

Laboratory Research Techniques in Biomedical Sciences

BIOC 3610

Department of Biochemistry & Molecular Biology
Fall 2023

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(s)

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Course Description

An introduction to key laboratory methods in biochemistry is presented, along with relevant theory and applications. Topics include liquid handling, protein chemistry, small molecule assays, data analysis and data management. Current context and emerging methodologies are introduced by guest experts.

Note

This course does not count as a Biochemistry & Molecular Biology credit towards any degree with a Major or Honours in Biochemistry & Molecular Biology, but it can be counted towards a Minor in Biochemistry & Molecular Biology. It can also count toward an Honours, Major or Minor in Biology.

Course Prerequisites

CHEM 2401.03 and CHEM 2402.03; BIOC 2300.03; BIOL 2020.03 and BIOL 2030.03; or instructor's permission.

Course Exclusions

This course cannot be included as a BIOC credit toward a Major or Honours programs in Biochemistry & Molecular Biology.

Student Resources

There are no weekly office hours, as those often conflict with students' class schedules. Questions outside of class and lab time can be asked directly by email or a meeting can be requested by email. Meetings can be held in person within regular working hours in Tupper 9S. Meetings can also be held on MS Teams at during regular working hours as well as on evenings and weekends.

Course Structure

Learning Objectives

This course was developed to provide an opportunity for B.Sc. Medical Sciences students to prepare for laboratory (lab) research opportunities in clinical, academic or industrial contexts. The course is also appropriate for students in other undergraduate programs, provided they have completed the prerequisites or have prior instructor's approval. The content was developed in consultation with the B.Sc. Medical Sciences program leaders, other Dalhousie researchers and local life sciences companies.

At the end of this course, students will be able to:

1. Understand the importance of responsible biomedical research in the lab setting.
2. Understand the importance of lab procedures and the roles of lab team members, both in discovery-based and production-based research.
3. Be aware of ethical considerations in discovery, production and clinical research.
4. Be acquainted with new developments in lab methods, lab technology and automation.
5. Skillfully and safely handle standard lab equipment.
6. Perform basic analyses on protein concentration data obtained in the lab and become aware of further analytical steps for different kinds of data.
7. Study the effects of physical and chemical treatments on protein stability and recognize the importance of good sample handling in the lab.
8. Separate proteins using affinity and ion exchange chromatography and understand the principles of molecular separation methods.
9. Analyze proteins based on size with subsequent preparation of a protein for mass spectrometry and understand some principles and applications of proteomics.
10. Perform assays for health-relevant small molecules and understand key concepts in clinical chemistry.
11. Record research data in a notebook and be aware of the information value and legal value of good lab records.
12. Prepare a formal scientific report on research conducted in a lab setting.

Course assessments

Component	Weight (% of final mark)	Date
Lab flow charts outlining the work planned	4% (0.8% each for 5 labs)	Due at the start (2:35 p.m.) of each of the five practical lab sessions (late not accepted)
Lab online notebook entries completed in proper format and according to directions provided and followed by answers to questions in lab instructions.	18% (3.6% each for 5 labs)	Due at 11:59 p.m. on the Thursday following each of the five practical labs (-1 point per day if late)
Guest expert quiz questions	6% (1.5% each for 4 quizzes)	Due before leaving class on the date of each guest visit indicated (late not accepted)
Completion of WHMIS training <u>and</u> Lab Safety training	4% (2% each for two certificates)	Due at 11:59 p.m. on Friday, September 29th, 2023 (-1 point per day if late)
Midterm exam* (evaluating Sept 8 th – Oct 6 th material, inclusive)	20%	October 20th, 2023 (To be written in an 80-minute interval at the start of class)
Individual report on original group research	18%	Due at 11:59 p.m. on Wednesday, December 6th, 2023 (-2 points per day if late)
Final exam* (evaluating full semester material)	30%	Date to be determined (within the regular final exam schedule)

*When a student earns a higher grade on the midterm than on the final exam, both exams will be adjusted to 25% for that student.

Conversion of numerical grades to final letter grades follows the

Dalhousie Grade Scale

A+ (90-100)

B+ (77-79)

C+ (65-69)

D (50-54)

A (85-89)

B (73-76)

C (60-64)

F (0-49)

A- (80-84)

B- (70-72)

C- (55-59)

Course Content

This course will focus on five technical topics and one non-technical topic. Each technical topic has an associated lab session. Pertinent live presentations by guest specialists will also be included.

Topic 1: Good lab procedures and liquid handling

Topic 2: Preservation and stability of biomolecules

Topic 3: Purification of biomolecules

Topic 4: Analysis and identification of biomolecules

Topic 5: Measurement of clinically relevant analytes

Topic 6: General research ethics and best practices

An original group research project will also be conducted.

