Biochemistry

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

Program Requirements

Course Categories for Biochemistry
The program descriptions below make use of the following course categories that are defined in the Regulations for the B.Sc.

- Approved Courses Outside the Faculties of Science and Engineering and Design
- Free Electives

Biochemistry

B.Sc. Honours (20.0 credits)

A. Credits included in the Major CGPA (13.5 credits)

1. 2.0 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 3104 [0.5] Molecular Genetics

2. 0.5 credit from:
   - BIOL 2001 [0.5] Animals: Form and Function
   - BIOL 2002 [0.5] Plants: Form and Function

3. 0.5 credit from:
   - 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. 1.0 credit from:
   - BIOL 3102 [0.5] Mycology
   - BIOL 3201 [0.5] Cell Biology
   - BIOL 3202 [0.5] Principles of Developmental Biology
   - BIOL 3205 [0.5] Plant Biochemistry and Physiology
   - BIOL 3301 [0.5] Biotechnology II
   - BIOL 3303 [0.5] Experimental Microbiology
   - BIOL 3305 [0.5] Human and Comparative Physiology
   - BIOL 3306 [0.5] Human Anatomy and Physiology
   - BIOL 3307 [0.5] Advanced Human Anatomy and Physiology
   - BIOL 4008 [0.5] Molecular Plant Development
   - BIOL 4103 [0.5] Population Genetics
   - 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 4209 [0.5] Advanced Plant Physiology
   - BIOL 4300 [0.5] Applied Microbiology

   - CHEM 1001 [0.5] General Chemistry I & CHEM 1002 [0.5] General Chemistry II
   - CHEM 2103 [0.5] Physical Chemistry I or BIOL 2300 [0.5] Physical Biochemistry
   - CHEM 2203 [0.5] Organic Chemistry I
   - CHEM 2204 [0.5] Organic Chemistry II
   - CHEM 2303 [0.5] Analytical Chemistry II
   - CHEM 2501 [0.5] Introduction to Inorganic and Bioinorganic Chemistry
   - CHEM 3201 [0.5] Advanced Organic Chemistry I

5. 4.0 credits in:
   - BIOL 2001 [0.5] Animals: Form and Function
   - BIOL 2002 [0.5] Plants: Form and Function
   - BIOL 3205 [0.5] Plant Biochemistry and Physiology
   - BIOL 3301 [0.5] Biotechnology II
   - BIOL 3303 [0.5] Experimental Microbiology
   - BIOL 3307 [0.5] Advanced Human Anatomy and Physiology
   - BIOL 4008 [0.5] Molecular Plant Development
   - BIOL 4103 [0.5] Population Genetics
   - 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 4209 [0.5] Advanced Plant Physiology
   - BIOL 4300 [0.5] Applied Microbiology

   - CHEM 1001 [0.5] General Chemistry I & CHEM 1002 [0.5] General Chemistry II
   - CHEM 2103 [0.5] Physical Chemistry I or BIOL 2300 [0.5] Physical Biochemistry
   - CHEM 2203 [0.5] Organic Chemistry I
   - CHEM 2204 [0.5] Organic Chemistry II
   - CHEM 2303 [0.5] Analytical Chemistry II
   - CHEM 2501 [0.5] Introduction to Inorganic and Bioinorganic Chemistry
   - CHEM 3201 [0.5] Advanced Organic Chemistry I

6. 0.5 credit from:
   - BIOL 2001 [0.5] Animals: Form and Function
   - BIOL 2002 [0.5] Plants: Form and Function

7. 3.5 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

8. 0.5 credit from:
   - BIOL 3008 [0.5] Bioinformatics
   - BIOL 4004 [0.5] Industrial Biochemistry
   - BIOL 4005 [0.5] Biochemical Regulation
   - BIOL 4006 [0.5] Membrane Biochemistry
   - BIOL 4007 [0.5] Computational Systems Biology
   - BIOL 4009 [0.5] Biochemistry of Disease
   - BIOL 4200 [0.5] Immunology
   - BIOL 4201 [0.5] Advanced Cell Culture and Tissue Engineering
   - BIOL 4202 [0.5] Mutagenesis and DNA Repair
   - BIOL 4203 [0.5] Advanced Metabolism
   - BIOL 4204 [0.5] Protein Biotechnology
   - BIOL 4400 [0.5] Nuclear Dynamics and the Cell Cycle
   - BIOL 4708 [0.5] Principles of Toxicology

9. 1.0 credit from:
   - BIOL 4906 [1.0] Interdisciplinary Research Project
   - BIOL 4907 [1.0] Honours Essay and Research Proposal
   - BIOL 4908 [1.0] Research Project

B. Credits Not included in the Major CGPA (6.5 credits)

10. 1.0 credit from:
    - PHYS 1007 [0.5] Elementary University Physics I & PHYS 1008 [0.5] Elementary University Physics II
    - or
    - PHYS 1003 [0.5] Introductory Mechanics and Thermodynamics
    - & PHYS 1004 [0.5] Introductory Electromagnetism and Wave Motion
11. 1.5 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

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

13. 1.5 credits from:
   BIOL courses listed in but not used to fulfill Item 4 above:
   BIOL 2001 [0.5] Animals: Form and Function
   BIOL 2002 [0.5] Plants: Form and Function
   BIOL 2301 [0.5] Biotechnology I
   BIOL 2303 [0.5] Microbiology

   CHEM courses listed in but not used to fulfill Item 6 above:
   CHEM 3100 [0.5] Physical Chemistry II
   CHEM 3101 [0.5] Quantum Chemistry
   CHEM 3102 [0.5] Methods of Computational Chemistry
   CHEM 3106 [0.5] Computational Chemistry Methods Laboratory
   CHEM 3107 [0.5] Experimental Methods in Nanoscience
   CHEM 3504 [0.5] Inorganic Chemistry II
   CHEM 3600 [0.5] Introduction to Nanotechnology
   CHEM 3700 [0.5] Industrial Applications of Chemistry
   CHEM 3800 [0.5] The Chemistry of Environmental Pollutants
   CHEM 4201 [0.5] Macromolecular Nanotechnology
   CHEM 4202 [0.5] Advanced Topics in Organic Chemistry I
   CHEM 4203 [0.5] Synthetic Organic Chemistry
   CHEM 4206 [0.5] Natural Products Chemistry
   CHEM 4406 [0.5] Pharmaceutical Drug Design
   PHYS 2202 [0.5] Wave Motion and Optics
   PHYS 2604 [0.5] Modern Physics I
   MATH 2007 [0.5] Elementary Calculus II
   MATH 2008 [0.5] Intermediate Calculus
   MATH 2107 [0.5] Linear Algebra II
   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

14. 0.5 credit in free electives.

