

# BIOLOGICAL SCIENCES

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## Biological Sciences

Biology is one of the most rapidly evolving and diverse sciences in the modern world, exploring all aspects of life from biomolecules to ecosystems. The Department of Biological Sciences is committed to advancing our understanding of biological structure and function, and developing new tools and technologies to address current and emerging problems facing all living organisms. Connections will be forged between molecules, cells, tissues, organs, organisms, populations, communities, and ecosystems, highlighting the need to explore all levels of biological interactions. Programs emphasize the organism as the key element in studies of the development and evolution of form and function, and the role in adaptations to the environment. Based on a core of fundamental biological principles, our programs explore diverse areas such as organismal biology, environmental biology, genetics, cell biology and development, physiology, ecology, behaviour, and systematics and evolution. The Department focuses on the integration of research and teaching expertise to create opportunities for growth and novel synergisms in the training of future leaders in the field.

### Biological Sciences Theme Areas

#### Cell, Molecular and Developmental Biology

Students in the Department of Biological Sciences with an interest in the exciting field of cell and developmental biology can select the Cell, Molecular, and Developmental Biology theme for focus. This theme will provide students a selection of courses that highlight fundamental principles and many important advances in this rapidly growing area of contemporary biology. Students can concentrate on aspects that deal with the molecular structures and processes of cellular life and their roles in the function, reproduction, and development of living organisms. The theme is structured such that students can choose from a broad range of disciplines, including biochemistry, molecular biology, morphology, genetics, cell biology, and developmental biology. The organisms under study in this theme are equally diverse, ranging from microbes through to invertebrates, vertebrates, plants, and fungi. The Department collaborates with many other life sciences departments and this theme allows student to develop a highly flexibly course portfolio that includes courses from the Departments of Biological Sciences, Chemistry, Microbiology, or Plant Science.

#### Specific courses required for the Cell, Molecular, and Developmental Biology Theme in addition to the core course requirements:

Course	Title	Hours
BIOL 3542	Developmental Biology	3
CHEM 1110	Introductory Chemistry 2: Interaction, Reactivity, and Chemical Properties	3
9 credit hours of Biochemistry - A or B: <sup>1</sup>		9
A:		
CHEM/MBIO 2700	Biochemistry 1: Biomolecules and an Introduction to Metabolic Energy	

CHEM/MBIO 2710	Biochemistry 2: Catabolism, Synthesis, and Information Pathways <sup>2</sup>
CHEM 2720	Principles and Practices of the Modern Biochemistry Laboratory
B:	
CHEM/MBIO 2730	Elements of Biochemistry 1
CHEM 2740	Introduction to the Biochemistry Laboratory
CHEM/MBIO 2750	Elements of Biochemistry 2

- Students are strongly recommended to complete the biochemistry requirements in their second year.
- The CHEM 2710 or MBIO 2710 prerequisite of CHEM 2100 can be used to fulfill the additional course from the list in the program grid.

#### Ecology and Environmental Biology

Ecology is the study of interactions between organisms and their environment, both in natural settings and human-influenced habitats. In our society ecology and environmental biology provides a scientific link to the living world. Ecologists study the lives of many organisms including animals, plants, fungi, protists, and bacteria. Interactions among these organisms are investigated at many scales ranging from the microscopic to the global. At the individual level, ecology investigates the impact of environmental factors on organisms through their physiology and behaviour. Ultimately, ecologists link these factors to survival and reproduction in variable environments. At the population level, ecology examines the causes of fluctuations in numbers and changes in distribution of a single species. This work is often the focus of agencies concerned with exploitation, extinction, and rehabilitation of both commercially and esthetically important species. At the community and ecosystem level, ecology considers many coexisting species. It examines the interactions between species within the communities (competition, predation, parasitism, mutualism, etc.) as well as broader investigations of community structure and composition. Ultimately, the skills developed within this theme prepare students for future careers in academia, government agencies, private consulting companies, or NGOs whose mandates encompass ecological and environmental concerns.

#### Specific courses required for the Ecology and Environmental Biology Theme in addition to the core course requirements:

Course	Title	Hours
BIOL 3310	Foundations of Population Ecology	3
BIOL 3312	Community Ecology	3
BIOL 3314	Field Ecology	3
STAT 2150 or STAT 2000	Statistics and Computing Basic Statistical Analysis 2	3

#### Environmental and Integrative Physiology

The Environmental and Integrative Physiology theme will be of interest to a wide array of students interested in pursuing employment opportunities in the Environmental, Consulting, Pharmaceutical, Healthcare, and Professional job markets. Based on the suggested courses and sub themes within this program students will be able to graduate with an all inclusive degree or specialize in particular disciplines ranging from molecular physiology to whole organism physiology and eco/ environmental physiology, a subject area that is at the interface between ecology and physiology. Students will be exposed to modern research techniques in lab classes and will be taught by instructors and faculty

with active research programs within the Department of Biological Sciences.

**Specific courses required for the Environmental and Integrative Physiology Theme in addition to the core course requirements:**

Course	Title	Hours
CHEM 1110	Introductory Chemistry 2: Interaction, Reactivity, and Chemical Properties	3
9 credit hours of Biochemistry - A or B:		9
A:		
CHEM/MBIO 2700	Biochemistry 1: Biomolecules and an Introduction to Metabolic Energy	
CHEM/MBIO 2710	Biochemistry 2: Catabolism, Synthesis, and Information Pathways	
CHEM 2720	Principles and Practices of the Modern Biochemistry Laboratory	
B:		
CHEM/MBIO 2730	Elements of Biochemistry 1	
CHEM 2740	Introduction to the Biochemistry Laboratory	
CHEM/MBIO 2750	Elements of Biochemistry 2	
Plus two additional courses from the following:		6
BIOL 3470	Environmental Physiology of Animals 1	
BIOL 3472	Environmental Physiology of Animals 2	
BIOL 3400	Plant Physiology	
BIOL 3452	Environmental Plant Physiology	

### Evolution and Biodiversity

Evolution is broadly defined as “descent with modification” and is the process that generates the earth’s biodiversity. The theory of evolution provides a unifying framework for biology because all organisms are descended from a common ancestor. As a result, evolutionary principles permeate research and teaching throughout biology.

