MASTER OF SCIENCE BIOCHEMISTRY SPECIALIZATION IN BIOINFORMATICS

Summary
• Degrees offered: Master of Science (MSc)
• Registration status option: Full-time
• Language of instruction: English
• Primary program: MSc in Biochemistry
• Collaborative specialization: Bioinformatics
• Program option (expected duration of the program):
  • with thesis (6 full-time terms; 24 consecutive months)
• Academic units: Faculty of Medicine (http://med.uottawa.ca/graduate-postdoctoral), Department of Biochemistry, Microbiology and Immunology (http://med.uottawa.ca/bmi).

Program Description
The programs prepare candidates for a variety of careers in teaching and research both within and outside of academia.

Graduate students are actively involved in laboratory research, course work, and presentation of research seminars. Thus, they acquire autonomy in conducting research and in preparing publications.

The programs create a stimulating and challenging environment which will allow students to achieve excellence in research. Graduates of the programs must demonstrate research skills and credibility as professionals in their area of research.

The Department is a participating unit in the Bioinformatics collaborative program.

Collaborative Program Description
Bioinformatics is an emerging and increasingly important scientific discipline dedicated to the pursuit of fundamental questions about the structure, function and evolution of biological entities through the design and application of computational approaches. Fundamental research in these areas is expected to increase our understanding of human health and disease which translates into innovation in industry. Bioinformaticians today must be able to appreciate significant research in other fields and therefore require an understanding of the basic principles of other disciplines.

The degree awarded specifies the primary program and indicates "specialization in Bioinformatics."

Main Areas of Research
• General biochemistry
• Molecular biology
• Nutrition and metabolism

Other Programs Offered Within the Same Discipline or in a Related Area
• Master of Science Biochemistry (MSc)
• Master of Science Biochemistry Specialization in Human and Molecular Genetics (MSc)
• Master of Science Biochemistry Specialization in Pathology and Experimental Medicine (MSc)
• Doctorate in Philosophy Biochemistry (PhD)
• Doctorate in Philosophy Biochemistry Specialization in Human and Molecular Genetics (PhD)
• Doctorate in Philosophy Biochemistry Specialization in Pathology and Experimental Medicine (PhD)
• Master of Science Biology Specialization in Bioinformatics (MSc)
• Master of Science Cellular and Molecular Medicine Specialization in Bioinformatics (MSc)
• Master of Science Microbiology and Immunology Specialization in Bioinformatics (MSc)
• Master of Applied Science Biomedical Engineering Specialization in Bioinformatics (MSc)
• Master of Science Mathematics and Statistics Specialization in Bioinformatics (MSc)

Fees and Funding
• Program fees:
  The estimated amount for university fees (https://www.uottawa.ca/university-fees) associated with this program are available under the section Finance your studies (http://www.uottawa.ca/graduate-studies/programs-admission/finance-studies).

  International students enrolled in a French-language program of study may be eligible for a differential tuition fee exemption (https://www.uottawa.ca/university-fees/differential-tuition-fee-exemption).

  To learn about possibilities for financing your graduate studies, consult the Awards and financial support (https://www.uottawa.ca/graduate-studies/students/awards) section.

Notes
• Programs are governed by the general regulations (http://www.uottawa.ca/graduate-studies/students/general-regulations) in effect for graduate studies.
• In accordance with the University of Ottawa regulation, students have the right to complete their assignments, examinations, research papers, and theses in French or in English.
Program Contact Information
Graduate Studies Office, Faculty of Medicine (https://med.uottawa.ca/graduate-postdoctoral)
451 Smyth Road, Room RGN 2016
Ottawa, Ontario, Canada
K1N 6N5

Tel.: 613-562-5215
Email: grad.med@uottawa.ca

Twitter | Faculty of Medicine (https://twitter.com/uOttawaMed)
Youtube | Faculty of Medicine (https://www.youtube.com/channel/UCP2nDLrjFEEtfMi0mfe2HA)
Flickr | Faculty of Medicine (https://www.flickr.com/photos/uottawamed)

Admission Requirements
For the most accurate and up to date information on application deadlines, language tests and other admission requirements, please visit the specific requirements webpage.

To be eligible, candidates must:

- Have one of the following:
  - A bachelor’s degree with a specialization or a major (or equivalent) in science with a minimum average of 75% (B+).
  - An MD (Doctor of Medicine) degree with a minimum average of 75% (B+).
  - A DVM (Doctor of Veterinary Medicine) degree with a minimum average of 75% (B+).