Total Credits 20.0

Biochemistry and Biotechnology
B.Sc. Honours (20.0 credits)

A. Credits Included in the Major CGPA (15.0 credits)
1. 2.5 credits in:
   BIOL 1103 [0.5] Foundations of Biology I
   BIOL 1104 [0.5] Foundations of Biology II

2. 0.5 credit from:
   BIOL 2001 [0.5] Animals: Form and Function
   BIOL 2002 [0.5] Plants: Form and Function

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. 1.5 credit from:
   BIOL 2301 [0.5] Biotechnology I
   BIOL 2302 [0.5] Cell Biology
   BIOL 3301 [0.5] Biotechnology II
   BIOL 3303 [0.5] Experimental Microbiology
   BIOL 4106 [0.5] Advances in Molecular Biology
   BIOL 4109 [0.5] Laboratory Techniques in Molecular Genetics
   BIOL 4201 [0.5] Advanced Cell Culture and Tissue Engineering
   BIOL 4300 [0.5] Applied Microbiology
   BIOL 4301 [0.5] Current Topics in Biotechnology

5. 3.0 credits in:
   BIOL 2200 [0.5] Cellular Biochemistry
   BIOL 3101 [0.5] General Biochemistry I
   BIOL 3102 [0.5] General Biochemistry II
   BIOL 3103 [0.5] Practical Biochemistry I
   BIOL 3104 [0.5] Practical Biochemistry II
   BIOL 3202 [0.5] Biophysical Techniques and Applications

6. 1.0 credit from:
   BIOL 4907 [1.0] Honours Essay and Research Proposal
   BIOL 4908 [1.0] Research Project

7. 1.0 credit from:
   BIOL 4004 [0.5] Industrial Biochemistry
   BIOL 4005 [0.5] Biochemical Regulation
   BIOL 4007 [0.5] Membrane Biochemistry
   BIOL 4009 [0.5] Biochemistry of Disease
   BIOL 4200 [0.5] Immunology
   BIOL 4201 [0.5] Advanced Cell Culture and Tissue Engineering
   BIOL 4202 [0.5] Mutagenesis and DNA Repair
   BIOL 4203 [0.5] Advanced Metabolism
   BIOL 4204 [0.5] Protein Biotechnology
   BIOL 4400 [0.5] Nuclear Dynamics and the Cell Cycle
   BIOL 4708 [0.5] Principles of Toxicology

8. 4.0 credits in:
   CHEM 1001 [0.5] General Chemistry I
   CHEM 1002 [0.5] General Chemistry II
   CHEM 2103 [0.5] Physical Chemistry I or BIOL 2300 [0.5] Physical Biochemistry
   CHEM 2203 [0.5] Organic Chemistry I
   CHEM 2204 [0.5] Organic Chemistry II
   CHEM 2303 [0.5] Analytical Chemistry II
### Credits Included in the Major (13.5 credits)

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<thead>
<tr>
<th>A. 2.0 credits in:</th>
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<td>BIOL 1103 [0.5]</td>
<td>Foundations of Biology I</td>
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<tr>
<td>BIOL 1104 [0.5]</td>
<td>Foundations of Biology II</td>
</tr>
<tr>
<td>BIOL 2104 [0.5]</td>
<td>Introductory Genetics</td>
</tr>
<tr>
<td>BIOL 3104 [0.5]</td>
<td>Molecular Genetics</td>
</tr>
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### Credits Not Included in the Major (6.5 credits)

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<thead>
<tr>
<th>B. Credits Not Included in the Major CGPA (5.0 credits)</th>
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<td>11. 1.0 credit from:</td>
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<tr>
<td>PHYS 1007 [0.5]</td>
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<tr>
<td>PHYS 1008 [0.5]</td>
</tr>
<tr>
<td>PHYS 1003 [0.5]</td>
</tr>
<tr>
<td>PHYS 1004 [0.5]</td>
</tr>
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### B.Sc. Honours (20.0 credits)

#### A. Credits Included in the Major (13.5 credits)

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<tr>
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<tr>
<td>CHEM 1001 [0.5]</td>
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<tr>
<td>CHEM 1002 [0.5]</td>
<td>General Chemistry II</td>
</tr>
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<td>CHEM 2103 [0.5]</td>
<td>Physical Chemistry I</td>
</tr>
<tr>
<td>CHEM 2104 [0.5]</td>
<td>Physical Biochemistry</td>
</tr>
<tr>
<td>CHEM 2203 [0.5]</td>
<td>Organic Chemistry I</td>
</tr>
<tr>
<td>CHEM 2303 [0.5]</td>
<td>Analytical Chemistry II</td>
</tr>
<tr>
<td>CHEM 2501 [0.5]</td>
<td>Introduction to Inorganic and Bioinorganic Chemistry</td>
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#### B. Credits Not Included in the Major (6.5 credits)

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<thead>
<tr>
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<tbody>
<tr>
<td>BIOL 2200 [0.5]</td>
<td>Cellular Biochemistry</td>
</tr>
<tr>
<td>BIOL 3101 [0.5]</td>
<td>General Biochemistry I</td>
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<tr>
<td>BIOL 3102 [0.5]</td>
<td>General Biochemistry II</td>
</tr>
<tr>
<td>BIOL 3103 [0.5]</td>
<td>Practical Biochemistry I</td>
</tr>
<tr>
<td>BIOL 3104 [0.5]</td>
<td>Practical Biochemistry II</td>
</tr>
<tr>
<td>BIOL 3202 [0.5]</td>
<td>Biophysical Techniques and Applications</td>
</tr>
<tr>
<td>BIOL 3008 [0.5]</td>
<td>Bioinformatics</td>
</tr>
<tr>
<td>BIOL 4008 [0.5]</td>
<td>Computational Systems Biology</td>
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</table>

#### C. 1.5 credits in:

<table>
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</thead>
<tbody>
<tr>
<td>COMP 1005 [0.5]</td>
<td>Introduction to Computer Science I</td>
</tr>
<tr>
<td>COMP 1006 [0.5]</td>
<td>Introduction to Computer Science II</td>
</tr>
<tr>
<td>COMP 2401 [0.5]</td>
<td>Introduction to Systems Programming</td>
</tr>
</tbody>
</table>

#### D. 1.5 credits from:

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<td>MATH 1805 [0.5]</td>
<td>Discrete Structures I</td>
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<tr>
<td>MATH 2107 [0.5]</td>
<td>Linear Algebra I</td>
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<td>MATH 2107 [0.5]</td>
<td>Linear Algebra II</td>
</tr>
<tr>
<td>MATH 2800 [0.5]</td>
<td>Discrete Mathematics and Algorithms</td>
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<tr>
<td>MATH 3800 [0.5]</td>
<td>Mathematical Modeling and Computational Methods</td>
</tr>
<tr>
<td>BIOC 2400 [0.5]</td>
<td>Independent Research I</td>
</tr>
<tr>
<td>BIOC 3400 [0.5]</td>
<td>Independent Research II</td>
</tr>
<tr>
<td>BIOC 4202 [0.5]</td>
<td>Mutagenesis and DNA Repair</td>
</tr>
</tbody>
</table>

### Interdisciplinary Research Project

<table>
<thead>
<tr>
<th>F. 1.0 credit in:</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC 4906 [1.0]</td>
<td>Interdisciplinary Research Project</td>
</tr>
<tr>
<td>BIOC 4908 [1.0]</td>
<td>Research Project</td>
</tr>
</tbody>
</table>

### Credits Not Included in the Major (6.5 credits)

<table>
<thead>
<tr>
<th>G. 2.0 credits in Approved Courses Outside the Faculties of Science and Engineering Design (may include NSCI 1000)</th>
<th>2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 1007 [0.5]</td>
<td>Elementary University Physics I</td>
</tr>
<tr>
<td>PHYS 1008 [0.5]</td>
<td>Elementary University Physics II</td>
</tr>
<tr>
<td>PHYS 1003 [0.5]</td>
<td>Introductory Mechanics and Thermodynamics</td>
</tr>
<tr>
<td>PHYS 1004 [0.5]</td>
<td>Introductory Electromagnetism and Wave Motion</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>H. 1.0 credit from:</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 1007 [0.5]</td>
<td>Elementary University Physics I</td>
</tr>
<tr>
<td>PHYS 1008 [0.5]</td>
<td>Elementary University Physics II</td>
</tr>
</tbody>
</table>

