305 or BIOL 3306. Students in Biology and Biochemistry programs may only take this course as a free elective.

Prerequisite(s): BIOL 1003 or BIOL 1103 and (CHEM 1001 and CHEM 1002) or (CHEM 1005 and CHEM 1006) or permission of the Department.

Lectures three hours a week.

**BIOL 2104 [0.5 credit]****Introductory Genetics**

A lecture and laboratory course on the mechanisms of inheritance and the nature of gene structure, composition and function, introducing both classical Mendelian genetics and modern molecular genetics. It is strongly recommended that this course be taken by Biology majors in their second year of study.

Precludes additional credit for BIOL 2106 (no longer offered) and BIOL 2107. Credit for BIOL 2106 will only be given if taken before BIOL 2104.

Prerequisite(s): (BIOL 1003 and BIOL 1004) or (BIOL 1103 and BIOL 1104) or permission of the Department.

Lectures three hours a week, laboratory or tutorial three hours a week.

**BIOL 2107 [0.5 credit]****Fundamentals of Genetics**

Mechanisms of inheritance and the nature of gene structure, composition and function, introducing both classical Mendelian genetics and modern molecular genetics.

Precludes additional credit for BIOL 2104 and BIOL 2106 (no longer offered).

Prerequisite(s): (BIOL 1003 and BIOL 1004) or (BIOL 1103 and BIOL 1104) or permission of the Department.

Lectures three hours a week.

**BIOL 2200 [0.5 credit]****Cellular Biochemistry**

Cellular functions and their interrelationships. Introduction to thermodynamics, membrane structure and function, transport mechanisms, basic metabolic pathways, energy production and utilization, communications between cells. Also listed as BIOC 2200.

Prerequisite(s): (BIOL 1003 and BIOL 1004) or (BIOL 1103 and BIOL 1104), (CHEM 1001 and CHEM 1002) or (CHEM 1005 and CHEM 1006), or permission of the Department.

Lectures three hours a week, laboratory or tutorial four hours a week.

**BIOL 2201 [0.5 credit]****Cell Biology and Biochemistry**

A study of the molecular, metabolic and structural organization of cells in relation to function. This course is recommended for students not taking upper year Biology laboratory courses for which BIOL/BIOC laboratories are prerequisites. Credit will not be given if taken concurrently with, or after, BIOL 2200 or BIOC 2200.

Prerequisite(s): (BIOL 1003 or BIOL 1103) and (CHEM 1002 or CHEM 1006), or permission of the Department.

Lectures three hours a week.

**BIOL 2303 [0.5 credit]****Microbiology**

The biology of the bacteria, Archaea, Viruses and Protozoans, from the fundamentals of cell chemistry, molecular biology, structure and function, to their involvement in ecological and industrial processes and human disease.

Prerequisite(s): BIOL 1003 or BIOL 1103.

Lectures three hours a week.

**BIOL 2600 [0.5 credit]****Introduction to Ecology**

The scientific study of interactions of living organisms and their environment, and how these affect the distribution and abundance of life. Topics include energy transformation and flow, nutrient cycling, population and community dynamics, human impacts on ecosystems, conservation issues. Laboratory includes field and computer exercises.

Prerequisite(s): (BIOL 1003 and BIOL 1004), or (BIOL 1103 and BIOL 1104) or permission of the Department.

Lectures three hours a week, laboratory or tutorial four hours a week.

**BIOL 2903 [0.5 credit]****Natural History of Ontario**

Introduction to the remarkable diversity and ecological relationships of Ontario's flora and fauna, which are explored in a habitat context.

Precludes additional credit for BIOL 1903 (no longer offered).

Prerequisite(s): BIOL 1902.

Lectures three hours a week.

**BIOL 3004 [0.5 credit]****Insect Diversity**

Introductory course dealing with the taxonomic diversity, anatomy, behavior and physiology of insects, as well as their impacts on ecosystems, agriculture and animal and human health.

Precludes additional credit for BIOL 4601.

Prerequisite(s): BIOL 2001.

Lectures three hours a week.