Note: International candidates must check the for the diploma they received in their country of origin.

- Demonstrate a good academic performance in previous studies as shown by official transcripts, research reports, abstracts or any other documents demonstrating research skills.
- Pay the $100 ($CDN non-refundable) application fee.
- Identify at least one professor who is willing to supervise your research and thesis.
- We recommend that you contact potential thesis supervisors as soon as possible.
- To register, you need to have been accepted by a thesis supervisor.
- The supervisor’s name is required at the time of application.
- The thesis supervisor must be a member of the collaborative program.
- Be sponsored into the collaborative specialization by a faculty member of the collaborative program, normally the thesis supervisor, who must be appointed, cross-appointed or stand as an adjunct at the primary program.

Language Requirements
Applicants must be able to understand and fluently speak the language of instruction in the program to which they are applying. Proof of linguistic proficiency may be required.

Applicants whose first language is neither French nor English must provide proof of proficiency in the language of instruction.

Language tests recognized by the University of Ottawa:

- TOEFL: 600 (paper-based) – 100 (internet-based); or
- IELTS: 7.0 Overall – 7.0 Individual (paper-based or internet-based); or
- An equivalent language test

Note: Candidates are responsible for any fees associated with the language tests.

Notes

- The admission requirements listed above are minimum requirements and do not guarantee admission to the program.
- Admissions are governed by the general regulations in effect for graduate studies.
- Students must indicate in their initial application for admission to the master’s program in Biochemistry that they wish to be accepted into the collaborative program in Bioinformatics. Students must be admitted in one of the primary programs participating in the collaborative program. Students will normally be informed about their acceptance into the collaborative program at the same time as being informed about their admission into the primary program.
- Research activities can be conducted either in English, French or both, depending on the language used by the professor and the members of his or her research group.

Documents Required for Admission
In addition to the documents required for graduate and postdoctoral studies, candidates must submit the following documents:

- A resume
- A letter of intent or motivation

  Letter outlining your professional goals and proposed research area.
• Three confidential letters of recommendation, including one from a professor who is willing and available to act as thesis supervisor.
• Transcripts from all universities attended:
  • Official transcripts from all universities attended must be submitted.
  This applies to all courses and programs at any university you attended, including regular programs (completed or not), exchanges, letters of permission, online or correspondence courses, courses taken as a special student or visiting student, etc.
  • If the transcript and degree certificate are not in English or French, a certified translation (signed and stamped/sealed) must be submitted.

Note: Documents that are not required for admission will not be consulted, conserved or returned to the student. These documents will be destroyed according to our administrative procedures.

Information about how to apply to this program is available under the Apply Now (http://www.uottawa.ca/graduate-studies/programs-admission/apply/#apply-now) section.

Students should complete and submit their online application with supporting documentation (if applicable) by the deadline indicated above.

Program Requirements
Master’s with Collaborative Specialization

The Department may require students to take additional courses, depending on their backgrounds. Students wishing to take a course in a related discipline must obtain prior approval from the Department.

Students must meet the following requirements for the master’s with collaborative specialization:

Compulsory Courses (BCH):
- MED 8166  Professionalism and Professional Skills  0 Unit
- 6 optional course units from the list of approved biochemistry (BCH) courses at the 8000 or 9000 level  6 Units

Compulsory Courses (BNF):
- BNF 5106  Bioinformatics  3 Units

Seminars:
- BCH 5366  MSc Seminar  3 Units
- BNF 6100  MSc Seminar  3 Units

Thesis:
- BCH 7999  M.Sc. Thesis Research  0 Unit

Note(s)

1 This requirement involves the presentation of a seminar and regular attendance at the departmental seminars until permission to write the thesis is granted.
2 The seminar course in bioinformatics involves a written report, the presentation of a seminar, and regular attendance at departmental seminars.
3 Successful presentation and defence of a research thesis on a topic in bioinformatics based on original research carried out under the supervision of a faculty member participating in the bioinformatics collaborative program.
4 Students are responsible for ensuring they have met all of the thesis requirements (http://www.uottawa.ca/graduate-studies/students/theses).

Minimum Requirements

The passing grade in all primary program courses is C+. The passing grade in all BNF courses is B.

