

Division of Natural Sciences and Mathematics

Overview

The Division of Natural Sciences and Mathematics offers a diverse range of courses, programs and degrees (B.Sc., B.A., M.Sc.) in Biochemistry, Biological Sciences, Chemistry, Computer Science, Environmental Science, Mathematics, and Physics and Astronomy.

Students enrolled in the experimental science classes receive extensive laboratory experience. Laboratories are well equipped and laboratory courses are instructed by the regular faculty. Each department has its own computer facilities and dedicated study rooms. Laboratories and classes tend to be small (often fewer than 20 students) and students are able to obtain essential feedback from Professors. The Division also offers students free help in learning mathematics/statistics, physics and computer science through Help Centres staffed with upper year students and/or professional tutors, under the supervision of Faculty members. The Bishop's University Astronomical Observatory is also available for graduate and undergraduate research as well as for public viewing.

Graduates from the Division pursue careers in many diverse fields. In recent years these careers have included, but are not limited to: medicine, veterinary medicine, dentistry, biomedical research, engineering, actuarial science, statistics, software engineering, pharmacology, physiotherapy, secondary and primary school science teaching and the chemical industry.

Degrees and Programs

Detailed descriptions of the degrees and programs offered are found under the respective Departmental sections of this calendar. The Division of Natural Sciences and Mathematics offers selected Masters of Science (M.Sc.) degrees and a wide range of programs leading to the Bachelor of Science (B.Sc.) or Bachelor of Arts (B.A) degrees with Honours or Majors specialization. In addition, several departments offer Minor programs that can be added to one's Honours/Major program, and Computer Science offers a certificate program. Please see the complete list of programs in Table I below.

Divisional Major

The Division offers an entry level program for a limited number of students, allowing them to register as Divisional Majors (rather than into a specific program) for a maximum of two semesters. After two semesters of full-time study are completed, students must enrol into a specific program (Major). Students who are not accepted into one of the regular programs must consult with the Dean of Arts and Science to determine an academic plan.

Length of Degrees and Collegial Equivalent Science Courses

All students admitted into their first Bachelor's degree come into a 4-year, 120-credit program. Students having a Québec collegial diploma (DEC), as well as Mature students (please consult the Admission section of the calendar for the definition of Mature status), will be granted up to one year of advanced credits (30 credits) if they have completed all the collegial courses that are equivalent to the introductory science courses which must be taken as part of the various science programs. CEGEP/Bishop's course equivalencies are listed below; Bishop's collegial-equivalent science courses that must be completed in each of our science programs are listed in Table II. Note that the labs that are associated with many of these courses (e.g. the course BIO 196 has an associated lab named BIL 196), must be taken concurrently.

Cellular/Molecular Biology	BIO 196
General Chemistry	CHM 191
Solutions Chemistry	CHM 192
Differential Calculus	MAT 191 or MAT 198
Integral Calculus	MAT 192 or MAT 199
Mechanics	PHY 191 or PHY 193
Electricity and Magnetism	PHY 192 or PHY 194

Arts and Science Requirement

In addition to the courses listed in Table II, in order to encourage students enrolled in the Division of Natural Sciences & Mathematics to broaden the scope of their education, all majors and honours are required to complete at least three credits in either the Division of Humanities or the Division of Social Sciences. While this requirement will not in itself ensure against excessive specialization, it is hoped that it will lead students to find and pursue various areas of interest. Students with program combinations which require more than 72 credits are exempt from this requirement.

Advanced Placement

The Division of Natural Sciences and Mathematics grants credit for successful completion of AP examinations in the Sciences as follows. Note that a minimum score of 4 is required. When applicable, credit will also be granted for the lab that is associated with the course (e.g. the course BIO 196 and associated lab BIL 196).