### Total Credits

| Total Credits | 20.0 |
Biochemistry
B.Sc. Major (20.0 credits)

A. Credits included in the Major CGPA (12.0 credits)

1. 2.0 credits in:
   - MATH 1007 [0.5] Elementary Calculus I
   - MATH 1107 [0.5] Linear Algebra I
   - MATH 2007 [0.5] Elementary Calculus II
   - STAT 2507 [0.5] Introduction to Statistical Modeling I

2. 1.0 credit from:
   - BIOL 2104 [0.5] Introductory Genetics
   - BIOL 4101 [0.5] Molecular Genetics

3. 0.5 credit from:
   - BIOL 4201 [0.5] Advanced Cell Culture and Tissue Engineering
   - BIOL 4202 [0.5] Mutagenesis and DNA Repair
   - BIOL 4206 [0.5] Human Genetics

4. 1.0 credit from:
   - 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 2303 [0.5] Plant Biochemistry and Physiology
   - BIOL 2301 [0.5] Human Anatomy and Physiology
   - BIOL 2302 [0.5] Bioinformatics
   - BIOL 3104 [0.5] Advanced Human Anatomy and Physiology
   - BIOL 3205 [0.5] Plant Biochemistry and Physiology
   - BIOL 3301 [0.5] Biotechnology II
   - BIOL 3303 [0.5] Experimental Microbiology
   - BIOL 3305 [0.5] Human and Comparative Physiology
   - BIOL 3102 [0.5] Cellular Biochemistry
   - BIOL 3103 [0.5] Practical Biochemistry I
   - BIOL 3104 [0.5] Practical Biochemistry II

5. 2.5 credits in:
   - BIOL 2002 [0.5] Principles of Developmental Biology
   - MATH 1007 [0.5] Elementary Calculus I
   - MATH 1107 [0.5] Linear Algebra I
   - STAT 2507 [0.5] Introduction to Statistical Modeling I

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

6. 1.0 credit from:
   - CHEM 3100 [0.5] Analytical Chemistry II
   - CHEM 3201 [0.5] Advanced Organic Chemistry I
   - CHEM 3202 [0.5] Advanced Organic Chemistry II
   - CHEM 3205 [0.5] Experimental Organic Chemistry

C. Biochemistry courses listed in but not used to fulfill Item 4 above

D. Biochemistry courses listed in but not used to fulfill Item 4 above
B.Sc. Regulations

The regulations presented in this section apply to all Bachelor of Science programs. In addition to the requirements presented here, students must satisfy the University regulations common to all undergraduate students including the process of Academic Performance Evaluation (see the Academic Regulations of the University section of this Calendar).

Breadth Requirement for the B.Sc.

Students in Bachelor of Science Honours, Major, or General programs must present the following credits at graduation:

1. 2.0 credits in Science Continuation courses not in the major discipline or disciplines;
2. 2.0 credits in approved courses outside of the faculties of Science and Engineering and Design (but may include NSCI 1000) if, on transfer, the student received credit for fewer than 10.0 credits.


<table>
<thead>
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<th>Credits</th>
<th>Description</th>
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<tbody>
<tr>
<td>CHEM 3101</td>
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<td>Quantum Chemistry</td>
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<td>CHEM 3102</td>
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<td>Methods of Computational Chemistry</td>
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<td>CHEM 3106</td>
<td>[0.5]</td>
<td>Computational Chemistry Methods Laboratory</td>
</tr>
<tr>
<td>CHEM 3107</td>
<td>[0.5]</td>
<td>Experimental Methods in Nanoscience</td>
</tr>
<tr>
<td>CHEM 3202</td>
<td>[0.5]</td>
<td>Advanced Organic Chemistry II</td>
</tr>
<tr>
<td>CHEM 3205</td>
<td>[0.5]</td>
<td>Experimental Organic Chemistry</td>
</tr>
<tr>
<td>CHEM 3504</td>
<td>[0.5]</td>
<td>Inorganic Chemistry II</td>
</tr>
<tr>
<td>CHEM 3600</td>
<td>[0.5]</td>
<td>Introduction to Nanotechnology</td>
</tr>
<tr>
<td>CHEM 3700</td>
<td>[0.5]</td>
<td>Industrial Applications of Chemistry</td>
</tr>
<tr>
<td>CHEM 3800</td>
<td>[0.5]</td>
<td>The Chemistry of Environmental Pollutants</td>
</tr>
<tr>
<td>CHEM 4201</td>
<td>[0.5]</td>
<td>Macromolecular Nanotechnology</td>
</tr>
<tr>
<td>CHEM 4202</td>
<td>[0.5]</td>
<td>Advanced Topics in Organic Chemistry I</td>
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<tr>
<td>CHEM 4203</td>
<td>[0.5]</td>
<td>Synthetic Organic Chemistry</td>
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<tr>
<td>CHEM 4206</td>
<td>[0.5]</td>
<td>Natural Products Chemistry</td>
</tr>
<tr>
<td>PHYS 2202</td>
<td>[0.5]</td>
<td>Wave Motion and Optics</td>
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<tr>
<td>PHYS 2604</td>
<td>[0.5]</td>
<td>Modern Physics I</td>
</tr>
<tr>
<td>MATH 2007</td>
<td>[0.5]</td>
<td>Elementary Calculus II</td>
</tr>
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<td>MATH 2008</td>
<td>[0.5]</td>
<td>Intermediate Calculus</td>
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<td>MATH 2107</td>
<td>[0.5]</td>
<td>Linear Algebra II</td>
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<td>COMP 1005</td>
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<td>Introduction to Computer Science I</td>
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<td>COMP 1006</td>
<td>[0.5]</td>
<td>Introduction to Computer Science II</td>
</tr>
<tr>
<td>COMP 2401</td>
<td>[0.5]</td>
<td>Introduction to Systems Programming</td>
</tr>
<tr>
<td>TOTAL</td>
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<td></td>
</tr>
</tbody>
</table>

13. 0.5 credit in free electives. 0.5

Declared and Undeclared Students

Students who are registered in a program within the degree are called Declared students. Most students designate a program of study when they first apply for admission and so begin their studies as Declared students. Students may also choose to begin their studies within the B.Sc. degree without being registered in a program. These students are referred to as Undeclared students. The recommended course pattern for Undeclared students is provided in the Undeclared entry of the Programs section of this Calendar. Undeclared students normally must apply to enter a program before beginning their second year of study. The Science Student Success Centre (SSSC) provides Undeclared students guidance to the appropriate support services in making this decision.

Change of Program within the B.Sc. Degree

Students may transfer to a program within the B.Sc. degree if upon entry to the new program they would be in good academic standing.

Applications to declare or change their program within the B.Sc. Degree must be made online through Carleton Central by completing a Change of Program Elements (COPE) application form within the published deadlines. Acceptance into a program or into a program element or option is subject to any enrolment, and/or specific program, program element or option requirements as published in the relevant Calendar entry.

Minors, Concentrations and Specializations

Students may add a minor, concentration or specialization by completing a Change of Program Elements (COPE) application form online through Carleton Central. Acceptance into a minor, concentration or specialization requires that the student be in Good Standing and is subject to any specific requirements of the intended Minor, Concentration or Specialization as published in the relevant Calendar entry.

