

BIOLOGICAL AND PHARMACEUTICAL CHEMISTRY (BPCH)

Department of Chemistry, College of Engineering and Physical Sciences

The Biological and Pharmaceutical Chemistry program combines the worlds of chemistry and biology in an interdisciplinary fashion using the powerful tools of chemistry to unravel the mysteries of biology. Through hands-on laboratory training, you will master synthetic and analytical techniques and explore pharmaceutical analysis, product formulations and research options. BPCH prepares you for a variety of career and research outcomes after your undergraduate degree. You can learn more about the Department of Chemistry on the Department's website (<https://www.uoguelph.ca/chemistry/>). If you need help with planning your courses, please contact your faculty advisor (<https://www.uoguelph.ca/uaic/facultyadvisors-bsc/>) or program counsellor (<https://bsc.uoguelph.ca/advisors/>).

Biological and Pharmaceutical Chemistry Program Learning Outcomes

- Critically evaluate ideas and arguments by gathering and integrating relevant information, assessing its credibility, and synthesizing evidence to formulate a hypothesis, and/or apply an appropriate model, or theory.
- Identify problems and propose solutions individually or as part of a group using creative approaches, acquired through interdisciplinary experiences, and a depth and breadth of knowledge/expertise.
- Accurately interpret and use numerical information or scientific reasoning to evaluate and formulate a hypothesis, model, or theory.
- Accurately and effectively communicate scientific ideas, arguments, and analyses, to a range of audiences, in graphical, oral and written form.
- Demonstrate clear and accurate scientific writing in literature reviews, laboratory reports, or term projects.
- Demonstrate personal and professional integrity by respectfully considering diverse points of view and the intellectual contribution of others, and by demonstrating a commitment to honesty and equity, in scientific practice and society at large.
- Collaborate effectively as part of a team by demonstrating mutual respect, leadership, and an ability to set goals and manage tasks and timelines.
- Plan for professional growth and personal development within and beyond the undergraduate program.
- Demonstrate the ability to examine and interpret intellectual property and/or liability issues pertinent to the range of chemical, pharmaceutical and biochemical industries.
- Demonstrate proper upkeep of laboratory notebooks and lab reports with accurate descriptions of steps carried out in laboratory settings and correct numerical values.
- Apply scientific methods and processes by formulating questions, designing investigations and collecting and processing data to draw conclusions and make scientifically based decisions.
- Generate and interpret scientific data using quantitative, qualitative, and analytical methodologies and techniques.

- Gather, critically assess, and utilize primary scientific literature, digital tools and databases to research a topic.
- Evaluate the limitations of and troubleshoot experimental approaches.
- Design and implement an experiment from start to finish that incorporates analytical, synthetic and/or biochemical techniques to solve a problem being presented.
- Apply the core concepts of mathematics, statistics, physics, chemistry, and biology to the chemistry discipline.
- Demonstrate knowledge of the environmental, ethical, economic, commercial, health and social implications of scientific discovery and/or technological innovation.
- Interpret current scientific concepts and gaps in knowledge (and methods) in the chemistry discipline.
- Demonstrate advanced, contemporary, and relevant knowledge in pharmaceutical chemistry and biochemistry.
- Apply contemporary research methods, skills, and techniques to conduct independent inquiry in chemistry.
- Work safely and effectively in the laboratory to generate reproducible and reliable results.
- Conduct research effectively and reliably with relevant, modern analytical, synthetic, and biochemical instrumentation and techniques.
- Understand and safely navigate hazards including biohazards associated with chemicals and equipment when working in a laboratory setting, including critical assessment of chemical accidents in industry and academia.

Major Requirements (Honours)

This is a major within the degree: Bachelor of Science.

Students may enter this major in Semester 1 or any semester thereafter. A student wishing to declare the major may wish to consult the Faculty Advisor or Program Counsellor.

Credit Summary

This major will require the completion of 20.00 total credits as indicated below:

Code	Title	Credits
	First year science credits	4.00
	Required science courses semesters 3 – 8	6.00
	Option A or Option B	2.00 - 2.50
	Restricted electives (1, 2 and 3 in restricted electives list)	3.00 - 3.50
	Approved Science electives	0.50
	Liberal Education electives	1.00
	Free electives - any approved elective for B.Sc. students	3.00
	Total Credits	20.00

Of the total credits required, students are required to complete 16.00 credits in science of which 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at https://www.uoguelph.ca/bsc/revised_SS/.

