

# DOCTORATE IN PHILOSOPHY BIOLOGY AND SPECIALIZATION BIOINFORMATICS

## Overview

### Summary

- Degree offered: Doctorate in Philosophy (PhD)
- Registration status option: Full-time
- Language of instruction: English
- Primary program: PhD in Biology
- Collaborative specialization: Bioinformatics
- Program option (expected duration of the program):
  - with thesis (12 full-time terms; 48 consecutive months)
- Academic units: Faculty of Science (<http://science.uottawa.ca/>), Department of Biology (<http://science.uottawa.ca/biology/>), Ottawa-Carleton Institute of Biology (<https://carleton.ca/biology/ottawa-carleton-institute-of-biology/>).

## 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

- Molecular and cellular biology
- Microbiology
- Genomics, transcriptomics, and proteomics
- Ecology and evolution
- Environmental toxicology

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

- Master of Science Biology (MSc)
- Master of Science Biology Specialization in Chemical and Environmental Toxicology (MSc)
- Master of Science Biology Specialization in Bioinformatics (MSc)
- Master of Science Biology Specialization in Science, Society and Policy (MSc)
- Doctorate in Philosophy Biology (PhD)
- Doctorate in Philosophy Biology Specialization in Chemical and Environmental Toxicology (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 academic regulations (<https://www.uottawa.ca/about-us/leadership-governance/policies-regulations/>) in effect for graduate studies and by the General Regulations of the Ottawa-Carleton Institute of Biology (OCIB).
- 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 Science (<https://science.uottawa.ca/en/faculty-services/graduate-studies/>)

30 Marie-Curie street, Gendron Hall, Room 181

Ottawa, Ontario, Canada

K1N 6N5

Tel.: 613-562-5800 x 3145

Email: [gradsci@uOttawa.ca](mailto:gradsci@uOttawa.ca)

Twitter | Faculty of Science (<https://twitter.com/uOttawaScience/?lang=en>)

Facebook | Faculty of Science (<https://www.facebook.com/uOttawaScience/>)

## 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 master's degree in science (or equivalent) 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.
- The requirements outlined above are a minimum. The Admission Committee reserves the right to add any course considered essential in light of the student's background. The courses BNF 5106 and/or BNF 6100 could be added to the student's program requirements.
- 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.

## 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.

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 academic regulations (<https://www.uottawa.ca/about-us/leadership-governance/policies-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.

## Fast-Track from Master's to PhD

Students enrolled in the master's program in Biology with specialization in Bioinformatics at the University of Ottawa may be eligible to fast-track directly into the doctoral program without writing a master's thesis, provided the following conditions are met:

- You must have completed the course requirements of your MSc program with a mark of A- or above in each course.
- Complete all the core courses required for the M.Sc.
- Demonstrate a satisfactory progress in the research program.
- Provide a written recommendation by the thesis supervisor.
- Provide a written recommendation by the Departmental Graduate Studies Committee.

Note: The transfer must take place within sixteen months of initial enrollment in the master's. Please note that the minimal admission average requirements for the doctoral program must also be met. Following transfer, all of the requirements of the doctoral program must be met.

## Program Requirements

Requirements for this program have been modified. Please consult the 2022-2023 calendars (<http://catalogue.uottawa.ca/en/archives/>) for the previous requirements.

## Doctorate with Specialization

Students must meet the following requirements:

### Optional Courses

3 optional course units in biology (BIO) or bioinformatics (BNF) at the 5000 or 8000 level <sup>1,2,3</sup>	3 Units
---	---------

### Seminars

BIO 8950	Research and Communication in Biology <sup>4</sup>	3 Units
BNF 8166	Seminar in Bioinformatics <sup>5</sup>	3 Units

### Comprehensive Examination

BIO 9998	Comprehensive Examination
----------	---------------------------

### Thesis

THD 9999	Doctoral Thesis <sup>6,7</sup>
----------	--------------------------------

### Note(s)

1

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

2

Complete one of BCH 5101, BCH 8110, BNF 5107, or CHM 8309 if previously taken BNF 5106.

3

The optional course units may be selected from other approved graduate courses in related disciplines approved by the Department.

