

Biochemistry

This section presents the requirements for programs in:

- **Biochemistry B.Sc. Honours**
- **Biochemistry and Biotechnology B.Sc. Honours**
- **Computational Biochemistry B.Sc. Honours**
- **Biochemistry B.Sc. Major**

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 (15.0 credits)

1. 2.0 credits in:	2.0
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:	0.5
BIOL 2001 [0.5]	Animals: Form and Function
BIOL 2002 [0.5]	Plants: Form and Function
3. 0.5 credit from:	0.5
BIOL 3205 [0.5]	Plant Biochemistry and Physiology
BIOL 3305 [0.5]	Human and Comparative Physiology
BIOL 3307 [0.5]	Advanced Human Anatomy and Physiology
4. 0.5 credit in BIOL at the 3000-level or higher	0.5
5. 3.5 credits in:	3.5
CHEM 1001 [0.5]	General Chemistry I
&	General Chemistry II
CHEM 1002 [0.5]	
CHEM 2203 [0.5]	Organic Chemistry I
&	Organic Chemistry II
CHEM 2204 [0.5]	
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:	0.5
CHEM 3202 [0.5]	Advanced Organic Chemistry II
CHEM 3205 [0.5]	Experimental Organic Chemistry
7. 4.5 credits in:	4.5
BIOC 1500 [0.5]	Biochemistry in a Modern Society
BIOC 2200 [0.5]	Cellular Biochemistry
BIOC 2500 [0.5]	Research Methods and Skills in Biochemistry

BIOC 2300 [0.5]	Physical Biochemistry	
or CHEM 2103 [0.5]	Physical Chemistry I	
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 4001 [0.5]	Methods in Biochemistry	
8. 2.0 credits in BIOC at the 2000-level or higher		2.0
9. 1.0 credit in:		1.0
BIOC 4907 [1.0]	Honours Essay and Research Proposal	
or BIOC 4908 [1.0]	Research Project	

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

10. 0.5 credit from:	0.5
PHYS 1007 [0.5]	Elementary University Physics I
or PHYS 1003 [0.5]	Introductory Mechanics and Thermodynamics
11. 1.0 credit in:	1.0
MATH 1007 [0.5]	Elementary Calculus I
MATH 1107 [0.5]	Linear Algebra I
12. 2.0 credits in Approved Courses Outside the Faculties of Science and Engineering and Design (may include NSCI 1000)	2.0
13. 1.0 credit in Science Faculty Electives	1.0
14. 0.5 credit in free electives.	0.5
Total Credits	20.0

Biochemistry and Biotechnology

B.Sc. Honours (20.0 credits)

A. Credits Included in the Major CGPA (16.0 credits)

1. 4.0 credits in:	4.0
BIOL 1103 [0.5]	Foundations of Biology I
BIOL 1104 [0.5]	Foundations of Biology II
BIOL 2104 [0.5]	Introductory Genetics
BIOL 2301 [0.5]	Biotechnology I
BIOL 2303 [0.5]	Microbiology
BIOL 3104 [0.5]	Molecular Genetics
BIOL 3301 [0.5]	Biotechnology II
BIOL 4301 [0.5]	Current Topics in Biotechnology
2. 0.5 credit from:	0.5
BIOL 2001 [0.5]	Animals: Form and Function
BIOL 2002 [0.5]	Plants: Form and Function
3. 0.5 credit from:	0.5
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 4109 [0.5]	Laboratory Techniques in Molecular Genetics
4. 0.5 credit in BIOL 3000-level or higher	0.5
5. 4.0 credits in:	4.0
BIOC 1500 [0.5]	Biochemistry in a Modern Society
BIOC 2200 [0.5]	Cellular Biochemistry
BIOC 2500 [0.5]	Research Methods and Skills in Biochemistry
BIOC 2300 [0.5]	Physical Biochemistry
or CHEM 2103 [0.5]	Physical Chemistry I

