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
- BIOL 4301 [0.5] Current Topics in Biotechnology
- BIOL 4306 [0.5] Animal Neurophysiology
- BIOL 4318 [0.5] Adaptations to Extreme Environments
- BIOL 4400 [0.5] Nuclear Dynamics and The Cell Cycle

5. 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 BIOC 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:

- CHEM 3202 [0.5] Advanced Organic Chemistry II
- CHEM 3205 [0.5] Experimental Organic Chemistry

7. 3.5 credits in:

- BIOC 2200 [0.5] Cellular Biochemistry
- BIOC 3101 [0.5] General Biochemistry I
- BIOC 3102 [0.5] General Biochemistry II
- BIOC 3103 [0.5] Practical Biochemistry I
- BIOC 3104 [0.5] Practical Biochemistry II
- BIOC 3202 [0.5] Biophysical Techniques and Applications
- BIOC 4001 [0.5] Methods in Biochemistry
- BIOC 3008 [0.5] Bioinformatics
- 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 4200 [0.5] Immunology
- BIOC 4201 [0.5] Advanced Cell Culture and Tissue Engineering
- BIOC 4202 [0.5] Mutagenesis and DNA Repair
- BIOC 4203 [0.5] Advanced Metabolism
- BIOC 4204 [0.5] Protein Biotechnology
- BIOC 4400 [0.5] Nuclear Dynamics and The Cell Cycle
- BIOC 4708 [0.5] Principles of Toxicology

9. 1.0 credit from:

- BIOC 4906 [1.0] Interdisciplinary Research Project
- BIOC 4907 [1.0] Honours Essay and Research Proposal
- BIOC 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
### Biochemistry
**B.Sc. Honours (20.0 credits)**

#### A. Credits Included in the Major CGPA (15.0 credits)

<table>
<thead>
<tr>
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<td>BIOL 1103 [0.5]</td>
<td>Foundations of Biology I</td>
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<tr>
<td></td>
<td>BIOL 1104 [0.5]</td>
<td>Foundations of Biology II</td>
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<td>MATH 1007 [0.5]</td>
<td>Elementary Calculus I</td>
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<td>MATH 1107 [0.5]</td>
<td>Linear Algebra I</td>
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<td>STAT 2507 [0.5]</td>
<td>Introduction to Statistical Modeling I</td>
</tr>
<tr>
<td>2.0</td>
<td>BIOL 2301 [0.5]</td>
<td>Biotechnology I</td>
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<td>BIOL 2303 [0.5]</td>
<td>Microbiology</td>
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<td>BIOL 3104 [0.5]</td>
<td>Molecular Genetics</td>
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#### B. Approved Courses Outside the Faculties of Science and Engineering and Design (may include NSCI 1000)

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<td>Animals: Form and Function</td>
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<td>BIOL 2002 [0.5]</td>
<td>Plants: Form and Function</td>
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<td>0.5</td>
<td>BIOL 3105 [0.5]</td>
<td>Human and Comparative Physiology</td>
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<td>1.5</td>
<td>CHEM 2303 [0.5]</td>
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#### C. CHEM courses listed in but not used to fulfill Item 6 above:

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<td>CHEM 3600 [0.5]</td>
<td>Synthetic Organic Chemistry</td>
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<td>CHEM 2204 [0.5]</td>
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#### D. Biochemistry and Biotechnology

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<td>BIOL 4301 [0.5]</td>
<td>Current Topics in Biotechnology</td>
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<td>3.0</td>
<td>BIOL 2200 [0.5]</td>
<td>Cellular Biochemistry</td>
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<td>BIOL 3101 [0.5]</td>
<td>General Biochemistry I</td>
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<td>BIOL 3102 [0.5]</td>
<td>General Biochemistry II</td>
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<td></td>
<td>BIOL 3103 [0.5]</td>
<td>Practical Biochemistry I</td>
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<td>BIOL 3104 [0.5]</td>
<td>Practical Biochemistry II</td>
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<td>BIOL 3202 [0.5]</td>
<td>Biophysical Techniques and Applications</td>
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<td>BIOL 4907 [1.0]</td>
<td>Honours Essay and Research Proposal</td>
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<td>BIOL 4908 [1.0]</td>
<td>Research Project</td>
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<td>4.0</td>
<td>CHEM 1001 [0.5]</td>
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<td>General Chemistry II</td>
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<td>CHEM 2103 [0.5]</td>
<td>Physical Chemistry I or BIOL 2300 [0.5] Physical Biochemistry</td>
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<td>CHEM 2203 [0.5]</td>
<td>Organic Chemistry I</td>
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<td>CHEM 2204 [0.5]</td>
<td>Organic Chemistry II</td>
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<tr>
<td></td>
<td>CHEM 2303 [0.5]</td>
<td>Analytical Chemistry II</td>
</tr>
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</table>
CHEM 2501 [0.5] Introduction to Inorganic and Bioinorganic Chemistry
CHEM 3201 [0.5] Advanced Organic Chemistry I