4

Students who have already completed BIO 5950 do not complete BIO 8950 and instead are required to complete 3 additional optional course units in biology (BIO) or bioinformatics (BNF) at the 5000 or 8000 level.

5

The seminar course in bioinformatics involves a written report, the presentation of a seminar, and regular attendance at departmental seminars.

6

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.

7

Students are responsible for ensuring they have met all of the thesis requirements.

## Research

### Research at the University of Ottawa

Located in the heart of Canada's capital, a few steps away from Parliament Hill, the University of Ottawa ranks among Canada's top 10 research universities. Our research is founded on excellence, relevance and impact and is conducted in a spirit of equity, diversity and inclusion.

Our research community thrives in four strategic areas:

- Creating a sustainable environment
- Advancing just societies
- Shaping the digital world
- Enabling lifelong health and wellness

From advancing healthcare solutions to tackling global challenges like climate change, the University of Ottawa's researchers are at the forefront of innovation, making significant contributions to society and beyond.

### Research at the Faculty of Science

The Faculty of Science has become a true centre of excellence in research through its world-class professors as well as its programs and infrastructure in Biology, Chemistry, Earth Sciences, Mathematics and Statistics, and Physics.

The research accomplished by its 140 internationally recognized professors, its approximately 400 graduate students and its dozens of postdoctoral researchers and visiting scientists has positioned the Faculty of Science as one of the most research intensive science faculties in Canada. Our professors have received many international and national awards including three NSERC Gerhard Herzberg Gold Medal winners and numerous Fellows of the Royal Society of Canada. The Faculty of Science, through its strategic use of infrastructure programs, hosts world-class Core Facilities and is at the leading edge for the study of Catalysis, Experimental and Computational Chemistry, Environmental Toxins, Nuclear Magnetic Resonance, Isotope Analysis, Molecular Biology and Genomics, X-Ray Spectrometry/Diffractometry, Geochemistry, Mass Spectrometry, Physiology and Genetics of Aquatic Organisms, and Photonics. The Faculty is also associated with the Fields Institute for research in mathematical science and the Centre de recherche

mathématiques (CRM) at the Université de Montréal, providing a unique setting for mathematical research.

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/study/graduate-studies/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

### BIO 5101 Topics in Biotechnology (3 units)

A course concerned with the utilization of biological substances and activities of cells, genes and enzymes in manufacturing, agricultural and service industries. A different topic will be selected each year. This course is equivalent to BIOL 5001 at Carleton University.

**Course Component:** Lecture

**Prerequisite:** A course in cell physiology or biochemistry, or permission of instructor.

### BIO 5102 Advanced Field Ecology (3 units)

Field experience in a new environment (e.g. local, national, international) to learn about ecological processes (note extra fees associated with course). This course is equivalent to BIOL 5605 at Carleton University.

**Course Component:** Lecture

### BIO 5104 Advances in Applied Biochemistry (3 units)

Contemporary methods of recombinant DNA technology combined with modern methods and strategies for expressing, secreting, purifying and characterizing proteins. This course is equivalent to BIOL 5004 at Carleton University.

**Course Component:** Lecture

### BIO 5105 Advanced Neuroethology (3 units)

A comparative and evolutionary approach to studying neural mechanisms underlying animal behaviour, including genetic, neural and hormonal influences on behaviour. This course is equivalent to BIOL 5801 at Carleton University.

**Course Component:** Lecture

**Prerequisites:** Biology 61.335 and 61.361 or equivalents and registration in a graduate program, or written permission of the department.

### BIO 5107 Seminar in Biochemistry I (3 units)

A graduate seminar on current topics in the field of Biochemistry. This course introduces the seminar format and involves student, faculty and invited seminar speakers. The student will present a seminar and submit a report on a current topic in Biochemistry. This course is equivalent to BIOL 5002 at Carleton University. Includes: Experiential Learning Activity

**Course Component:** Lecture

### BIO 5108 Bayesian Statistics for Biologists (3 units)

Introduction to the philosophy of Bayesian inference; practical experience applying to biological data. Model formulation, identification of appropriate priors and resulting posteriors given priors and data, and the practice of drawing inferences from these posteriors. This course is equivalent to BIOL 5408 at Carleton University.