**BIOL 3102 [0.5 credit]****Mycology**

This introductory course will cover the morphology, physiology, life cycles, evolution, ecology and biotechnology of the fungi.

Prerequisite(s): BIOL 2104 or BIOL 2107.

Lectures three hours a week.

**BIOL 3104 [0.5 credit]****Molecular Genetics**

A lecture course dealing with modern advances in molecular genetics.

Prerequisite(s): BIOL 2104 or BIOL 2017 or permission of the Department.

Lectures three hours a week.

**BIOL 3201 [0.5 credit]****Cell Biology**

A lecture and laboratory course on the structure, composition, and function of eukaryotic cells.

Prerequisite(s): BIOL 2104 and BIOL 2200/BIOC 2200, or permission of the Department.

Lectures three hours a week, laboratory four hours a week.

**BIOL 3202 [0.5 credit]****Principles of Developmental Biology**

Introduction to the underlying principles and mechanisms governing development in multicellular animals and plants.

Differentiation, growth, morphogenesis, and patterning will be examined at the organismal, cellular, and molecular levels to provide a balanced view of developmental phenomena in key model organisms.

Prerequisite(s): BIOL 2104 or BIOL 2107 and one of BIOL 2001 or BIOL 2002, or permission of the Department.

Lectures three hours a week.

**BIOL 3205 [0.5 credit]****Plant Biochemistry and Physiology**

A lecture and laboratory course consisting of selected topics in metabolism and physiology of plants, including photosynthesis, nutrient uptake and transport, intermediary and secondary metabolism, germination, growth and development.

Prerequisite(s): BIOL 2002 and BIOL 2200/BIOC 2200, or permission of the Department.

Lectures three hours a week, laboratory four hours a week.

**BIOL 3303 [0.5 credit]****Experimental Microbiology**

Intensive training in laboratory techniques in microbiology, using bacteria and other microorganisms to demonstrate processes of cell growth, metabolism, gene expression, rapid evolution, gene transfer, microbial community dynamics and interactions with other organisms.

Prerequisite(s): BIOL 2104, BIOL 2200/BIOC 2200 and BIOL 2303, or permission of the Department.

Lecture/tutorial one and a half hours a week, laboratory four hours a week.

**BIOL 3305 [0.5 credit]****Human and Comparative Physiology**

The properties of physiological systems and components of humans and other animals with an emphasis on physical and chemical bases.

Precludes additional credit for BIOL 3306.

Prerequisite(s): BIOL 2200/BIOC 2200 and BIOL 2001. A credit in PHYS at the 1000-level is strongly recommended.

Lectures three hours a week, laboratory four hours a week.

**BIOL 3306 [0.5 credit]****Human Anatomy and Physiology**

The anatomy and physiology of the neuromuscular, cardiovascular, respiratory, and excretory systems of humans with comparison to other animals.

Precludes additional credit for BIOL 3305.

Prerequisite(s): (BIOL 1003 and BIOL 1004) or (BIOL 1103 and BIOL 1104), and (CHEM 1001 and CHEM 1002) or (CHEM 1005 and CHEM 1006).

Lectures three hours per week.

**BIOL 3307 [0.5 credit]****Advanced Human Anatomy and Physiology**

The anatomy and physiology of the endocrine, skeletal, digestive, immunological, and reproductive systems, with additional emphasis on the embryological origins of the major physiological systems.

Prerequisite(s): BIOL 3305 or BIOL 3306.

Lectures three hours per week, workshop or laboratory four hours per week.

**BIOL 3501 [0.5 credit]****Biomechanics**

Properties of muscles, tendons, bones, joints and the co-ordinated use of these structures. Human and other animal locomotion and fitness, bird flight, especially the soaring of the vulture and the albatross, and animal migration are covered in detail.

Prerequisite(s): (BIOL 1003 and BIOL 1004) or (BIOL 1103 and BIOL 1104).

Lectures three hours a week, workshop two hours a week.

**BIOL 3601 [0.5 credit]****Ecosystems and Environmental Change**

Exploration of the unique contribution of the ecosystem approach to ecology, and of early key literature in ecosystem ecology through to current work on global environmental change.

