

Biochemistry

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

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

Graduation Requirements

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

1. the University regulations (see the Academic Regulations of the University section of this Calendar).
2. the Faculty regulations applying to all B.Sc. students including those relating to Science Continuation and Breadth requirements (see the Academic Regulations for the Bachelor of Science).

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

Course Categories for Biochemistry

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

- Approved Arts or Social Sciences
- Free Electives

Program Requirements

Biochemistry

B.Sc. Honours (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 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:	1.0
BIOL 2303 [0.5] Microbiology	
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 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 4400 [0.5] Nuclear Dynamics and The Cell Cycle	
5. 4.0 credits in:	4.0
CHEM 1001 [0.5] General Chemistry I & CHEM 1002 [0.5] and 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:	0.5
CHEM 3202 [0.5] Advanced Organic Chemistry II	
CHEM 3205 [0.5] Experimental Organic Chemistry	
7. 3.5 credits in:	3.5
BIOC 2200 [0.5] Cellular Biochemistry	
BIOC 3006 [1.0] Practical Biochemistry	
BIOC 3101 [0.5] General Biochemistry I	
BIOC 3102 [0.5] General Biochemistry II	
BIOC 3202 [0.5] Biophysical Techniques and Applications	
BIOC 4001 [0.5] Methods in Biochemistry	
8. 0.5 credit from:	0.5
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:	1.0
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:		1.0
PHYS 1007 [0.5]	Elementary University Physics I	
& PHYS 1008 [0.5]	and Elementary University Physics II	
or		
PHYS 1003 [0.5]	Introductory Mechanics and	
& PHYS 1004 [0.5]	Thermodynamics and Introductory Electromagnetism and Wave Motion	
11. 1.5 credits in:		1.5
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
STAT 2507 [0.5]	Introduction to Statistical Modeling I	
12. 0.5 credit in:		0.5
NSCI 1000 [0.5]	Seminar in Science (or Approved Arts or Social Sciences)	
13. 1.5 credits in	Approved Arts or Social Sciences	1.5
14. 1.5 credits from:		1.5
BIOC courses listed in but not used to fulfill Item 8 above, one of:		
BIOC 2400 [0.5]	Independent Research I	
BIOC 3400 [0.5]	Independent Research II	
BIOC 4901 [0.5]	Selected Topics in Biochemistry	
BIOC 4008 [0.5]	Computational Systems Biology	
BIOL courses listed in but not used to fulfill Item 4 above		
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	
15. 0.5 credit in	free electives.	0.5
Total Credits		20.0

Computational Biochemistry B.Sc. Honours (20.0 credits)

A. Credits Included in the Major (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. 3.0 credits in:		3.0
CHEM 1001 [0.5]	General Chemistry I	
& CHEM 1002 [0.5]	and 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:		0.5
CHEM 2204 [0.5]	Organic Chemistry II	
CHEM 2206 [0.5]	Organic Chemistry IV	
4. 4.0 credits in:		4.0
BIOC 2200 [0.5]	Cellular Biochemistry	
BIOC 3006 [1.0]	Practical Biochemistry	
BIOC 3101 [0.5]	General Biochemistry I	
BIOC 3102 [0.5]	General Biochemistry II	
BIOC 3202 [0.5]	Biophysical Techniques and Applications	
BIOC 3008 [0.5]	Bioinformatics	
BIOC 4008 [0.5]	Computational Systems Biology	
5. 1.5 credits in:		1.5
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	
6. 1.5 credits from:		1.5
MATH 1805 [0.5]	Discrete Structures I	
MATH 2107 [0.5]	Linear Algebra II	
STAT 2509 [0.5]	Introduction to Statistical Modeling II	
MATH 2800 [0.5]	Discrete Mathematics and Algorithms	
MATH 3800 [0.5]	Modeling and Computational Methods for Experimental Science	
BIOC 2400 [0.5]	Independent Research I	
BIOC 3400 [0.5]	Independent Research II	
BIOC 4202 [0.5]	Mutagenesis and DNA Repair	
7. 1.0 credit in:		1.0
BIOC 4906 [1.0]	Interdisciplinary Research Project	
or BIOC 4908 [1.0]	Research Project	
B. Credits Not Included in the Major (6.5 credits)		
8. 1.0 credit from:		1.0