Biology	BIO 196
Chemistry	CHM 191 and CHM 192
Computer Science AB	CS 311
Mathematics BC	MAT 191 and MAT 192
Physics C-Mechanics	PHY 191 (or PHY 193)
Physics C-Electricity	PHY 192 (or PHY 194)

Table I: Programs Offered

Department/Program	Concentration	Degree type	Specialization Level
Biochemistry		B.Sc.	Honours, Major, Minor
Biological Sciences	Health Science	B.Sc., B.A	Honours, Major
	Biodiversity and Ecology	B.Sc., B.A	Honours, Major
	Biology		Minor
Chemistry		B.Sc.	Honours, Major, Minor
Computer Science		M.Sc.	
		B.Sc.	Honours, Major, Minor
		Certificate	
	Information Technology	B.A.	Major
Environmental Science (part of Environment and Geography)	Physics	B.Sc.	Major
	Chemistry	B.Sc.	Major
	Environmental Science		Minor
Mathematics		B.Sc., B.A	Honours, Major, Minor
	Mathematics Education	B.Sc., B.A	Double Major*
	Matematicas en Español	B.Sc., B.A	Honours, Major
	Mathematical Contexts		Minor
Physics		M.Sc.	
		B.Sc.	Honours, Major, Minor
Science Teaching	Biology	B.Sc.	Double Major*
	Chemistry	B.Sc.	Double Major*
	Physics	B.Sc.	Double Major*

*The Division of Natural Sciences and Mathematics, in cooperation with the School of Education, offers students in these programs the opportunity to prepare for professional careers as Secondary School science and mathematics educators. Students must also be registered Education majors in the **School of Education**. The specific required course lists and program regulations for these double Major programs are found in the School of Education section of this Calendar. All questions concerning application to the School and course requirements should be referred to the Dean of the School of Education.

Table II: Collegial-equivalent courses

Department/Program	Life Science	Chemistry	Mathematics	Physics	Humanities*
Biochemistry	BIO 196	CHM 191	MAT 198	PHY 191 or PHY 193	ENG 116 + 1**
		CHM 192	MAT 199	PHY 192 or PHY 194	
Biological Sciences B.Sc.	BIO 196	CHM 191	MAT 198	PHY 191 or BIO 197	ENG 116 + 1**
		CHM 192	MAT 199	PHY 192 or PHY 194	
Biological Sciences B.A.	BIO 196				ENG 116 + 1**
	BIO 197				
Chemistry		CHM 191	MAT 198	PHY 191	ENG 116 + 1**
		CHM 192	MAT 199	PHY 192	
Computer Science B.Sc.			MAT 191	PHY 191	ENG 116 + 1**
			MAT 192	PHY 192	
Information Technology B.A.			MAT 196		ENG 116 + 1**
			MAT 197		
Environmental Science	BIO 196	CHM 191	MAT 191	PHY 191	ENG 116 + 1**
		CHM 192	MAT 192	PHY 192	
Mathematics B.Sc.			MAT 191	PHY 191	ENG 116 + 1**
			MAT 192	PHY 192	
Mathematics B.A.			MAT 191		ENG 116 + 1**
			MAT 192		
Physics		CHM 191	MAT 191	PHY 191	ENG 116 + 1**
		CHM 192	MAT 192	PHY 192	
Science Teaching	BIO 196	CHM 191	MAT 191 or MAT 198	PHY 191 or PHY 193	ENG 116 + 1**
		CHM 192	MAT 192 or MAT 199	PHY 192 or PHY 194	

* Any CEGEP DEC fulfils the Humanities requirement

** ENG 116 (Effective Writing) can be replaced by another English course (coded 'ENG'). The second humanities course can be selected from the 100- or 200-level courses in the following disciplines: Classical Studies (CLA), English (ENG), History (HIS), Liberal Arts (LIB), Philosophy (PHI) and Religion (REL)

Transfers from other Universities and Colleges

Students entering a program in the Division of Natural Sciences and Mathematics from another Canadian University or College, or from accredited international post-secondary institutions, will have their transcripts of grades examined individually for possible transfer credit against a Bishop's program's requirements. Please consult the Admission section of this Calendar or the Admissions Office, admissions@ubishops.ca for details.

