Biology

Program Requirements

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 Courses Outside the Faculties of Science and Engineering and Design
- 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.

Bioinformatics

B.Sc. Honours (20.0 credits)

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

1. 4.0 credits in:
   - 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] Molecular Genetics
   - BIOL 4905 [1.0] Honours Workshop
     or BIOL 4907 [1.0] Honours Essay and Research Proposal
   - BIOL 4908 [1.0] Honours Research Thesis

2. 0.5 credit from:
   - 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] Genomics
   - BIOL 3305 [0.5] Human and Comparative Physiology
   - BIOL 3306 [0.5] Human Anatomy and Physiology

3. 3.5 credits from:
   - 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 4104 [0.5] Evolutionary Genetics
   - BIOC 4202 [0.5] Mutagenesis and DNA Repair

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

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

6. 3.0 credits in:
   - 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)

7. 2.0 credits in:
   - CHEM 1001 [0.5] General Chemistry I
   - CHEM 1002 [0.5] General Chemistry II
   - CHEM 2203 [0.5] Organic Chemistry I
   - CHEM 2204 [0.5] Organic Chemistry II

8. 1.0 credit from:
   - PHYS 1007 [0.5] Elementary University Physics I
   - PHYS 1008 [0.5] Elementary University Physics II
   - PHYS 1003 [0.5] Introductory Mechanics and Thermodynamics
   - PHYS 1004 [0.5] Introductory Electromagnetism and Wave Motion

9. 2.0 credits in:
   - 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

10. 2.0 credits in Approved Courses Outside the Faculties of Science and Engineering and Design (may include NSCI 1000)

11. 0.5 credit in free electives.

Total Credits: 20.0

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)

1. 2.0 credits in:
   - BIOL 1103 [0.5] Foundations of Biology I
   - BIOL 1104 [0.5] Foundations of Biology II
   - BIOL 4905 [1.0] Honours Workshop
     or BIOL 4907 [1.0] Honours Essay and Research Proposal
Biology

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)

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

1. 2.0 credits in:
   - BIOL 1103 [0.5] Foundations of Biology I
   - BIOL 1104 [0.5] Foundations of Biology II
   - BIOL 4905 [1.0] Honours Workshop
     or BIOL 4907 [1.0] Honours Essay and Research Proposal
     or BIOL 4908 [1.0] Honours Research Thesis

2. 2.5 credits in:
   - 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

3. 0.5 credit from:
   - 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

4. 1.0 credit in BIOL at the 2000-level or higher

5. 3.5 credits in BIOL or BIOC at the 3000-level or higher

6. 0.5 credit from:
   - BIOL 3901 [0.5] Research Proposal
   - BIOL 4901 [0.5] Directed Special Studies
   or 4000-level BIOL

7. 1.0 credit in Advanced Science Faculty Electives

B. Credits not included in the Major CGPA (9.0 credits)

8. 1.0 credit in:
   - CHEM 1001 [0.5] General Chemistry I
   & CHEM 1002 [0.5] General Chemistry II (See Note 2, below)

9. 1.0 credit in:
   - BIOL 1105 [0.5] Biological Methods, Analysis and Interpretation
   - MATH 1007 [0.5] Elementary Calculus I

10. 1.0 credit from:
    - COMP 1005 [0.5] Introduction to Computer Science I
    - COMP 1006 [0.5] Introduction to Computer Science II
    - MATH 1107 [0.5] Linear Algebra I
    - PHYS 1007 [0.5] Elementary University Physics I
    - PHYS 1003 [0.5] Introductory Mechanics and Thermodynamics
    - PHYS 1008 [0.5] Elementary University Physics II
    - PHYS 1004 [0.5] Introductory Electromagnetism and Wave Motion
    - STAT 2507 [0.5] Introduction to Statistical Modeling I

11. 1.0 credit in Science Faculty Electives

12. 2.0 credits in Science Continuation (not in BIOL)

13. 2.0 credits in Approved Courses Outside the Faculties of Science and Engineering and Design (may include NSCI 1000)

14. 1.0 credit in free electives.

Total Credits 20.0
Biology with Concentration in Health Science

B.Sc. Honours (20.0 credits)

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

1. 2.0 credits in:
   - BIOL 1103 [0.5] Foundations of Biology I
   - BIOL 1104 [0.5] Foundations of Biology II
   - BIOL 4905 [1.0] Honours Workshop
     or BIOL 4907 [1.0] Honours Essay and Research Proposal
     or BIOL 4908 [1.0] Honours Research Thesis

2. 2.0 credits in:
   - 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

3. 1.0 credit in:
   - BIOL 3305 [0.5] Human and Comparative Physiology
   - BIOL 3307 [0.5] Advanced Human Anatomy and Physiology

4. 1.0 credit in:
   - BIOL 3101 [0.5] General Biochemistry I
   - BIOL 3102 [0.5] General Biochemistry II

5. 1.0 credit from:
   - 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

6. 1.0 credit from:
   - BIOL 4009 [0.5] Biochemistry of Disease
   - BIOL 4106 [0.5] Advances in Molecular Biology
   - BIOL 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

7. 1.0 credit from BIOL or BIOC at the 3000-level or higher

8. 0.5 credit from:
   - BIOL 3901 [0.5] Research Proposal
   - BIOL 4901 [0.5] Directed Special Studies
   - or 4000-level BIOL

9. 1.0 credit from:
   - NEUR 2201 [0.5] Cellular and Molecular Neuroscience
   - NEUR 2202 [0.5] Neurodevelopment and Plasticity
   - NEUR 3204 [0.5] Neuropharmacology
   - PSYC 2301 [0.5] Introduction to Health Psychology