**Course Component:** Lecture

**BIO 5109 Biological Data Science in R (3 units)**

Develops the practical skills needed to work with large and complex datasets, as a complement to statistical methods. Topics include programming, quality control, tidy data, visualization, project organization, reproducibility, how to troubleshoot code, and how to translate research goals into a project pipeline. This course is equivalent to BIOL 5404 at Carleton University.

**Course Component:** Lecture

**BIO 5111 Biophysical Techniques (3 units)**

Theory and application of current biochemical/biophysical instrumentation and techniques including X-ray crystallography, nuclear magnetic resonance spectrometry, infrared, circular dichroism and fluorescence spectroscopy, isothermal titration and differential scanning calorimetry. This course is equivalent to BIOL 5111 at Carleton University.

**Course Component:** Lecture

**BIO 5126 Analysis of Next-Generation Sequence Data (3 units)**

Assembly and analysis of next-generation sequence (NGS) data. Through hands-on exercises and independent projects, students will learn to use tools for quality control, assembly, mutation calling, and other NGS applications. No previous knowledge of bioinformatics or programming is required. This course is equivalent to BIOL 5526 at Carleton University.

**Course Component:** Lecture

**BIO 5128 Molecular Methods (3 units)**

An intensive two-week laboratory course where students are introduced to methods such as CRISPR-Cas9 genome editing, in situ hybridization, immunohistochemistry, qRT-PCR and digital droplet PCR.

**Course Component:** Theory and Laboratory

**BIO 5130 Ethnobotany and Ethnopharmacology (3 units)**

Introduction and current perspectives on world ethnobotanies, traditional knowledge, medicinal and food systems; quantitative and qualitative methods; ethical requirements; pharmacological basis of traditional drugs, phytochemistry, drug discovery and development; safety, risk assessment and regulations.

**Course Component:** Lecture

**BIO 5144 Plant Molecular Biology (3 units)**

An introduction to plant gene structure and function, cloning into plants and the manipulation of plant genes. The course will combine elements of plant biochemistry, physiology and molecular biology with a strong emphasis on practical research aspects. This course is equivalent to BIOL 5144 at Carleton University.

**Course Component:** Lecture

**BIO 5158 Applied Biostatistics (3 units)**

Applied biostatistics to real problems. Experimental design and data collection. Consequences of violating assumptions of different tests. Monte Carlo and Bootstrap analysis. Case studies and exercises in using statistical analysis packages. This course is equivalent to BIOL 5158 at Carleton University.

**Course Component:** Lecture

**BIO 5302 Methods in Molecular Genetics (3 units)**

Theory and associated applications of emerging methods in molecular genetics, including information gathered from large-scale genome-wide analysis and protein-protein interaction data, and how this information can advance understanding of cell biology. This course is equivalent to BIOL 5105 at Carleton University.

**Course Component:** Lecture

Prerequisites: Graduate standing and permission of the department.

**BIO 5305 Biostatistics I (3 units)**

Application of statistical analyses to biological data. Topics include ANOVA, regression, GLMs, and may include loglinear models, logistic regression, general additive models, mixed models, bootstrap and permutation tests. This course is equivalent to BIOL 5407 at Carleton University.

**Course Component:** Lecture

Prerequisites: Graduate standing, courses in elementary ecology and statistics and permission of the department.

**BIO 5306 Modelling for Biologists (3 units)**

Use and limitations of mathematical and simulation modelling approaches for the study of biological phenomena. This course is equivalent to BIOL 5409 at Carleton University.

**Course Component:** Lecture

**BIO 5308 Laboratory Techniques in Molecular Genetics (3 units)**

Laboratory course designed to give students practical experience in recent important techniques in molecular genetics. This course is equivalent to BIOL 5106 at Carleton University.

**Course Component:** Lecture

Prerequisites: Graduate standing and permission of the department.

**BIO 5310 Advanced Evolutionary Biology (3 units)**

Advances in micro-and macroevolution including the mechanisms both driving and constraining evolutionary change, phylogenetic relationships, patterns of evolutionary change at the molecular or phenotypic level, and evolutionary theory and techniques as applied to these areas. This course is equivalent to BIOL 5510 at Carleton University.