Transfers from other programs at Bishop's University

Bishop's students wishing to transfer into a program offered by the Division of Natural Sciences and Mathematics normally require a cumulative average of 65% on all courses attempted at Bishop's. Students whose average is below 65% may still register in courses offered in the Division, subject to the normal regulations regarding course registration in the University. Program transfers are not normally permitted in a student's first semester of studies at Bishop's University.

Graduation "with Distinction"

The notation "with Distinction" will appear on the transcript of students who graduate with a cumulative average of 80% or more. It is only available for first degree students.

Biochemistry

Faculty

Elizabeth Prusak,

M.Sc. Eng. (Tech. Univ., Poland);
Ph.D. (Polish Academy of Science);
Professor
Chair of the Department

Virginia L. Stroher,

B.Sc. (Montana State), Ph.D.
(University of Washington); Professor

Program Overview

The Biochemistry program at Bishop's is coordinated through an interdisciplinary committee of chemists, biochemists and biologists, providing students with a strong background in chemistry, biochemistry and biology necessary for membership in the Chemical Institute of Canada and accreditation by *l'Ordre des chimistes du Québec*.

The Biochemistry program offers both an Honours degree, which rigorously prepares students for graduate studies or professional schools, and a Major degree, which provides students more flexibility in their program. The program places strong emphasis on mastering the fundamentals of experimental biochemistry, and provides students with well-equipped laboratory facilities, first-hand experience with modern laboratory

equipment, and close instructional contact with professors. As well, the Agriculture Canada Research Station in Lennoxville and the Université de Sherbrooke, with its associated medical research hospital, are easily accessible to students and provide additional opportunities and exposure for interested Honours students.

Programs

Biochemistry Honours (99 credits)

HONBCH

Students are not admitted to the Honours Biochemistry program until the end of their Y3 year.

To be eligible to enter the Honours Biochemistry program, a student must normally achieve:

- a minimum cumulative average of 75% by the end of the Y3 year, and
- at least 75% in each 300-level and 400-level course required in the program.

To complete the Honours Biochemistry program, a student must;

- maintain a minimum cumulative average of 75% and
- achieve at least 75% in each 300-level and 400-level course required in the program with a maximum permitted exemption of four credits and
- achieve at least 75% in each of BCH 491 and BCH 492.

The Honours Biochemistry program includes a three credit scientific writing course and a six-credit honours research project that will be evaluated by faculty from, or recognized by, the Biochemistry Program Committee. The scientific results of the honours research project must be presented in public, either through an oral seminar or poster presentation, and the scientific results submitted in a written thesis.

The Biochemistry Honours program is a four-year program that requires 40 three-credit courses, or their equivalent, for a total of 120 course credits, plus associated laboratory courses. The 120 course credits are divided as follows: 78 core required course credits, 21 required optional course credits, 18 free elective credits and 3 humanities or social sciences elective credits.

Core Required Courses (78 course credits)**Y1 Year**

BIO 196 / BIL 196 (Intro Cellular and Molecular Biology)
CHM 191 / CHL 191 (General Chemistry I)
PHY 193 / PHL 193 (General Physics I for Life Science)
MAT 198 (Calculus I for Life Science)
ENG 116 (Effective Writing)

CHM 192 / CHL 192 (General Chemistry II)
PHY 194 / PHL 194 (General Physics II for Life Science)
MAT 199 (Calculus II for Life Science)
OPT
OPT

Y2 Year

BIO 201 (Cellular and Molecular Biology)
CHM 131 / CHL 131 (Physical Chemistry I)
CHM 141 / CHL 141 (Analytical Chemistry)
CHM 111 / CHL 111 (Organic Chemistry I)
PHY 101 (Statistical Methods)

