

# MASTER OF SCIENCE MICROBIOLOGY AND IMMUNOLOGY SPECIALIZATION IN BIOINFORMATICS

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## Summary

- Degree offered: Master of Science (MSc)
- Registration status option: Full-time
- Language of instruction: English
- Primary program: MSc in Microbiology and Immunology
- 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/en/>), Department of Biochemistry, Microbiology and Immunology (<http://med.uottawa.ca/bmi/>).

## Program Description

The programs refine critical and scholarly skills in fields and areas of specialization and prepare students for a variety of careers in teaching and research both within and outside of academia, including in a governmental, clinical, or industrial setting. Graduates are expected to have acquired autonomy in conducting research, in preparing scholarly publications, through a training that includes course work, research seminars, and independent research leading to a thesis.

The Department is a participating unit in the following collaborative programs: the Bioinformatics program (at the master's level) and the Pathology and Experimental Medicine program (at the master's and doctoral levels).

## 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

- Microbiology
- Host biology

## Other Programs Offered Within the Same Discipline or in a Related Area

- Master of Science Microbiology and Immunology (MSc)
- Master of Science Microbiology and Immunology Specialization in Pathology and Experimental Medicine (MSc)
- Doctorate in Philosophy Microbiology and Immunology (PhD)
- Doctorate in Philosophy Microbiology and Immunology Specialization in Pathology and Experimental Medicine (PhD)

## 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. 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.

**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](mailto:grad.med@uottawa.ca)**

**Twitter | Faculty of Medicine (<https://twitter.com/uOttawaMed/>)**

**Youtube | Faculty of Medicine (<https://www.youtube.com/channel/UCP2nDlrjFEetyfMiOmle2HA/>)**

**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 (<https://www.uottawa.ca/graduate-studies/programs-admission/apply/specific-requirements/>) webpage.

### To be eligible, candidates must:

- Have a bachelor's degree with a specialization or a major (or equivalent) in biochemistry, biology, or microbiology with a minimum average of 75% (B+).

Note: International candidates must check the admission equivalencies (<https://www.uottawa.ca/graduate-studies/international/study-uottawa/admission-equivalencies/>) 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.
- 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 director 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, write and fluently speak the language of instruction (English) 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.

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 (<http://www.uottawa.ca/graduate-studies/students/general-regulations/>) in effect for graduate studies and the general regulations of the Ottawa-Carleton Joint Institutes.
- Candidates must apply to the primary program and indicate in their application for admission to the master's program in Microbiology and Immunology that they wish to be accepted into the collaborative specialization in Bioinformatics. Students are normally informed about their acceptance into the collaborative program at the same time as being informed about their admission into the primary program. To be admitted to the collaborative program, candidates must also be accepted in the primary program.

## Program Requirements Master's with Collaborative Specialization

The Department may require students to take additional courses, depending on their backgrounds.

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

### Compulsory Courses (MIC):

MED 8166	Professionalism and Professional Skills	
MIC 5100	Pathogen Interactions and Host	3 Units
3 elective course units in microbiology and immunology (MIC) at the graduate level		3 Units

### Compulsory Course (BNF):

BNF 5106	Bioinformatics	3 Units
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### Seminars:

BNF 6100	MSc Seminar <sup>1</sup>	3 Units
MIC 5366	MSc Seminar <sup>2</sup>	3 Units

### Thesis:

THM 7999	Master's Thesis <sup>3, 4</sup>	
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#### Note(s)

- <sup>1</sup> The seminar course in bioinformatics involves a written report, the presentation of a seminar, and regular attendance at departmental seminars.
- <sup>2</sup> The seminar course involves the presentation of a seminar and regular attendance at the seminars presented by the Department.
- <sup>3</sup> 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.
- <sup>4</sup> Students are responsible for ensuring they have met all of the thesis requirements (<http://www.uottawa.ca/graduate-studies/students/theses/>).

## Fast-Track from Master's to PhD

Students enrolled in the master's program in Microbiology and Immunology 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.

## Minimum Requirements

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

Students who fail two courses (equivalent to 6 units), the thesis proposal, or whose research progress is deemed unsatisfactory are required to withdraw.

## 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."

- Dr. 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. The course is offered in the language in which it is described.

Course codes in parentheses are for Carleton University. A 3-unit course at the University of Ottawa is equivalent to a 0.5-unit course at Carleton University.