9. 0.5 credit from:
CHEM 3202 [0.5] Advanced Organic Chemistry II
CHEM 3205 [0.5] Experimental Organic Chemistry

10. 0.5 credit from:
BIOC courses listed in, but not used to fulfil, Item 7 above
BIOC 2400 [0.5] Independent Research I
BIOC 3400 [0.5] Independent Research II
BIOC 3008 [0.5] Bioinformatics
BIOC 4001 [0.5] Methods in Biochemistry
BIOC 4008 [0.5] Computational Systems Biology
BIOC 4901 [0.5] Selected Topics in Biochemistry
BIOC courses listed in, but not used to fulfil, Item 3 or 4
BIOC 2001 [0.5] Animals: Form and Function
BIOC 2002 [0.5] Plants: Form and Function
BIOC 3102 [0.5] Mycology
BIOC 3306 [0.5] Human Anatomy and Physiology
BIOC 3307 [0.5] Advanced Human Anatomy and Physiology
BIOC 4206 [0.5] Human Genetics
BIOC 4209 [0.5] Advanced Plant Physiology
- BIOC courses listed in, but not used to fulfil Item 4 above
CHEM 3100 [0.5] Physical Chemistry II
CHEM 3107 [0.5] Experimental Methods in Nanoscience
CHEM 3202 [0.5] Advanced Organic Chemistry II
CHEM 3205 [0.5] Experimental Organic Chemistry
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 4406 [0.5] Pharmaceutical Drug Design

B. Credits Not Included in the Major CGPA (5.0 credits)
11. 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

12. 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

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

14. 0.5 credit in free elective.

Total Credits

Computational Biochemistry

B.Sc. Honours (20.0 credits)

A. Credits Included in the Major (13.5 credits)

1. 2.0 credits in:

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<tr>
<td>BIOL 1103 [0.5]</td>
<td>Foundations of Biology I</td>
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<td>BIOL 1104 [0.5]</td>
<td>Foundations of Biology II</td>
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<td>BIOL 2104 [0.5]</td>
<td>Introductory Genetics</td>
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<td>BIOL 3104 [0.5]</td>
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2. 3.0 credits in:

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<tbody>
<tr>
<td>CHEM 1001 [0.5]</td>
<td>General Chemistry I</td>
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</table>
& CHEM 1002 [0.5] General Chemistry II
| CHEM 2103 [0.5] | Physical Chemistry I |
or BIOC 2300 [0.5] Physical Biochemistry
| CHEM 2203 [0.5] | Organic Chemistry I |
| CHEM 2303 [0.5] | Analytical Chemistry II |
| CHEM 2501 [0.5] | Introduction to Inorganic and Bioinorganic Chemistry |

3. 0.5 credit from:

<table>
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<td>CHEM 2204 [0.5]</td>
<td>Organic Chemistry II</td>
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<td>CHEM 2206 [0.5]</td>
<td>Organic Chemistry IV</td>
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4. 4.0 credits in:

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<tr>
<td>BIOC 2200 [0.5]</td>
<td>Cellular Biochemistry</td>
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<tr>
<td>BIOC 3101 [0.5]</td>
<td>General Biochemistry I</td>
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<td>BIOC 3102 [0.5]</td>
<td>General Biochemistry II</td>
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<td>BIOC 3103 [0.5]</td>
<td>Practical Biochemistry I</td>
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<td>BIOC 3104 [0.5]</td>
<td>Practical Biochemistry II</td>
</tr>
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<td>BIOC 3202 [0.5]</td>
<td>Biophysical Techniques and Applications</td>
</tr>
<tr>
<td>BIOC 3008 [0.5]</td>
<td>Bioinformatics</td>
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<tr>
<td>BIOC 4008 [0.5]</td>
<td>Computational Systems Biology</td>
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5. 1.5 credits in:

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<td>COMP 1005 [0.5]</td>
<td>Introduction to Computer Science I</td>
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<td>COMP 1006 [0.5]</td>
<td>Introduction to Computer Science II</td>
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<tr>
<td>COMP 2401 [0.5]</td>
<td>Introduction to Systems Programming</td>
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6. 1.5 credits from:

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<tr>
<td>MATH 1805 [0.5]</td>
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<td>MATH 2107 [0.5]</td>
<td>Linear Algebra II</td>
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<td>STAT 2509 [0.5]</td>
<td>Introduction to Statistical Modeling II</td>
</tr>
<tr>
<td>MATH 2800 [0.5]</td>
<td>Discrete Mathematics and Algorithms</td>
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<td>MATH 3800 [0.5]</td>
<td>Mathematical Modeling and Computational Methods</td>
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<tr>
<td>BIOC 2400 [0.5]</td>
<td>Independent Research I</td>
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<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>
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7. 1.0 credit in:

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<tbody>
<tr>
<td>BIOC 4906 [1.0]</td>
<td>Interdisciplinary Research Project</td>
</tr>
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</table>
or BIOC 4908 [1.0] Research Project |