Recommended Program Sequence

Code	Title	Credits
Semester 1		
BIOL*1090	Introduction to Molecular and Cellular Biology	0.50
CHEM*1040	General Chemistry I	0.50
MATH*1200	Calculus I	0.50
PHYS*1500	Introductory Mechanics	0.50
0.50 Liberal Education electives		0.50
Semester 2		
BIOL*1070 or BIOL*1080	Discovering Biodiversity Biological Concepts of Health	0.50
CHEM*1050	General Chemistry II	0.50
MATH*1210	Calculus II	0.50
PHYS*1510	Introductory Electricity & Magnetism	0.50
0.50 Liberal Education electives		0.50
Semester 3		
CHEM*2060	Structure and Bonding	0.50
CHEM*2700	Organic Chemistry I: Fundamentals	0.50
CHEM*2820 or CHEM*2880	Thermodynamics and Kinetics Physical Chemistry	0.50
STAT*2040	Statistics I	0.50
0.50 electives or restricted electives		0.50
Semester 4		
BIOC*2580	Introduction to Biochemistry	0.50
CHEM*2070	Structure and Spectroscopy	0.50
CHEM*2400	Analytical Chemistry I: Chemical Analysis	0.75
MICR*2420	Introduction to Microbiology	0.50
Electives or restricted electives to a maximum of 2.75 total credits in this semester		
Option A		
Code	Title	Credits
Semester 5		
CHEM*3430	Analytical Chemistry II: Instrumental Analysis	0.50
CHEM*3640	Main Group Chemistry	0.50
CHEM*3750	Organic Chemistry II: Structure and Synthesis	0.50
1.00 electives or restricted electives		1.00
Semester 6		
BIOC*3560	Structure and Function in Biochemistry	0.50
CHEM*3650	Transition Metal Chemistry	0.50
CHEM*4020	Chemical Discovery	0.50
1.00 electives or restricted electives		1.00
Semester 7		
BIOC*3570	Analytical Biochemistry	0.75
Electives or restricted electives to a maximum of 2.75 total credits in this semester		
Semester 8		
2.50 electives or restricted electives		2.50

Restricted Electives (Option A)

Code	Title	Credits
1. Select 1.00 credits from the following:		
MBG*2040	Foundations in Molecular Biology and Genetics	0.50
MCB*2050	Molecular Biology of the Cell	0.50
MICR*2430	Methods in Microbial Culture and Physiology	0.50
TOX*2000	Principles of Toxicology	0.50
2. Select 0.50 credits from the following:		
CHEM*4720	Organic Reactivity	0.50
CHEM*4730	Advanced Organic Synthesis	0.50
CHEM*4740	Bioorganic Chemistry	0.50
3. Select a minimum of 0.50 credits at the 3000/4000 level and an additional 1.00 credits at the 4000 level from the following:		
BIOC*4050	Protein and Nucleic Acid Structure	0.50
BIOC*4520	Metabolic Processes	0.50
BIOC*4540	Enzymology	0.75
BIOC*4580	Membrane Biochemistry	0.50
BIOM*3090	Principles of Pharmacology	0.50
BIOM*3200	Biomedical Physiology	1.00
BIOM*4090	Pharmacology	0.50
CHEM*3360	Environmental Chemistry and Toxicology	0.50
CHEM*3440	Chemical Instrumentation	0.50
CHEM*4010	Chemical Industry, Safety and Sustainability	0.50
CHEM*4400	Electrochemistry and Sensors	0.50
CHEM*4630	Bioinorganic Chemistry	0.50
CHEM*4720	Organic Reactivity	0.50
CHEM*4730	Advanced Organic Synthesis	0.50
CHEM*4740	Bioorganic Chemistry	0.50
CHEM*4900	Chemistry Research Project I	1.00
CHEM*4910	Chemistry Research Project II	1.00
MBG*3040	Molecular Biology of the Gene	0.50
MBG*3350	Laboratory Methods in Molecular Biology	0.75
MICR*3230	Immunology	0.50
TOX*4590	Biochemical Toxicology	0.50

Note: Some courses have prerequisites not on the required course list, and some are offered in alternate years. Students must plan ahead, with the assistance of the faculty advisor or program counsellor.

