

**Nucleic Acid Biochemistry and Molecular Biology Syllabus  
Department of Biochemistry & Molecular Biology  
BIOC 3400 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 Instructors**

**Lecturers:** P. Liu (Coordinator)      Email: [paul.liu@dal.ca](mailto:paul.liu@dal.ca)  
Room 9-M1, Tupper Medical Building, Tel: 494-1208

C. Slamovits,      Email: [claudio.slamovits@dal.ca](mailto:claudio.slamovits@dal.ca)  
Room 8-B, Tupper Medical Building, Tel: 494-8825

**Instructor:** S. Xiong,      Email: [shawn.xiong@dal.ca](mailto:shawn.xiong@dal.ca)  
Room 8-J3, Tupper Medical Building, Tel: 494-2382

**Lectures:**                    M W F                    10:35-11:25 AM                    Room 3156, Dentistry Building

**Laboratories:**            Wednesday            2:35 - 5:25 PM    Room 8J-1, Tupper Medical Building  
                                  Thursday                2:35 - 5:25 PM    Room 8J-1, Tupper Medical Building

**Course delivery:**      In-person (lectures will not be recorded.)

**Course Description**

This class focuses on the relationship of structure to function in RNA and DNA. Methods of studying the primary, secondary and tertiary structures of nucleic acids are explored in lectures and in the laboratory. Enzymatic mechanisms for biosynthesis, rearrangement, degradation and repair of nucleic acid molecules are studied, as are the processes of replication, transcription and translation. In this context, nucleic acid biochemistry is emphasized as a basis for understanding storage and transfer of biological information. Molecular biological techniques are based on underlying principles of nucleic acid biochemistry and will be described in that context.

**Course Prerequisites / Restrictions**

BIOL2020 and BIOL2030 (both with a grade of B-minus or better), CHEM2401 and 2402, as well as BIOC2300; or instructor's permission.

## Course Materials

**Recommended / suggested text:** Cox, Doudna, and O'Donnell: *Molecular Biology (Principles and Practice)*, 2<sup>nd</sup> Edition (2015).

Paper and digital copies are available through the Dalhousie bookstore [here](#).

Although this text is recommended, no single textbook covers all material in the course, and none is absolutely required. Lectures will be drawn from a variety of sources, including the recent literature. Copies of slides shown in online lectures will be available on the course Brightspace page (see below). For much of the material in the course, any modern textbook of biochemistry and/or molecular biology will provide the basic background, such as:

- Voet and Voet: *Biochemistry* (4<sup>th</sup> Edn, 2011)
- Nelson and Cox: *Lehninger Principles of Biochemistry* (5th Edn, 2008)

## Course website:

Information relating to the lectures and exams, including PDF copies of lecture materials, will appear on Brightspace. The course Brightspace page will also contain information about labs, including weekly tasks/assignments, answers to frequently asked questions, changes to lab schedules / assignments, etc.

## Course Assessment

The final grade will be determined as follows:

30%	two mid-term examinations (15% each; October 11 <sup>th</sup> and November 8 <sup>th</sup> )
30%	laboratory
40%	final examination (scheduled by the Registrar)

**Please note:** The final examination is cumulative. Students who fail to achieve a passing grade in both midterms must achieve a passing grade in the final exam in order to pass the course.

## Conversion of numerical grades to Final Letter Grades follows the Dalhousie Common Grade Scale

A+ (90-100)	B+ (77-79)	C+ (65-69)	D	(50-54)
A (85-89)	B (73-76)	C (60-64)	F	(<50)
A- (80-84)	B- (70-72)	C- (55-59)		

## Course Policies

**Policy for students repeating a BIOC course with an integral lab component (BIOC 3300, BIOC 3400, BIOC 3700)** — Students who have previously taken BIOC 3300, BIOC 3400, or BIOC 3700 and passed the laboratory component will not be allowed to retake the lab component if they redo the course. The previous lab marks will be used to assign the grade for the lab component based on the weight given to this component in the prospectus for the course in the year it is retaken.

**Policies on missed examinations, assignments, etc.** — A student who misses a midterm examination due to illness should, if possible, notify the lecturer, course coordinator, or department office either prior to, or within, 48 hrs of the examination window. The student must also submit a **Student Declaration of Absence**

**Form** (through the course Brightspace page or via e-mail) within three (3) calendar days following the last day of absence. Special 'make-up' exams (if offered) will normally be written within 7 calendar days after the missed exam. Absence for non-medical reasons is not ordinarily acceptable unless prearranged with the course coordinator / lecturer. A missed examination for which no satisfactory arrangement has been made will be given a mark of zero. **The Student Declaration of Absence form can only be submitted up to two (2) separate times per course during a term.** Students who exceed this limit must inform their course coordinator and will be required to register with an Advisor at Student Academic Success (SAS). If students have recurring short-term absences and do not register with SAS, it is at the discretion of the course coordinator to disallow any further Student Declarations and deny alternate arrangements. Virtual laboratory assignments must be submitted to the course instructor as specified on the course Brightspace page.

Students are expected to work through all lab assignments individually. Plagiarism detection software will be used in the evaluation of laboratory reports.