### MIC 5100 Pathogen Interactions and Host (3 units)

This course will examine current issues in microbiology/immunology. Topics to be chosen to allow discussion across the broad areas of virology, immunology and bacteriology. Within each of the modules, the focus will be on host-pathogen interactions at the molecular level, how microorganisms utilize, modify or disrupt host cell functions, including immune cell functions and immune responses, to establish infection and cause diseases, or on immunological diseases which may have an infectious component.

**Course Component:** Lecture

**Prerequisite:** At least one undergraduate course in microbiology and/or immunology and one course in molecular biology.

### MIC 5366 MSc Seminar (3 units)

Attendance at two half-day symposia with guest speakers, attendance and participation in the annual BMI Student Symposium and BMI Poster Day, attendance at BMI seminars relevant to Microbiology and Immunology. Students must present at least one poster and one oral presentation during the course of their program. Graded S (Satisfactory) or NS (Not satisfactory).

**Course Component:** Seminar

### MIC 6003 Thesis Research in Microbiology and Immunology III

**Volet / Course Component:** Cours magistral / Lecture

**MIC 8120 ADVANCED TOPICS IN IMMUNOMETABOLISM (3 units)**

An advanced study of the recent literature dealing with the field of immunometabolism, with a focus on both immunometabolic pathways and the specialized techniques that allow for understanding chronic inflammatory/metabolic diseases, such as cancer, type 2 diabetes, obesity, atherosclerosis, neurodegeneration, etc.

**Course Component:** Lecture

**MIC 8122 Advanced Topics in Immunology (3 units)**

Focus on cellular immunology, including thymocyte maturation, induction and regulation of cellular responses, immune responses to pathogens, immunological memory, tolerance. Student assessments to be conducted by two methods: weekly assessment of student presentations and participation in class discussions; assessment of take-home assignments such as completion of a research grant on a topic covered in the course. To be offered alternate years subject to sufficient demand.

**Course Component:** Seminar

Prerequisite: MIC 4125.

**MIC 8124 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

**MIC 8125 Special Topics in Microbiology and Immunology (3 units)**

Discussion of current topics in Microbiology and Immunology. Topics to vary from year to year depending on the interest of faculty members offering the course and students. Student assessments to be conducted by two methods: weekly assessment of student presentations and participation in class discussions; assessment of take-home assignments such as completion of a research grant on a topic covered in the course.

**Course Component:** Lecture

Prerequisite: Permission of the course coordinator.

**MIC 8126 Immunochemistry (3 units)**

Focus is on antigen structure of protein and carbohydrate antigens, receptor structure of B cells and T cells, structure of MHC molecules, accessory molecules and cytokine receptors and cell signalling pathways induced by the antigen and cytokine receptors. Student assessments to be conducted by two methods: weekly assessment of student presentations and participation in class discussions; assessment of take-home assignments such as completion of a research grant on a topic covered in the course. To be offered alternate years subject to sufficient demand.

**Course Component:** Lecture

Prerequisite: MIC 4125.

**MIC 8129 Current Topics in Haematopoietic Stem Cells and Immune Development (3 units)**

This course will focus on the haematopoietic system that gives rise to the many cell types of the immune system. Topics to be covered include the developmental processes of embryonic stem cell differentiation into mesoderm and then into haematopoietic and non-haematopoietic progenitors; development of adult haematopoietic and immune systems; symmetric and asymmetric division of cells; intrinsic transcription factors and extracellular microenvironment factors regulating cell fate; immunological aspects of stem-cell based therapy; new technologies and their use in the field, and experimental design.

**Course Component:** Lecture

Prerequisite: At least one undergraduate course in immunology or cell biology.

**MIC 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

**MIC 8236 Advanced Topics in Virology (3 units)**

An in-depth presentation of current topics in virological research. Topics will vary from year to year. To be offered every alternate year subject to sufficient demand.

**Course Component:** Lecture

**MIC 8238 Advanced Topics in Bacteriology - Mechanisms of Pathogenesis (3 units)**

Recent advances and current topics in selected areas of bacteriology with emphasis on mechanisms of pathogenesis. Students present and discuss journal articles. Offered every alternate year subject to sufficient demand.

**Course Component:** Lecture

**MIC 8241S Seminars II (2 crédits / 2 units)**

Every graduate student will be required to attend the weekly departmental seminars. Compulsory for all graduate students.

