

# Laboratory in Comparative Animal Physiology Syllabus

## Department of Biology

BIOL/MARI 3371 Winter 2025

*Dalhousie University acknowledges that we are in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People and pays respect to the Indigenous knowledges held by the Mi'kmaq People, and to the wisdom of their Elders past and present. The Mi'kmaq People signed Peace and Friendship Treaties with the Crown, and section 35 of the Constitution Act, 1982 recognizes and affirms Aboriginal and Treaty rights. We are all Treaty people.*

*Dalhousie University also acknowledges the histories, contributions, and legacies of African Nova Scotians, who have been here for over 400 years.*

### Course Instructor

Name	Email	Office Hours
Dr. Margaret Cooper	Margaret.Cooper@dal.ca	LSC 4130; by appointment

### Course Description

This laboratory intensive course will provide opportunities for students to experience firsthand the role that experimentation, and data collection, interpretation, and communication plays in our understanding of how animals function. Vertebrate and invertebrate examples are used, in a comparative approach, to study a variety of physiological processes. NOTES: Laboratory experiments involve live invertebrates and/or vertebrate tissues. Students are required to handle live invertebrates during the lab.

**PREREQUISITES:** BIOL 3078 or MARI 3074 or BIOL 3370 or MARI 3370; CHEM 1011 and CHEM 1012; STAT 1060 or STAT 2060

**EXCLUSIONS:** BIOL 3079, MARI 3076

### Course Structure

Course delivery and all examinations will be in-person.

**Lectures:** Three hours per week

**Laboratories:** Three hours most but not all weeks

**Statement of Respect:** You are encouraged to speak up and participate during class meetings and on our Brightspace discussion board. Students in the class will have a diversity of

backgrounds, experiences, and knowledge. Every member of the class must show respect for every other member of the class.

**Communication:** Good communication between the instructor and students is key to the success of students in a course. I will do my best to respond to your emails within 24 hours except over the weekend when it will be 48 hours.

## Course Materials

Hill, R., G. Wyse and M. Anderson. *Animal Physiology*. Fifth edition. 2021.

*You will be able to access the e-textbook inside Brightspace. All you need to do is click on the link to the e-textbook. You can access your course material for free any time before the add-drop deadline. If you have any questions, please feel free to reach out to [support@willolabs.com](mailto:support@willolabs.com).*

I also recommend that you consider purchasing the text ***A Student Handbook for Writing in Biology; 6<sup>th</sup> ed., 2021 by Karin Knisely***. This text is a very good reference to consult when writing your formal reports.

Most of the labs will use sensors and data recording equipment from iWorx. The software used by this equipment is called LabScribe and is free from iWorx and will be available during our first lab session. Students will need a computer onto which they can download the LabScribe software. It will be best if that computer is a laptop that can be brought to lab and tutorial. If that is not possible, please contact me as soon as possible.

## Assessment

Assessment	Value	Due
Data Analysis Assignment	3%	January 24
Pre-Lab Assignments	12% (2% each)	Six throughout term
Data Reports	30% (5% each)	Six throughout term
Midterm Test	10%	February 12
Formal Report	15%	March 21
Final Exam	30%	Exam Period

***Conversion of numerical grades to final letter grades follows the Dalhousie Grade Scale***

Grade	Mark	Definition	
A+ A A-	90-100 85-89 80-84	Excellent	Considerable evidence of original thinking; demonstrated outstanding capacity to analyze and synthesize; outstanding grasp of subject matter; evidence of extensive knowledge base.
B+ B B-	77-79 73-76 70-72	Good	Evidence of grasp of subject matter, some evidence of critical capacity and analytical ability; reasonable understanding of relevant issues; evidence of familiarity with the literature.
C+ C C-	65-69 60-64 55-59	Satisfactory	Evidence of some understanding of the subject matter; ability to develop solutions to simple problems; benefitting from his/her university experience.
D	50-54	Marginal Pass	Evidence of minimally acceptable familiarity with subject matter, critical and analytical skills (except in programs where a minimum grade of 'C' is required).
F	0-49	Inadequate	Insufficient evidence of understanding of the subject matter; weakness in critical and analytical skills; limited or irrelevant use of the literature.

### **Course Policies on Missed or Late Academic Requirements**

Open communication is essential for a positive learning experience. I will be communicating with you regularly, and hope that you will feel comfortable asking for help when you need it.

To avoid any misunderstanding or confusion during the term, please note the following policies. These regulations have been put in place to try to ensure fair and equal treatment for all. Extenuating circumstances can arise, however, so please feel free to talk to me if you have problems with any of these regulations at any time during the term.