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	
6. 1.0 credit in:		1.0
BIOC 4907 [1.0]	Honours Essay and Research Proposal	
	or BIOC 4908 [1.0] Research Project	
7. 1.5 credits in	BIOC 2000-level or higher	1.5
8. 3.5 credits in:		3.5
CHEM 1001 [0.5]	General Chemistry I	
&	General Chemistry II	
CHEM 1002 [0.5]		
CHEM 2203 [0.5]	Organic Chemistry I	
&	Organic Chemistry II	
CHEM 2204 [0.5]		
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	
9. 0.5 credit from	BIOL or CHEM at the 2000-level or above	0.5
B. Credits Not Included in the Major CGPA (4.0 credits)		
10. 0.5 credit from:		0.5
PHYS 1007 [0.5]	Elementary University Physics I	
	or PHYS 1003 [0.5] Introductory Mechanics and Thermodynamics	
11. 1.0 credit in:		1.0
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
12. 2.0 credits in	Approved Courses Outside the Faculties of Science and Engineering and Design (may include NSCI 1000)	2.0
13. 0.5 credit in	free elective.	0.5
Total Credits		20.0

Computational Biochemistry

B.Sc. Honours (20.0 credits)

A. Credits Included in the Major (14.5 credits)

1. 2.0 credits in:		2.0
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. 3.0 credits in:		3.0
CHEM 1001 [0.5]	General Chemistry I	
&	General Chemistry II	
CHEM 1002 [0.5]		
CHEM 2203 [0.5]	Organic Chemistry I	
&	Organic Chemistry II	
CHEM 2204 [0.5]		
CHEM 2303 [0.5]	Analytical Chemistry II	
CHEM 2501 [0.5]	Introduction to Inorganic and Bioinorganic Chemistry	
3. 5.0 credits in:		5.0
BIOC 1500 [0.5]	Biochemistry in a Modern Society	
BIOC 2200 [0.5]	Cellular Biochemistry	
BIOC 2300 [0.5]	Physical Biochemistry	
	or CHEM 2103 [0.5] Physical Chemistry I	

BIOC 2500 [0.5]	Research Methods and Skills in Biochemistry	
BIOC 3008 [0.5]	Bioinformatics	
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 4008 [0.5]	Computational Systems Biology	
4. 1.5 credits in:		1.5
COMP 1005 [0.5]	Introduction to Computer Science I	
&	Introduction to Computer Science II	
COMP 1006 [0.5]		
COMP 2401 [0.5]	Introduction to Systems Programming	
5. 2.0 credits from:		2.0
MATH 1805 [0.5]	Discrete Structures I	
MATH 2107 [0.5]	Linear Algebra II	
MATH 2800 [0.5]	Discrete Mathematics and Algorithms	
MATH 3800 [0.5]	Mathematical Modeling and Computational Methods	
STAT 2507 [0.5]	Introduction to Statistical Modeling I	
STAT 2509 [0.5]	Introduction to Statistical Modeling II	
	BIOC courses at the 2000-level and above	
6. 1.0 credit in:		1.0
BIOC 4907 [1.0]	Honours Essay and Research Proposal	
	or BIOC 4908 [1.0] Research Project	
B. Credits Not Included in the Major (5.5 credits)		
7. 0.5 credit from:		0.5
PHYS 1007 [0.5]	Elementary University Physics I	
	or PHYS 1003 [0.5] Introductory Mechanics and Thermodynamics	
8. 1.5 credits in:		1.5
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
MATH 2007 [0.5]	Elementary Calculus II	
9. 2.0 credits in	Approved Courses Outside the Faculties of Science and Engineering and Design (may include NSCI 1000)	2.0
10. 1.0 credit in:		1.0
COMP 2402 [0.5]	Abstract Data Types and Algorithms	
	COMP at the 2000-level or above	
11. 0.5 credit in	free electives.	0.5
Total Credits		20.0

Biochemistry

B.Sc. Major (20.0 credits)