Experimental Science Requirement

Students in B.Sc. Honours, Major, or General degree programs must present at graduation at least two full credits of experimental science chosen from two different departments or institutes from the list below:

Approved Experimental Science Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Description</th>
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<td>Cellular Biochemistry</td>
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<td>BIOC 4001</td>
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<td>Methods in Biochemistry</td>
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<tr>
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<td>Course Title</td>
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</tr>
<tr>
<td>-------------</td>
<td>--------------</td>
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</tr>
<tr>
<td>BIOC 4201</td>
<td>Advanced Cell Culture and Tissue Engineering</td>
<td></td>
</tr>
<tr>
<td>BIOL 1103</td>
<td>Foundations of Biology I</td>
<td></td>
</tr>
<tr>
<td>BIOL 1104</td>
<td>Foundations of Biology II</td>
<td></td>
</tr>
<tr>
<td>BIOL 2001</td>
<td>Animals: Form and Function</td>
<td></td>
</tr>
<tr>
<td>BIOL 2002</td>
<td>Plants: Form and Function</td>
<td></td>
</tr>
<tr>
<td>BIOL 2104</td>
<td>Introductory Genetics</td>
<td></td>
</tr>
<tr>
<td>BIOL 2200</td>
<td>Cellular Biochemistry</td>
<td></td>
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<tr>
<td>BIOL 2600</td>
<td>Introduction to Ecology</td>
<td></td>
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<tr>
<td>CHEM 1001</td>
<td>General Chemistry I</td>
<td></td>
</tr>
<tr>
<td>CHEM 1002</td>
<td>General Chemistry II</td>
<td></td>
</tr>
<tr>
<td>CHEM 1005</td>
<td>Elementary Chemistry I</td>
<td></td>
</tr>
<tr>
<td>CHEM 1006</td>
<td>Elementary Chemistry II</td>
<td></td>
</tr>
<tr>
<td>CHEM 2103</td>
<td>Physical Chemistry I</td>
<td></td>
</tr>
<tr>
<td>CHEM 2203</td>
<td>Organic Chemistry I</td>
<td></td>
</tr>
<tr>
<td>CHEM 2204</td>
<td>Organic Chemistry II</td>
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<tr>
<td>CHEM 2206</td>
<td>Organic Chemistry IV</td>
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<tr>
<td>CHEM 2302</td>
<td>Analytical Chemistry I</td>
<td></td>
</tr>
<tr>
<td>CHEM 2303</td>
<td>Analytical Chemistry II</td>
<td></td>
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<tr>
<td>CHEM 2800</td>
<td>Foundations for Environmental Chemistry</td>
<td></td>
</tr>
<tr>
<td>ERTH 1006</td>
<td>Exploring Planet Earth</td>
<td></td>
</tr>
<tr>
<td>ERTH 1009</td>
<td>The Earth System Through Time</td>
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</tr>
<tr>
<td>ERTH 2102</td>
<td>Mineralogy to Petrology</td>
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<tr>
<td>ERTH 2404</td>
<td>Engineering Geoscience</td>
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<tr>
<td>ERTH 2802</td>
<td>Field Geology I</td>
<td></td>
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<tr>
<td>ERTH 3111</td>
<td>Vertebrate Evolution II</td>
<td></td>
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<tr>
<td>ERTH 3112</td>
<td>Vertebrate Evolution I</td>
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<tr>
<td>ERTH 3204</td>
<td>Mineral Deposits</td>
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<td>ERTH 3205</td>
<td>Physical Hydrogeology</td>
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<tr>
<td>ERTH 3806</td>
<td>Structural Geology</td>
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<tr>
<td>FOOD 3001</td>
<td>Food Chemistry</td>
<td></td>
</tr>
<tr>
<td>FOOD 3002</td>
<td>Food Analysis</td>
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</tr>
<tr>
<td>FOOD 3005</td>
<td>Food Microbiology</td>
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<tr>
<td>GEOG 1010</td>
<td>Global Environmental Systems</td>
<td></td>
</tr>
<tr>
<td>GEOG 3108</td>
<td>Soil Properties</td>
<td></td>
</tr>
<tr>
<td>NEUR 3206</td>
<td>Sensory and Motor Neuroscience</td>
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<tr>
<td>NEUR 3207</td>
<td>Integrative Neuroscience</td>
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<tr>
<td>NEUR 4600</td>
<td>Advanced Lab in Neuroanatomy</td>
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<tr>
<td>PHYS 1001</td>
<td>Foundations of Physics I</td>
<td></td>
</tr>
<tr>
<td>PHYS 1002</td>
<td>Foundations of Physics II</td>
<td></td>
</tr>
<tr>
<td>PHYS 1003</td>
<td>Introductory Mechanics and Thermodynamics</td>
<td></td>
</tr>
<tr>
<td>PHYS 1004</td>
<td>Introductory Electromagnetism and Wave Motion</td>
<td></td>
</tr>
<tr>
<td>PHYS 1007</td>
<td>Elementary University Physics I</td>
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<tr>
<td>PHYS 1008</td>
<td>Elementary University Physics II</td>
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<tr>
<td>PHYS 2202</td>
<td>Wave Motion and Optics</td>
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<tr>
<td>PHYS 2604</td>
<td>Modern Physics I</td>
<td></td>
</tr>
<tr>
<td>PHYS 3007</td>
<td>Third Year Physics Laboratory: Selected Experiments and Seminars</td>
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<tr>
<td>PHYS 3606</td>
<td>Modern Physics II</td>
<td></td>
</tr>
<tr>
<td>PHYS 3608</td>
<td>Modern Applied Physics</td>
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</table>

**Course Categories for B.Sc. Programs**

**Science Geography Courses**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOG 1010</td>
<td>Global Environmental Systems</td>
</tr>
<tr>
<td>GEOG 2006</td>
<td>Introduction to Quantitative Research</td>
</tr>
<tr>
<td>GEOG 2013</td>
<td>Weather and Water</td>
</tr>
<tr>
<td>GEOG 2014</td>
<td>The Earth's Surface</td>
</tr>
<tr>
<td>GEOG 3003</td>
<td>Quantitative Geography</td>
</tr>
<tr>
<td>GEOG 3010</td>
<td>Field Methods in Physical Geography</td>
</tr>
<tr>
<td>GEOG 3102</td>
<td>Geomorphology</td>
</tr>
<tr>
<td>GEOG 3103</td>
<td>Watershed Hydrology</td>
</tr>
<tr>
<td>GEOG 3104</td>
<td>Principles of Biogeography</td>
</tr>
<tr>
<td>GEOG 3105</td>
<td>Climate and Atmospheric Change</td>
</tr>
<tr>
<td>GEOG 3106</td>
<td>Aquatic Science and Management</td>
</tr>
<tr>
<td>GEOG 3108</td>
<td>Soil Properties</td>
</tr>
<tr>
<td>GEOG 4000</td>
<td>Field Studies</td>
</tr>
<tr>
<td>GEOG 4005</td>
<td>Directed Studies in Geography</td>
</tr>
<tr>
<td>GEOG 4013</td>
<td>Cold Region Hydrology</td>
</tr>
<tr>
<td>GEOG 4017</td>
<td>Global Biogeochemical Cycles</td>
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<tr>
<td>GEOG 4101</td>
<td>Two Million Years of Environmental Change</td>
</tr>
<tr>
<td>GEOG 4103</td>
<td>Water Resources Engineering</td>
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<tr>
<td>GEOG 4104</td>
<td>Microclimatology</td>
</tr>
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<td>GEOG 4108</td>
<td>Permafrost</td>
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</table>