#### *Exams*

**Please inform me in advance, or as soon as possible after,** if you are unable to attend an exam. Make-up exams will be given **within one week** of the scheduled exam date, at a mutually convenient time if possible. *The weight of missed exams will not be redistributed to another exam.* A Self-Declaration of Absence (SDA) will be required if you need to write a make-up midterm exam, but as per University policy, SDA forms cannot be used in relation to the final exam. Make-up final exams will only be provided in the case of illness or extreme circumstances.

### *Assignments*

Participation in the laboratory is integral to your learning in this course. If you cannot attend your regular lab section during a particular week, please contact me in advance to arrange attending one of the others, where possible.

The purpose of the Pre-Lab Assignments is to ensure that you come to lab well prepared. **An SDA form cannot be used for Pre-Lab Assignments.** An SDA form can be used to gain a maximum three-day extension on a Data Report or the Formal Report.

Assignments submitted late, without an arranged extension, will receive a late penalty of **10% per day** up to 5 days late. Assignments more than 5 days late will not be accepted.

***Only TWO SDA forms in total may be used throughout the term.***

SDA forms are meant to deal with short term illnesses. If a circumstance arises that affects your ability to participate in the course over a longer term, contact me as soon as possible to discuss options for rescheduling assessments.

### **Course Policies related to Academic Integrity**

You are expected to abide by Dalhousie University's policies on academic integrity.

I encourage you to work with classmates to help each other learn the content of the class. The discussion boards will be particularly important for asking questions and receiving help.

***However, all assignments that you submit must be independent and entirely your own wording.*** You can work together to understand content, but assignments must be your own work. Paraphrasing appropriately from source material is an important skill that you should be learning. If this is something that you struggle with, I encourage you to work with the Writing Centre to develop this skill. This class subscribes to a Brightspace Learning web-based service that checks for originality in submitted work. This service will be used for all assignments.

Generative AI and large language model (LLM) based websites (e.g. ChatGPT) deserve special mention. **I do not consider content generated by ChatGPT, or something similar, to be your own work.** It is also not possible to properly cite content generated by these sites. As such, using LLM generated content in your assignments is not appropriate in this course. The data report and formal report assignments are designed to teach you important data analysis, interpretation, and communication skills. Taking short cuts in the production of these assignments undermines your learning.

If, for any reason, an exam cannot take place in a proctored setting, please remember that it is an independent assessment. You may consult your notes, textbook, or other course content, but you cannot collaborate with classmates or post questions to external websites. By accessing an exam, you are acknowledging that the work submitted is solely of your own efforts.

The contents of the assessments in the course are the property of BIOL/MARI 3371 and are confidential. You may not share the contents of these assessments on 'homework sharing' websites, (e.g. Chegg, Course Hero, Studocu, etc.)

### **Copyright Notice:**

All course materials are designed for use as part of BIOL/MARI 3371 at Dalhousie University and are the property of the course instructor. This includes all images, videos, documents, assignments and exams. These documents are solely for your learning and evaluation in BIOL/MARI 3371. It is an academic offence to share these materials outside of this course space in such a way that others might gain an unfair advantage, and students who do so may be subject to University discipline. Copying this material for distribution may also lead to a violation of Copyright law.

### **Assumed Learning Outcomes**

Students are expected to possess the following knowledge and skills from prerequisite courses:

- Describe mechanisms used by animals to exchange gases with their external environment, highlighting form and function in respiratory systems of a variety of animals. (BIOL 1011)
- Describe the long-distance transport of materials within animal bodies, highlighting form and function in circulatory systems of a variety of animals. (BIOL 1011)
- Describe mechanisms of osmoregulation and thermoregulation in a variety of animals (BIOL 1011)
- Describe how physiological processes underlie life history variation in wild animals (BIOL/MARI 3370)
- Describe the role that environment and climate play in physiological processes (BIOL/MARI 3370)
- Explain the integration of the sciences at the physiological level from molecules to populations. (BIOL/MARI 3370)
- Provide examples of adaptations and diversity of physiology across terrestrial and marine phyla (BIOL/MARI 3370)
- Define and give examples of homeostasis (BIOL/MARI 3370)
- Describe the structure of striated and smooth muscle tissue and explain how it functions

(BIOL/MARI 3370)