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

1. 2.0 credits in:		2.0
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:		0.5
BIOL 2001 [0.5]	Animals: Form and Function	
BIOL 2002 [0.5]	Plants: Form and Function	

3. 0.5 credit from:		0.5
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. 0.5 credit in BIOL at the 3000-level or higher		0.5
5. 4.0 credits in:		4.0
BIOC 1500 [0.5]	Biochemistry in a Modern Society	
BIOC 2200 [0.5]	Cellular Biochemistry	
BIOC 2300 [0.5]	Physical Biochemistry	
or CHEM 2103 [0.5]	Physical Chemistry I	
BIOC 2500 [0.5]	Research Methods and Skills in 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	
6. 2.5 credits in BIOC at the 2000-level or higher		2.5
7. 3.5 credits in:		3.5
CHEM 1001 [0.5]	General Chemistry I	
&	General Chemistry II	
CHEM 1002 [0.5]		
CHEM 2203 [0.5]	Organic Chemistry I	
&	Organic Chemistry II	
CHEM 2204 [0.5]		
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	
B. Credits Not Included in the Major CGPA (6.5 credits)		
8. 0.5 credit from:		0.5
PHYS 1007 [0.5]	Elementary University Physics I	
or PHYS 1003 [0.5]	Introductory Mechanics and Thermodynamics	
9. 1.0 credit in:		1.0
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
10. 2.0 credits in Approved Courses Outside the Faculties of Science and Engineering and Design (may include NSCI 1000)		2.0
11. 2.5 credits in science faculty electives		2.5
12. 0.5 credit in free electives.		0.5
Total Credits		20.0

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 Continuation Evaluation (see the *Academic Regulations of the University* section of this Calendar).

Breadth Requirement for the B.Sc.

Students in a Bachelor of Science program must present the following credits at graduation:

- 2.0 credits in Science Continuation courses not in the major discipline; **students completing a double major are considered to have completed this requirement providing they have 2.0 credits in Science Continuation courses in each of the two majors;**
- 2.0 credits in courses outside of the faculties of Science and Engineering and Design (may include NSCI 1000)

In most cases, the requirements for individual B.Sc. programs, as stated in this Calendar, contain these requirements, explicitly or implicitly.

Students admitted to B.Sc. programs by transfer from another institution must present at graduation (whether taken at Carleton or elsewhere):

- 2.0 credits in courses outside of the faculties of Science and Engineering and Design (may include NSCI 1000) if the student received fewer than 10.0 transfer credits; or,
- 1.0 credit in courses outside of the faculties of Science and Engineering and Design (may include NSCI 1000) if the student received 10.0 or more transfer credits.

Declared and Undeclared Students

Degree students are considered "Undeclared" if they have been admitted to a degree, but have not yet selected and been accepted into a program within that degree. The status "Undeclared" is available only in the B.A. and B.Sc. degrees. Undeclared students must apply to enter a program upon or before completing 3.5 credits.

Change of Program within the B.Sc. Degree

To transfer to a program within the B.Sc. degree, applicants must normally be *Eligible to Continue* (EC) in the new program, by meeting the CGPA thresholds described in Section 3.1.9 of the *Academic Regulations of the University*.

Applications to declare or change programs 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 limitations, 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 normally requires that the student be *Eligible to Continue* (EC) and is meeting the minimum CGPAs described in Section 3.1.9 of the *Academic Regulations of the University*, as well as being subject to any specific requirements of the intended Minor,

Concentration, or Specialization as published in the relevant Calendar entry.