Prerequisite(s): BIOL 2600.

Lectures three hours a week, laboratory four hours a week in six sessions.

**BIOL 3602 [0.5 credit]****Conservation Biology**

The science of biology as applied to the problem of maintaining species diversity. Topics include: history of conservation biology, valuation of species, indices of biodiversity, extinction, conservation genetics, conservation planning in parks and reserves, landscape ecology and case studies of conservation problems.

Prerequisite(s): BIOL 2600 or permission of the Department.

Lectures three hours a week and laboratory/workshop three hours a week.

**BIOL 3604 [0.5 credit]****Analysis of Ecological Relationships**

Introduction to the analysis of ecological data. Students analyze real ecological data sets in weekly laboratory sessions. Methods introduced include simple linear, polynomial, and multiple regression analysis, analysis of variance, nonparametric tests, tests of independence and logistic regression analysis.

Prerequisite(s): BIOL 2600 and STAT 2507.

Lectures one and one-half hours and laboratory two and one-half hours a week.

**BIOL 3605 [0.5 credit]****Field Course I**

An intensive study of living organisms under natural conditions. Credit is based on two weeks of full-time fieldwork with attendant assignments. A wide range of modules is available. Transportation and room and board costs are borne by the student. Students may take both BIOL 3605 and BIOL 3606 for credit, but neither may be used to repeat a particular module.

Also listed as NEUR 3203, for animal behaviour modules only.

Prerequisite(s): at least one course in BIOL beyond the 1000-level and written permission of the Department.

All day, approximately six days a week.

**BIOL 3606 [0.5 credit]****Field Course II**

An intensive study of living organisms under natural conditions. Credit is based on two weeks of full-time fieldwork with attendant assignments. A wide range of modules is available. Transportation and room and board costs are borne by the student. Students may take both BIOL 3605 and BIOL 3606 for credit, but neither can be used to repeat a particular module.

Prerequisite(s): at least one course in BIOL beyond the 1000-level and written permission of the Department.

All day, approximately six days a week.

**BIOL 3608 [0.5 credit]****Principles of Biogeography**

Contemporary and past controls on distribution of plants and animals at global, regional and local scales; significance of these distributions.

Also listed as GEOG 3104.

Prerequisite(s): BIOL 2600 or GEOG 1010 or permission of the Department.

**BIOL 3609 [0.5 credit]****Evolutionary Concepts**

Evolution is the change in population properties across generations. Genetic variation, mutation, selection, drift, gene flow, genome evolution, speciation, development, biodiversity, fossils, and macro-evolution.

Prerequisite(s): BIOL 2104 or BIOL 2107 or permission of the instructor.

Lectures three hours a week.

**BIOL 3611 [0.5 credit]****Evolutionary Ecology**

The term "adaptation" is meaningful only with respect to an ecological context. Ecological contexts lead to evolutionary outcomes such as diverse mating systems, ageing, sexual reproduction, sexual dimorphism, geographic variation, phenotypic plasticity, and diverse life histories.

Precludes additional credit for BIOL 4608.

Prerequisite(s): BIOL 2600.

Lectures three hours a week; one field trip.

**BIOL 3612 [0.5 credit]****Computational Methods in Ecology and Evolution**

Introduction to the development and use of computer programs to address biological problems. Topics include the development of programs to analyse ecological data, models of population dynamics, deterministic chaos, cellular automata, simulations of foraging behaviour and evolutionary computation.

Prerequisite(s): BIOL 2600 or permission of the Department.

Lectures two hours per week, workshop three hours per week.

**BIOL 3801 [0.5 credit]****Plants and Herbivores**

Exploration of the chemical, physiological, ecological and evolutionary interactions that underlie the relationship between plants and their insect herbivores.

Prerequisite(s): BIOL 2001 and BIOL 2002.

Lectures/seminars three hours a week.

**BIOL 3802 [0.5 credit]****Animal Behaviour**

Advanced study of animal behaviour including the environmental, genetic, and neural influences on behaviour. Topics such as predator-prey interactions, mating behaviour, migration, parental care and social interactions are interpreted in an evolutionary context.