10. 0.5 credit from:
    - 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

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

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 BIOL 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. Credits not included in the Major CGPA (9.0 credits)

11. 2.0 credits from:
   - CHEM 1001 [0.5] General Chemistry I
   - CHEM 1002 [0.5] General Chemistry II
   - CHEM 2203 [0.5] Organic Chemistry I
   - CHEM 2204 [0.5] Organic Chemistry II
   - CHEM 2207 [0.5] Introduction to Organic Chemistry I
   - CHEM 2208 [0.5] Introduction to Organic Chemistry II

See Note 2, below

12. 1.0 credit in:
   - BIOL 1105 [0.5] Biological Methods, Analysis and Interpretation
   - MATH 1007 [0.5] Elementary Calculus I

13. 1.0 credit from:
   - COMP 1006 [0.5] Introduction to Computer Science II
   - COMP 1005 [0.5] Introduction to Computer Science I
   - MATH 1107 [0.5] Linear Algebra I
   - PHYS 1007 [0.5] Elementary University Physics I
   - PHYS 1008 [0.5] Elementary University Physics II
   - STATS 2507 [0.5] Introduction to Statistical Modeling I

14. 1.0 credit in:
   - PSYC 1001 [0.5] Introduction to Psychology I
   - PSYC 1002 [0.5] Introduction to Psychology II

15. 1.0 credit in Science Faculty Electives

16. 1.0 credit in Science Continuation courses (not in BIOL)

17. 1.0 credit in Approved Courses Outside the Faculties of Science and Engineering and Design (may include NSCI 1000)

18. 1.0 credit in free electives.

Total Credits 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 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 BIOL 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. Credits Not included in the Major CGPA (9.0 credits)

10. 2.0 credits in:
   - CHEM 1001 [0.5] General Chemistry I
   - CHEM 1002 [0.5] General Chemistry II
   - CHEM 2203 [0.5] Organic Chemistry I
   - CHEM 2204 [0.5] Organic Chemistry II

See Note 2, below

11. 1.0 credit in:
   - BIOL 1105 [0.5] Biological Methods, Analysis and Interpretation
   - MATH 1007 [0.5] Elementary Calculus I

12. 1.0 credit from:

13. 1.0 credit in:
   - BIOL 1105 [0.5] Biological Methods, Analysis and Interpretation
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 10 above, CHEM 1001 and CHEM 1002 are strongly recommended for this program. Students may substitute CHEM 1001 and CHEM 1002 with BIOL or BIOC at the 3000-level or higher.
3. Students completing CHEM 1005 with 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)

1. 2.0 credits in:
   - BIOL 1103 [0.5] Foundations of Biology I
   - BIOL 1104 [0.5] Foundations of Biology II
   - BIOL 4905 [1.0] Honours Workshop
     or BIOL 4907 [1.0] Honours Essay and Research Proposal
     or BIOL 4908 [1.0] Honours Research Thesis

2. 2.0 credits in:
   - 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

3. 1.5 credits in:
   - 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

4. 1.5 credits in:
   - BIOC 2300 [0.5] Physical Biochemistry
   - BIOC 3101 [0.5] General Biochemistry I
   - BIOC 3102 [0.5] General Biochemistry II

5. 2.0 credits from:
   - MATH 1007 [0.5] General Calculus I
   - MATH 1107 [0.5] Linear Algebra I
   - PHYS 1007 [0.5] Elementary University Physics I
   - PHYS 1008 [0.5] Elementary University Physics II
   - PHYS 2204 [0.5] Organic Chemistry II (or)
   - PHYS 2207 [0.5] Introduction to Organic Chemistry I
   - PHYS 2208 [0.5] Introduction to Organic Chemistry II
   - STAT 2507 [0.5] Introduction to Statistical Modeling I

B. Credits not included in the Major CGPA (9.0 credits)

9. 2.0 credits from:
   - CHEM 1001 [0.5] General Chemistry I
   & CHEM 1002 [0.5] General Chemistry II
   - CHEM 2203 [0.5] Organic Chemistry I
   & CHEM 2204 [0.5] Organic Chemistry II (or)
   - CHEM 2207 [0.5] Introduction to Organic Chemistry I
   & CHEM 2208 [0.5] Introduction to Organic Chemistry II
   - See Note 2, below

10. 1.0 credit in:
    - BIOL 1105 [0.5] Biological Methods, Analysis and Interpretation
    - MATH 1007 [0.5] Elementary Calculus I

11. 1.0 credit from:
    - PHYS 1007 [0.5] Elementary University Physics I
    or PHYS 1003 [0.5] Introductory Mechanics and Thermodynamics

12. 1.0 credit in Science Faculty electives
13. 1.0 credit in Science Continuation courses (not in BIOL)
14. 2.0 credits in Approved Courses Outside the Faculties of Science and Engineering and Design (may include NSCI 1000)
15. 2.0 credits in free electives.