BIO 208 / BIL 208 (Genetics)
BCH 210 (General Biochemistry)
CHM 245 / CHL 245 (Instrumental Analysis)
CHM 211 / CHL 211 (Organic Chemistry II)
OPT

Y3 Year

BIO 336 / BIL 336 (Animal Physiology I)
BCH 311 (Proteins)
CHM 341 / CHL 341 (Molecular Spectroscopy)
OPT
OPT

BCH 312 (Lipids & Biomembranes)
BCH 313 / BCL 313 (Metabolism)
OPT
OPT
OPT

Y4 Year

BCH 411 (Molecular Biology)
BIO 386 (Scientific Writing)
BCH 491 (Honours Research Project I)
OPT
OPT

BCH 492 (Honours Research Project II)
OPT
OPT
OPT
OPT

Required Optional Courses (21 course credits from the list)

BCH 381 (Immunology)
BCH 382 (Environmental Biochemistry and Toxicology)
BCH 421 (Enzymology)
BCH 422 / BCL 422 (Biotechnology)
BIO 310 (Advanced Cell Biology)
BIO 320 (Programmed Cell Death)
BIO 337 / BIL 337 (Animal Physiology II)
BIO 352 / BIL 352 (Microbiology)
BIO 359 (Human Genetics)
BIO 365 (Developmental Biology)
BIO 394 (Biology of Cancer)
CHM 231 / CHL 231 (Physical Chemistry II)
CHM 311 / CHL 311 (Physical Chemistry III)
PBI 380 (Psychopharmacology)

Free Electives (18 course credits)**Humanities or Social Sciences Elective (3 course credits)**

Biochemistry Major (90 credits)

MAJBCH

The Biochemistry Major program is a four-year program that requires 40 three-credit courses, or their equivalent, for a total of 120 course credits, plus associated laboratory courses, the number of lab courses required depending on the specialization selected. The 120 course credits are divided as follows: 69 core required course credits, 21 required optional course credits, 27 free elective credits and 3 humanities or social sciences elective credits.

Core Required Courses (69 course credits):

Y1 Year

BIO 196 / BIL 196 (Intro Cellular and Molecular Biology)	CHM 192 / CHL 192 (General Chemistry II)
CHM 191 / CHL 191 (General Chemistry I)	PHY 194 / PHL 194 (General Physics II for Life Science)
PHY 193 / PHL 193 (General Physics I for Life Science)	MAT 199 (Calculus II for Life Science)
MAT 198 (Calculus I for Life Science)	OPT
ENG 116 (Effective Writing)	OPT

Y2 Year

BIO 201 (Cellular and Molecular Biology)	BIO 208 / BIL 208 (Genetics)
CHM 131 / CHL 131 (Physical Chemistry I)	BCH 210 (General Biochemistry)
CHM 141 / CHL 141 (Analytical Chemistry)	CHM 245 / CHL 245 (Instrumental Analysis)
CHM 111 / CHL 111 (Organic Chemistry I)	CHM 211 / CHL 211 (Organic Chemistry II)
PHY 101 (Statistical Methods)	OPT

Y3 Year

BIO 336 / BIL 336 (Animal Physiology I)	BCH 312 (Lipids & Biomembranes)
BCH 311 (Proteins)	BCH 313 / BCL 313 (Metabolism)
CHM 341 / CHL 341 (Molecular Spectroscopy)	OPT
OPT	OPT
OPT	OPT

Y4 Year

BCH 411 (Molecular Biology)	OPT
OPT	OPT
OPT	OPT
OPT	OPT

Required Optional Courses (21 course credits from the list)

BCH 381 (Immunology)
 BCH 382 (Environmental Biochemistry and Toxicology)
 BCH 421 (Enzymology)
 BCH 422 / BCL 422 (Biotechnology)
 BIO 310 (Advanced Cell Biology)
 BIO 320 (Programmed Cell Death)
 BIO 337 / BIL 337 (Animal Physiology II)
 BIO 352 / BIL 352 (Microbiology)
 BIO 359 (Human Genetics)
 BIO 365 (Developmental Biology)
 BIO 394 (Biology of Cancer)
 CHM 231 / CHL 231 (Physical Chemistry II)
 CHM 311 / CHL 311 (Physical Chemistry III)
 PBI 380 (Psychopharmacology)

