MASTER OF SCIENCE
CELLULAR AND MOLECULAR
MEDICINE SPECIALIZATION
IN PATHOLOGY AND
EXPERIMENTAL MEDICINE

Summary
• Degree offered: Master of Science (MSc)
• Registration status option: Full-time
• Language of instruction:
  • French
  • English
  
  Note: Most of the courses in this program are offered in English.

• Primary program: MSc in Cellular and Molecular Medicine
• Collaborative specialization: Pathology and Experimental Medicine
• 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 Cellular and Molecular Medicine (http://med.uottawa.ca/cellular-molecular/).

Program Description
The programs prepare candidates for a variety of careers in teaching and research both within and outside of academia. During training, the student will develop a critical approach to published work and to his own work. Graduates acquire an excellent knowledge of their chosen field and a general understanding of the areas related to their own particular research project. They must demonstrate research skills and credibility as professionals in their area of research.

The Department is a participating unit in the collaborative programs in Bioinformatics (at the master’s level), in Human and Molecular Genetics (at the master’s and doctoral levels), and in Pathology and Experimental Medicine (at the master’s and doctoral levels).

Collaborative Program Description
The objective of the Pathology and Experimental Medicine collaborative program is to provide graduate students with the knowledge and skills to examine the basic mechanisms of disease pathology, and to develop new strategies for prevention and treatment. The degree awarded specifies the primary program and indicates “Specialization in Pathology and Experimental Medicine.”

Main Areas of Research
Most research groups in the Department are part of a research centre. These centres include the Centre for Neuromuscular Disease, the Kidney Research Centre, and the Centre for Research in Biopharmaceuticals. Members of the Department are involved in three main research fields:

• Growth and development
• Pharmacology
• Physiology

Other Programs Offered Within the Same Discipline or in a Related Area
• Master of Science Cellular and Molecular Medicine Specialization in Bioinformatics (MSc)
• Master of Science Cellular and Molecular Medicine Specialization in Human and Molecular Genetics (MSc)
• Master of Science Cellular and Molecular Medicine (MSc)
• Master of Science Neuroscience (MSc)
• Master of Science Neuroscience Specialization in Human and Molecular Genetics (MSc)
• Master of Science Neuroscience Specialization in Pathology and Experimental Medicine (MSc)
• Doctorate in Philosophy Cellular and Molecular Medicine (PhD)
• Doctorate in Philosophy Cellular and Molecular Medicine Specialization in Human and Molecular Genetics (PhD)
• Doctorate in Philosophy Cellular and Molecular Medicine Specialization in Pathology and Experimental Medicine (PhD)
• Doctorate in Philosophy Neuroscience (PhD)
• Doctorate in Philosophy Neuroscience Specialization in Human and Molecular Genetics (PhD)
• Doctorate in Philosophy Neuroscience 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.
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 of sciences (BSc) degree with a specialization or major (or equivalent) in one of the following areas: biology, biochemistry, pharmacology, physiology, human kinetics (kinesiology), biopharmaceutical or biomedical sciences 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 thesis director must be a member of the collaborative program.

- Be sponsored into the collaborative program by a faculty member, normally the thesis supervisor, who must be a member of the Pathology and Experimental Medicine program.

Language Requirements

Applicants must be able to understand and fluently speak the language of instruction (French or English) in the program to which they are applying. Proof of linguistic proficiency may be required. Most of the courses in this program are offered in English.

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.

- Candidates must apply to the primary program and indicate in their application for admission to the master's program in Cellular and Molecular Medicine that they wish to be accepted into the collaborative-specialization in Pathology and Experimental Medicine. 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:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>MED 8166</td>
<td>Professionalism and Professional Skills</td>
<td>3</td>
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3 course units from:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCH 8107</td>
<td>Advanced Topics in Lipid Metabolism and Disease</td>
<td>3</td>
</tr>
<tr>
<td>CMM 5001</td>
<td>The Pathological Basis of Disease</td>
<td>3</td>
</tr>
<tr>
<td>CMM 5105</td>
<td>Introduction to Cancer Biology</td>
<td>3</td>
</tr>
<tr>
<td>CMM 5315</td>
<td>Cellular and Molecular Basis of Cardiovascular Function/Dysfunction</td>
<td>3</td>
</tr>
<tr>
<td>CMM 8105</td>
<td>Advanced Topics in Cancer Biology</td>
<td>3</td>
</tr>
<tr>
<td>NSC 8101</td>
<td>Advanced Topics in Neuropathology</td>
<td>3</td>
</tr>
</tbody>
</table>
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 Centre for Neuromuscular Disease (http://med.uottawa.ca/neuromuscular/)
- 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 (https://uniweb.uottawa.ca/#farts/themes).