**Course Component:** Lecture

**BIO 5311 Advanced Evolutionary Ecology (3 units)**

The ecological causes and consequences of evolutionary change, focussing on how the ecological interactions among organisms and their biotic and abiotic environments shape the evolution of phenotypic and species diversity. This course is equivalent to BIOL 5511 at Carleton University.

**Course Component:** Lecture

**BIO 5312 Principles and Methods of Biological Systematics (3 units)**

Biological systematics with reference to morphological and molecular character evolution and phylogeny reconstruction.

**Course Component:** Lecture

**BIO 5313 Topics in Evolutionary and Comparative Biology (3 units)**

In the ever-diversifying field of evolutionary and comparative biology, it is becoming increasingly necessary for early-career researchers to cultivate a broad set of skills, eventually to launch a project of interdisciplinary nature. This course provides workshop and hands-on training for students to develop broad basis and familiarity with the research toolkit of modern biology. Topics include the use of statistical programs, 3D data acquisition and analysis, cladistic analysis and phylogenetic comparative method, microscopy and histology, basic bioinformatics, and scientific illustration. Each workshop will be led by a faculty expert. Offered in alternate years. This course is equivalent to BIOL 5313 at Carleton University.

**Course Component:** Lecture

**BIO 5314 Advances in Aquatic Sciences (3 units)**

Advanced theoretical and applied aquatic sciences including current topics in limnology and oceanography (e.g. impacts of climate change, invasive species, and atmospheric pollution) with implications for lake, river, coastal and wetland management. This course is equivalent to BIOL 5514 at Carleton University.

**Course Component:** Lecture



**BIO 5320 Advances in Conservation Biology (3 units)**

Interdisciplinary exploration of the science of scarcity and diversity in a human dominated world. This course is equivalent to BIOL 5520 at Carleton University.

**Course Component:** Lecture

**BIO 5558 Biostatistiques appliquées (3 crédits)**

Application des biostatistiques à des problèmes concrets. Design expérimental et échantillonnage. Impact des violations des hypothèses implicites d'application de divers tests. Analyse de Monte Carlo et Bootstrap. Études de cas et exercices d'utilisation de logiciels courants d'analyse statistique.

**Volet :** Cours magistral

**BIO 5950 Recherche et communication en biologie / Research and Communication in Biology (3 crédits / 3 units)**

Une introduction aux études supérieures en biologie en mettant l'accent sur les compétences centrales requises pour mener à bien des projets de recherche et développer les habiletés professionnelles requises. Le cours s'adresse aux étudiant.e.s débutant.e.s aux cycles supérieurs et sera composé de modules couvrant la rédaction scientifique et la communication orale, la gestion de projets de recherche, le développement de carrière et diverses compétences centrales requises dans les programmes d'études supérieures en biologie. / An introduction to graduate studies in biology with an emphasis on central skills required to successfully conduct research projects and develop required professional abilities. The course is intended for starting graduate students and will be composed of modules covering scientific writing and oral communication, research project management, career development and various central skills required in biology graduate programs.

**Volet / Course Component:** Séminaire / Seminar

**BIO 6103 Special Topics in Neuroscience (3 units)**

An in-depth study of current topics in neuroscience. Course content varies yearly and has recently included cognitive neuroscience, neuropharmacology, neurodegeneration, and behavioural medicine. Also listed as PSYC 6300. This course is equivalent to BIOL 6203 at Carleton University.

**Course Component:** Lecture

**BIO 6300 Advanced Science Communication (3 units)**

The theory and practice of effective science communication. Topics may include : writing for, presenting to, and engaging with diverse audiences, as well as graphic design and data visualization, social and digital media, and knowledge mobilization. Experiential Learning Activity: Applied Research. This course is equivalent to BIOL 6500 at Carleton University.

**Course Component:** Lecture

**BIO 6304 Techniques in Neuroscience (3 units)**

Completion of a research project carried out under the supervision of a neuroscience faculty member. The student will learn a new neuroscience technique and apply it to a research objective. May be repeated for different projects. Also listed as PSYC 6204. This course is equivalent to BIOL 6204 at Carleton University.

**Course Component:** Lecture

**BIO 6305 Advanced Seminar in Neuroscience (3 units)**

A comprehensive pro-seminar series, covering issues ranging from cellular and molecular processes through to neural systems and behaviours as well as psychopathology. Also listed as PSYC 6202. Courses BIO 6305, BIO 6303 (BIOL 6303) cannot be combined for units. This course is equivalent to BIOL 6305 at Carleton University.