Option B

Code	Title	Credits
Semester 5		
CHEM*3430	Analytical Chemistry II: Instrumental Analysis	0.50
CHEM*3750	Organic Chemistry II: Structure and Synthesis	0.50
1.50 credits electives or restricted electives		1.50
Semester 6 ¹		
2.50 credits from:		
XSEN*3030	Pharmacology and Applied Toxicology	0.50
XSEN*3040	Occupational Health and Chemistry	0.50

XSEN*3060	Pharmaceutical Analysis - Advanced	0.50
XSEN*3070	Pharmaceutical Product Formulations	0.50
XSEN*3090	Biopharmaceuticals	0.50
XSEN*3200	Pharmaceutical Organic Chemistry	0.50
XSEN*3210	Introduction to Pharmaceutical Manufacturing	0.50

Semester 7

BIOC*3570	Analytical Biochemistry	0.75
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Electives or restricted electives to a maximum of 2.75 total credits in this semester

Semester 8

2.50 credits electives or restricted electives	2.50
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¹ All XSEN courses are taught at the Seneca@York campus of Seneca College in Toronto.

Restricted Electives (Option B)

Code	Title	Credits
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1. Select 1.00 credits from the following:

MBG*2040	Foundations in Molecular Biology and Genetics	0.50
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MCB*2050	Molecular Biology of the Cell	0.50
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MICR*2430	Methods in Microbial Culture and Physiology	0.50
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TOX*2000	Principles of Toxicology	0.50
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2. Select 0.50 credits from the following:

CHEM*4720	Organic Reactivity	0.50
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CHEM*4730	Advanced Organic Synthesis	0.50
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CHEM*4740	Bioorganic Chemistry	0.50
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3. Select a minimum of 1.50 credits at the 4000 level from the following:

BIOC*4050	Protein and Nucleic Acid Structure	0.50
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BIOC*4520	Metabolic Processes	0.50
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BIOC*4540	Enzymology	0.75
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BIOC*4580	Membrane Biochemistry	0.50
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BIOM*4090	Pharmacology	0.50
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CHEM*4010	Chemical Industry, Safety and Sustainability	0.50
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CHEM*4020	Chemical Discovery	0.50
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CHEM*4400	Electrochemistry and Sensors	0.50
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CHEM*4630	Bioinorganic Chemistry	0.50
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CHEM*4720	Organic Reactivity	0.50
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CHEM*4730	Advanced Organic Synthesis	0.50
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CHEM*4740	Bioorganic Chemistry	0.50
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CHEM*4900	Chemistry Research Project I	1.00
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CHEM*4910	Chemistry Research Project II	1.00
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TOX*4590	Biochemical Toxicology	0.50
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Note: Some courses have prerequisites not on the required course list, and some are offered in alternate years. Students must plan ahead, with the assistance of the faculty advisor or program counsellor.

Co-op Requirements (Honours)

This is a major within the degree: Bachelor of Science.

The Co-op program in Biological and Pharmaceutical Chemistry is a four and a half year program, including four work terms. Students must follow the academic work schedule as outlined below (also found on the Co-operative Education website: <https://www.recruitguelph.ca/cecs/>).

Academic and Co-op Work Term Schedule

Year	Fall	Winter	Summer
1	Academic Semester 1	Academic Semester 2 COOP*1100	Off
2	Academic Semester 3	COOP*1000 Work Term I	Academic Semester 4
3	Academic Semester 5	Academic Semester 6	COOP*2000 Work Term II
4	COOP*3000 Work Term III	Academic Semester 7	COOP*4000 Work Term IV
5	Academic Semester 8	N/A	N/A

Please refer to the Co-operative Education program policy with respect to work term performance grading, work term report grading and program completion requirements.

For additional program information students should consult with their Co-op Co-ordinator and Co-op Faculty Advisor, listed on the Co-operative Education web site.