Total Credits 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 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 BIOC and CHEM. 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. Major (20.0 credits)**

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

1. **1.0 credit in:**
   - BIOL 1103 [0.5] Foundations of Biology I
   - BIOL 1104 [0.5] Foundations of Biology II

2. **2.5 credits from:**
   - 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

3. **0.5 credit from:**
   - BIOL 3205 [0.5] Plant Biochemistry and Physiology
   - BIOL 3306 [0.5] Human Anatomy and Physiology

4. **3.0 credits in BIOL at the 3000-level or higher**

5. **2.0 credits in Advanced Science Faculty electives**

**B. Credits Not included in the Major CGPA (11.0 credits)**

6. **1.0 credit from:**
   - CHEM 1001 [0.5] General Chemistry I
   - & CHEM 1002 [0.5] General Chemistry II
   - CHEM 1005 [0.5] Elementary Chemistry I
   - & CHEM 1006 [0.5] Elementary Chemistry II (See Note 2, below)

7. **1.0 credit in:**
   - BIOL 1105 [0.5] Biological Methods, Analysis and Interpretation
   - MATH 1007 [0.5] Elementary Calculus I

8. **1.0 credit from:**
   - MATH 1107 [0.5] Linear Algebra I
   - COMP 1005 [0.5] Introduction to Computer Science I
   - COMP 1006 [0.5] Introduction to Computer Science II
   - PHYS 1007 [0.5] Elementary University Physics I
   - or PHYS 1003 [0.5] Introductory Mechanics and Thermodynamics
   - PHYS 1008 [0.5] Elementary University Physics II
   - or PHYS 1004 [0.5] Introductory Electromagnetism and Wave Motion

9. **1.0 credit in Science Faculty Electives**

10. **2.0 credits in Advanced Science Faculty Electives**

11. **2.0 credits in Science Continuation courses (not in BIOL)**

12. **2.0 credits in Approved Courses Outside the Faculties of Science and Engineering and Design (may include NSCI 1000)**

13. **1.0 credit in free electives.**

**Total Credits** 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 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)**

1. **1.0 credit in:**
   - BIOL 1103 [0.5] Foundations of Biology I
   - BIOL 1104 [0.5] Foundations of Biology II

2. **2.0 credits from:**
   - 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

3. **0.5 credit in:**
   - BIOL 3306 [0.5] Human Anatomy and Physiology

4. **2.5 credits from BIOL at the 2000-level and 3000-level or higher**

5. **2.0 credits in Advanced Science Faculty electives**

6. **1.0 credit in:**
   - MATH 1007 [0.5] Elementary Calculus I

7. **1.0 credit from:**
   - MATH 1107 [0.5] Linear Algebra I
   - COMP 1005 [0.5] Introduction to Computer Science I
   - COMP 1006 [0.5] Introduction to Computer Science II
   - PHYS 1007 [0.5] Elementary University Physics I
   - or PHYS 1003 [0.5] Introductory Mechanics and Thermodynamics
   - PHYS 1008 [0.5] Elementary University Physics II
   - or PHYS 1004 [0.5] Introductory Electromagnetism and Wave Motion

8. **2.0 credits in Science Continuation (not in BIOL)**

9. **1.0 credit in Science Faculty Electives**

**Total Credits** 20.0
10. 2.0 credits in Approved Courses Outside the Faculties of Science and Engineering and Design (may include NSCI 1000)

11. 1.0 credit free electives.

Total Credits 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. 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 Biotechnology

B.Sc. Honours (20.0 credits)

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

1. 6.0 credits in:
   - 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 2002 [0.5] Plants: Form and Function
   - BIOL 2104 [0.5] Introductory Genetics
   - BIOL 2200 [0.5] Cellular Biochemistry
   - BIOL 2301 [0.5] Biotechnology I
   - BIOL 2303 [0.5] Microbiology
   - BIOL 3104 [0.5] Molecular Genetics
   - BIOL 3201 [0.5] Cell Biology
   - BIOL 3301 [0.5] Biotechnology II
   - BIOL 4301 [0.5] Current Topics in Biotechnology

2. 1.0 credit in:
   - BIOC 3101 [0.5] General Biochemistry I
   - BIOC 3102 [0.5] General Biochemistry II

3. 4.5 credits from:
   - BIOC 2300 [0.5] Physical Biochemistry
   - BIOC 3008 [0.5] Bioinformatics
   - BIOC 3103 [0.5] Practical Biochemistry I
   - BIOC 3104 [0.5] Practical Biochemistry II
   - BIOC 3202 [0.5] Biophysical Techniques and Applications
   - BIOL 3004 [0.5] Insect Diversity
   - BIOL 3102 [0.5] Mycology
   - BIOL 3205 [0.5] Plant Biochemistry and Physiology
   - BIOL 3303 [0.5] Experimental Microbiology
   - BIOL 3305 [0.5] Human and Comparative Physiology
   - BIOL 3501 [0.5] Biomechanics
   - BIOL 3901 [0.5] Research Proposal
   - BUSI 2800 [0.5] Entrepreneurship
   - CHEM 3700 [0.5] Industrial Applications of Chemistry
   - CHEM 3800 [0.5] The Chemistry of Environmental Pollutants
   - FOOD 3005 [0.5] Food Microbiology
   - BIOC 4001 [0.5] Methods in Biochemistry
   - BIOC 4004 [0.5] Industrial Biochemistry
   - BIOC 4005 [0.5] Biochemical Regulation
   - BIOC 4007 [0.5] Membrane Biochemistry
   - BIOC 4008 [0.5] Computational Systems Biology
   - BIOC 4009 [0.5] Biochemistry of Disease
   - BIOC 4203 [0.5] Advanced Metabolism
   - BIOC 4204 [0.5] Protein Biotechnology
   - BIOC 4708 [0.5] Principles of Toxicology
   - BIOL 4106 [0.5] Advances in Molecular Biology
   - BIOL 4109 [0.5] Laboratory Techniques in Molecular Genetics
   - BIOL 4200 [0.5] Immunology
   - BIOL 4201 [0.5] Advanced Cell Culture and Tissue Engineering
   - BIOL 4202 [0.5] Mutagenesis and DNA Repair
   - BIOL 4206 [0.5] Human Genetics
   - BIOL 4901 [0.5] Directed Special Studies
   - TSES 4001 [0.5] Technology and Society: Risk
   - TSES 4002 [0.5] Technology and Society: Forecasting