- Explain neuronal function and signal transmission (BIOL/MARI 3370)
- Relate how nerves and muscles coordinate to allow for movement (BIOL/MARI 3370)
- Outline basic endocrine functioning (BIOL/MARI 3370)
- Demonstrate understanding of laboratory safety and laboratory techniques including pipetting, titrating, and centrifuging (CHEM 1011)
- Practice proper laboratory techniques including pipetting, spectroscopy, and separations (centrifuging and column chromatography), while maintaining safety standards in the context of a chemical laboratory (CHEM 1012)

## Learning Outcomes

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

- Define metabolic rate, identify factors affecting an animal's metabolic rate, and describe methods used for its measurement.
- Use a dissolved oxygen electrode, and specialized software, to measure changes in the oxygen concentration of water containing an aquatic invertebrate.
- Calculate the oxygen consumption rate of an aquatic invertebrate from measures of dissolved oxygen concentration taken over time.
- Graph oxygen consumption rate vs. size for an aquatic invertebrate, based on data collected in lab.
- Relate an animal's maximum rate of oxygen consumption to parameters affecting fitness as well as strenuousness of exercise.
- Relate the diffusion of oxygen and carbon dioxide in air and aqueous solutions to the respiratory physiology of air breathing and water breathing animals.
- Describe the importance of the relationship between the flow of blood and the flow of respiratory fluid in breathing organs, comparing the effectiveness of various arrangements.
- Calculate and compare the ventilatory requirements of air breathers and water breathers.
- Describe the anatomy and physiology of breathing in a variety of animal groups.
- Use a spirometer and specialized software to measure various lung volumes and breathing rate in humans before and after exercise.
- Estimate oxygen consumption rates in humans from spirometry data collected in lab and convert these to estimates of metabolic rate.
- Describe the role of respiratory pigments and how their structure affects the shape of oxygen equilibrium curves.
- Measure hematocrit and hemoglobin concentration from samples of animal blood.
- Interpret oxygen equilibrium curves in terms of oxygen affinity and oxygen carrying capacity; describe factors that affect both these characteristics.
- Describe the various ways in which carbon dioxide is transported in the blood of animals.
- Describe the structure of cardiac muscle and relate the electrical and molecular events of cardiac action potentials.
- Describe the mechanical and electrical events of the cardiac cycle.

- Use a force transducer and specialized software to measure the effect of stimulatory and inhibitory neurotransmitters on the heart rate and force of contraction in a bivalve heart.
- Relate pressure, resistance, and flow within vascular systems.
- Describe the anatomy and physiology of circulation in a variety of animal groups.
- Using ECG, pulse oximeter, and blood pressure equipment, measure blood pressure, blood oxygen saturation, and heart rate in humans before and after exercise.
- Calculate cardiac output for humans before and after exercise, based on data collected in lab.
- Define and differentiate between muscle twitch, summation, and tetanus. Explain how nervous stimulus leads to each.
- Use a force transducer and specialized software to measure the effect of electrical stimulus and neurotransmitters on contraction and relaxation of a bivalve muscle.
- Describe the compartmentalization and composition of body fluid in animals.
- Explain how osmotic, ionic, and volume regulation are achieved in freshwater, marine, and terrestrial animals.
- Measure the osmolarity of coelomic fluid from an echinoderm species to observe the animals' short-term osmoregulatory response to seawater of higher or lower than normal osmolarity.
- Measure the osmolarity of coelomic fluid from two species of crabs, after a period of acclimation to seawater of higher or lower than normal osmolarity, to observe the different osmoregulatory capabilities of the two species.
- Demonstrate safe behaviour, with respect to chemicals and equipment, in a laboratory setting.
- Demonstrate safe and ethical handling of animals in a laboratory setting.
- Collaborate with other students to collect qualitative and quantitative data in laboratory experiments.
- Use R to statistically analyze and present physiological data collected in lab.
- Interpret physiological data and practice written communication skills to produce data reports and formal reports.
- Conduct literature and online searches of primary and secondary sources using electronic databases and online search tools.