Courses

Not all of the listed courses are given each year. The course is offered in the language in which it is described.

CMM 5001 The Pathological Basis of Disease (3 crédits / 3 units)
Introductory course for non-medical graduate students in Life Sciences. This course will consist of a brief introduction to pathology describing the manifestation of disease at the macroscopic and microscopic level. This will be followed by (i) a description of various types of microscopy and methodology; (ii) concepts in flow cytometry, tissue/cell fractionation; (iii) histo/cytochemistry and immunohisto/cytochemistry; (iv) normal cells and tissues; (v) organs; (vi) the general pathology of cells and tissues including hypertrophy, aplasia, atrophy, hyperplasia, metaplasia, dysplasia, neoplasia, storage diseases, extracellular space pathologies, necrosis and apoptosis. Blood vessel and cardiac pathologies will be covered as well as concepts in neuropathology, organ/system specific pathologies and genetic diseases.

Volet / Course Component: Cours magistral / Lecture

CMM 5105 Introduction to Cancer Biology (3 units)
An introduction to the biology of cancer. Major topics in cancer biology include the following: tumor suppression/oncogenes; apoptosis in cancer; cell immortalization and senescence; genomic instability; multistep tumorigenesis/inflammation in cancer; biology of angiogenesis; rational therapies.

Course Component: Lecture

CMM 5111 Computational Cell Biology (3 units)
Emphasis is on providing students with the background knowledge and
the tools needed to develop and analyze models of cellular processes.
Topics include modelling enzyme kinetics, signal transduction pathways,
and gene regulatory networks, using differential equations, nonlinear
dynamics, and stochastic processes.
Course Component: Lecture
Permission of the Department is required.

CMM 5210 Mammalian Physiology (6 units)
Course Component: Lecture

CMM 5302 Comprehensive Pharmacology I (3 units)
Extensive coverage of pharmacodynamics, pharmacokinetics, and the
pharmacology of the autonomic and central nervous system. Courses
CMM 5301, CMM 5302 cannot be combined for units.
Course Component: Lecture

CMM 5303 Comprehensive Pharmacology II (3 units)
Extensive coverage of the pharmacology of antibiotic and anti-
inflammatory drugs, of chemotherapeutic agents, and of the
cardiovascular and gastro-intestinal systems. Courses CMM 5301,
CMM 5303 cannot be combined for units.
Course Component: Lecture

CMM 5304 Introduction to Developmental Biology (3 units)
Concepts in development and signalling pathways during development
including formation of the germ layers; establishment of the body
axis and principles of segmentation; patterning and homeobox genes;
neurogenesis; axonal and neuronal guidance; stem cell concepts; germ
cells; animal models in developmental biology.
Course Component: Lecture

CMM 5311 Physiology and Pathophysiology of Energy Metabolism and
Muscle Functions (3 units)
Advanced comprehensive training in mammalian and human physiology
with emphasis on pathophysiology. Topics include: neural and endocrine
control of the hypothalamic-hypophysis axis; role of pancreas, adipose
tissue and skeletal muscle in carbohydrate and lipid metabolism; cellular
and molecular aspects of muscle contraction and fatigue in cardiac and
skeletal muscle.
Course Component: Lecture

CMM 5313 Physiology and Pathophysiology of the Reproductive, Renal
and Gastrointestinal Systems (3 units)
Advanced comprehensive training in mammalian and human physiology
with emphasis on pathophysiology. Topics covered include reproductive
physiology, molecular and bulk transport processes in the renal system,
enteric control of the gastrointestinal tract.
Course Component: Lecture

CMM 5315 Cellular and Molecular Basis of Cardiovascular Function/
Dysfunction (3 units)
Mechanism of failing heart and cardiovascular system, its associated
functions and associated conditions. Therapies for restoring function.
Topics include: regulation of heart development, cell signaling, cellular
and molecular mechanisms of atherosclerosis and heart disease,
endocrine regulation, hypertension, bioenergetics, cardiovascular
genomics and genetics, cell therapy, and regenerative medicine.
Course Component: Lecture