4. 1.0 credit in:
   - BIOL 4905 [1.0] Honours Workshop
   - or 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 (7.5 credits)

5. 2.0 credits in:
   - CHEM 1001 [0.5] General Chemistry I
   - CHEM 1002 [0.5] General Chemistry II
   - CHEM 2203 [0.5] Organic Chemistry I
   - CHEM 2204 [0.5] Organic Chemistry II (See Note, below)

6. 1.0 credit in:
   - BIOL 1105 [0.5] Biological Methods, Analysis and Interpretation
   - MATH 1007 [0.5] Elementary Calculus I

7. 1.5 credits from:
   - COMP 1005 [0.5] Introduction to Computer Science I
   - COMP 1006 [0.5] Introduction to Computer Science II
   - MATH 1107 [0.5] Linear Algebra I
   - PHYS 1007 [0.5] Elementary University Physics I
   - or PHYS 1003 [0.5] Introductory Mechanics and Thermodynamics
   - PHYS 1008 [0.5] Elementary University Physics II
   - or PHYS 1004 [0.5] Introductory Electromagnetism and Wave Motion
   - STAT 2507 [0.5] Introduction to Statistical Modeling I

8. 2.0 credits in Approved Courses Outside the Faculties of Science and Engineering and Design (may include NSCI 1000)

19. 1.0 credit free elective.

Total Credits 20.0

Note: For Item 5 above, CHEM 1001 General Chemistry I and CHEM 1002 General Chemistry II are strongly recommended for this program. Students may substitute CHEM 1001 General Chemistry I and CHEM 1002 General Chemistry II with CHEM 1005 Elementary Chemistry I and CHEM 1006 Elementary Chemistry II, respectively. Students choosing CHEM 1005 Elementary Chemistry I and CHEM 1006 Elementary Chemistry II will be required to obtain a grade of B- or higher in CHEM 1006 Elementary Chemistry II to take BIOL 2200 Cellular Biochemistry and more advanced courses in
BIOC and CHEM. Students completing CHEM 1005 Elementary Chemistry I with a grade of B- or higher are encouraged to register for CHEM 1002 General Chemistry II.

### Biology and Earth Sciences
#### B.Sc. Combined Honours (20.0 credits)

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

<table>
<thead>
<tr>
<th>1. 1.5 credits in:</th>
<th>1.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 1103 [0.5] Foundations of Biology I</td>
<td></td>
</tr>
<tr>
<td>BIOL 1104 [0.5] Foundations of Biology II</td>
<td></td>
</tr>
<tr>
<td>BIOL 2001 [0.5] Animals: Form and Function</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. 1.0 credit in:</th>
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</thead>
<tbody>
<tr>
<td>ERTH 1006 [0.5] Exploring Planet Earth</td>
<td></td>
</tr>
<tr>
<td>ERTH 1009 [0.5] The Earth System Through Time</td>
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</tr>
<tr>
<td>0.5 credit from:</td>
<td>0.5</td>
</tr>
<tr>
<td>BIOL 2600 [0.5] Introduction to Ecology</td>
<td></td>
</tr>
<tr>
<td>BIOL 3605 [0.5] Field Course I</td>
<td></td>
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</tbody>
</table>

| 4. 3.5 credits in BIOL or BIOC, with at least 1.0 credit at the 3000-level and 1.0 credit at the 4000-level | 3.5 |
| 5. 3.0 credits in: | 3.0 |
| ERTH 2102 [0.5] Mineralogy to Petrology |
| ERTH 2312 [0.5] Paleontology |
| ERTH 2314 [0.5] Sedimentation and Stratigraphy |
| ERTH 3111 [0.5] Vertebrate Evolution II |
| ERTH 3112 [0.5] Vertebrate Evolution I |
| ERTH 3113 [0.5] Geology of Human Origins |

<table>
<thead>
<tr>
<th>6. 0.5 credit from:</th>
<th>0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERTH 3203 [0.5] Applied Sedimentology</td>
<td></td>
</tr>
<tr>
<td>ERTH 3206 [0.5] Oceanography: Its Modern and Geologic Records</td>
<td></td>
</tr>
</tbody>
</table>

| 7. 1.0 credit in ERTH at the 4000-level | 1.0 |
| 8. 1.0 credit from: | 1.0 |
| BIOL 4905 [1.0] Honours Workshop |
| BIOL 4907 [1.0] Honours Essay and Research Proposal |
| BIOL 4908 [1.0] Honours Research Thesis |
| ERTH 4909 [0.5] Research in Earth Sciences (and 0.5 credit in ERTH at the 4000-level) |

**B. Credits Not Included in the Major CGPA (8.0 credits)**

<table>
<thead>
<tr>
<th>9. 1.0 credit in:</th>
<th>1.0</th>
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<tbody>
<tr>
<td>MATH 1007 [0.5] Elementary Calculus I</td>
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<tr>
<td>MATH 1107 [0.5] Linear Algebra I</td>
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<table>
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<tr>
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<tbody>
<tr>
<td>CHEM 1001 [0.5] General Chemistry I</td>
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</tr>
<tr>
<td>&amp; CHEM 1002 [0.5] General Chemistry II</td>
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</tr>
<tr>
<td>CHEM 1005 [0.5] Elementary Chemistry I</td>
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</tr>
<tr>
<td>&amp; CHEM 1006 [0.5] Elementary Chemistry II</td>
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<thead>
<tr>
<th>11. 1.0 credit in:</th>
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<tbody>
<tr>
<td>PHYS 1007 [0.5] Elementary University Physics I</td>
<td></td>
</tr>
<tr>
<td>&amp; PHYS 1008 [0.5] Elementary University Physics II</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>12. 0.5 credit in:</th>
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</thead>
<tbody>
<tr>
<td>STAT 2507 [0.5] Introduction to Statistical Modeling I</td>
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<table>
<thead>
<tr>
<th>13. 0.5 credit in:</th>
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</thead>
<tbody>
<tr>
<td>COMP 1005 [0.5] Introduction to Computer Science I</td>
<td></td>
</tr>
</tbody>
</table>

| 14. 1.0 credit in Science Continuation courses | 1.0 |

**15. 2.0 credits in Approved Courses Outside the Faculties of Science and Engineering and Design (may include NSCI 1000)**