## Course Content

Date	Lecture	Labs	Assessments and Due Dates
Jan	6 Course Introduction and Animal Energetics	No Lab	
	8 Animal Energetics cont.		
	10 Measuring Metabolic Rate		
	13 Metabolic Scaling Relationships	Introduction to LabScribe and R for Data Analysis	
	15 External Respiration		
	17 External Respiration cont.		
	20 Ventilatory Requirements of Air and Water Breathers	Lab 1: Oxygen Consumption vs. Size	Pre-lab Assignment 1 (2%) - Due 11:59pm, Jan 19
	22 Breathing in Terrestrial Animals		
	24 Breathing in Fish and Aquatic Invertebrates		Data Analysis Assignment (3%) - Due 11:59pm, Jan 24
	27 Blood Gas Transport	Lab 2: Oxygen Consumption in Mammals	Pre-lab Assignment 2 (2%) - Due 11:59pm, Jan 26
	29 Blood Gas Transport cont.		
	31 Hearts		Data Report 1 (5%) - Due 11:59pm, Jan. 31
Feb	3 Hearts cont.		Lab 3: Neurotransmitter Effects on Molluscan Hearts
	5 Hearts cont.		
	7 Munro Day	Data Report 2 (5%) - Due 11:59pm, Feb 7	
	10 Exam Review	No Lab	
	12 <b>Midterm Exam (Through Breathing in Fish...10%)</b>		
	14 Principles of Pressure, Resistance, and Flow		Data Report 3 (5%) - Due 11:59pm, Feb 14
	17-21 Reading Break		
	24 Circulation in Mammals and Birds	Lab 4: Blood Gas Transport, Mammalian ECG and Cardiac Output	Pre-lab Assignment 4 (2%) - Due 11:59pm, Feb 23
	26 Circulation in Fish, Amphibians, and Reptiles		
	28 Circulation in Invertebrates		
Mar	3 Muscles 1	No Lab	
	5 Muscles 2		
	7 Full Report Options		Data Report 4 (5%) - Due 11:59pm, Mar 7
	10 Full Report Work Period	No Lab	
	12 Muscles 3		
	14 Full Report Work Period		
	17 Full Report Work Period		
	19 Water and Salt Physiology: Intro and Mechanisms	Lab 5: Mytilus Anterior Byssal Retractor Muscle	Pre-lab Assignment 5 (2%) - Due 11:59pm, Mar 16
	21 Ionic and Osmotic Adaptations in Aquatic Animals		Full Report (15%) - Due 11:59pm, Mar 21
	24 Ionic and Osmotic Adaptations in Aquatic Animals	Lab 6: Osmoregulation in Aquatic Invertebrates	Pre-lab Assignment 6 (2%) - Due 11:59pm, Mar 23
	26 Water Conservation in Terrestrial Animals		
	28 TBD		Data Report 5 (5%) - Due 11:59pm, Mar 28
	31 TBD	No Lab	
Apr	2 TBD		
	4 Exam Review		Data Report 6 (5%) - Due 11:59pm, Apr 4
	7 Exam Review		
	<b>Exam Period - Final Exam (30%)</b>		



## University Policies and Statements

### Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit or e-mail the Indigenous Student Centre at 1321 Edward St or [elders@dal.ca](mailto:elders@dal.ca). Additional information regarding the Indigenous Student Centre can be found at: [https://www.dal.ca/campus\\_life/communities/indigenous.html](https://www.dal.ca/campus_life/communities/indigenous.html)

### Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." Additional internationalization information can be found at: <https://www.dal.ca/about-dal/internationalization.html>

### Academic Integrity

At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. Additional academic integrity information can be found at: [https://www.dal.ca/dept/university\\_secretariat/academic-integrity.html](https://www.dal.ca/dept/university_secretariat/academic-integrity.html)

### Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre ([https://www.dal.ca/campus\\_life/academic-support/accessibility.html](https://www.dal.ca/campus_life/academic-support/accessibility.html)) for all courses offered by Dalhousie with the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro (<https://www.dal.ca/about-dal/agricultural-campus/student-success-centre.html>)

## **Conduct in the Classroom – Culture of Respect**

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

## **Diversity and Inclusion – Culture of Respect**

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). Additional diversity and inclusion information can be found at: <http://www.dal.ca/cultureofrespect.html>

## **Student Code of Conduct**

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner - perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. The full Code of Student Conduct can be found at:

[https://www.dal.ca/dept/university\\_secretariat/policies/student-life/code-of-student-conduct.html](https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html)

## **Fair Dealing Policy**

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. Additional information regarding the Fair Dealing Policy can be found at: [https://www.dal.ca/dept/university\\_secretariat/policies/academic/fair-dealing-policy-.html](https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html)

## **Originality Checking Software**

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. Additional information regarding Originality Checking Software can be found at:

[https://www.dal.ca/dept/university\\_secretariat/policies/academic/student-submission-of-assignments-and-use-of-originality-checking-software-policy-.html](https://www.dal.ca/dept/university_secretariat/policies/academic/student-submission-of-assignments-and-use-of-originality-checking-software-policy-.html)

## **Student Use of Course Materials**

Course materials are designed for use as part of this course at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading to a commercial third-party website) may lead to a violation of Copyright law.