CMM 5326 Experimental Preparations and Animal Models (3 units)
Applied and theoretical course intended to give the potential researcher
basic surgical skills. Lectures followed by demonstrations and/or
practical exercises.
Course Component: Lecture

CMM 5341 Stem Cells (3 units)
Topics in stem cell biology which will include an in-depth look at the
properties of embryonic and adult stem cell populations, tissue-specific
stem cells (muscle, skin, neural, etc.), differentiation and reprogramming,
the stem cell niche, induced pluripotent stem cells, and therapeutic
advances using stem cell therapy.
Course Component: Lecture

CMM 5360 Imaging in Cell Biology (3 units)
Microscopy, biological imaging, and image generation. Overviews of
common transmitted light, electron microscopic and epifluorescent
techniques. Discussion of enhanced fluorescence microscopy and live
cell imaging techniques, including image acquisition, processing and
analysis with focus on quantitative and ethical issues.
Course Component: Lecture

CMM 5372 Cell Signalling and Hormone Action (3 units)
Topics will include the major cell signaling pathways and the action of steroid and non-steroid hormones. These signaling pathways will be
discussed in the context of biological function and pharmacology.
Course Component: Lecture

CMM 5375 Developmental Biology (3 units)
Advanced study of recent developments in the field of development
biology, with emphasis on state-of-art molecular and cell biology
techniques as well as their applications to reproductive diseases.
Course Component: Lecture

CMM 5380 Special Topics in Reproductive and Developmental Biology (3
units)
In-depth study of current topics in reproductive and developmental
biology, with emphasis on state-of-the art molecular and cell biology
techniques as well as their applications to reproductive diseases.
Topics may include assisted reproductive technologies, embryonic stem
cells, contraception, endocrine disruptors, reproductive toxicology, and
transgenics.
Course Component: Lecture

CMM 5380 Special Topics in Reproductive and Developmental Biology (3
units)
In-depth study of current topics in reproductive and developmental
biology, with emphasis on state-of-the art molecular and cell biology
techniques as well as their applications to reproductive diseases.
Topics may include assisted reproductive technologies, embryonic stem
cells, contraception, endocrine disruptors, reproductive toxicology, and
transgenics.
Course Component: Lecture

CMM 5380 Special Topics in Reproductive and Developmental Biology (3
units)
In-depth study of current topics in reproductive and developmental
biology, with emphasis on state-of-the art molecular and cell biology
techniques as well as their applications to reproductive diseases.
Topics may include assisted reproductive technologies, embryonic stem
cells, contraception, endocrine disruptors, reproductive toxicology, and
transgenics.
Course Component: Lecture

CMM 7301 Directed Studies (3 units)
A program of study designed for a given student according to the
student’s educational requirements.
Course Component: Seminar

BCH 8310 and CMM 8310 cannot be combined for units.

CMM 8103 Epithelial Cell Polarity (3 units)
Cell polarity with emphasis on tight junctions and Claudins (tight junction
molecules). Topics include: the molecular basis of cell polarity and
permeability barrier during development, organogenesis and disease
including inflammatory disease and cancer.
Course Component: Lecture

CMM 8105 Advanced Topics in Cancer Biology (3 units)
Advanced study of recent developments in the field of cancer biology
with emphasis on cellular and molecular aspects. Specific topics to be
covered include: angiogenesis, apoptosis, cancer genetics, cell signaling,
genetic instability, oncogenes and tumour suppressors.
Course Component: Lecture

CMM 8300 Special Topics in Reproductive and Developmental Biology (3
units)
In-depth study of current topics in reproductive and developmental
biology, with emphasis on state-of-the art molecular and cell biology
techniques as well as their applications to reproductive diseases.
Topics may include assisted reproductive technologies, embryonic stem
cells, contraception, endocrine disruptors, reproductive toxicology, and
transgenics.
Course Component: Lecture

BCH 8310 and CMM 8310 cannot be combined for units.
Course Component: Lecture

Courses BCH 8310 and CMM 8310 cannot be combined for units.