**Science Psychology Courses**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>PSYC 2001</td>
<td>Introduction to Research Methods in Psychology</td>
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<tr>
<td>PSYC 2002</td>
<td>Introduction to Statistics in Psychology</td>
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<tr>
<td>PSYC 2700</td>
<td>Introduction to Cognitive Psychology</td>
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<tr>
<td>PSYC 3000</td>
<td>Design and Analysis in Psychological Research</td>
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<tr>
<td>PSYC 3506</td>
<td>Cognitive Development</td>
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<tr>
<td>PSYC 3700</td>
<td>Cognition (Honours Seminar)</td>
</tr>
<tr>
<td>PSYC 3702</td>
<td>Perception</td>
</tr>
<tr>
<td>PSYC 2307</td>
<td>Human Neuropsychology I</td>
</tr>
<tr>
<td>PSYC 3307</td>
<td>Human Neuropsychology II</td>
</tr>
</tbody>
</table>

**Science Continuation Courses**

A course at the 2000 level or above may be used as a Science Continuation credit in a B.Sc. program if it is not in the student's major discipline, and is chosen from the following:

- BIOC (Biochemistry)
- BIOL (Biology)
- COMP (Computer Science)
- CHEM (Chemistry)

A maximum of two half-credits at the 1000-level in COMP, excluding COMP 1001 may be used as Science Continuation credits.
ERTH (Earth Sciences), except ERTH 2415 which may be used only as a free elective for any B.Sc. program. Students in Earth Sciences programs may use ERTH 2401, ERTH 2402, and ERTH 2403 only as free electives.

Engineering. Students wishing to register in Engineering courses must obtain the permission of the Faculty of Engineering and Design.

ENSC (Environmental Science)

FOOD (Food Science and Nutrition)

GEOM (Geomatics)

HLTH (Health Sciences)

MATH (Mathematics)

NEUR (Neuroscience)

PHYS (Physics), except PHYS 2903

Science Geography Courses (see list above)

Science Psychology Courses (see list above)

STAT (Statistics)

TSES (Technology, Society, Environment) except TSES 2305. Biology General, Major, and Honours students may use these courses only as free electives. Integrated Science and Environmental Science students may include these courses in their programs but may not count them as part of the Science Sequence.

Science Faculty Electives

Science Faculty Electives are courses at the 1000-4000 level chosen from:

- BIOC (Biochemistry)
- BIOL (Biology) Biochemistry students may use BIOL 1010 and BIOL 2005 only as free electives
- CHEM (Chemistry) except CHEM 1003, CHEM 1004 and CHEM 1007
- COMP (Computer Science) except COMP 1001
- ERTH (Earth Sciences) except ERTH 1010, ERTH 1011 and ERTH 2415. Earth Sciences students may use ERTH 2401, ERTH 2402, and ERTH 2403 only as free electives.
- Engineering
- ENSC 2001
- FOOD (Food Science and Nutrition)
- GEOM (Geomatics)
- HLTH (Health Science)
- MATH (Mathematics)
- NEUR (Neuroscience)
- PHYS (Physics) except PHYS 1901, PHYS 1902, PHYS 1905, PHYS 2903
- Science Geography (see list above)
- Science Psychology (see list above)
- STAT (Statistics)
- TSES (Technology, Society, Environment) Biology General, Major and Honours students may use these courses only as free electives.

Advanced Science Faculty Electives

Advanced Science Faculty Electives are courses at the 2000-4000 level chosen from the Science Faculty Electives list above.

Approved Courses Outside the Faculties of Science and Engineering and Design (may include NSCI 1000)

All courses offered by the Faculty of Arts and Social Sciences, the Faculty of Public Affairs, and the Sprott School of Business are approved as Arts or Social Sciences courses EXCEPT FOR: All Science Geography courses (see list above), all Geomatics (GEOM) courses, all Science Psychology courses (see list above). NSCI 1000 may be used as an Approved Course Outside the Faculties of Science and Engineering and Design.

Free Electives

Any course is allowable as a Free Elective providing it is not prohibited (see below). Students are expected to comply with prerequisite requirements and enrolment restrictions for all courses as published in this Calendar.

Courses Allowable Only as Free Electives in any B.Sc. Program

CHEM 1003 [0.5] The Chemistry of Food, Health and Drugs
CHEM 1004 [0.5] Drugs and the Human Body
CHEM 1007 [0.5] Chemistry of Art and Artifacts
ERTH 1010 [0.5] Our Dynamic Planet Earth
ERTH 1011 [0.5] Evolution of the Earth
ERTH 2415 [0.5] Natural Disasters
ISCI 1001 [0.5] Introduction to the Environment
ISCI 2000 [0.5] Natural Laws
ISCI 2002 [0.5] Human Impacts on the Environment
MATH 0107 [0.5] Algebra and Geometry
PHYS 1901 [0.5] Planetary Astronomy
PHYS 1902 [0.5] From our Star to the Cosmos
PHYS 1905 [0.5] How Things Work: Physics in Everyday Life
PHYS 2903 [0.5] Physics and the Imagination

Prohibited Courses

The following courses are not acceptable for credit in any B.Sc. program:

COMP 1001 [0.5] Introduction to Computational Thinking for Arts and Social Science Students
MATH 0005 [0.5] Precalculus: Functions and Graphs
MATH 0006 [0.5] Precalculus: Trigonometric Functions and Complex Numbers
MATH 1009 [0.5] Calculus: with Applications to Business
MATH 1119 [0.5] Linear Algebra: with Applications to Business
MATH 1401 [0.5] Elementary Mathematics for Economics I
MATH 1402 [0.5] Elementary Mathematics for Economics II

Co-operative Education

Co-operative Education is based on the principle that academic study combined with alternating work periods is an effective method of professional preparation. Work periods at various points in the academic program allow students to acquire experience within their discipline. The Co-operative Education program is a complement to the students' academic studies.
Application Requirements

Students can apply to co-op in one of two ways; directly from high school or after beginning a degree program at Carleton. If a student is admitted to co-op from high school, their grades will be reviewed two terms to one year prior to their first work term to ensure they continue to meet the academic requirements after their 1st or 2nd year of study. The time at which evaluation takes place depends on the program of study. Students will automatically be notified via their Carleton email account if they are permitted to continue.

Students not admitted to Carleton University with the co-op option on their degree can apply for admission via the co-operative education program website. To view application deadlines, visit carleton.ca/co-op.

Admission to the co-op option is based on the completion of 5.0 or more credits at Carleton University, the CGPA requirement for the students’ academic program as well as any course prerequisites. The articulated CGPA for each program is the normal standard for assessment. Please see the specific degree program sections for the unique admission and continuation requirements for each academic program.

English Language Proficiency

Students admitted to Carleton based on CAEL, IELTS or TOEFL assessments and who are required to take an ESL course must take and pass the Oral Proficiency in Communicative Settings (OPECS) Test. The test must be taken before being permitted to register in COOP 1000. Admission to the co-op program can be confirmed with a minimum score of 4+.

Participation Requirements

Once a student has been given admission or continuation confirmation to the co-op option s/he must complete and pass COOP 1000 (a mandatory online 0.0 credit course). Students will have access to this course a minimum of two terms prior to their first work term and will be notified when to register.