Students who fail 6 units, or whose research progress is deemed unsatisfactory must withdraw from the program.

Fast-Track from Master’s to PhD

Students enrolled in the master’s program in Biochemistry at the University of Ottawa may be eligible to fast-track directly into the doctoral program without writing a master’s thesis. For additional information, please consult the “Admission Requirements” section of the PhD program.

Research

Research Fields & Facilities

Located in the heart of Canada’s capital, a few steps away from Parliament Hill, the University of Ottawa is among Canada’s top 10 research universities.

uOttawa focuses research strengths and efforts in four Strategic Areas of Development in Research (SADRs):

- Canada and the World
- Health
- e-Society
- Molecular and Environmental Sciences

With cutting-edge research, our graduate students, researchers and educators strongly influence national and international priorities.

Research at the Faculty of Medicine

“The Faculty of Medicine has a long history of conducting both basic and clinical research of the highest quality. Many of our high profile research projects are conducted in partnership with affiliated-teaching hospitals and research institutes. These partnerships lead to biomedical discoveries that have a significant impact on health care. In the process they educate the next generation of Canadian scientists. Our research activity also attracts significant investment, which stimulates the Ottawa economy.”

-D. Bernard Jasmin, Vice-Dean, Research

Facilities, Research Centres and Institutes at the Faculty of Medicine

- Centre for Neural Dynamics (http://www.neurodynamic.uottawa.ca)
- University of Ottawa Centre for Neuromuscular Disease (http://med.uottawa.ca/neuromuscular)
- Centre for Research in Biopharmaceuticals and Biotechnology (http://www.med.uottawa.ca/crbb/eng)
- Canadian Partnership for Stroke Recovery (http://www.canadianstroke.ca/en)
- Kidney Research Centre (http://www.ohri.ca/centres/KRC/default.asp)
- University of Ottawa Skills and Simulation Centre (http://uossc.ca)
- Medical Devices Innovation Institute
- Ottawa Institute of Systems Biology (http://med.uottawa.ca/oisb)
- University of Ottawa Brain and Mind Research Institute (http://www.uottawa.ca/brain)

For more information, refer to the list of faculty members and their research fields on Uniweb.

IMPORTANT: Candidates and students looking for professors to supervise their thesis or research project can also consult the website of the faculty or department (https://www.uottawa.ca/graduate-studies/students/academic-unit-contact-information) of their program of choice. Uniweb does not list all professors authorized to supervise research projects at the University of Ottawa.

**Courses**

Not all of the listed courses are given each year.

A 3-unit course at the University of Ottawa is equivalent to a 0.5-unit course at Carleton University.

**BCH 5101 Analysis of -Omics Data (3 units)**
Theoretical and practical aspects of various methods currently used to analyze the plethora mountain of omics data. Methods: sequence alignment and database searches; sequence analysis and bioinformatics of gene regulation; DNA microarray and sequencing technologies to identify transcription factor binding sites; analysis of proteomics data; statistical analysis of preprocessed gene expression and protein/metabolite abundance data; epidemiology applications. Critical reading of the literature and strategies for making informed choices of methods for the analysis of students' own data.

**Course Component:** Lecture

**BCH 5366 MSc Seminar (3 units)**
Attendance and participation in the annual BMI Student Symposium and BMI Poster Day, attendance at BMI seminars relevant to Biochemistry. Students must present at least one poster and one oral presentation during the course of their program. Graded S (Satisfactory) / NS (Not Satisfactory).

**Course Component:** Seminar

**BCH 5501 Analyse des données omiques (3 crédits)**
Les aspects théoriques et pratiques des méthodes actuellement utilisées pour l'analyse des données omiques. Méthodes : alignement des séquences et recherche dans les bases de données; analyse des séquences et bioinformatique de l'expression génique; micro puces d'ADN et technologies de séquençage utilisées pour l'identification des sites de liaison des facteurs de transcription; l'analyse des données protéomiques; l'analyse statistique de l'expression génique prétraitée; et applications aux données protéine/abondance de métabolites, épidémiologie. Lecture critique de la littérature et stratégies pour faire des choix informés quant à la sélection des méthodes pour l'analyse des données.