CMM 8311 Current Topics in Transcriptional Regulation (3 units)
Topics will include chromatin structure and its impact on gene expression, protein:DNA interactions, the assembly of transcriptional complexes, and the control of gene expression in mammalian systems.
Course Component: Lecture

CMM 83241 Seminars I (Part 1 of 2)
Compulsory for one year for all students enrolled in the master's program. Presentation of two seminars or one seminar and one poster required during the year as well as regular attendance at the departmental seminar series. (Part 1 of 2)
Course Component: Seminar
Prerequisite: CMM 83241

CMM 8311 Special Topics in Gastroenterology (3 units)
Lectures, tutorials and seminar-discussion sessions, designed to provide advanced training in gastrointestinal function. Emphasis on pathophysiological mechanisms.
Course Component: Lecture

CMM 83245 Seminars I (3 crédits / 3 units)
Compulsory for one year for all students enrolled in the master's program. Presentation of two seminars or one seminar and one poster required during the year as well as regular attendance at the departmental seminar series.
Volet / Course Component: Séminaire / Seminar

CMM 83251 Seminars II (Part 1 of 2)
Compulsory for all students enrolled in the doctorate program. Presentation of two seminars or one seminar and one poster required during the year as well as regular attendance at the departmental seminar series. (Part 1 of 2)
Course Component: Seminar
Prerequisite: CMM 83251

CMM 83252 Seminars II (Part 2 of 2) (3 units)
Compulsory for all students enrolled in the doctorate program. Presentation of two seminars or one seminar and one poster required during the year as well as regular attendance at the departmental seminar series. (Part 2 of 2)
Course Component: Seminar
Prerequisite: CMM 83251

CMM 83255 Seminars II (3 crédits / 3 units)
Compulsory for all students enrolled in the doctorate program. Presentation of two seminars or one seminar and one poster required during the year as well as regular attendance at the departmental seminar series.
Volet / Course Component: Séminaire / Seminar

CMM 8340 Neuromuscular Function and Dysfunction (3 units)
Topics to be covered include factors controlling muscle and synapse-specific gene expression, regulation of myogenesis and muscle cell growth, formation of the neuromuscular junction, motor neuron - muscle interactions, the role of the cytoskeleton in organization of post-synaptic domains, functional role of ion channels in muscle, molecular genetics of neuromuscular disease.
Course Component: Lecture

CMM 8341 Cell Stress (3 units)
Topics will include cellular responses to cell stress and will include hypoxia, oxidative stress, ER stress, autophagy, apoptosis and aging.
Course Component: Lecture

CMM 8345 Renal Physiology (3 units)
Topics to include: detailed structure and function of nephron segments, localization of primary and secondary active transport carriers, theories of autoregulation, hormone action in the kidney, drug action in the kidney, and regulation of renal vascular resistance.
Course Component: Lecture

CMM 8355 Renal Physiology (3 units)
Lecture and seminar course with emphasis on electrolyte transport. Topics to include: detailed structure and function of nephron segments, localization of primary and secondary active transport carriers, theories of autoregulation, hormone action in the kidney, drug action in the kidney, and regulation of renal vascular resistance.
Course Component: Lecture

PME 5367 Seminar
Presentation of one poster during the Research Day organized by the Pathology and Experimental Medicine collaborative program. Active participation in the annual Pathology Research Day of the Department of Pathology and Laboratory Medicine. Poster evaluated by Pathology and Experimental Medicine program faculty members. Graded S (Satisfactory) / NS (Not satisfactory).
Course Component: Seminar

PME 8112 Cell Biology and the Molecular Basis of Pathological Phenotypes (3 units)
Molecular principles of cell biology, with a focus on the mechanisms of disease. Disorders in cell biological processes that underlie many pathological phenotypes, such as intracellular transport, mitochondrial dynamics, cell biology of the nucleus and the regulation of the cytoskeleton. Emphasis on emerging experimental techniques, including functional assay design, fluorescence microscopy (multi-photon, confocal, assays like Fluorescence Resonance Energy Transfer (FRET), Fluorescence Lifetime Imaging Microscopy (FLIM), Fluorescence Recovery After Photobleaching (FRAP), photoactivation and uncaging) and electron microscopy. Participants will have hands-on experience and will work to apply these techniques to their own research problems by rotation through participating laboratories. The experiments performed by the students during the course will be assembled into a manuscript-style paper for submission at the end of the term to be graded by the course co-ordinator. Enrolment is limited to 10 students and preference will be given to students whose projects are related directly to these concepts and techniques.
Course Component: Lecture

PME 8367 Seminar
Presentation of one poster during the Research Day organized by the Pathology and Experimental Medicine collaborative program. Active participation in the annual Pathology Research Day of the Department of Pathology and Laboratory Medicine. Poster evaluated by Pathology and Experimental Medicine program faculty members. Graded S (Satisfactory) / NS (Not satisfactory).
Course Component: Seminar