**Course Component:** Lecture

**BIO 8102 Special Topics in Biology (3 units)**

Selected aspects of specialized biological subjects not covered by other graduate courses. This course is equivalent to BIOL 5502 at Carleton University.

**Course Component:** Laboratory, Lecture

**BIO 8105 Advances in Applied Ecology (3 units)**

The application of ecological and evolutionary principles in addressing resource management challenges and environmental problems. This course is equivalent to BIOL 5512 at Carleton University.

**Course Component:** Lecture

Permission of the Department is required.

**BIO 8108 Advanced Topics in Development (3 units)**

Recent advances in developmental biology. Topics may include embryonic induction, regulation of morphogenesis and differentiation, mechanisms of regional specification and pattern formation, and developmental genetics. This course is equivalent to BIOL 6505 at Carleton University.

**Course Component:** Lecture

**BIO 8109 Advanced Molecular Biology (3 units)**

In-depth coverage of the structure, function, and synthesis of DNA, RNA, and proteins. This course is equivalent to BIOL 6001 at Carleton University.

**Course Component:** Lecture

**BIO 8115 Genomics in Graduate Studies (3 units)**

Applying tools of genomics in the current research environment. Students will build an original research proposal that includes genomics analyses distinct from those they currently use. The goal of this course is to investigate how genomics (broadly defined) can help students tackle and/or uncover new interesting questions related to their current graduate research. This course is equivalent to BIOL 6115 at Carleton University.

**Course Component:** Lecture

**BIO 8116 Advances on Plant Molecular Biology (3 units)**

Use of molecular genetics in general plant biology and the contribution of plant genomics to our understanding of plant metabolism, plant development, and plant interactions with the environment at the molecular, genome, and cellular levels. This course is equivalent to BIOL 6002 at Carleton University.

**Course Component:** Lecture

Prerequisite: BIO 8109/61.601F1 and this course normally will be offered together in the same year but only in alternate years.

**BIO 8120 Directed Studies in Biology (3 units)**

One-on-one instruction in selected aspects of specialized biological subjects not covered by other graduate courses. Students may not take this course from their thesis supervisor(s), and are limited to one directed studies course per program. This course is equivalent to BIOL 5502 at Carleton University.

**Course Component:** Lecture

**BIO 8122 Advanced Insect Biology (3 units)**

Overview of the biological processes that allow insects to function in their environments and to overcome the constraints and limitations that the environment places on them. This course is equivalent to BIOL 5307 at Carleton University.

**Course Component:** Lecture

Prerequisite: In addition to the course material, students will write two terms papers (Alternate years).

**BIO 8162 Advanced Endocrinology (3 units)**

Major topics in comparative endocrinology: understanding the structure, function and evolution of vertebrate endocrine systems, including endocrine disruption. This course is equivalent to BIOL 5402 at Carleton University.

**Course Component:** Lecture

Prerequisite: An undergraduate Endocrinology course (BIO 4127 or equivalent).

**BIO 8303 Advanced Microscopy (3 units)**

Development of the practical skills of microscopy through original research and supporting theory lectures. This course is equivalent to BIOL 5203 at Carleton University.

**Course Component:** Lecture

Prerequisites: Open to 4th year and graduate students with consent of the instructor.

**BIO 8320 Advanced Plant Biology (3 units)**

Recent developments in plant biology. Topics may include plant anatomy, systematics, evolution, genetics, ecology, ethnobotany, cell biology, and/or biotechnology. This course is equivalent to BIOL 6300 at Carleton University.

**Course Component:** Lecture

Prerequisite: Biology 61.425 and Biology 61.426/427, or permission of the department.

**BIO 8361 Advanced Animal Physiology (3 units)**

Recent advances in animal physiology, emphasizing comparative, evolutionary and environmental approaches. This course is equivalent to BIOL 6304 at Carleton University.

**Course Component:** Lecture

**BIO 8365 Advanced Behavioural Ecology (3 units)**

Recent advances in behavioural ecology including topics such as the evolution of tactics and strategies of group living, foraging, anti-predation, resource use and defence, cooperation, reproduction, and parental care. This course is equivalent to BIOL 5802 at Carleton University.