Prerequisite(s): BIOL 2001 and BIOL 2600, or permission of the Department.

Lectures three hours a week and workshop/tutorials three hours a week.

**BIOL 3804 [0.5 credit]****Social Evolution**

Diversity in social behaviour from evolutionary and ecological perspectives. Topics include ecological determinants of social living, social networks, social foraging, inclusive fitness, kin selection, altruism, cooperation, and mating systems and strategies.

Prerequisite(s): BIOL 2001 and BIOL 2600, or permission of the Department.

Lectures three hours a week.

**BIOL 3901 [0.5 credit]****Research Proposal**

The development of a competitive research proposal in consultation with an advisor.

Prerequisite(s): third year standing in an Honours Biology program and permission of the Department.

**BIOL 3999 [0.0 credit]****Co-operative Work Term Report**

Practical experience for students enrolled in the Co-operative Option. Students must receive satisfactory evaluations from their work term employer. Written reports describing the work term project will be required. Graded Sat or Uns.

Prerequisite(s): registration in the Biology Co-operative Option and permission of the Department.

**BIOL 4008 [0.5 credit]****Molecular Plant Development**

Recent advances in plant development including molecular, biochemical, genomics, and proteomics studies.

Prerequisite(s): BIOL 2002 or permission of the Department.

Lectures three hours a week.

**BIOL 4102 [0.5 credit]****Molecular Ecology**

The interface of molecular biology, ecology and population biology. Topics include experimental design and a survey and critique of molecular genetic methods to study ecology.

Prerequisite(s): BIOL 2104 or BIOL 2107 and BIOL 2600; BIOL 3104 or one of BIOL 3601, BIOL 3602 (may be taken concurrently), or permission of the Department.

Lectures three hours a week.

**BIOL 4103 [0.5 credit]****Population Genetics**

Evolution of gene frequencies, including selection, mutation, genetic drift, inbreeding, gene flow, and population structure.

Prerequisite(s): BIOL 2104 or BIOL 2107 or permission of the Department. A course in statistics is highly recommended.

Lectures and seminars three hours a week.

**BIOL 4104 [0.5 credit]****Evolutionary Genetics**

A continuation of BIOL 4103 dealing with molecular evidence of evolution, speciation as well as the analysis of biometrical traits.

Prerequisite(s): BIOL 4103 and BIOL 3609, or permission of the Department. A course in statistics is highly recommended.

Lectures and seminars three hours a week.

**BIOL 4106 [0.5 credit]****Advances in Molecular Biology**

Review of the application of high throughput approaches to research in molecular and cellular biology and biochemistry with an emphasis on gene function and human disease progression.

Prerequisite(s): BIOL 2303 and (BIOL 3104 or BIOL 3201).

Lectures and seminars three hours a week.

**BIOL 4109 [0.5 credit]****Laboratory Techniques in Molecular Genetics**

This laboratory course is complementary to BIOL 4106 and designed to provide practical familiarity with commonly used techniques in molecular genetics. The laboratory is suitable for students with a developing interest in problems of molecular and cellular biology and biochemistry.

Prerequisite(s): BIOL 2200/BIOC 2200 and BIOL 2303 and BIOL 3104 or permission of the Department.

Lecture/laboratory six hours a week in two sessions.

**BIOL 4200 [0.5 credit]****Immunology**

The organization and function of the immune system, including the anatomy of the immune system, the properties and behaviour of cells of the immune system, and the molecular and genetic bases of the immune response.

Also listed as BIOC 4200.

Prerequisite(s): BIOL 3201 or permission of the Department.

Lectures three hours a week.

**BIOL 4201 [0.5 credit]****Advanced Cell Culture and Tissue Engineering**

Theory and application of current techniques and developments in cell culture as applied to research questions in the field of stem cells and tissue engineering. Also listed as BIOC 4201.

Prerequisite(s): BIOL 3201 or permission of the Department.

Laboratory four hours per week, tutorial one hour a week. Labs require regular participation outside of the scheduled lab time to maintain cell cultures and set up or complete experiments.