Communication with the Co-op Office

Students must maintain contact with the co-op office during their job search and while on a work term. All email communication will be conducted via the students’ Carleton email account.

Graduation with the Co-op Designation

In order to graduate with the co-op designation, students must satisfy all requirements for their degree program in addition to the requirements according to each co-op program (i.e. successful completion of three or four work terms).

Note: Participation in the co-op option will add up to one additional year for a student to complete their degree program.

Employment

Although every effort is made to ensure a sufficient number of job postings for all students enrolled in the co-op option of their degree program, no guarantee of employment can be made. Carleton’s co-op program operates a competitive job search process and is dependent upon current market conditions. Academic performance, skills, motivation, maturity, attitude and potential will determine whether a student is offered a job. It is the student's responsibility to actively conduct a job search in addition to participation in the job search process operated by the co-op office. Once a student accepts a co-op job offer (verbally or written), his/her job search will end and access to co-op jobs will be removed for that term. Students that do not successfully obtain a co-op work term are expected to continue with their academic studies. The summer term is the exception to this rule. Students should also note that hiring priority is given to Canadian citizens for co-op positions in the Federal Government of Canada.

Work Term Assessment and Evaluation

To obtain a Satisfactory grade for the co-op work term students must have:

1. A satisfactory work term evaluation by the co-op employer;
2. A satisfactory grade on the work term report.

Students must submit a work term report at the completion of each four-month work term. Reports are due on the 16th of April, August, and December and students are notified of due dates through their Carleton email account.

Workplace performance will be assessed by the workplace supervisor. Should a student receive an unsatisfactory rating from their co-op employer, an investigation by the co-op program manager will be undertaken. An unsatisfactory employer evaluation does not preclude a student from achieving an overall satisfactory rating for the work term.

Voluntary Withdrawal from the Co-op Option

Students may withdraw from the co-op option of their degree program during a study term ONLY. Students at work may not withdraw from the work term or the co-op option until s/he has completed the requirements of the work term.

Students are eligible to continue in their regular academic program provided that they meet the academic standards required for continuation.

Involuntary or Required Withdrawal from the Co-op Option

Students may be required to withdraw from the co-op option of their degree program for one or any of the following reasons:

1. Failure to achieve a grade of SAT in COOP 1000
2. Failure to pay all co-op related fees
3. Failure to actively participate in the job search process
4. Failure to attend all interviews for positions to which the student has applied
5. Declining more than one job offer during the job search process
6. Continuing a job search after accepting a co-op position
7. Failure to be registered in the Co-op Work Term course
8. Dismissal from a work term by the co-op employer
9. Leaving a work term without approval by the Co-op manager
10. Receipt of an unsatisfactory work term evaluation
11. Submission of an unsatisfactory work term report

Standing and Appeals
The Co-op and Career Services office administers the regulations and procedures that are applicable to all co-op program options. All instances of a student’s failure during a work term or other issues directly related to their participation in the co-op option will be reported to the academic department.

Any decision made by the Co-op and Career Services office can be appealed via the normal appeal process within the University.

Registering in Co-op Courses
Students will be registered in a Co-op Work Term course while at work. The number of Co-op Work Term courses that a student is registered in is dependent upon the number of four-month work terms that a student accepts.

Students must be registered as full-time before they begin their co-op job search (2.0 credits). All co-op work terms must be completed before the beginning of the final academic term. Students may not finish their degree on a co-op work term.

International Students
All International Students are required to possess a Co-op Work Permit issued by Citizenship and Immigration Canada before they can begin working. It is illegal to work in Canada without the proper authorization. Students will be provided with a letter of support to accompany their application. Students must submit their application for their permit before being permitted to view and apply for jobs on the Co-op Services database. Confirmation of a position will not be approved until a student can confirm they have received their permit. Students are advised to discuss the application process and requirements with the International Student Services Office.

Co-operative Education - Bachelor of Science
The following programs in the Bachelor of Science Honours offer a co-operative education option:

Applied Physics, Biochemistry (including computational), Bioinformatics, Biology (including computational), Biotechnology, Chemistry (including computational), Earth Sciences, Environmental Science, Food Science and Nutrition, Geomatics, Neuroscience, Neuroscience and Mental Health and Physics.

Students in all streams of the Bachelor of Science must successfully complete three (3) work terms to obtain the co-op designation.

Co-op Admission and Continuation Requirements for Students in the Bachelor of Science
For admission to and continuation in the co-op option, all students must:

• Maintain full-time status in each study term (2.0 credits);
• Be eligible to work in Canada (for off-campus work)
• Have successfully completed COOP 1000

Program-Specific Admission and Continuation Requirements:
Applied Physics, Biochemistry (including computational), Bioinformatics, Biology (including computational), Biotechnology, Chemistry (including computational), Earth Sciences, Environmental Science, Neuroscience, Neuroscience and Mental Health and Physics:
1. Completion of 5.0 or more credits at Carleton University;
2. Registered as a full-time student in the Bachelor of Science Honours degree program;
3. Obtained and maintained a major CGPA of 8.0 or higher and an overall CGPA of 6.50 or higher

Food Science and Nutrition
1. Registered as a full-time student in the Bachelor of Science Honours in Food Science and Nutrition;
2. Obtained and maintained a major CGPA of 9.0 or higher and an overall CGPA of 7.5 or higher in the first three years of academic study
3. Have obtained third-year standing;
4. Successfully completed, by the start date of the first work term, at least 2.0 credits from the following list of courses: FOOD 3001, FOOD 3002, FOOD 3003, FOOD 3004, and FOOD 3005

Geomatics and Physical Geography:
1. Registered in the Bachelor of Science (Honours) Programs in Physical Geography or Geomatics;
2. Obtained and maintained an overall minimum CGPA of 9.5 and a major CGPA of 9.5;
3. Have obtained third-year standing;
4. Successfully completed, by the start-date of the first work term:
   a. the required second-year methods courses in their program (GEOG/ENST 2005, GEOG/ENST 2006)
   b. the required field course in their program (ENST 3900/GEOG 3000/GEOG 3010/GEOG 3030)
5. Be registered as a full-time student.

Co-op Work Term Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 3999 [0.0]</td>
<td></td>
<td>Co-operative Work Term Report</td>
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<tr>
<td>Biochemistry and Computational Biochemistry</td>
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<td>Co-operative Work Term</td>
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<tr>
<td>BIOC 3999 [0.0]</td>
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<td>Co-operative Work Term Report</td>
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<td>Biochemistry and Biotechnology, Bioinformatics, Biology, Biotechnology, Computational Biology, Biology and Physics</td>
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</tr>
<tr>
<td>BIOL 3999 [0.0]</td>
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<td>Co-operative Work Term Report</td>
</tr>
<tr>
<td>Chemistry, Chemistry and Physics, Computational Chemistry</td>
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</tr>
<tr>
<td>CHEM 3999 [0.0]</td>
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<td>Co-operative Work Term</td>
</tr>
<tr>
<td>Earth Sciences</td>
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</tbody>
</table>
Admission Requirements

Honours Program

First Year
The Ontario Secondary School Diploma (OSSD) or equivalent including a minimum of six 4U or M courses. For most programs including Bioinformatics, Biology, Biochemistry, Biotechnology, Chemistry, combined Honours in Biology and Physics, Chemistry and Physics, Computational Biochemistry, Food Science and Nutrition, Neuroscience, Neuroscience and Mental Health, Nanoscience and Psychology, the six 4U or M courses must include Advanced Functions and two of Biology, Chemistry, Earth and Space Sciences or Physics. (Calculus and Vectors is strongly recommended).