**Volet / Course Component:** Cours magistral / Lecture

**MIC 8242S Seminars III (2 crédits / 2 units)**

Every graduate student will be required to attend the weekly departmental seminars. Compulsory for all graduate students.

**Volet / Course Component:** Cours magistral / Lecture

**MIC 8243S Seminars IV (2 crédits / 2 units)**

Every graduate student will be required to attend the weekly departmental seminars. Compulsory for all graduate students.

**Volet / Course Component:** Cours magistral / Lecture

**MIC 8244S Seminars V (2 crédits / 2 units)**

Every graduate student will be required to attend the weekly departmental seminars. Compulsory for all graduate students.

**Volet / Course Component:** Cours magistral / Lecture

**MIC 8366 PhD Seminar (3 units)**

Attendance at two half-day symposia with guest speakers, attendance and participation in the annual BMI Student Symposium and BMI Poster Day, attendance at BMI seminars relevant to Microbiology and Immunology. Students will present a poster in their first and every alternate year, and an oral presentation the second and every alternate year until they have permission to write their thesis. Graded S (Satisfactory) / NS (Not satisfactory).

**Course Component:** Seminar

**MIC 8401 Advanced Topics in Bacterial Genetics (3 units)**

Microbial genetic and genomic methods: origin, purpose and functioning. Analysis and use of genomes to study bacterial pathogenesis and host-microbe interactions.

**Course Component:** Lecture

Prerequisite: MIC 5224 or equivalent.

**MIC 8500 Special Topics in Health- Related Environmental Microbiology (3 crédits)**

Recent advances and current topics in selected areas of health-related environmental microbiology. Topics reflect student interest. Offered in alternate years subject to sufficient demand.

**Volet :** Cours magistral

Prerequisite: MIC 5500 or equivalent.

**MIC 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 métagénomiques 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 gène-environnement.

**Volet :** Cours magistral

**MIC 8700 Biology and Pathogenesis of HIV Infection (3 crédits)**

Biology and pathogenesis of Human Immunodeficiency Virus (HIV) infection. Genetics, replication, structure, regulation of gene expression, immunopathogenesis, antiviral therapy and vaccine development. Offered in alternate years subject to sufficient demand.

**Volet :** Séminaire

**MIC 9998 Examen de synthèse / Comprehensive Examination**

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

**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

**BNF 5504 Laboratoire de bioinformatique (3 crédits)**

Principes d'organisation, de récupération, de manipulation et d'analyse de données moléculaires en génomique, protéomique et transcriptomique. Analyses pratiques de ces données pour résoudre des questions biologiques en utilisant des méthodes quantitatives et computationnelles.

**Volet :** Théorie et laboratoire

Les cours BPS 4504 et BNF 5504 ne peuvent être combinés pour l'obtention de crédits.

**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 6100 MSc Seminar (3 units)**

Current topics in bioinformatics presented by program professors and invited speakers. Oral presentation and written report required. Graded S (Satisfactory) / NS (Not satisfactory).

**Course Component:** Lecture

**BNF 6500 Séminaire de maîtrise (3 crédits)**

Sujets courants en bioinformatique présentés par des professeurs membres du programme et des conférenciers invités. Présentation orale et rapport écrit requis. Noté S (satisfaisant) ou NS (non satisfaisant).

**Volet :** Cours magistral

**BNF 8166 Seminar in Bioinformatics (3 units)**

Current research topics in bioinformatics presented by PhD students and invited speakers. Oral presentation required. Graded S (Satisfactory) / NS (Not satisfactory).

**Course Component:** Seminar

**BNF 8301 Evolutionary Bioinformatics (3 units)**

Fundamental concepts in molecular evolution and hands-on experience with computer analysis of DNA sequences. Topics may include molecular sequence databases, multiple alignments and phylogenetic trees. This course is equivalent to BIOL 5201 at Carleton University.

**Course Component:** Lecture

Prerequisite: Graduate standing plus basic courses in genetics and evolution.

**BNF 8766 Séminaire en bioinformatique (3 crédits)**

Sujets courants en bioinformatique présentés par des étudiants en PhD et des conférenciers invités. Présentation orale requise. Noté S (satisfaisant) ou NS (non satisfaisant).

**Volet :** Séminaire