**BIOL 4202 [0.5 credit]****Mutagenesis and DNA Repair**

A molecular study of mutagenesis and DNA repair. Topics include DNA structure perturbations, spontaneous and induced mutagenesis, the genetics and biochemistry of DNA repair and recombination, and the role of mutagens in the development of genetic disease and cancer. Also listed as BIOC 4202.

Prerequisite(s): BIOL 3104 and one of: BIOL 2200/BIOC 2200, BIOL 2201, BIOC 3102 (may be taken concurrently) or permission of the Department.

Lectures two hours a week and workshop two hours a week.

**BIOL 4203 [0.5 credit]****Evolution of Sex**

The evolution of sex, including meiosis, syngamy, sex determination, sex chromosomes, and gender from organismal, genetic, and developmental perspectives; the origin, maintenance, function, and ubiquity of sex.

Prerequisite(s): one of BIOL 2104 or BIOL 2106.

Lectures three hours a week.

**BIOL 4206 [0.5 credit]****Human Genetics**

A survey of human genetic variation and mutation in a molecular genetics context. Topics may include molecular basis of diseases, chromosomal abnormalities, genomic imprinting, cancer genetics, genomics, gene mapping and gene therapy.

Prerequisite(s): BIOL 3104 or permission of the Department.

Lectures three hours a week.

**BIOL 4209 [0.5 credit]****Advanced Plant Physiology**

An advanced course dealing with recent developments in selected topics of plant physiology.

Prerequisite(s): BIOL 3205 and CHEM 2203, CHEM 2204 or permission of the Department.

Lectures/discussion three hours a week.

**BIOL 4300 [0.5 credit]****Applied and Environmental Microbiology**

Studies of microbial ecology, physiology, biochemistry and genetics as they apply to microorganisms and microbial communities functioning in natural, agricultural and industrial environments.

Prerequisite(s): (BIOL 2200/BIOC 2200 or BIOL 2201), BIOL 2303 and BIOL 3104, or permission of the Department.

Lectures and tutorial three hours a week.

**BIOL 4301 [0.5 credit]****Current Topics in Biotechnology**

Explorations of developing biotechnologies in areas such as microbial products, protein engineering, plant genetic engineering, environmental remediation, pharmaceuticals production and medical diagnostics and therapy.

Prerequisite(s): BIOL 2104 or BIOL 2107, and (BIOL 2200/BIOC 2200 or BIOL 2201); or permission of the department.

Lectures and tutorials three hours a week.

**BIOL 4306 [0.5 credit]****Animal Neurophysiology**

A course dealing with recent advances made in particular areas of animal neurophysiology.

Precludes additional credit for BIOL 4305.

Prerequisite(s): BIOL 3305 or BIOL 3306, or permission of the Department.

Lectures two hours a week, workshops or laboratory four hours a week.

**BIOL 4317 [0.5 credit]****Neuroethology: The Neural Basis of Animal Behaviour**

The proximate mechanisms underlying animal behaviour are examined focusing on how nervous systems evolve in response to environmental selection pressures.

Topics include genetic and hormonal influences on behaviour (e.g. maternal care), unique sensory worlds (e.g. magnetic), and various levels of neural integration, from simple reflexes to complex social behaviour.

Prerequisite(s): BIOL 3305 or BIOL 3306, or permission of the Department.

Lectures three hours a week.

**BIOL 4318 [0.5 credit]****Adaptations to Extreme Environments**

Lectures, discussions and student presentations will be used to examine adaptations of animals to extreme environments (e.g. desert) or lifestyles (e.g. diving), at the physiological, biochemical and molecular levels. Emphasis on becoming familiar with the current primary literature.

Prerequisite(s): BIOL 3305, or permission of the Department.

Lectures three hours a week, workshop two hours a week.

**BIOL 4400 [0.5 credit]****Nuclear Dynamics and The Cell Cycle**

Molecular cell biology of nuclear functions and the eukaryotic cell cycle. Topics may include chromosome architecture and dynamics; nucleocytoplasmic exchange; pre-mRNA processing; ribosome biogenesis; mitotic and meiotic nuclear disassembly and reassembly; and regulation of cell proliferation and cell death.