Specific Honours Admission Requirements

For the Honours programs in Environmental Science, Geography, Geomatics and Earth Sciences, Calculus and Vectors may be substituted for Advanced Functions. For the Honours programs in Physics and Applied Physics and for double Honours in Mathematics and Physics, Calculus and Vectors is required in addition to Advanced Functions and one of 4U Physics Chemistry, Biology, or Earth and Space Sciences. For all programs in Physics, 4U Physics is strongly recommended.

For the Combined Honours program in Chemistry and Computer Science, 4U Chemistry and Calculus and Vectors are strongly recommended. For Honours in Psychology, a 4U course in English is recommended.

For Honours in Biology and Chemistry, a 4U course in Biology and Chemistry is recommended.

Advanced Standing
For entry to an Honours program after the completion of 5.0 included credits, a student must have a major CGPA of 5.50 or higher, an overall CGPA of 4.50 or higher and the recommendation of the Honours department or committee. A student beginning the final 10.0 credits towards an Honours degree must present a major CGPA of 6.00 or higher, an overall CGPA of 5.00 or higher and the recommendation of the Honours department or committee. A student beginning the final 5.0 credits towards an Honours degree must present a major CGPA of 6.50 or higher and an overall CGPA of 5.00 or higher, as calculated for graduation. Advanced standing will be granted for studies undertaken elsewhere when these

Legend
S: Study
W: Work
O: Optional
* indicates recommended work study pattern
** student finds own employer for this work-term.

Admissions Information
Admission Requirements are for the 2017-2018 year only, and are based on the Ontario High School System. Holding the minimum admission requirements only establishes eligibility for consideration. The cut-off averages for admission may be considerably higher than the minimum. See also the General Admission and Procedures section of this Calendar. An overall average of at least 70% is normally required to be considered for admission. Some programs may also require specific course prerequisites and prerequisite averages and/or supplementary admission portfolios. Higher averages are required for admission to programs for which the demand for places by qualified applicants exceeds the number of places available. The overall average required for admission is determined each year on a program by program basis. Consult admissions.carleton.ca for further details.

Degrees
• B.Sc. (Honours)
• B.Sc. (General)
• B.Sc. (Major)

Admission Requirements
are recognized as the equivalent of subjects offered at Carleton University.

Major Program

General Program

First Year
The Ontario Secondary School Diploma (OSSD) or equivalent including a minimum of six 4U or M courses. The six 4U or M courses must include Advanced Functions and two of Calculus and Vectors, Biology, Chemistry, Earth and Space Science or Physics (Calculus and Vectors is strongly recommended). For the B.Sc. Major in Physics, 4U Physics is strongly recommended. Equivalent courses may be substituted between the old and new Ontario mathematics curriculum.

Advanced Standing
For entry to a General or Major program after the completion of 5.0 included credits, a student must have a major and core CGPA of 3.50 or higher and an overall CGPA of 3.50 or higher. A student beginning the final 5.0 credits towards a General or Major degree must present a major and core CGPA of 4.00 or higher and an overall CGPA of 4.00 or higher, as calculated for graduation. Advanced standing will be granted for studies undertaken elsewhere when these are recognized as the equivalent of subjects offered at Carleton University.

Co-op Option

Direct Admission to the First Year of the Co-op Option
Applicants must:
1. meet the required overall admission cut-off average and prerequisite course average. These averages may be higher than the stated minimum requirements;
2. be registered as a full-time student in the Bachelor of Science Honours program;
3. be eligible to work in Canada (for off-campus work placements).

Note that meeting the above requirements only establishes eligibility for admission to the program. The prevailing job market may limit enrolment in the co-op option.

Note: continuation requirements for students previously admitted to the co-op option and admission requirements for the co-op option after beginning the program are described in the Co-operative Education Regulations section of this Calendar.

Biochemistry (BIOC) Courses

BIOC 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 BIOL 2200.
Precludes additional credit for BIOL 2201.
Prerequisite(s): (BIOL 1003 and BIOL 1004) or (BIOL 1103 and BIOL 1104), (CHEM 1006 or CHEM 1002) or permission of the Institute. It is strongly recommended that students in Biochemistry programs take this course in their second year of study.
Lectures three hours a week, laboratory or tutorial four hours a week.

BIOC 2300 [0.5 credit]
Physical Biochemistry
Energy of biological systems, molecular interactions, diffusion principles, introduction to protein folding, structure and thermodynamics, ligand binding and nucleic acid structures; experimental design and data management.
Precludes additional credit for CHEM 2103.
Prerequisite(s): BIOC 2200 (can be taken concurrently with BIOC 2300) and MATH 1007 and MATH 1107, and (PHYS 1007 and PHYS 1107, and PHYS 1003 and PHYS 1004).
Lectures three hours a week, tutorials three hours a week.

BIOC 2400 [0.5 credit]
Independent Research I
Students carry out a laboratory research project under the supervision of a faculty member from the Institute of Biochemistry. A research report must be submitted by the last day of classes for evaluation by the Director and Faculty supervisor.
Prerequisite(s): restricted to Honours students of second-year standing in a Biochemistry program with a GPA of 10.0 or higher in first year, and approval of the Director and a Faculty supervisor.
Laboratory research for at least three hours a week over two terms.

BIOC 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 BIOL 3008 and COMP 3308.
Prerequisite(s): BIOC 2200 or BIOL 2200; or permission of the Institute.
Lecture two hours a week, computer workshop three hours a week.
BIOC 3101 [0.5 credit]
General Biochemistry I
Chemistry, structure and function of proteins, lipids, carbohydrates and nucleic acids. Monomers, linkages and types of biochemical polymers that are formed. Mechanism of action of enzymes, regulatory control mechanisms of proteins and integration of biochemical pathways. Precludes additional credit for CHEM 3401.
Prerequisite(s): (BIOC 2200 or BIOL 2200), and (CHEM 2203 and CHEM 2204) or (CHEM 2207 and CHEM 2208) or permission of the Institute. Lectures three hours a week.

BIOC 3102 [0.5 credit]
General Biochemistry II
Anabolic and catabolic processes. Regulation of cell compartment (membranes, mitochondria, chloroplast, peroxisome, nuclei) composition. Genetic controls of transcription, translation and post-translational modification of protein structure and function. Biochemical processes of disease, development, and toxicology. Prerequisite(s): BIOC 3101 and BIOL 2104. Lectures three hours a week.

BIOC 3103 [0.5 credit]
Practical Biochemistry I
Introduction to experimental biochemistry and the theory and concepts dealt with in BIOC 3101, and BIOC 3202. Precludes additional credit for BIOC 3006 (no longer offered). Prerequisite(s): BIOC 2200/BIOL2200 and CHEM 2203 or permission of the Institute. CHEM 2204 and (BIOC 2300 or CHEM 2103) are also recommended. It is highly recommended that BIOC 3101 and BIOC 3202 be taken concurrently. Laboratory four hours a week, tutorial one hour per week.

BIOC 3104 [0.5 credit]
Practical Biochemistry II
Introduction to experimental biochemistry and the theory and concepts dealt with in BIOC 3101, BIOC 3102, and BIOC 3202. Precludes additional credit for BIOC 3006 (no longer offered). Prerequisite(s): BIOC 3103. It is highly recommended that BIOC 3102 be taken concurrently. Laboratory four hours a week, tutorial one hour a week.