**Volet : Cours magistral**

**BCH 7999 Recherche pour la thèse de maîtrise / M.Sc. Thesis Research**
À l'intention des étudiants faisant de la recherche en vue de l'obtention de la maîtrise. Les étudiants doivent soumettre au Département un plan détaillé de la recherche qu'ils se proposent de faire. Ils doivent rencontrer leur comité consultatif de thèse au moins une fois par année et soumettre un rapport de progrès au Département. / For students doing research leading to the master's degree. Students must ensure that a detailed outline of their proposed research is on file with the Department. They must meet at least once per year with their thesis advisory committee and submit a progress report to the Department.

**Volet / Course Component:** Recherche / Research

**BCH 8101 Physical and Chemical Methods in Biochemistry (3 units)**
Current applications of physical and chemical methods to the study of macromolecule structure-function relationships.

**Course Component:** Lecture

**BCH 8102 Selected Topics in Protein Structure and Function (3 units)**
An advanced study of recent literature dealing with structure-function relationships in selected proteins.

**Course Component:** Lecture

**BCH 8103 Advanced Topics in Gene Expression and Protein Synthesis (3 units)**
An advanced study of the recent literature dealing with the chemistry, metabolism and function of nucleic acids, the biosynthesis of proteins, biochemical and genetic control mechanisms, genetic engineering and the control of gene expression. Offered every second year in alternation with BCH 8105.

**Course Component:** Lecture

**BCH 8104 Advanced Topics in Cell Regulation (3 units)**
An advanced study of recent literature dealing with signal transduction processes and the regulation of metabolism, cell proliferation and differentiation.

**Course Component:** Lecture

Offered in alternate years.

**BCH 8105 Advanced Topics in Molecular Biology of Human Diseases (3 units)**
Topics will be selected and representative of current developments in the field. The course consists of a repeated series of a 3 hour lecture by an expert in the field one week, followed by student presentations, discussions and critique of assigned papers on that topic the following week. Topics on selected diseases will focus on various aspects of cancer, apoptosis, disease gene identification and gene therapy. In the past these topics have included the molecular aspects of various cancers, spinal muscular atrophy, tissue regeneration, the discovery of disease genes, infectious disease (HIV) and gene therapy. Students will write a grant proposal and participate in mock grant review panels. Depending on enrolment, the course may be limited to HMG students only.

**Course Component:** Lecture

**BCH 8106 Advanced Topics in Nutrition and Regulation of Metabolism (3 units)**
An advanced study of the recent literature dealing with metabolism, nutrition and metabolic control theory, with emphasis on both whole body and cell metabolism in metabolic and nutritional disorders such as obesity and non-insulin-dependent diabetes mellitus (NIDDM).

**Course Component:** Lecture
BCH 8108 Advanced Methods of Macro-Molecular Structure Determination (3 units)
A detailed examination of modern methods used to determine the structures of proteins, nucleic acids, and carbohydrates. May include X-ray crystallography, electron diffraction, nuclear magnetic resonance, and other spectroscopic methods.
Course Component: Lecture

BCH 8109 Advanced Topics in Cell Death (3 units)
Molecular mechanisms of cell death. Particular attention to be paid to role of aberrant cell death in human disease. Offered in the Fall of odd numbered years.
Course Component: Lecture

BCH 8110 Advanced Topics in Systems Biology (3 units)
Recent advances in genomics, proteomics, bioinformatics, and neuroinformatics including functional and chemical genomics, RNA analyses, microarrays, mass spectrometry, and neural imaging. Course requirements include student presentations and writing a mock research proposal based on Canadian Institutes of Health Research (CIHR) guidelines. Limited enrollment. Offered in alternate years with BCH 8101 Physical and Chemical Methods in Biochemistry.
Course Component: Lecture

BCH 8111 Chromosome and Chromatin Biology (3 units)
Higher order chromosome structure and chromatin remodeling and their impact on regulation of gene expression, DNA replication, repair and recombination, and chromosome segregation. Histone modifications and nucleosome positioning and their influence on higher order chromosome structure. Importance of chromosome and chromatin in the context of the cell cycle, development, and disease. Critical reading of the literature on chromosome and chromatin biology.
Course Component: Seminar

BCH 8114 Advanced Topics in the Cell Cycle (3 units)
Mechanisms of cell cycle regulation. Model systems critical to deciphering the cell cycle in eukaryotes: budding and fission yeast, Xenopus laevis egg extracts, Aspergillus nidulans, Drosophila melanogaster, sea urchin and mouse oocytes and cultured vertebrate cells. Overview of the prokaryotic cell cycle.
Course Component: Lecture