**16. 1.0 credit in free electives**

| Total Credits | 20.0 |

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)**

<table>
<thead>
<tr>
<th>1. 1.0 credit from:</th>
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<tbody>
<tr>
<td>PHYS 1001 [0.5] Foundations of Physics I</td>
<td></td>
</tr>
<tr>
<td>&amp; PHYS 1002 [0.5] Foundations of Physics II (recommended)</td>
<td></td>
</tr>
<tr>
<td>PHYS 1003 [0.5] Introductory Mechanics and &amp; PHYS 1004 [0.5] Thermodynamics Introductory Electromagnetism and Wave Motion</td>
<td></td>
</tr>
<tr>
<td>PHYS 1007 [0.5] Elementary University Physics I &amp; PHYS 1008 [0.5] Elementary University Physics II (with an average grade of B- or higher)</td>
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</table>

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>PHYS 2604 [0.5] Modern Physics I</td>
<td></td>
</tr>
<tr>
<td>PHYS 2202 [0.5] Wave Motion and Optics</td>
<td></td>
</tr>
<tr>
<td>PHYS 2305 [0.5] Electricity and Magnetism</td>
<td></td>
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<tr>
<td>PHYS 2401 [0.5] Thermal Physics</td>
<td></td>
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<table>
<thead>
<tr>
<th>3. 2.0 credits in:</th>
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<tbody>
<tr>
<td>PHYS 3007 [0.5] Third Year Physics Laboratory: Selected Experiments and Seminars</td>
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</tr>
<tr>
<td>PHYS 3207 [0.5] Topics in Biophysics</td>
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<tr>
<td>PHYS 3806 [0.5] Modern Physics II</td>
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<tr>
<td>PHYS 3701 [0.5] Elements of Quantum Mechanics</td>
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<table>
<thead>
<tr>
<th>4. 1.0 credit from:</th>
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<tbody>
<tr>
<td>PHYS 3308 [0.5] Electromagnetism</td>
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<tr>
<td>PHYS 3802 [0.5] Advanced Dynamics</td>
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<tr>
<td>PHYS 3807 [0.5] Mathematical Physics I</td>
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<tr>
<td>PHYS 4008 [0.5] Fourth-Year Physics Laboratory: Selected Experiments and Workshop</td>
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<tr>
<td>PHYS 4203 [0.5] Physical Applications of Fourier Analysis</td>
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<tr>
<td>PHYS 4409 [0.5] Thermodynamics and Statistical Physics</td>
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<tr>
<td>PHYS 4608 [0.5] Nuclear Physics</td>
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<tr>
<td>PHYS 4707 [0.5] Introduction to Quantum Mechanics I</td>
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</table>

<table>
<thead>
<tr>
<th>5. 4.0 credits in:</th>
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</thead>
<tbody>
<tr>
<td>BIOL 1103 [0.5] Foundations of Biology I</td>
<td></td>
</tr>
<tr>
<td>BIOL 1104 [0.5] Foundations of Biology II</td>
<td></td>
</tr>
<tr>
<td>BIOL 2200 [0.5] Cellular Biochemistry</td>
<td></td>
</tr>
<tr>
<td>BIOL 2104 [0.5] Introductory Genetics</td>
<td></td>
</tr>
<tr>
<td>BIOL 2001 [0.5] Animals: Form and Function</td>
<td></td>
</tr>
<tr>
<td>BIOL 3201 [0.5] Cell Biology</td>
<td></td>
</tr>
<tr>
<td>BIOL 3104 [0.5] Molecular Genetics</td>
<td></td>
</tr>
</tbody>
</table>
**B.Sc. Combined Honours (20.0 credits)**

Neuroscience

**CHEM Students completing CHEM 1005 with a grade of B- or higher in CHEM 1006 to take choosing CHEM 1005 and CHEM 1006, respectively. Students may substitute CHEM 1001 and CHEM 1002 with are strongly recommended for this program. 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 BIOL 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 (14.5 credits)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEUR 1202</td>
<td>Neuroscience of Mental Health and Psychiatric Disease</td>
</tr>
<tr>
<td>NEUR 1203</td>
<td>Neuroscience of Mental Health and Neurological Disease</td>
</tr>
<tr>
<td>BIOL 3000</td>
<td>Human and Comparative Physiology</td>
</tr>
</tbody>
</table>

**B. Credits Not Included in the Major CGPA (8.0 credits)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEUR 4200</td>
<td>Introduction to Research Methods in Neuroscience</td>
</tr>
<tr>
<td>NEUR 4001</td>
<td>Introduction to Statistics in Neuroscience</td>
</tr>
<tr>
<td>NEUR 2201</td>
<td>Cellular and Molecular Neuroscience</td>
</tr>
<tr>
<td>NEUR 2202</td>
<td>Neurodevelopment and Plasticity</td>
</tr>
<tr>
<td>NEUR 3001</td>
<td>Data Analysis in Neuroscience I</td>
</tr>
<tr>
<td>NEUR 3002</td>
<td>Data Analysis in Neuroscience II</td>
</tr>
<tr>
<td>NEUR 3204</td>
<td>Neuropharmacology</td>
</tr>
<tr>
<td>NEUR 3206</td>
<td>Sensory and Motor Neuroscience</td>
</tr>
<tr>
<td>NEUR 3207</td>
<td>Integrative Neuroscience</td>
</tr>
</tbody>
</table>