Experimental Science Requirement

Students in a B.Sc. degree program 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

Biochemistry

BIOC 2200 [0.5]	Cellular Biochemistry
BIOC 4001 [0.5]	Methods in Biochemistry
BIOC 4201 [0.5]	Advanced Cell Culture and Tissue Engineering

Biology

BIOL 1103 [0.5]	Foundations of Biology I
BIOL 1104 [0.5]	Foundations of Biology II
BIOL 2001 [0.5]	Animals: Form and Function
BIOL 2002 [0.5]	Plants: Form and Function
BIOL 2104 [0.5]	Introductory Genetics
BIOL 2200 [0.5]	Cellular Biochemistry
BIOL 2600 [0.5]	Ecology

Chemistry

CHEM 1001 [0.5]	General Chemistry I
CHEM 1002 [0.5]	General Chemistry II
CHEM 2103 [0.5]	Physical Chemistry I
CHEM 2203 [0.5]	Organic Chemistry I
CHEM 2204 [0.5]	Organic Chemistry II
CHEM 2302 [0.5]	Analytical Chemistry I
CHEM 2303 [0.5]	Analytical Chemistry II
CHEM 2800 [0.5]	Foundations for Environmental Chemistry

Earth Sciences

ERTH 1006 [0.5]	Exploring Planet Earth
ERTH 1009 [0.5]	The Earth System Through Time
ERTH 2102 [0.5]	Mineralogy to Petrology
ERTH 2404 [0.5]	Engineering Geoscience
ERTH 2802 [0.5]	Field Geology I
ERTH 3111 [0.5]	Vertebrate Evolution: Mammals, Reptiles, and Birds
ERTH 3112 [0.5]	Vertebrate Evolution: Fish and Amphibians
ERTH 3204 [0.5]	Mineral Deposits
ERTH 3205 [0.5]	Physical Hydrogeology
ERTH 3806 [0.5]	Structural Geology

Food Sciences

FOOD 3001 [0.5]	Food Chemistry
FOOD 3002 [0.5]	Food Analysis
FOOD 3005 [0.5]	Food Microbiology

Geography

GEOG 1010 [0.5]	Global Environmental Systems
GEOG 3108 [0.5]	Soil Properties

Neuroscience

NEUR 3206 [0.5]	Sensory and Motor Neuroscience
NEUR 3207 [0.5]	Systems Neuroscience
NEUR 4600 [0.5]	Advanced Lab in Neuroanatomy

Physics

PHYS 1001 [0.5]	Foundations of Physics I
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PHYS 1002 [0.5]	Foundations of Physics II
PHYS 1003 [0.5]	Introductory Mechanics and Thermodynamics
PHYS 1004 [0.5]	Introductory Electromagnetism and Wave Motion
PHYS 1007 [0.5]	Elementary University Physics I
PHYS 1008 [0.5]	Elementary University Physics II
PHYS 2202 [0.5]	Wave Motion and Optics
PHYS 2604 [0.5]	Modern Physics I
PHYS 3007 [0.5]	Third Year Physics Laboratory: Selected Experiments and Seminars
PHYS 3606 [0.5]	Modern Physics II
PHYS 3608 [0.5]	Modern Applied Physics

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) Biochemistry students may use BIOL 2005 only as a free elective.

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)

ISAP (Interdisciplinary Science Practice)

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 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) 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)

ISAP (Interdisciplinary Science Practice)

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 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

BIOL 4810 [0.5]	Education Research in Undergraduate Science
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]	Physics Behind Everyday Life
PHYS 2903 [0.5]	Physics Towards the Future

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]	Mathematics for 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

For more information about how to apply for the Co-op program and how the Co-op program works please visit the Co-op website.

All students participating in the Co-op program are governed by the Undergraduate Co-operative Education Policy.

Undergraduate Co-operative Education Policy

Admission 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 applies to a degree program with a Co-op option from high school, their university grades will be reviewed two terms to one year prior to their first work term to ensure they meet the academic requirements after their first or second year of study. The time at which the evaluation takes place depends on the program of study. Students will automatically receive an admission decision via their Carleton email account.

Students who did not request Co-op at the time they applied to Carleton can request Co-op after they begin their university studies. To view application instructions and deadlines, please visit carleton.ca/co-op.

To be admitted to Co-op, a student must successfully complete 5.0 or more credits that count towards their degree, meet the minimum CGPA requirement(s) for the student's Co-op option, and fulfil any specified course prerequisites. To see the unique admission and continuation requirements for each Co-op option, please refer to the specific degree programs listed in the Undergraduate Calendar.