## **Course Objectives / Learning Outcomes**

- Recognize different types of non-coding RNAs, and recognize/identify their roles in gene expression.
- Explain the steps of protein synthesis identifying the differences between prokaryotes and eukaryotes.
- Distinguish the nucleotides that compose DNA and RNA.
- Given DNA sequence data design (probes), recognize their use in different techniques such as PCR, microarray, Southern blotting.
- Predict the fate of a protein based on features of the primary sequence.
- Apply/use knowledge on DNA replication to explain the behavior of these molecules in different stages and under specific conditions (UV, analogs, salt concentration).
- Distinguish between RNA dependent and DNA dependent Polymerases and identify the process where they are involved.
- Explain the process of chain termination DNA sequencing.
- Explain the processing (splicing, editing) of RNA (mRNA, tRNA, rRNA). Predict the effects of mutations in the primary RNA sequence.
- Given a DNA sequence and restriction enzyme data, analyze a band pattern in a gel and generate a restriction map.
- Identify the specific nucleotide and recognize the distinguishing features.
- Interpret data obtained from electrophoresis-based methods (e.g., blotting, restriction enzyme, PFGE, gel mobility assays and CHIP).
- Based on the properties of the polynucleotides predict the outcome of differential chemical or enzymatic treatment.
- Design a strategy for manipulating DNA molecules in particular scenarios (e.g., Radio labeling and sub cloning).
- Distinguish the differences between prokaryotes and eukaryotes in terms of genome organization, gene structure, and expression and DNA replication.
- Given a type of DNA damage explain the repair mechanisms that can occur.
- Identify/recognize and explain the roles of the major proteins involved in the process of DNA replication/RNA synthesis and its regulation.
- Distinguish the differences in DNA packaging/chromatin organization between prokaryotes and eukaryotes.
- Identify the RNA molecules that participate protein synthesis and explain their contributions.

- Predict the mRNA and the amino acid sequence given a DNA sequence.
- Explain the contribution of DNA packaging/chromatin to gene expression and regulation.
- Provide evidence for the roles of catalytic RNA in different cellular process such as protein synthesis and RNA splicing.
- Identify techniques to study DNA packaging/chromatin (e.g., CHIP, DNA sensitivity).

## Course Content

DATE	DAY	TOPIC	LECTURER
Sept. 6	Wed	1. Introduction.	Paul Liu (PL)
8	Fri	2. Nucleosides and nucleotides	PL
11	Mon	3. Polynucleotide structure (1)	PL
13	Wed	4. Polynucleotide structure (2)	PL
15	Fri	5. Nucleases; DNA/RNA modifying enzymes	PL
18	Mon	6. DNA replication (1): introduction	PL
20	Wed	7. DNA replication (2): DNA polymerases	PL
22	Fri	8. DNA replication (3): biochemical mechanism	PL
25	Mon	9. DNA replication (4): biochemical mechanism	PL
27	Wed	10. DNA replication (5) eukaryotes	PL
29	Fri	11. DNA repair (1)	PL
Oct. 2	Mon	<i>NO LECTURE (National Day for Truth and Reconciliation)</i>	
4	Wed	12. DNA repair (2)	PL
Oct. 6	Fri	13. Denaturation, renaturation of nucleic acids	PL
9	Mon	<i>NO LECTURE (Thanksgiving)</i>	
11	Wed	<b>MID-TERM EXAM #1 (lectures 1-12)</b>	<b>PL / CS</b>
13	Fri	14. Restriction enzymes/restriction analysis	PL
16	Mon	15. Recombinant DNA (1)	PL
18	Wed	16. Recombinant DNA (2)	PL
20	Fri	17. Recombinant DNA (3)	PL
23	Mon	18. Nucleic acid sequencing	Claudio Slamovits (CS)
25	Wed	19. Gene structure, prokaryotic vs. eukaryotic	CS
27	Fri	20. Transcription and its control (1)	CS
30	Mon	21. Transcription and its control (2)	CS
Nov. 1	Wed	22. Transcription and its control (3)	CS
3	Fri	23. Chromatin	CS
6	Mon	24. Genetic code	CS
8	Wed	<b>MID-TERM EXAM #2 (lectures 13-23)</b>	<b>CS / PL</b>
10	Fri	25. Transfer RNA	CS
13-17	Mon-Fri	<i>NO LECTURES (Fall study week)</i>	
20	Mon	26. Ribosome structure, function, rRNA processing	CS
22	Wed	27. Translation (1)	CS
24	Fri	28. Translation (2)	CS
27	Mon	29. Post-translation modification and transport	CS
29	Wed	30. mRNA processing: spliceosome, snRNAs	CS
Dec. 1	Fri	31. RNA editing; catalytic RNAs	CS

4	Mon	32. Non-coding RNAs: micro-RNA, siRNA, RNAi	CS
6	Wed	33. Special topics and review	CS

**FINAL EXAM (all lectures, with a higher weight on lectures 24-33) to be scheduled by Registrar.**

## 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.

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](http://www.dal.ca/academics/important_dates.html)

Classroom Recording Protocol:

[https://www.dal.ca/dept/university\\_secretariat/policies/academic/classroom-recording-protocol.html](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](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](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](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](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](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](https://www.dal.ca/campus_life/academic-support/On-track.html)

Indigenous Student Centre:

[https://www.dal.ca/campus\\_life/communities/indigenous.html](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](mailto: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](https://www.dal.ca/campus_life/communities/black-student-advising.html)

International Centre: [https://www.dal.ca/campus\\_life/international-centre.html](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](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](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](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>