Credit Summary

(22.00 Total Credits)

Code	Title	Credits
	First year science credits	4.00
	Required science courses semesters 3 – 8	6.00
	Option A or Option B	2.00 - 2.50
	Restricted electives (1, 2 and 3 in restricted electives list)	3.00 - 3.50
	Approved Science electives	0.50
	Liberal Education electives	1.00
	Free electives - any approved elective for B.Sc. students	3.00
	Co-op Work Terms	2.00
	Total Credits	22.00

Of the total credits required, students are required to complete 16.00 credits in science of which a minimum of 2.00 credits must be at the 4000 level and an additional 4.00 credits must be at the 3000 or 4000 level.

Recommended Program Sequence

Students lacking Grade 12 or 4U Biology, Chemistry or Physics should follow the revised schedule of study for this major found at https://www.uoguelph.ca/bsc/revised_SS/.

Code	Title	Credits
Semester 1 - Fall		
BIOL*1090	Introduction to Molecular and Cellular Biology	0.50
CHEM*1040	General Chemistry I	0.50
MATH*1200	Calculus I	0.50

PHYS*1500	Introductory Mechanics	0.50
0.50 Liberal Education electives		0.50

Semester 2 - Winter

BIOL*1070	Discovering Biodiversity	0.50
or BIOL*1080	Biological Concepts of Health	
CHEM*1050	General Chemistry II	0.50
COOP*1100	Introduction to Co-operative Education	0.00
MATH*1210	Calculus II	0.50
PHYS*1510	Introductory Electricity & Magnetism	0.50
0.50 Liberal Education electives		0.50

Semester 3 - Fall

CHEM*2060	Structure and Bonding	0.50
CHEM*2400	Analytical Chemistry I: Chemical Analysis	0.75
CHEM*2700	Organic Chemistry I: Fundamentals	0.50
STAT*2040	Statistics I	0.50

Electives or restricted electives to a maximum of 2.75 total credits in this semester

Winter Semester

COOP*1000	Co-op Work Term I	0.50
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Semester 4 - Summer

BIOC*2580	Introduction to Biochemistry	0.50
CHEM*2070	Structure and Spectroscopy	0.50
CHEM*3430	Analytical Chemistry II: Instrumental Analysis	0.50
MICR*2420	Introduction to Microbiology	0.50
0.50 electives or restricted electives		0.50

Option A

Code	Title	Credits
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Semester 5 - Fall

BIOC*3570	Analytical Biochemistry	0.75
CHEM*2820	Thermodynamics and Kinetics	0.50
or CHEM*2880	Physical Chemistry	
CHEM*3640	Main Group Chemistry	0.50
CHEM*3750	Organic Chemistry II: Structure and Synthesis	0.50

Electives or restricted electives to a maximum of 2.75 total credits in this semester

Semester 6 - Winter

BIOC*3560	Structure and Function in Biochemistry	0.50
CHEM*3650	Transition Metal Chemistry	0.50
CHEM*4020	Chemical Discovery	0.50
1.00 electives or restricted electives		1.00

Summer Semester

COOP*2000	Co-op Work Term II	0.50
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Fall Semester

COOP*3000	Co-op Work Term III	0.50
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Semester 7 - Winter

CHEM*4020	Chemical Discovery	0.50
2.00 electives or restricted electives		2.00

Summer Semester

COOP*4000	Co-op Work Term IV	0.50
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Semester 8 - Fall

2.50 electives or restricted electives	2.50
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Restricted Electives (Option A)

Code	Title	Credits
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1. Select 1.00 credits from the following:

MBG*2040	Foundations in Molecular Biology and Genetics	0.50
MCB*2050	Molecular Biology of the Cell	0.50
MICR*2430	Methods in Microbial Culture and Physiology	0.50
TOX*2000	Principles of Toxicology	0.50

2. Select 0.50 credits from the following:

CHEM*4720	Organic Reactivity	0.50
CHEM*4730	Advanced Organic Synthesis	0.50
CHEM*4740	Bioorganic Chemistry	0.50

3. Select a minimum of 0.50 credits at the 3000/4000 level and an additional 1.00 credits at the 4000 level from the following:

BIOC*4050	Protein and Nucleic Acid Structure	0.50
BIOC*4520	Metabolic Processes	0.50
BIOC*4540	Enzymology	0.75
BIOC*4580	Membrane Biochemistry	0.50
BIOM*3090	Principles of Pharmacology	0.50
BIOM*3200	Biomedical Physiology	1.00
BIOM*4090	Pharmacology	0.50
CHEM*3360	Environmental Chemistry and Toxicology	0.50
CHEM*3440	Chemical Instrumentation	0.50
CHEM*4010	Chemical Industry, Safety and Sustainability	0.50
CHEM*4400	Electrochemistry and Sensors	0.50
CHEM*4630	Bioinorganic Chemistry	0.50
CHEM*4720	Organic Reactivity	0.50
CHEM*4730	Advanced Organic Synthesis	0.50
CHEM*4740	Bioorganic Chemistry	0.50
CHEM*4900	Chemistry Research Project I	1.00
CHEM*4910	Chemistry Research Project II	1.00
MBG*3040	Molecular Biology of the Gene	0.50
MBG*3350	Laboratory Methods in Molecular Biology	0.75
MICR*3230	Immunology	0.50
NUTR*3210	Fundamentals of Nutrition	0.50
PATH*3610	Principles of Disease	0.50
TOX*4590	Biochemical Toxicology	0.50

Note: Some of these courses are offered only in alternate years, and some have additional prerequisites for which the student must plan ahead, with the assistance of the faculty advisor or program counsellor.

Option B

Code	Title	Credits
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Semester 5 - Fall

BIOC*3570	Analytical Biochemistry (can be taken in Semester 8)	0.75
CHEM*2820	Thermodynamics and Kinetics	0.50
or CHEM*2880	Physical Chemistry	

CHEM*3750	Organic Chemistry II: Structure and Synthesis	0.50
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Electives or restricted electives to a maximum of 2.75 total credits in this semester

Semester 6 - Winter ¹

Select 2.50 credits from the following:

XSEN*3030	Pharmacology and Applied Toxicology	0.50
XSEN*3040	Occupational Health and Chemistry	0.50
XSEN*3060	Pharmaceutical Analysis - Advanced	0.50
XSEN*3070	Pharmaceutical Product Formulations	0.50
XSEN*3090	Biopharmaceuticals	0.50
XSEN*3200	Pharmaceutical Organic Chemistry	0.50
XSEN*3210	Introduction to Pharmaceutical Manufacturing	0.50

Summer Semester

COOP*2000	Co-op Work Term II	0.50
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Fall Semester

COOP*3000	Co-op Work Term III	0.50
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Semester 7 - Winter

2.50 electives or restricted electives	2.50
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Summer Semester

COOP*4000	Co-op Work Term IV	0.50
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Semester 8 - Fall

2.50 electives or restricted electives	2.50
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¹ All XSEN courses are taught at the Seneca@York campus of Seneca College in Toronto.

Restricted Electives (Option B)

Code	Title	Credits
1. Select 1.00 credits from the following:		
MBG*2040	Foundations in Molecular Biology and Genetics	0.50
MCB*2050	Molecular Biology of the Cell	0.50
MICR*2430	Methods in Microbial Culture and Physiology	0.50
TOX*2000	Principles of Toxicology	0.50
2. Select 0.50 credits from the following:		
CHEM*4720	Organic Reactivity	0.50
CHEM*4730	Advanced Organic Synthesis	0.50
CHEM*4740	Bioorganic Chemistry	0.50
3. Select a minimum 1.50 credits at the 4000 level from the following:		
BIOC*4050	Protein and Nucleic Acid Structure	0.50
BIOC*4520	Metabolic Processes	0.50
BIOC*4540	Enzymology	0.75
BIOC*4580	Membrane Biochemistry	0.50
BIOM*4090	Pharmacology	0.50
CHEM*4010	Chemical Industry, Safety and Sustainability	0.50
CHEM*4020	Chemical Discovery	0.50
CHEM*4400	Electrochemistry and Sensors	0.50
CHEM*4630	Bioinorganic Chemistry	0.50
CHEM*4720	Organic Reactivity	0.50

CHEM*4730	Advanced Organic Synthesis	0.50
CHEM*4740	Bioorganic Chemistry	0.50
CHEM*4900	Chemistry Research Project I	1.00
CHEM*4910	Chemistry Research Project II	1.00
TOX*4590	Biochemical Toxicology	0.50

Note: Some of these courses are offered only in alternate years, and some have additional prerequisites for which the student must plan ahead, with the assistance of the faculty advisor or program counsellor.