Also listed as BIOC 4400.

Prerequisite(s): BIOL 3201, or BIOC 3102, or permission of the Department.

Lectures one and a half hours per week, workshop one and a half hours per week.

**BIOL 4500 [0.5 credit]****Ornithology I**

Introduction to ornithology, the study of birds; the evolution of birds, migration, geographic variation, adaptations for flight, feeding, reproduction; extinction and preservation.

Prerequisite(s): BIOL 2001.

Lectures three hours per week.

**BIOL 4501 [0.5 credit]****Ornithology II**

The taxonomy of birds and species identification are learned through the use of study skins in the lab. Field excursions allow first-hand study of wintering species. Participants must acquire a pair of binoculars and one of the recommended field guides.

Prerequisite(s): BIOL 4500.

Laboratory/field excursions four hours per week.



**BIOL 4503 [0.5 credit]****Fish Ecology, Conservation and Management**

Introduction to the diversity and environmental biology of the world's fishes. Applied issues in fisheries management, conservation, and aquaculture. Workshops expose students to techniques in fisheries science through hands-on demonstrations and field excursions.

Prerequisite(s): BIOL 2600 or permission of the Department.

Lectures/seminars two hours a week, plus labs/workshops two hours a week.

**BIOL 4603 [0.5 credit]****Insect Evolution and Biology**

Major questions on the origin, evolution and adaptation of structures and physiology of terrestrial arthropods, especially insects.

Prerequisite(s): BIOL 3004, or permission of the Department.

Lectures two hours a week, laboratory four hours a week.

**BIOL 4604 [0.5 credit]****Landscape Ecology**

Landscape ecology is the study of how landscape structure affects the abundance and distribution of organisms. The focus of this course is on research methods and results in landscape ecology. Applications in forestry, agriculture, and species conservation.

Prerequisite(s): BIOL 2600 or equivalent, BIOL 3601 or BIOL 3602 or BIOL 3608 or equivalent, and honours standing in Biology, Geography, or Environmental Sciences.

Lecture three hours a week.

**BIOL 4802 [0.5 credit]****Advanced Animal Behaviour**

Contemporary issues in behavioural ecology. Topics may include the relevance of behavioural ecology to conservation biology, to new insights into human social behaviour, and will be selected through consultation between professor and students.

Prerequisite(s): BIOL 3802 or BIOL 3804, or permission of the Department.

Lectures two hours a week, laboratory four hours a week.

**BIOL 4900 [1.0 credit]****Directed Special Studies and Seminar**

Prerequisite(s): permission of the Department.

**BIOL 4901 [0.5 credit]****Directed Special Studies**

Independent or group study, open to third- and fourth-year students to explore a particular topic, in consultation with a Faculty supervisor. May include directed reading, written assignments, tutorials, laboratory or field work.

Prerequisite(s): permission of the Department. Students normally may not offer more than 1.0 credit of Directed Special Studies in their program.

**BIOL 4907 [1.0 credit]****Honours Essay and Research Proposal**

An independent critical review and research proposal, using library resources, under the direct supervision of a Faculty advisor. Evaluation is based on a written report and a poster presentation.

Precludes additional credit for BIOL 4908.

Prerequisite(s): fourth-year standing in an Honours Biology program and permission of the Department.

**BIOL 4908 [1.0 credit]****Honours Research Thesis**

An independent research project undertaken in the field and/or the laboratory, under the direct supervision of a faculty adviser. Evaluation is based on a written thesis and a poster presentation.

Precludes additional credit for BIOL 4907.

Prerequisite(s): fourth-year standing in an Honours Biology program and permission of the Department.

**Summer session:** some of the courses listed in this Calendar are offered during the summer. Hours and scheduling for summer session courses will differ significantly from those reported in the fall/winter Calendar. To determine the scheduling and hours for summer session classes, consult the class schedule at [central.carleton.ca](http://central.carleton.ca)

Not all courses listed are offered in a given year. For an up-to-date statement of course offerings for the current session and to determine the term of offering, consult the class schedule at [central.carleton.ca](http://central.carleton.ca)