**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 BIOL and CHEM. Students completing CHEM 1005 with a grade of B- or higher are encouraged to register for CHEM 1002.**

**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 BIOL and CHEM. Students completing CHEM 1005 with a grade of B- or higher are encouraged to register for CHEM 1002.
NEUR 4202 [0.5]  Seminar on Current Research in Neuroscience and Psychiatric Disease
NEUR 4203 [0.5]  Seminar on Current Research in Neuroscience and Clinical Neurology

<table>
<thead>
<tr>
<th>Credit Group</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Credits</strong></td>
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</tr>
</tbody>
</table>

### Biology

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

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

<table>
<thead>
<tr>
<th>Credit Group</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 1.0 credit in:</td>
<td>1.0</td>
</tr>
<tr>
<td>BIOL 1103 [0.5]  Foundations of Biology I</td>
<td>1.0</td>
</tr>
<tr>
<td>BIOL 1104 [0.5]  Foundations of Biology II</td>
<td>0.5</td>
</tr>
<tr>
<td>2. 2.5 credits from:</td>
<td>2.5</td>
</tr>
<tr>
<td>BIOL 2001 [0.5]  Animals: Form and Function</td>
<td>0.5</td>
</tr>
<tr>
<td>BIOL 2002 [0.5]  Plants: Form and Function</td>
<td>0.5</td>
</tr>
<tr>
<td>BIOL 2104 [0.5]  Introductory Genetics</td>
<td>0.5</td>
</tr>
<tr>
<td>or BIOL 2107 [0.5]  Fundamentals of Genetics</td>
<td>0.5</td>
</tr>
<tr>
<td>BIOL 2200 [0.5]  Cellular Biochemistry</td>
<td>0.5</td>
</tr>
<tr>
<td>or BIOL 2201 [0.5]  Cell Biology and Biochemistry</td>
<td>0.5</td>
</tr>
<tr>
<td>BIOL 2303 [0.5]  Microbiology</td>
<td>0.5</td>
</tr>
<tr>
<td>BIOL 2600 [0.5]  Introduction to Ecology</td>
<td>0.5</td>
</tr>
<tr>
<td>3. 0.5 credit from:</td>
<td>0.5</td>
</tr>
<tr>
<td>BIOL 3205 [0.5]  Plant Biochemistry and Physiology</td>
<td>0.5</td>
</tr>
<tr>
<td>BIOL 3303 [0.5]  Experimental Microbiology</td>
<td>0.5</td>
</tr>
<tr>
<td>BIOL 3305 [0.5]  Human and Comparative Physiology</td>
<td>0.5</td>
</tr>
<tr>
<td>BIOL 3306 [0.5]  Human Anatomy and Physiology</td>
<td>0.5</td>
</tr>
<tr>
<td>4. 1.0 credit in BIOL at the 3000-level or higher</td>
<td>1.0</td>
</tr>
<tr>
<td>5. 2.0 credits in BIOL</td>
<td>2.0</td>
</tr>
<tr>
<td>6. 1.0 credit from:</td>
<td>1.0</td>
</tr>
<tr>
<td>BIOL 4905 [1.0]  Honours Workshop</td>
<td>1.0</td>
</tr>
<tr>
<td>or BIOL 4907 [1.0]  Honours Essay and Research Proposal</td>
<td>1.0</td>
</tr>
</tbody>
</table>

##### B. Credits not included in the Major CGPA (5.5 credits)

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<tr>
<th>Credit Group</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>MATH 1007 [0.5]  Elementary Calculus I</td>
<td>1.0</td>
</tr>
<tr>
<td>MATH 1107 [0.5]  Linear Algebra I</td>
<td>1.0</td>
</tr>
<tr>
<td>2. 1.5 credits in:</td>
<td>1.5</td>
</tr>
<tr>
<td>CHEM 1001 [0.5]  General Chemistry I</td>
<td>1.5</td>
</tr>
<tr>
<td>&amp; CHEM 1002 [0.5]  General Chemistry II</td>
<td>0.5</td>
</tr>
<tr>
<td>CHEM 2203 [0.5]  Organic Chemistry I (See Note 2 below)</td>
<td>1.0</td>
</tr>
<tr>
<td>3. 1.0 credit in:</td>
<td>1.0</td>
</tr>
<tr>
<td>PHYS 1007 [0.5]  Elementary University Physics I</td>
<td>1.0</td>
</tr>
<tr>
<td>&amp; PHYS 1008 [0.5]  Elementary University Physics II</td>
<td>0.5</td>
</tr>
<tr>
<td>4. 2.0 credits in approved courses outside of the faculties of Science and Engineering and Design (may include NSCI 1000)</td>
<td>2.0</td>
</tr>
</tbody>
</table>

#### 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 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 BIOL 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)