B. Credits Not Included in the Major (6.5 credits)

8. 1.0 credit from:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>PHYS 1007 [0.5]</td>
<td>Elementary University Physics I</td>
</tr>
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</table>
& PHYS 1008 [0.5] | Elementary University Physics II |
| PHYS 1003 [0.5] | Introductory Mechanics and Therodynamics |
& PHYS 1004 [0.5] | Introductory Electromagnetism and Wave Motion |
Biochemistry

B.Sc. Major (20.0 credits)

A. Credits included in the Major CGPA (12.0 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 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
   - BIOL 3306 [0.5] Human Anatomy and 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
   - BIOL 4301 [0.5] General Biochemistry I
   - BIOL 4302 [0.5] General Biochemistry II
   - BIOL 4303 [0.5] Practical Biochemistry I
   - BIOL 4304 [0.5] Practical Biochemistry II
   - BIOL 4400 [0.5] Nuclear Dynamics and The Cell Cycle

5. 2.5 credits in:
   - BIOT 2200 [0.5] Cellular Biochemistry
   - BIOT 3101 [0.5] General Biochemistry I
   - BIOT 3102 [0.5] General Biochemistry II
   - BIOT 3103 [0.5] Practical Biochemistry I
   - BIOT 3104 [0.5] Practical Biochemistry II

6. 1.0 credit from:
   - BIOL 3008 [0.5] Bioinformatics
   - BIOL 3202 [0.5] Biophysical Techniques and Applications
   - BIOL 3204 [0.5] Biochemistry

7. 4.0 credits from:
   - CHEM 1001 [0.5] General Chemistry I
   - CHEM 1002 [0.5] General Chemistry II
   - CHEM 2103 [0.5] Physical Chemistry I
   - CHEM 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

8. 0.5 credit from:
   - CHEM 3202 [0.5] Advanced Organic Chemistry II
   - CHEM 3205 [0.5] Experimental Organic Chemistry

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

9. 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

10. 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

11. 2.0 credits in Approved Courses Outside the Faculties of Science and Engineering and Design (may include NSCI 1000)

12. 3.0 credits from:
    - Biochemistry courses listed in but not used to fulfill Item 6 above
    - BIOL 4901 [0.5] Selected Topics in Biochemistry
    - Biology 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 3100 [0.5] Physical Chemistry II
Students admitted to B.Sc. programs by transfer from other 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: Approved Experimental Science Courses

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<td>CHEM 3102</td>
<td>Methods of Computational Chemistry</td>
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<td>CHEM 3106</td>
<td>Computational Chemistry Methods</td>
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<td>CHEM 3107</td>
<td>Experimental Methods in Nanoscience</td>
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<td>CHEM 3202</td>
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<td>CHEM 3600</td>
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</tr>
</tbody>
</table>

Good Standing

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.

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 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.

2. 1.0 credit 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 10.0 or more credits.

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:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC 2200</td>
<td>Cellular Biochemistry</td>
</tr>
<tr>
<td>BIOC 4001</td>
<td>Methods in Biochemistry</td>
</tr>
</tbody>
</table>

Regulations (B.Sc.)

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

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

### Science Geography Courses
- GEOG 1010 [0.5] Global Environmental Systems
- GEOG 2006 [0.5] Introduction to Quantitative Research
- GEOG 2013 [0.5] Weather and Water
- GEOG 2014 [0.5] The Earth's Surface
- GEOG 3003 [0.5] Quantitative Geography
- GEOG 3010 [0.5] Field Methods in Physical Geography
- GEOG 3102 [0.5] Geomorphology
- GEOG 3103 [0.5] Watershed Hydrology
- GEOG 3104 [0.5] Principles of Biogeography
- GEOG 3105 [0.5] Climate and Atmospheric Change
- GEOG 3106 [0.5] Aquatic Science and Management
- GEOG 3108 [0.5] Soil Properties
- GEOG 4000 [0.5] Field Studies
- GEOG 4005 [0.5] Directed Studies in Geography
- GEOG 4013 [0.5] Cold Region Hydrology
- GEOG 4017 [0.5] Global Biogeochemical Cycles
- GEOG 4101 [0.5] Two Million Years of Environmental Change
- GEOG 4103 [0.5] Water Resources Engineering
- GEOG 4104 [0.5] Microclimatology
- GEOG 4108 [0.5] Permafrost

### Science Psychology Courses
- PSYC 2001 [0.5] Introduction to Research Methods in Psychology
- PSYC 2002 [0.5] Introduction to Statistics in Psychology
- PSYC 2700 [0.5] Introduction to Cognitive Psychology
- PSYC 3000 [1.0] Design and Analysis in Psychological Research
- PSYC 3506 [0.5] Cognitive Development
- PSYC 3700 [1.0] Cognition (Honours Seminar)
- PSYC 3702 [0.5] Perception
- PSYC 2307 [0.5] Human Neuropsychology I
- PSYC 3307 [0.5] Human Neuropsychology II

### 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)
- CHEM (Chemistry)
- COMP (Computer Science) 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 Sciences)
- 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
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 1008) or (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
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 3102 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): BIOC 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.

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