Free Electives (27 course credits)

Humanities or Social Sciences Elective (3 course credits)

Biochemistry Minor (24 credits) MINBCH

The program requires 8 three-credit one-semester courses, or their equivalent, for a total of 24 course credits, plus credits for associated laboratory courses.

Required Courses: (15 course credits)

BCH 311 (Proteins)
 BCH 312 (Lipids & Biomembranes)
 BIO 208 / BIL 208 (Genetics)
 BIO 336 / BIL 336 (Animal Physiology I)
 CHM 141 / CHL 141 (Analytical Chemistry)

Required Optional Courses

(9 course credits from list):

BCH 313 / BCL 313 (Metabolism)
 BCH 381 (Immunology)
 BCH 411 (Molecular Biology)
 BCH 421 (Enzymology)
 BIO 310 (Advanced Cell Biology)
 BIO 320 (Programmed Cell Death)
 BIO 337 / BIL 337 (Animal Physiology II)
 BIO 352 / BIL 352 (Microbiology)
 BIO 394 (Biology of Cancer)
 CHM 131 / CHL 131 (Physical Chemistry I)
 CHM 211 / CHL 211 (Organic Chemistry II)

List of Courses

- BCH 101 Introduction to Nutrition 3-3-0**
 This course is designed for students from any discipline (except Biochemistry, Biology and Chemistry). It will provide an introduction to basic concepts of nutrition and ways that good nutrition can be integrated into a healthy life style. Principles of digestion and absorption, the function of nutrients, disease prevention, diet modification and weight control will be discussed.
Prerequisites: None. However, secondary school Biology is strongly recommended.
Note: This course may not be taken for credit by students in Biology, Biochemistry or Chemistry programs.
- BCH 210 General Biochemistry 3-1-0**
 An introduction to the structure and function of biomolecules with the emphasis on the central phenomena behind the behavior of biomolecules in the cellular environment.
Prerequisites: CHE 111 and BIO 201
- BCH 311 Proteins 3-3-0**
 Protein structure and function, including protein purification, structure analysis, protein synthesis, distribution and degradation, as well as molecular visualization of protein structure.
Prerequisite: Chemistry 111 and BCH 210
- BCH 312 Lipids and Biomembranes 3-3-0**
 Biomembranes structure and function, including study of cell membrane structure, and transport, trans-membrane signaling, hormones and secondary messengers.
Prerequisite: BCH 311
- BCH 313 Metabolism 3-3-0**
 Introduction to the basic metabolic pathways of living cells. These include the central metabolic pathways associated with cellular energy generation, carbohydrate degradation and synthesis, fatty acid degradation and synthesis, lipid metabolism and nitrogen metabolism. Emphasis will be placed on the role and regulation of enzymes associated with these pathways.
Prerequisite: Chemistry 111 or BIO 155, and BIO 336
Co-requisite: BCL 313
- BCL 313 Metabolism Laboratory 1-0-3**
 This course introduces the student to research approaches in metabolic enzymology and the study of enzyme kinetics. Environmental factors influencing enzyme activity as well as the effects of different inhibitory molecules will be examined. As well, protein isolation and analysis will be covered.
Co-requisite: BCH 313
- BCH 371 Independent Studies in Biochemistry I 3-1-3**
 This course is not regularly offered and is only meant for final-year students who wish to pursue in-depth study of a particular area of biochemistry or who have a special need for a biochemistry course that would otherwise not be available during their final year of course work. This course can only be done in close collaboration with a faculty advisor from within the Biochemistry program, and may not be used as a supplement to a student's honours project. Requirements for this course will be agreed upon by a committee of professors from within the Biochemistry Program.
Prerequisite: Permission of the Biochemistry Committee
- BCH 372 Independent Studies in Biochemistry II 3-1-3**
 This course represents an additional semester of independent work, either a continuation of or a separate course from BCH 371, meant for final-year students who wish to pursue in-depth study of a particular area of biochemistry or who have a special need for a biochemistry course that would otherwise not be available during their final semester of course work. This course can only be done in close collaboration with a faculty advisor from within the Biochemistry Program, and may not be used as a supplement to a student's honours project. Requirements for this course will be agreed upon by a committee of professors from within the Biochemistry Program.
Prerequisite: Permission of the Biochemistry Committee