<table>
<thead>
<tr>
<th>Credit Group</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 1.0 credit in:</td>
<td>1.0</td>
</tr>
<tr>
<td>BIOL 1103 [0.5]  Foundations of Biology I</td>
<td>1.0</td>
</tr>
<tr>
<td>BIOL 1104 [0.5]  Foundations of Biology II</td>
<td>0.5</td>
</tr>
<tr>
<td>2. 2.0 credits from:</td>
<td>2.0</td>
</tr>
<tr>
<td>BIOL 2001 [0.5]  Animals: Form and Function</td>
<td>0.5</td>
</tr>
<tr>
<td>BIOL 2002 [0.5]  Plants: Form and Function</td>
<td>0.5</td>
</tr>
<tr>
<td>BIOL 2104 [0.5]  Introductory Genetics</td>
<td>0.5</td>
</tr>
<tr>
<td>or BIOL 2107 [0.5]  Fundamentals of Genetics</td>
<td>0.5</td>
</tr>
<tr>
<td>BIOL 2200 [0.5]  Cellular Biochemistry</td>
<td>0.5</td>
</tr>
<tr>
<td>or BIOL 2201 [0.5]  Cell Biology and Biochemistry</td>
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</tr>
<tr>
<td>BIOL 2303 [0.5]  Microbiology</td>
<td>0.5</td>
</tr>
<tr>
<td>BIOL 2600 [0.5]  Introduction to Ecology</td>
<td>0.5</td>
</tr>
<tr>
<td>3. 3.0 credits in BIOL</td>
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##### B. Credits not included in the Major CGPA (9.0 credits)

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<tr>
<th>Credit Group</th>
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</thead>
<tbody>
<tr>
<td>1. 1.0 credit from:</td>
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</tr>
<tr>
<td>CHEM 1001 [0.5]  General Chemistry I</td>
<td>1.0</td>
</tr>
<tr>
<td>&amp; CHEM 1002 [0.5]  General Chemistry II</td>
<td>0.5</td>
</tr>
<tr>
<td>CHEM 1005 [0.5]  Elementary Chemistry I</td>
<td>1.5</td>
</tr>
<tr>
<td>&amp; CHEM 1006 [0.5]  Elementary Chemistry II</td>
<td>0.5</td>
</tr>
<tr>
<td>(see Note 2 below)</td>
<td>1.0</td>
</tr>
<tr>
<td>2. 1.0 credit in Science Faculty Electives at the 2000-level or higher, not in BIOL</td>
<td>1.0</td>
</tr>
<tr>
<td>3. 1.0 credit at the 3000- or 4000-level</td>
<td>1.0</td>
</tr>
<tr>
<td>4. 2.0 credits in free electives.</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Total Credits</strong></td>
<td>20.0</td>
</tr>
</tbody>
</table>
7. 1.0 credit at the 2000-level or higher 1.0
8. 2.0 credits in free electives. 2.0
Total Credits 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)

<table>
<thead>
<tr>
<th>1. 1.0 credit in:</th>
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</thead>
<tbody>
<tr>
<td>BIOL 1103 [0.5] Foundations of Biology I</td>
<td></td>
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<tr>
<td>BIOL 1104 [0.5] Foundations of Biology II</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>2. 2.5 credits from:</th>
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</thead>
<tbody>
<tr>
<td>BIOL 2001 [0.5] Animals: Form and Function</td>
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</tr>
<tr>
<td>BIOL 2002 [0.5] Plants: Form and Function</td>
<td></td>
</tr>
<tr>
<td>BIOL 2104 [0.5] Introductory Genetics</td>
<td></td>
</tr>
<tr>
<td>or BIOL 2107 [0.5] Fundamentals of Genetics</td>
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<tr>
<td>BIOL 2200 [0.5] Cellular Biochemistry</td>
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<td>or BIOL 2201 [0.5] Cell Biology and Biochemistry</td>
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<tr>
<td>BIOL 2303 [0.5] Microbiology</td>
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<tr>
<td>BIOL 2600 [0.5] Introduction to Ecology</td>
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| 3. 1.0 credit in BIOL at the 2000-level or higher | 1.0 |
| 4. 1.5 credits from BIOL | 1.5 |

B. Additional Requirements (14.0 credits)

<table>
<thead>
<tr>
<th>5. 1.0 credit from:</th>
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<tbody>
<tr>
<td>CHEM 1001 [0.5] General Chemistry I &amp; CHEM 1002 [0.5] General Chemistry II</td>
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<tr>
<td>CHEM 1005 [0.5] Elementary Chemistry I &amp; CHEM 1006 [0.5] Elementary Chemistry II</td>
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<th>6. 1.0 credit from:</th>
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<tr>
<td>BIOL 4905 [1.0] Honours Workshop</td>
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<tr>
<td>or BIOL 4907 [1.0] Honours Essay and Research Proposal</td>
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<tr>
<td>or BIOL 4908 [1.0] Honours Research Thesis</td>
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<td>or equivalent from the other Honours department</td>
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7. 1.0 credit in Science Faculty Electives, not in BIOL, at the 2000-level or higher 1.0
8. 1.0 credit in Science Faculty Electives, not in BIOL 1.0
9. 7.0 credits in approved courses outside of the faculties of Science and Engineering and Design (may include NSCI 1000), to include the requirements for the other discipline 7.0
10. 3.0 credits in free electives. 3.0
Total Credits 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.