Participation Requirements

COOP 1000

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.

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.

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.

While on a co-op work term students may take a maximum of 0.5 credit throughout each four-month co-op work term. Courses must be scheduled outside of regular working hours.

Students must be registered as full-time before they begin their co-op job search. 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.

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.

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.

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. Dismissal from a work term by the co-op employer
8. Leaving a work term without approval by the Co-op manager
9. Receipt of an unsatisfactory work term evaluation
10. 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.

International Students

All International Students are required to possess a Co-op Work Permit issued by Immigration, Refugees and Citizenship 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.

B.Sc. Biochemistry, Computational Biochemistry: Co-op Admission and Continuation Requirements

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

In addition to the following:

1. Registered as a full-time student in the B.Sc. Honours Biochemistry or Computational Biochemistry program;
2. Successfully completed 5.0 or more credits;
3. Obtained an Overall CGPA of at least 6.50 and a Major CGPA of at least 8.00. These CGPAs must be maintained throughout the duration of the degree.

B.Sc. Honours Biochemistry and Computational Biochemistry students must successfully complete three (3) work terms to obtain the Co-op Designation.

Work Term Course: BIOC 3999

Work/Study Pattern:

Year 1		Year 2		Year 3		Year 4		Year 5	
Term	Pattern	Term	Pattern	Term	Pattern	Term	Pattern	Term	Pattern
Fall	S	Fall	S	Fall	S	Fall	W	Fall	S
Winter	S	Winter	S	Winter	S	Winter	W	Winter	S
Summer		Summer	W	Summer	W	Summer	W		

Legend

S: Study

W: Work

Admissions Information

Admission Requirements are for the 2024-25 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.

Note: Courses listed as *recommended* are not mandatory for admission. Students who do not follow the recommendations will not be disadvantaged in the admission process.

Admissions Information

Admission requirements are based on the Ontario High School System. Prospective students can view the admission requirements through the Admissions website at admissions.carleton.ca. The overall average required for admission is determined each year on a program-by-program basis. Holding the minimum admission requirements only establishes eligibility for consideration; higher averages are required for admission to programs for which the demand for places by qualified applicants exceeds the number of places available. All programs have limited enrolment and admission is not guaranteed. Some programs may also require specific course prerequisites and prerequisite averages and/or supplementary admission portfolios. Consult admissions.carleton.ca for further details.

Note: If a course is listed as recommended, it is not mandatory for admission. Students who do not follow the recommendations will not be disadvantaged in the admission process.

Degrees

- B.Sc. (Honours)
- B.Sc. (Major)
- B.Sc.

Admission Requirements

B. Sc. Honours

First Year

The Ontario Secondary School Diploma (OSSD) or equivalent including a minimum of six 4U or M courses. For most programs including Biochemistry, Bioinformatics, Biotechnology, Chemistry, Combined Honours in Biology and Physics, Chemistry and Physics, Computational Biochemistry, Food Science, Nanoscience, Neuroscience and Biology, Neuroscience and Mental Health, 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 Earth Sciences, Environmental Science, Geomatics, Interdisciplinary Science and Practice, and Physical Geography, 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 Honours in Psychology, a 4U course in English is recommended.

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

Advanced Standing

Applications for admission beyond first year will be assessed on their merits. Applicants must normally be *Eligible to Continue* in their year level, in addition to meeting the CGPA thresholds described in Section 3.1.9 of the Academic Regulations of the University. Advanced standing will be granted only for those subjects deemed appropriate for the program and stream selected.

B.Sc. Major and B.Sc.

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.

Advanced Standing

Applications for admission beyond first year will be assessed on their merits. Applicants must normally be *Eligible to Continue* (EC) in their year level. Advanced standing will be granted only for those subjects deemed appropriate for the program and stream selected.

