



# **BIOL\*4010 Adaptational Physiology**

Winter 2020

Section(s): C01

Department of Integrative Biology

Credit Weight: 0.50

Version 1.00 - November 01, 2019

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## **1 Course Details**

### **1.1 Calendar Description**

This course examines adaptations of organisms to various aquatic and terrestrial environments. A mechanistic approach will be used to establish the strategies (anatomical, physiological, biochemical) of environmental adaptation. Examples will include adaptations of deep-sea and polar organisms, adaptations to salinity and desiccation challenges, oxygen availability, sensory adaptations and symbiotic adaptations.

**Co-Requisites:** ZOO\*3210 or ZOO\*3620

### **1.2 Course Description**

This course will provide an in depth coverage of strategies of adaptation of organisms to various environmental conditions. The course will be of value to students interested in the physiological and biochemical basis for the effects of changing environmental conditions on living things. Environmental constraints and the limits of adaptation will provide the underlying framework for the course. The evolution of adaptive processes as well as phenotypic adaptation will be examined. Examples of recently published research will be used to familiarize students with developing areas, analytical techniques and the investigative approaches used in studying environmental adaptation. Biomedical applications of some of these natural phenomena will be discussed.

### **1.3 Timetable**

Tuesday and Thursday 11:30 – 12:50 AM MINS 106

### **1.4 Final Exam**

Exam time and location is subject to change. Please see WebAdvisor for the latest information.

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## 2 Instructional Support

### 2.1 Instructional Support Team

<b>Instructor:</b>	Jim S. Ballantyne
<b>Email:</b>	jballant@uoguelph.ca
<b>Telephone:</b>	+1-519-824-4120 x52708
<b>Office:</b>	SC1 3465
<b>Office Hours:</b>	Please email to make an appointment.

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## 3 Learning Resources

### 3.1 Recommended Resources

#### **Environmental Physiology of Animals (Textbook)**

Environmental Physiology of Animals. 2nd edition. 2005. Willmer, P., Stone, G. and Johnston, I. Blackwell Science Limited.

#### **Biochemical Adaptation: Response to environmental challenges from life's origins to the Anthropocene (Textbook)**

Biochemical Adaptation: Response to environmental challenges from life's origins to the Anthropocene. 2017. Somero, G.N. et al. Sinauer Associates.

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## 4 Learning Outcomes

### 4.1 Course Learning Outcomes

By the end of this course, you should be able to:

1. Understand the mechanisms involved in adaptation of a variety of aquatic and terrestrial invertebrates and vertebrates to changing temperature, salinity, high pressure, high altitude and low nutrient availability. They will be able to extrapolate this information to novel situations.
2. Understand how such adaptations may have evolved.
3. Provide examples of how recent research in comparative animal physiology has contributed to our understanding of basic science (e.g. structure-function relationships, acclimation/acclimatization changes) and applied science (e.g. aquaculture, global climate change).
4. Understand the use of some of the tools and instruments employed in studying

environmental adaptation.

5. Write a coherent and concise essay relating to environmental adaptation using the primary literature.
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## 5 Teaching and Learning Activities

Lecture material (PDFs of Powerpoint presentations) will be available online via Courselink at least the day before the lecture. These PDFs do not contain all the information conveyed in the lectures. Attendance at all lectures is highly recommended.

### 5.1 Topics Covered (Subject to Modification)

#### Introduction

1. Constraints on life in water and on land. The environmental factors that affect the survival of organisms.
2. Changing environmental conditions during the evolution of life.
3. What drives organisms to adapt?
4. How much environmental change is needed to drive adaptation?
5. What evolutionary constraints limit the ability to adapt?
6. Stress and adaptation.
7. What is regulated? Homeostasis vs enantiostasis.

#### Temperature

1. Introduction and background
2. Freezing tolerance of terrestrial insects and vertebrates (nucleating proteins, cryoprotectants).
3. Freezing avoidance by Arctic and Antarctic teleost fish (antifreeze molecules).
4. Adaptation to changing environmental temperatures (heat shock proteins, enzymes, membranes, pH changes and alphasat regulation).
5. Biomedical implications of diets rich in marine mammals and cold water fishes.

#### Life in the Abyss

1. Adaptation to high or changing pressure.
2. Buoyancy regulation in deep-sea cephalopods, crustaceans, fishes and marine mammals.

3. Metabolic adaptations of hydrothermal vent and cold seep organisms.

### **Osmotic Adaption**

1. Adaptation to high salt environments (halophilic bacteria, plants and animals).
2. Adaptation to changing salinity. Solute systems of marine invertebrates and lower vertebrates.
3. Desiccation tolerance (intertidal and desert organisms).