Requirements (4.0 credits)

<table>
<thead>
<tr>
<th>1. 1.0 credit in:</th>
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<tbody>
<tr>
<td>BIOL 1103 [0.5] Foundations of Biology I</td>
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<tr>
<td>BIOL 1104 [0.5] Foundations of Biology II</td>
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<th>2. 1.0 credit from:</th>
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<tbody>
<tr>
<td>BIOL 1105 [0.5] Biological Methods, Analysis and Interpretation</td>
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<tr>
<td>BIOL 1010 [0.5] Biotechnology and Society</td>
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<tr>
<td>BIOL 1902 [0.5] Natural History</td>
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<tr>
<td>BIOL 2001 [0.5] Animals: Form and Function</td>
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<tr>
<td>BIOL 2002 [0.5] Plants: Form and Function</td>
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<tr>
<td>BIOL 2005 [0.5] Human Physiology</td>
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<tr>
<td>BIOL 2107 [0.5] Fundamentals of Genetics</td>
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<tr>
<td>BIOL 2201 [0.5] Cell Biology and Biochemistry</td>
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<tr>
<td>BIOL 2303 [0.5] Microbiology</td>
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<tr>
<td>BIOL 2903 [0.5] Natural History and Ecology of Ontario</td>
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| 3. 1.0 credit in BIOL at the 2000-level or higher | 1.0 |

| 4. 1.0 credit in BIOL at the 3000-level or higher | 1.0 |
Total Credits 4.0

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

Biology (BIOL) Courses

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. Precludes additional credit for BIOL 1003 (no longer offered). 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. Precludes additional credit for BIOL 1004 (no longer offered). 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 1105 [0.5 credit]
Biological Methods, Analysis and Interpretation
Formulation of biological research questions, development of hypotheses and predictions, design of experiments, collection and analysis of data, interpretation and presentation of results. Lectures 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
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. It is strongly recommended that Biology Majors and Honours students take this course in their second year of study. Also listed as BIOC 2200. Precludes additional credit for BIOL 2201. 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.
Precludes additional credit for BIOL 2200, 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 2301 [0.5 credit]
Biotechnology I
An introductory course on the science, technology, entrepreneurial skills and business considerations related to biotechnology. The course will survey broadly across the disciplines of Biology, including applications in agriculture, health, environment and industry.
Prerequisite(s): (BIOL 1003 and BIOL 1004) or (BIOL 1103 and BIOL 1104) or permission of the department.
Lectures and workshops 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 and Ecology 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 1004 or BIOL 1104 or 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 3008 [0.5 credit]
Bioinformatics
A practical exploration in the application of information technology to biochemistry and molecular biology. Insight into biological knowledge discovery via molecular structure and function prediction, comparative genomics and biological information management.
Also listed as BIOC 3008, COMP 3308.
Prerequisite(s): BIOC 2200 or BIOL 2200, or permission of the Department.
Lectures two hours a week, computer workshop 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 2107 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 3301 [0.5 credit]
Biotechnology II
An interdisciplinary course on interactions between science, invention and innovation in biotechnology. Case studies related to regional biotechnology opportunities; social and ethical issues impacting biotechnology.
Prerequisite(s): BIOL 2301 or (BIOL 2104 and BIOL 2200/BIOC 2200) or permission of the department.
Lectures and laboratory/workshops three 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.
Lectures, laboratory, and fieldwork five hours a week.

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 or BIOL 2600 or permission of the Department.
Lectures 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 3902 [0.5 credit]
**Topics in Biology I**
Specific topics of current interest. Topics may vary from year to year.
Prerequisite(s): third-year standing in a Biology program or permission of the Department.
Lecture, seminars, or workshops three hours per week.
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
An overview of the molecular evidence of evolution, speciation as well as the phylogenetic analysis of biological sequence data and biometrical traits.
Prerequisite(s): (BIOL 2001 or BIOL 2002) and (BIOL 2104 or BIOL 2107) or permission of the Department. A course in statistics is recommended.
Lectures and computer lab 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 provides 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 mechanistic 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 mutations in the development of genetic disease and cancer.
Also listed as BIOC 4202.
Prerequisite(s): BIOL 3104 and BIOL 2200/BIOC 2200 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): BIOL 2104 or BIOL 2107.
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 4207 [0.5 credit]
Advanced Embryology & Developmental Biology
A laboratory-based exploration of techniques and recent developments in the use of model embryological systems as applied to questions of development and human health.
Prerequisite(s): BIOL 3201 or BIOL 3202 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 set up or complete experiments.

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 Microbiology
Studies of the application of microorganisms. Topics may include: microbial communities, and agricultural, pharmaceutical, industrial and health sciences.
Prerequisite(s): (BIOL 2200/BIOC 2200 or BIOL 2201), BIOL 2303 and (BIOL 3104 or BIOL 3303) 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 3301 or (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 4303 [0.5 credit]
Advances in Microbiology
Exploration of current microbiology including the biology of infectious agents, microbial and functional genomics and proteomics. Special attention will be paid to the “big questions” in the field. Students will be exposed to proposing research to answer a specific question in microbiology.
Prerequisite(s): BIOL 2303 and (BIOL 3104 or BIOL 3303 or BIOC 3102) or permission of the Department.
Lectures three hours per 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 4502 [0.5 credit]  
Herpetology  
Herpetology is the study of amphibians and reptiles. The behaviours, physiological ecology, conservation and identification of amphibians and reptiles will be examined through lectures, seminars and hands-on activities.  
Prerequisite(s): BIOL 2001.  
Lectures or seminars three 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 or 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 4902 [0.5 credit]  
Topics in Biology II  
Specific topics of current interest. Topics may vary from year to year.  
Prerequisite(s): fourth-year standing in a Biology program or permission of the Department.  
Lecture, seminars, or workshops three hours per week.

BIOL 4905 [1.0 credit]  
Honours Workshop  
Within the context of an active learning environment, students participate in a variety of activities which may include literature reviews and critiques, media releases and response papers, oral presentations, and posters. Projects are focused on an area of biological research of interest to the student.  
Precludes additional credit for BIOL 4907 and BIOL 4908.  
Prerequisite(s): fourth-year standing in an Honours biology program and permission of the Department.  
Workshops three hours per week.

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 4905 and 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 4905 and BIOL 4907. Prerequisite(s): fourth-year standing in an Honours biology program with a minimum CGPA of 8.0 in the major or 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
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