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 1500 [0.5 credit]

Biochemistry in a Modern Society

Explore biochemistry's real-world applications, cutting-edge research, and transformative technologies. Learn through case studies and collaborative group work about how biochemistry revolutionizes industries, medicine, and environmental stewardship in this dynamic course.

Includes: Experiential Learning Activity

Prerequisite(s): Enrolled in a Biochemistry program.

Workshop, three hours per week

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.

Includes: Experiential Learning Activity

Also listed as BIOL 2200.

Precludes additional credit for BIOL 2201, CHEM 4401.

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

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 or PHYS 1003.

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.

Includes: Experiential Learning Activity

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 2500 [0.5 credit]**Research Methods and Skills in Biochemistry**

An introduction to research methods in biochemistry.

Includes modern information literacy, study designs, descriptive and inferential statistics, and effective communication of research. Examples drawn from current issues in biochemistry.

Includes: Experiential Learning Activity

Prerequisite(s): 2nd year standing in a Biochemistry program.

Workshop, three hours per week.

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.

Includes: Experiential Learning Activity

Also listed as BIOL 3008 and COMP 3308.

Prerequisite(s): BIOC 2200 or BIOL 2200, or BIOL 2201.

Lecture two hours a week, computer workshop three hours a week.

BIOC 3101 [0.5 credit]**General Biochemistry I**

This course examines biological macromolecules as well as their chemistry, structure and function. Enzymatic reactions and their regulation, as well as carbohydrate, lipid and protein metabolism, is emphasized. Students apply knowledge of course concepts to relevant scientific problems (disease, development).

Precludes additional credit for CHEM 3401 (no longer offered), CHEM 4401.

Prerequisite(s): (BIOC 2200 or BIOL 2200), and (CHEM 2203 and CHEM 2204) or (CHEM 2207 and CHEM 2208).

Lectures three hours a week.

BIOC 3102 [0.5 credit]**General Biochemistry II**

This course examines secondary metabolism, membrane composition/synthesis, cell communication, and flow of genetic information within a biological system. Emphasis is on understanding molecular structures, the reactions/processes they facilitate, and their regulation. Students apply knowledge of course concepts to relevant scientific problems.

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.

Includes: Experiential Learning Activity

Precludes additional credit for BIOC 3006 (no longer offered).

Prerequisite(s): BIOC 2200/BIOL 2200 and CHEM 2203. 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.

Includes: Experiential Learning Activity

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 3203 [0.5 credit]**Biochemical Pharmacology**

Biochemical principles of pharmacology, including receptor mechanisms, signal transduction, pharmacokinetics, and pharmacodynamics. Genome-wide association studies, pharmacogenomics, and personalized medicine will also be included.

Prerequisite(s): BIOC 2200 or BIOL 2200 or BIOL 2201, 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.

Includes: Experiential Learning Activity

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.

Includes: Experiential Learning Activity

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.

Includes: Experiential Learning Activity

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): BIOC 3101 and BIOC 3102.

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.

Includes: Experiential Learning Activity

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.

Includes: Experiential Learning Activity

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 and tutorial three hours a week.

BIOC 4203 [0.5 credit]**Secondary Metabolism and Natural Products
Biochemistry**

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 BIOL 3104), 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.

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 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 fourth-year standing 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]**Directed Special Studies**

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

Prerequisite(s): permission of the Institute. Students normally may not offer more than 0.5 credit of Directed Special Studies in their program.

BIOC 4902 [0.5 credit]**Special Topics in Biochemistry**

Specific topics of current interest. Topics may vary from year to year.

Prerequisite(s): third or fourth-year standing in a Biochemistry program or permission of the Institute.

Lecture, seminars, or workshops three hours per week.

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

An independent research study using library resources.

The candidate will prepare a critical review of a topic and research proposal approved by a faculty adviser.

Evaluation will be based on a written report and a poster presentation of the project.

Includes: Experiential Learning Activity

Precludes additional credit for BIOC 4906 (no longer offered), 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.

Includes: Experiential Learning Activity

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.