In all, the course will involve several components.

1. **Lecture sessions:** There will be six 3-hour classroom sessions, held from 2:35 – 5:25 p.m. on Fridays. Generally, each session will introduce a lab research topic, including fundamentals, methodology and current and future applications. Guest experts will be involved in some of the lecture sessions and on-campus field trips will be conducted to visit research facilities.
2. **Lab sessions:** There will be five 3-hour lab sessions held from 2:35 – 5:25 p.m. on Fridays, in alternating weeks with the lectures (see schedule below). Each lab session will highlight an important aspect of research methodology corresponding to the associated lecture. (Please be sure to read the procedures for each lab session and prepare flow charts as required before coming to the lab sessions.)
3. **Original group research:** In steps over the course of the semester, students will conduct an original group research project. This will include pre-planned and student-led components. A formal scientific report on the group project will be produced independently by each student.
4. **Student involvement:** In addition to lecture and lab attendance, this course requires substantial independent study of the material in order to develop broadly based and in-depth knowledge of the methods and concepts covered. Teamwork will be essential in the lab sessions. Preparation of assignments will also require careful planning and time management.

Course schedule

Sept. 8th: Tupper Medical Building, Theatre B

(Note: The first lecture will be in Theatre B; however, the location of subsequent lectures is subject to change. Any change will be indicated on Brightspace and in class.)

Introduction to course

Lecture 1 on good lab procedures and liquid handling

Sept. 15th: Tupper Medical Building, 8-J1

Lab 1 - Liquid handling and data generation

Introduction to original group research project

Sept. 22nd: Tupper Medical Building, Theatre B

Lecture 2 on the preservation and stability of biomolecules

Guest expert: Dr. Victoria Miller

(Senior Scientist, Allumiqs Corporation, Halifax NS)

Sept 29th: Tupper Medical Building, 8-J1

Lab 2 - Denaturation and stabilization of proteins

Progress on the original group research project

Oct. 6th: Tupper Medical Building, Theatre B

Lecture 3 on the purification of biomolecules

Guest expert: Dr. Paul Gratzner

(Associate Professor, School of Biomedical Engineering, Dalhousie, and Co-founder and CSO, DeCell Technologies, Halifax NS)

Oct. 13th: Tupper Medical Building, 8-J1

Lab 3 - Separation of proteins by chromatography

Progress on the original group research project

Oct. 20th: Tupper Medical Building, Theatre B

Mid-term exam (80 minutes) followed by 10-minute break

Lecture 4 on the identification and analysis of biomolecules

Oct. 27th: Tupper Medical Building, 8-J1

Lab 4 - Analysis of proteins by SDS-PAGE and MS

Progress on the original group research project

Nov 3th: Tupper Medical Building, Theatre B

Lecture 5 on the measurement of clinically relevant analytes

Guest expert: TBA

Nov. 10th: Tupper Medical Building, 8-J1

Lab 5 - Measurement of clinically relevant analytes

Progress on the original group research project

Nov. 17th: No session (study break)

Nov. 24th: Tupper Medical Building, LSRI Atrium at 2:35 and then Theatre B

Guest expert: Mat Nightingale

(Facility Manager, Genomics Core Facility, Dalhousie Medical School)

NOTE: Class meets in LSRI Atrium at 2:35

Lecture 6 on general research ethics and best practices

Dec. 1st: Tupper Medical Building, Theatre B

Open session for questions on preparation of the individual reports on the group project and other questions pertinent to the course

December exam period (date and time TBA)

Final exam (3 hours)

Course Materials

There is no textbook or lab manual to purchase for this course. Study materials, including the lectures, lab manual, lab notebook template, reading materials, videos and any relevant links will be provided on Brightspace. Students will be required to print appropriate lab manual sections before attending labs. Research materials required for the original group research project should be available through the Dalhousie library.

Course Policies on Academic and Classroom/Lab Requirements

- **Proper lab safety attire** (as outlined in the lab manual introduction section) must be worn in the lab sessions and safety rules must be followed.
- **Lab flow charts** must be prepared ahead of time. They must be provided on paper and available and ready for instructor or TA viewing at the **beginning** of the lab session. They are not submitted, but are assessed directly in the lab. No mark will be given for flow charts that are not ready for evaluation at the beginning of lab sessions.
- **Lab notebooks and course assignments** (WHMIS and lab safety certification, research report, completed notebook) will be submitted electronically and **docked one point per day** if submitted late (-1 point for one day past due, -2 points for two days past due, etc.). **(Please see Course Assessments for details.)**
- Although the students will work in **pairs** for the **lab sessions and in a group for the research project**, their flow charts, notebooks and reports will be marked **individually**.