Evolutionary biology addresses two overarching questions:

1. What was the history of life?
2. What processes account for adaptation and diversification?

Systematics reconstructs the history of life by studying relationships among species, and involves comparisons of physical appearance, development, biochemistry, genetics, behaviour, ecology and biogeography. Evolutionary Genetics investigates how processes such as natural selection, mutation, and migration interact to cause evolutionary change within populations. Evolutionary history, genetics, and ecological context are required to fully understand the evolution of traits, for example body size, wing shape or leaf structure. Thus evolution integrates knowledge from a wide spectrum of sub-disciplines within biology.

Evolutionary biology has wide-ranging practical applications. Principles of evolution are required to understand: the evolution of pathogens such as HIV and avian influenza; domestication of wild species and consequences of genetic modifications; the identification of natural products; long-term responses to environmental change; and human biology. Courses from this theme will prepare students for academia, medicine, and government agencies or NGO’s that emphasize the cataloguing and conservation of biological diversity.

**Specific courses required for the Evolution and Biodiversity Theme in addition to the core course requirements:**

Course	Title	Hours
STAT 2150	Statistics and Computing	3
or STAT 2000	Basic Statistical Analysis 2	
One of the following Evolutionary Processes courses:		3
BIOL 3360	Animal Behaviour	
BIOL 4300	Evolution and Adaptation	
BIOL 4362	Behavioural Ecology and Cognitive Ethology	
BIOL 4510	Evolutionary Genetics	
One of the following Biodiversity courses:		3
BIOL 3200	Advanced Invertebrate Biology	
BIOL 3242	Vascular Flora of Manitoba	
BIOL 3250	Lichens and Bryophytes	
BIOL 3270	Introductory Parasitology	
BIOL 3340	Biology of Primitive Fungi and Allies	
BIOL 4212	Systematics and Biogeography of Fishes	
BIOL 4214	Biology of Amphibians and Reptiles	
BIOL 4216	Biology of Birds	
BIOL 4218	Biology of Mammals	

### Integrative Biology

The Integrative Biology theme will be of interest to students planning to pursue careers in the various biology sub disciplines and who wish an undergraduate degree that is “interdisciplinary” within the life science departments that cuts across the traditional boundaries. This program will suit students who are interested in the “after degree” program in Education or who are intending to apply to a professional program (e.g. Medicine, Dentistry, Pharmacy, Medical Rehabilitation) and who would like a broad background in the Life Sciences. With the appropriate choice of Biological Science courses it would be possible to indicate the Integrative Biology theme along with a second theme from the department.

**Specific courses required for the Integrative Biology Theme in addition to the core course requirements:**

Course	Title	Hours
CHEM 1110	Introductory Chemistry 2: Interaction, Reactivity, and Chemical Properties	3
MBIO 1010	Microbiology I	3
6 credit hours from A or B:		6
A:		
CHEM/MBIO 2700	Biochemistry 1: Biomolecules and an Introduction to Metabolic Energy	
CHEM/MBIO 2710	Biochemistry 2: Catabolism, Synthesis, and Information Pathways	
CHEM 2720	Principles and Practices of the Modern Biochemistry Laboratory	
B:		
CHEM/MBIO 2730	Elements of Biochemistry 1	
CHEM 2740	Introduction to the Biochemistry Laboratory	
CHEM/MBIO 2750	Elements of Biochemistry 2	
12 credit hours of second-year program courses including:		12

BIOL 2200	The Invertebrates	One of the following:	3
BIOL 2210	The Chordates	BIOL 3400	Plant Physiology
BIOL 2240	The Non-Flowering Plants	BIOL 3470	Environmental Physiology of Animals 1
BIOL 2242	The Flowering Plants	BIOL 3472	Environmental Physiology of Animals 2
BIOL 2260	Biology of Fungi and Lichens	24 credit hours in Biological Sciences (3000/4000 level courses)	24
BIOL 2262	Biology of Algae	6 credit hours in Microbiology (3000/4000 level courses)	6
BIOL 2420	Human Physiology 2		
BIOL 2600	Introduction to Computational Biology		

## Programs

Degree/Diploma	Years to Completion	Total Credit Hours	Has Co-op Option
Biological Sciences, B.Sc. Honours ( <a href="https://catalog.umanitoba.ca/undergraduate-studies/science/biological-sciences/biological-sciences-bsc-honours/">https://catalog.umanitoba.ca/undergraduate-studies/science/biological-sciences/biological-sciences-bsc-honours/</a> )	4	120	Yes
Biological Sciences, B.Sc. Major ( <a href="https://catalog.umanitoba.ca/undergraduate-studies/science/biological-sciences/biological-sciences-bsc-major/">https://catalog.umanitoba.ca/undergraduate-studies/science/biological-sciences/biological-sciences-bsc-major/</a> )	4	120	Yes
Biological Sciences Minor ( <a href="https://catalog.umanitoba.ca/undergraduate-studies/science/biological-sciences/biological-sciences-minor/">https://catalog.umanitoba.ca/undergraduate-studies/science/biological-sciences/biological-sciences-minor/</a> )		18	