PHYS 1007 [0.5] & PHYS 1008 [0.5]	Elementary University Physics I and Elementary University Physics II	
PHYS 1003 [0.5] & PHYS 1004 [0.5]	Introductory Mechanics and Thermodynamics and Introductory Electromagnetism and Wave Motion	
9. 2.0 credits in:		2.0
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	
10. 0.5 credit in:		0.5
NSCI 1000 [0.5]	Seminar in Science (or Approved Arts or Social Sciences)	
11. 1.5 credits in	Approved Arts or Social Sciences	1.5
12. 1.0 credit in:		1.0
COMP 2402 [0.5]	Abstract Data Types and Algorithms	
	COMP at the 2000-level or above	
13. 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 (12.0 credits)

1. 2.0 credits in:		2.0
BIOL 1003 [0.5]	Introductory Biology I	
BIOL 1004 [0.5]	Introductory 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 3306 [0.5]	Human Anatomy and Physiology	
BIOL 3307 [0.5]	Advanced Human Anatomy and Physiology	
4. 1.0 credit from:		1.0
BIOL 2303 [0.5]	Microbiology	
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 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 4400 [0.5]	Nuclear Dynamics and The Cell Cycle	
5. 2.5 credits in:		2.5
BIOC 2200 [0.5]	Cellular Biochemistry	
BIOC 3006 [1.0]	Practical Biochemistry	
BIOC 3101 [0.5]	General Biochemistry I	
BIOC 3102 [0.5]	General Biochemistry II	
6. 1.0 credit from:		1.0
BIOC 3008 [0.5]	Bioinformatics	
BIOC 3202 [0.5]	Biophysical Techniques and Applications	
	BIOC at the 4000-level	
7. 4.0 credits from:		4.0
CHEM 1001 [0.5] & CHEM 1002 [0.5]	General Chemistry I and General Chemistry II	
CHEM 2103 [0.5] or BIOC 2300 [0.5]	Physical Chemistry I 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	
8. 0.5 credit from:		0.5
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:		1.0
PHYS 1007 [0.5] & PHYS 1008 [0.5]	Elementary University Physics I and Elementary University Physics II	
PHYS 1003 [0.5] & PHYS 1004 [0.5]	Introductory Mechanics and Thermodynamics and Introductory Electromagnetism and Wave Motion	
10. 1.5 credits in:		1.5
MATH 1007 [0.5]	Elementary Calculus I	
MATH 1107 [0.5]	Linear Algebra I	
STAT 2507 [0.5]	Introduction to Statistical Modeling I	
11. 0.5 credit in:		0.5
NSCI 1000 [0.5]	Seminar in Science (or an Approved Arts or Social Sciences)	
12. 1.5 credits in	Approved Arts or Social Sciences	1.5
13. 3.0 credits from:		3.0
	Biochemistry courses listed in but not used to fulfill Item 6 above	
BIOC 4901 [0.5]	Selected Topics in Biochemistry	

Biology courses listed in but not used to fulfill Item 4 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 3202 [0.5]	Advanced Organic Chemistry II
CHEM 3205 [0.5]	Experimental Organic Chemistry
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
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. 0.5

Total Credits 20.0

Institute of Biochemistry

Faculty of Science

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.

Prerequisite(s): (BIOL 1003 and BIOL 1004) or (BIOL 1103 and BIOL 1104), (CHEM 1006 with a minimum grade of B- 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 3006 [1.0 credit]

Practical Biochemistry

Introduction to experimental biochemistry and the theory and concepts dealt with in BIOC 3101, BIOC 3102 and BIOC 3202.

Prerequisite(s): BIOC 2200/BIOL 2200 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, BIOC 3102 and BIOC 3202 be taken concurrently.

Laboratory four hours a week, tutorial one hour a 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.

Also listed as COMP 3308.

Prerequisite(s): BIOC 2200 or BIOL 2200; or permission of the Institute.

Five 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, CHEM 2203 and CHEM 2204 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 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 3006 or permission of the Institute.

Lectures and discussion two hours, laboratory six 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 with BIOC 4004), or permission of the Institute.

Lecture 2 hours

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 [1.0] and BIOC 4908 [1.0].

Prerequisite(s): BIOC 3006, (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 [1.0] and BIOC 4907 [1.0].

Prerequisite(s): BIOC 3006 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