BCH 381 Immunology 3-3-0

A comprehensive study of the fundamental principles of immunobiology. Intercellular recognition and self/non-self discrimination. Clonal selection theory and genetic basis of antibody diversity. Biochemistry of immunoglobulins. Regulation of immune response and tolerance.

Prerequisites: BIO 201 and BIO 208

BCH 382 Environmental Biochemistry and Toxicology 3-3-0

This course will examine the biochemical effects of environmental stresses on organisms, and adaptations that allow organisms to face these stresses. Emphasis is placed on biochemical responses to toxic compounds such as aromatics, halogenated aliphatics, drugs, and heavy metals. Other topics will include adaptations to stresses such as temperature extremes, pathogens, and ionizing radiation. Applications to related biotechnological processes may also be considered.

Prerequisite: BIO 201 and BIO 208

BCH 411 Molecular Biology 3-3-0

The molecular biology of nucleic acids and proteins, including DNA replication, mutation, and recombination; RNA transcription; and protein synthesis. Also covered will be protein/nucleic acid interactions and regulation of gene expression.

Prerequisite: BIO 201, BIO 208

BCH 421 Enzymology 3-3-0

Kinetics of enzyme reactions and mechanism of catalysis. Regulation by allosteric effectors and covalent modification. Protein targeting and degradation.

Prerequisites: BCH 311, BCH 312 and BCH 313

BCH 422 Biotechnology 3-3-0

This course will explore the technical approaches used in current research and biotechnology, emphasizing the applications of molecular strategies and processes studied in BCH 383. Both the theoretical and practical aspects of these molecular approaches will be discussed, as well as how these techniques are utilized and how they have changed modern research and medicine.

This course will be offered every second year.

Prerequisite: BCH 383 (may be taken concurrently)

Corequisite: BCL 422

BCL 422 Biotechnology Laboratory 1-0-3

Practical application of several of the techniques introduced in BCH 422.

Prerequisite: BCH 383 (may be taken concurrently)

Corequisite: BCH 422

BCH 491 Honours Research Project I 3-1-6

An introduction to the planning, execution and reporting of biological research offered to students matching eligibility criteria. Each student is required to choose a research problem and, in consultation with a departmentally approved supervisor, draw up a formal research proposal of work to be undertaken. The final mark in this course will be based on the research proposal, preliminary research completed on the stated project, and presentation of a poster during the final week of classes. Satisfactory completion of BCH 491 with a minimum overall mark of 75% with a minimal score of 70% in each graded component, is required for enrolment in BCH 492.

Prerequisite: Permission of Biochemistry Committee

Co-requisite or prerequisite: BIO 386

BCH 492 Honours Research Project II 3-1-12

A continuation of BCH 491 offered to students matching eligibility criteria. The student will complete all research as outlined in the research proposal. The final mark in this course will be based on the quality and amount of research completed, presentation of a departmental seminar during the final week of classes, open to the public, based on research findings, and submission of a final written honours thesis. Enrolment in BCH 492 is conditional upon completing BCH 491 with a minimum mark of 75%. Satisfactory completion of BIO 492 with a minimum overall mark of 75%, with a minimal score of 70% in each graded component, is required to complete the Honours program

Prerequisite: BCH 491