BCH 8116 Model Organisms and Systems Biology (3 units)
Utilization of model organisms in the development and advancement of the systems biology field. Particular attention will be paid to the use of organisms such as Saccharomyces cerevisiae as a model platform for cell cycle progression/cancer. Other models may also be included. The basics of the technology will be discussed along with the application of technology to complex biological questions, in particular relating to the cell cycle. Course offered in alternate years.
Course Component: Lecture

BCH 8117 Advanced Topics Relating to the Cell Cytoskeleton and Membranes (3 units)
Advanced study of recent literature dealing with the mammalian cellular cytoskeleton and membrane with an emphasis on the regulation of cell motility, adhesion and cell division.
Course Component: Lecture

BCH 8134 Structure and Expression of Eukaryotic and Prokaryotic Genomes (3 units)
Sequencing of eukaryote and prokaryote genomes with emphasis on recent technologies, sequence alignments and databases and assembly of genomes from massively parallel sequencing data. Focus on mapping studies, including linkage disequilibrium-based genome-wide association study (GWAS), to characterize functional variants associated with complex traits. Analysis and structure of microbial metagenomes from environmental and human habitats, including structure-function analysis of microbial communities, microbiota-human disease correlations, and molecular phylogeny. Genome expression, including measures of RNA transcripts and proteins and statistical analysis of data. Combination of various -omics data to understand gene-environment interactions.
Course Component: Lecture
BCH 8511 Biologie des chromosomes et de la chromatine (3 crédits)
Organisation de la structure des chromosomes et le remodelage de la chromatine ainsi que l’impact de ceux-ci sur la régulation de l’expression génique, la réplication, la séparation et la recombinaison de l’ADN ainsi que sur la ségrégation des chromosomes. Les modifications histoniques et le positionnement des nucléosomes ainsi que leur influence sur la structure organisée des chromosomes. Importance des chromosomes et de la chromatine dans le contexte du cycle cellulaire, du développement et des maladies. Lecture critique de la littérature portant sur la biologie des chromosomes et de la chromatine.
Volet : Cours magistral

BCH 8534 Structure et expression des génomes procaryotes et eucaryotes (3 crédits)
Le séquençage des génomes eucaryotes et procaryotes, avec un accent particulier sur les technologies récentes, l’alignement des séquences et les bases de données, et l’assemblage des génomes à partir de données générées par séquençage haut débit. Les études de cartographie comparée incluant les études d’associations pangénomiques basées sur le déséquilibre de liaison pour caractériser les variantes fonctionnelles associées aux traits complexes. L’analyse et la structure de métagénomes microbiens issus d’habitats humains et environnementaux incluant l’analyse structure-fonction des communautés microbiennes, les corrélations entre les maladies humaines et le microbiome ainsi que la phylogénie moléculaire. L’expression génique incluant les mesures de transcriptomes et de protéomes ainsi que l’analyse statistique des données. La combinaison des différentes données omiques pour comprendre les interactions géné-environnement.
Volet : Cours magistral

BCH 8535 Examen de synthèse (doctorat) / Comprehensive-Examination (PhD)
À l’intention des étudiants inscrits au programme de Ph.D. L’inscription à ce cours est limitée à trois sessions consécutives. / For students enrolled in the doctoral program. Enrolment in this course is limited to three consecutive academic sessions.
Volet / Course Component: Recherche / Research

BNF 5506 Bioinformatique (3 crédits)
Concepts et méthodes en bioinformatique. Les sujets abordés peuvent inclure, entre autres, la génétique, les statistiques et les théories des probabilités, les alignements, la phylogénétique, la génomique et la structure de protéines.
Volet : Cours magistral

BNF 5106 Bioinformatics (3 units)
Major concepts and methods of bioinformatics. Topics may include, but are not limited to: genetics, statistics & probability theory, alignments, phylogenetics, genomics, data mining, protein structure, cell simulation and computing.
Course Component: Lecture

BNF 5107 Applied Bioinformatics (3 units)
Computational knowledge discovery in and the dynamic nature of cellular networks. Includes, but is not limited to, knowledge representation, large scale data integration, data mining and computational systems biology. This course is equivalent to BIOL 5516 at Carleton University.
Course Component: Lecture