### **Living with too Little or too Much Oxygen**

1. Too little oxygen. Anaerobic metabolism of anoxia tolerant marine invertebrates, fish and marine mammals.
2. Life at high altitude: humans (Sherpas, Quechua), other mammals (llamas, alpacas) and birds.
3. Too much oxygen (e.g. tidepool anemones, corals, cold water organisms)

### **Metabolic Depression as Adaptation to Various Conditions**

1. Estivation in lungfish and snails.
2. Hibernation in mammals.
3. Dormant embryonic stages (Brine shrimp, annual fish, delayed implantation of mammalian embryos).

### **Sensory Adaptations**

1. Visual pigments and depth.
2. Echolocation and acoustical lipids of marine mammals.

### **Symbiosis**

1. Adaptation to reduced energy and/or nutrient availability (tropical coral reefs, giant clams and hydrothermal vent and cold seep organisms).
2. Digestive deficiencies. (shipworms, termites).

### **Evolutionary Considerations**

1. Evolution of adaptive mechanisms (e.g. evolution of antifreeze molecules).
2. Salinity-related allele selection.
3. Toxins and toxin resistance.

### **Climate Change and Conservation**

1. Adaptation to anthropogenic environmental challenges.
  2. Stress physiology and environmental challenges.
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## **6 Assessments**

### **6.1 Marking Schemes & Distributions**

<b>Name</b>	<b>Scheme A (%)</b>
Midterm Examination	30
Writing Assignment	25
Final Exam	45
Total	100

### **6.2 Assessment Details**

#### **Midterm Examination (30%)**

**Date:** Thu, Feb 14, In class

#### **Writing Assignment (25%)**

**Date:** Thu, Feb 28

Values 25% Details TBA

#### **Final Exam (45%)**

**Date:** TBA, TBA

Value 45%

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## **7 Course Statements**

### **7.1 Late Policy**

Work that is handed in late will be penalized 10% for every day that it is late.

### **7.2 Absence & Illness**

If you are absent from classes during the semester, you will be expected to make up missed lecture material on your own. If requesting academic consideration on medical or compassionate grounds, be prepared to provide supporting documentation. Be sure to obtain a written statement of your revised grade evaluation from the instructor. See the undergraduate calendar for information on regulations and procedures for Academic consideration.

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

## 8 Department of Integrative Biology Statements

### 8.1 Academic Advisors

If you are concerned about any aspect of your academic program:

- Make an appointment with a program counsellor in your degree program. [B.Sc. Academic Advising](#) or [Program Counsellors](#)

### 8.2 Academic Support

If you are struggling to succeed academically:

- Learning Commons: There are numerous academic resources offered by the Learning Commons including, Supported Learning Groups for a variety of courses, workshops related to time management, taking multiple choice exams, and general study skills. You can also set up individualized appointments with a learning specialist. <http://www.learningcommons.uoguelph.ca/>
- Science Commons: Located in the library, the Science Commons provides support for physics, mathematic/statistics, and chemistry. Details on their hours of operations can be found at: <http://www.lib.uoguelph.ca/get-assistance/studying/chemistry-physics-help> and <http://www.lib.uoguelph.ca/get-assistance/studying/math-stats-help>

### 8.3 Wellness

If you are struggling with personal or health issues:

- Counselling services offers individualized appointments to help students work through personal struggles that may be impacting their academic performance. <https://www.uoguelph.ca/counselling/>
- Student Health Services is located on campus and is available to provide

medical attention. <https://www.uoguelph.ca/studenthealthservices/clinic>

- For support related to stress and anxiety, besides Health Services and Counselling Services, Kathy Somers runs training workshops and one-on-one sessions related to stress management and high performance situations. <http://www.selfregulationskills.ca/>

## 9 University Statements

### 9.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

### 9.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Graduate Calendar - Grounds for Academic Consideration

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions

<https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml>

### 9.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>

Graduate Calendar - Registration Changes

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml>

Associate Diploma Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml>

## 9.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

## 9.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to book their exams at least 7 days in advance and not later than the 40th Class Day.

For Guelph students, information can be found on the SAS website

<https://www.uoguelph.ca/sas>

For Ridgetown students, information can be found on the Ridgetown SAS website

<https://www.ridgetownc.com/services/accessibilityservices.cfm>

## 9.6 Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity, and it is the responsibility of all members of the University community—faculty, staff, and students—to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff, and students have the responsibility of supporting an environment that encourages academic integrity. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

Undergraduate Calendar - Academic Misconduct

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08->



amisconduct.shtml

Graduate Calendar - Academic Misconduct

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

## **9.7 Recording of Materials**

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

## **9.8 Resources**

The Academic Calendars are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars

<https://www.uoguelph.ca/academics/calendars>

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