**Course Component:** Lecture

**BIO 8510 Thèmes choisis en biologie (3 crédits)**

Aspects de sujets biologiques spécialisés qui ne sont pas couverts dans d'autres cours d'études supérieures.

**Volet :** Cours magistral

**BIO 8520 Études dirigées en biologie (3 crédits)**

Enseignement individualisé sur un sujet biologique spécialisé qui n'est pas couvert dans d'autres cours d'études supérieures. Il est interdit de suivre ce cours avec son directeur de thèse. Limite d'une seule étude dirigée par programme.

**Volet :** Cours magistral

**BIO 8910 Thèmes choisis en biologie / Special Topics in Biology (3 crédits / 3 units)**

Aspects de sujets biologiques spécialisés qui ne sont pas couverts dans d'autres cours d'études supérieures. / Selected aspects of specialized biological subjects not covered by other graduate courses.

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

Préquis : connaissance passive de l'anglais. / Prerequisite: Passive knowledge of French.

**BIO 8938 Interaction entre plantes et animaux / Plant Animal Interactions (3 crédits / 3 units)**

Les substances métaboliques secondaires des plantes et leur rôle en tant que phagorépresseurs ou phagostimulants pour les animaux et en tant qu'agents antifongiques ou allélopathiques. On discutera de la co-évolution des plantes et des organismes phytophages (insectes et mammifères) et des dimensions physiologique et écologique de cette relation. / Secondary metabolites of plants and their role as attractants or antifeedants to animals and as allelopathic or antifungal agents.

Emphasis will be placed on co-evolution of plants and phytophagous organisms such as insects and mammals, and the ecological and physiological dimensions of this relationship. Offered in alternate years.

Ce cours est équivalent à BIOL 6404 à la Carleton University. / This course is equivalent to BIOL 6404 at Carleton University.

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

**BIO 8940 Statistiques avancées et science ouverte / Advanced Statistics and Open Science (3 crédits / 3 units)**

Les analyses statistiques sont fondamentales à un processus scientifique rigoureux. Par conséquent, il est primordial de comprendre les statistiques et de reporter correctement les analyses pour améliorer la transparence et la qualité de la science. Le cours a pour objectifs: 1) d'améliorer la compréhension des modèles statistiques avancés (incluant les modèles mixtes généralisés); 2) de développer de bonnes habitudes pour coder (utilisation de R et Rmarkdown); 3) d'améliorer la gestion des données et du code statistique (manipulation de données et github); et 4) de présenter les principes de science ouverte (se basant sur OSF). / Statistics are a key component of rigorous science and as such there is a need to both understand advanced statistics and properly document the analysis to improve scientific communication transparency and quality. The course aims to 1) provide an understanding of advanced statistical models (including generalized linear mixed models), 2) develop good coding practices (using R and Rmarkdown), 3) improve data and code management (data manipulation and github) and 4) present the principles of open science (using OSF).

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

**BIO 8950 Recherche et communication en biologie / Research and Communication in Biology (3 crédits / 3 units)**

Une introduction aux études supérieures en biologie en mettant l'accent sur les compétences centrales requises pour mener à bien des projets de recherche et développer les habiletés professionnelles requises. Le cours s'adresse aux étudiant.e.s débutant.e.s aux cycles supérieurs et sera composé de modules couvrant la rédaction scientifique et la communication orale, la gestion de projets de recherche, le développement de carrière et diverses compétences centrales requises dans les programmes d'études supérieures en biologie. / An introduction to graduate studies in biology with an emphasis on central skills required to successfully conduct research projects and develop required professional abilities. The course is intended for starting graduate students and will be composed of modules covering scientific writing and oral communication, research project management, career development and various central skills required in biology graduate programs.

**Volet / Course Component:** Séminaire / Seminar

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

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

**BNF 5104 Bioinformatics Laboratory (3 units)**

Principles of organization, retrieval, manipulation, and analysis of molecular data in genomics, proteomics and transcriptomics. Hands-on analysis of these data to solve biological questions using quantitative and computational methods. This course is equivalent to BIOL 5104 at Carleton University. Prerequisites: Graduate standing and permission of the instructor

**Course Component:** Laboratory

**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