- **The mid-term and final exams** will cover the specific techniques used, principles upon which they are based and current developments relating to those techniques. They will consist of multiple choice and short answer questions. The purpose of each exam is to assess the students' knowledge in a fair and objective manner.
- **A maximum of 2 declarations of absence** will be accepted in total per student in this course. If a student is unable to complete an assignment at the scheduled time due to illness or another valid reason, the student must submit a declaration of absence form (available on Brightspace) electronically within 3 days of the event. In the case of an assignment, the declaration of absence will allow the student an extra week to submit the material before points are docked for lateness. However, even with a declaration of absence form submitted, all assignments must be submitted by December 19th (the last day of the exam period). In the case of a missed exam, a declaration of absence would allow a make-up exam to be scheduled at a later date.
- **Travel for holidays is not an exceptional circumstance and will not be accommodated.**
- There will be **no food allowed** in the classroom or lab sessions during this course. If a student has food, it must be stored in a backpack or other suitable case. Water and covered beverages may be brought into classrooms, but not into lab areas.

Course Policies related to Academic Integrity

- Students are welcome (and encouraged!) to collaborate in the lab. However, **all assessed work**, such as exams, lab notebooks and the individual reports on group research, **has to be done individually**.
- Students are welcome to use generative AI and large language models (e.g., ChatGPT) as research or study aids. However, it is important that they **refrain from using generative AI and large language model tools to generate text in the individual reports** (e.g., ChatGPT) on the group research project.
(There are two reasons for this: (1) the purpose of the report is to allow students to gain scientific writing skills and (2) there is a possibility of publishing the results.)

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. Additional information regarding the Indigenous Student Centre can be found at: 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

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) 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

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

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

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.

Faculty of Science

Student Resources and Support

University Policies and Programs

Important Dates in the Academic Year (including add/drop dates):

http://www.dal.ca/academics/important_dates.html

Classroom Recording Protocol:

https://www.dal.ca/dept/university_secretariat/policies/academic/classroom-recording-protocol.html

Dalhousie Grading Practices Policies:

https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html

Grade Appeal Process: https://www.dal.ca/campus_life/academic-support/grades-and-student-records/appealing-a-grade.html

Sexualized Violence Policy: https://www.dal.ca/dept/university_secretariat/policies/health-and-safety/sexualized-violence-policy.html

Scent-Free Program: <https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html>

Learning and Support Resources

General Academic Support – Advising (Halifax): https://www.dal.ca/campus_life/academic-support/advising.html

General Academic Support – Advising (Truro): <https://www.dal.ca/about-dal/agricultural-campus/ssc/academic-support/advising.html>

Student Health & Wellness Centre: https://www.dal.ca/campus_life/health-and-wellness.html

On Track (helps you transition into university, and supports you through your first year at Dalhousie and beyond): https://www.dal.ca/campus_life/academic-support/On-track.html

Indigenous Student Centre: https://www.dal.ca/campus_life/communities/indigenous.html

Indigenous Connection: <https://www.dal.ca/about-dal/indigenous-connection.html>

Elders-in-Residence (The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit the office in the Indigenous Student Centre or contact the program at elders@dal.ca or 902-494-6803:

<https://cdn.dal.ca/content/dam/dalhousie/pdf/academics/UG/indigenous-studies/Elder-Protocol-July2018.pdf>

Black Student Advising Centre: https://www.dal.ca/campus_life/communities/black-student-advising.html

International Centre: https://www.dal.ca/campus_life/international-centre.html

South House Sexual and Gender Resource Centre: <https://southhousehalifax.ca/about/>

LGBTQ2SIA+ Collaborative: <https://www.dal.ca/dept/vpei/edia/education/community-specific-spaces/LGBTQ2SIA-collaborative.html>

Dalhousie Libraries: <http://libraries.dal.ca/>

Copyright Office: <https://libraries.dal.ca/services/copyright-office.html>

Dalhousie Student Advocacy Services: <https://www.dsu.ca/dsas?rq=student%20advocacy>

Dalhousie Ombudsperson: https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html

Human Rights and Equity Services: <https://www.dal.ca/dept/hres.html>

Writing Centre: https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html

Study Skills/Tutoring: http://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html

Faculty of Science Advising Support: <https://www.dal.ca/faculty/science/current-students/undergrad-students/degree-planning.html>

Safety

Biosafety: <http://www.dal.ca/dept/safety/programs-services/biosafety.html>

Chemical Safety: <https://www.dal.ca/dept/safety/programs-services/chemical-safety.html>

Radiation Safety: <http://www.dal.ca/dept/safety/programs-services/radiation-safety.html>

Laser Safety: <https://www.dal.ca/dept/safety/programs-services/radiation-safety/laser-safety.html>