BIOC 3202 [0.5 credit]
Biophysical Techniques and Applications
Theory and applications of current biochemical biophysical instrumentation and techniques including biophysical spectroscopy, molecular structure determination, calorimetry, and mass spectrometry. Precludes additional credit for BIOC 4002. Prerequisite(s): BIOC 2200 or permission of the Institute. Lectures three hours a week.

BIOC 3400 [0.5 credit]
Independent Research II
Students carry out a laboratory research project under the supervision of faculty member from the Institute of Biochemistry. A research report must be submitted by the last day of classes for evaluation by the Director and Faculty supervisor. Prerequisite(s): restricted to Honours students of third-year standing in a Biochemistry program with a GPA of 10.0 or higher in second year, and approval of the Director and Faculty supervisor. Laboratory research for at least three hours a week over two terms.

BIOC 3999 [0.0 credit]
Co-operative Work Term
Practical experience for students enrolled in the co-operative option. Students must receive a satisfactory evaluation from their work term employer; and present a written report describing their work term project. Graded Sat or Uns. Prerequisite(s): registration in the Biochemistry co-operative option and permission of the Institute.

BIOC 4001 [0.5 credit]
Methods in Biochemistry
Principles and applications of modern biochemical methodology, including ultracentrifugation, electrophoresis, ELISA, EMSA, experimental planning, ligand binding kinetics, fluorescence spectroscopy, affinity purification, and in vitro translation. Prerequisite(s): BIOC 3103 and BIOC 3104 or permission of the Institute. Lectures and discussion two hours, laboratory four hours a week.

BIOC 4004 [0.5 credit]
Industrial Biochemistry
The application of biochemistry to the production of biological compounds useful in nutrition, medicine, and the food and chemical industries. General strategies for efficient production of these compounds by controlling the activities of living cells or enzymes. Prerequisite(s): BIOC 3101 and BIOC 3102 (BIOC 3102 may be taken concurrently), or permission of the Institute. Lecture three hours a week.

BIOC 4005 [0.5 credit]
Biochemical Regulation
Regulation at the transcriptional, translational and metabolic level; regulation of cell and subcellular organelle function and other timely topics may be included. Prerequisite(s): BIOC 3101 and BIOC 3102. Lectures three hours a week.
BIOC 4007 [0.5 credit]
Membrane Biochemistry
Biochemical and biophysical aspects of biomembrane structure and function. Topics may include: membrane lipids and proteins, lipid polymorphism, model membranes, liposomes, membrane biogenesis, the membrane cytoskeleton, membrane trafficking, membrane fusion, exocytosis and signal transduction across membranes. Prerequisite(s): BIOL 2200 or BIOC 2200, or BIOC 3101 (which may be taken concurrently with BIOC 4007), or permission of the Institute. Lectures two hours a week and workshop two hours a week.

BIOC 4008 [0.5 credit]
Computational Systems Biology
Modeling and simulation of metabolic and regulatory networks towards understanding complex and highly dynamic cellular systems. Biotechnological applications include metabolic engineering, synthetic biology, and drug discovery. Also listed as COMP 4308. Prerequisite(s): BIOC 3101 or permission of the Institute. Lecture one and a half hours per week, workshop one and a half hours per week.

BIOC 4009 [0.5 credit]
Biochemistry of Disease
The biochemical basis of disease including genetic and metabolic disorders such as cancer, neurological degenerative conditions, diabetes, stroke and microbial infections. Prerequisite(s): BIOC 3101 and BIOC 3102, or permission of the Institute. Lectures three hours a week.

BIOC 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 BIOL 4200. Prerequisite(s): BIOL 3201 or permission of the Institute. Lectures three hours a week.

BIOC 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 BIOL 4201. Prerequisite(s): BIOL 3201 or permission of the Institute. Laboratory four hours per week, tutorial one hour a week.

BIOC 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 BIOL 4202. Prerequisite(s): BIOL 3104 and BIOL 2200/BIOC 2200, or permission of the Institute. Lectures two hours a week and workshop two hours a week.

BIOC 4203 [0.5 credit]
Advanced Metabolism
Structure, biochemical derivation and function of secondary metabolites such as toxins and antibiotics. Examples from plant, fungal and animal systems. Prerequisite(s): BIOC 3101 and BIOC 3102, or permission of the Institute. Lectures three hours a week.

BIOC 4204 [0.5 credit]
Protein Biotechnology
An advanced lecture, discussion and seminar course covering the theory, development and current techniques of protein and enzyme engineering. Topics to be discussed may also include applications in biotechnology, nanotechnology and new frontiers in basic and applied research. Precludes additional credit for BIOC 4002. Prerequisite(s): BIOC 3101 and BIOC 3202 (may be taken concurrently), or permission of the Institute. Lectures two hours a week, workshop two hours a week.

BIOC 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; regulation of cell proliferation and cell death. Also listed as BIOL 4400. Prerequisite(s): BIOL 3201, or BIOC 3102 or permission of the Institute. Lectures one and a half hours per week, workshop one and a half hours per week.
BIOC 4708 [0.5 credit]  
**Principles of Toxicology**  
Basic theorems of toxicology with examples of current research problems. Toxic risk is defined as the product of intensive hazard and extensive exposure. Each factor is assessed in scientific and social contexts and illustrated with many types of experimental material.  
Prerequisite(s): (BIOC 3101 and BIOC 3102), or (CHEM 2204, CHEM 2303, FOOD 3001, and FOOD 3005), or permission of the Institute.  
Also offered at the graduate level, with different requirements, as BIOL 6402, CHEM 5708, for which additional credit is precluded.  
Lectures three hours a week.

BIOC 4901 [0.5 credit]  
**Selected Topics in Biochemistry**  
Selected topics of current interest in biochemistry are offered upon approval by the Director in consultation with members of the Institute.

BIOC 4906 [1.0 credit]  
**Interdisciplinary Research Project**  
Collaborative, interdisciplinary research project approved by the Director. Requires co-supervision, with at least one faculty member from the Institute of Biochemistry. Evaluation is based on a written thesis and poster presentation.  
Precludes additional credit for BIOC 4907 and BIOC 4908.  
Prerequisite(s): (BIOC 3103 and BIOC 3104) and (BIOC 3101 and BIOC 3102) or equivalent, eligibility to continue in Honours Biochemistry or in Biochemistry and Biotechnology, permission of the Institute.

BIOC 4907 [1.0 credit]  
**Honours Essay and Research Proposal**  
An independent research study using library or computational resources. The candidate will prepare a critical review of a topic approved by a faculty adviser. Evaluation will be based on a written report and a poster presentation of the project.  
Precludes additional credit for BIOC 4906 [1.0] and BIOC 4908 [1.0].  
Prerequisite(s): fourth-year standing in an Honours Biochemistry program and permission of the Institute.

BIOC 4908 [1.0 credit]  
**Research Project**  
Students carry out a research project approved by the Director, under the supervision of a faculty member of the Institute, in either the Biology or Chemistry departments. Evaluation is based on a written thesis and poster presentation.  
Precludes additional credit for BIOC 4906 and BIOC 4907.  
Prerequisite(s): (BIOC 3103 and BIOC 3104) and (BIOC 3101 and BIOC 3102) or equivalent, and eligibility to continue in Honours Biochemistry or in Biochemistry and Biotechnology.

**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