Nucleic Acid Biochemistry and Molecular Biology Syllabus

Department of Biochemistry and Molecular Biology

Faculty of Science - **BIOC 3400** - **Fall 2026**

Dalhousie University operates in the unceded territories of the Mi'kmaw, Wolastoqey, and Peskotomuhkati Peoples. These sovereign nations hold inherent rights as the original peoples of these lands, and we each carry collective obligations under the Peace and Friendship Treaties. Section 35 of the Constitution Act, 1982, recognizes and affirms Aboriginal and Treaty rights in Canada.

We recognize that African Nova Scotians are a distinct people whose histories, legacies, and contributions have enriched the part of Mi'kma'ki known as Nova Scotia for over 400 years.

Course Instructors

Name	Email	Office Location
Dr. Elizabeth Polvi (Course Coordinator and Lecturer)	elizabeth.polvi@dal.ca	Tupper, Room 8J-03
Dr. James Davey (Lecturer)	james.davey@dal.ca	Tupper, Room 10M1
Dr. Eric Pringle (Lab Coordinator)	eric.pringle@dal.ca	Tupper, Room 8H-03

Course Description

This course focuses on the relationship of structure to function in RNA and DNA. Methods for studying the primary, secondary, and tertiary structures of nucleic acids are explored in lectures and in the laboratory. Topics covered include enzymic mechanisms for biosynthesis, rearrangement, degradation, and repair of nucleic acid molecules, and processes of replication, transcription, and translation. Nucleic acid biochemistry is emphasized as a basis for understanding storage and transfer of biological information. Credit Hours: 3

Course Prerequisites/ Exclusions:

BIOL 2020.03 and BIOL 2030.03 (both with grades of B- or higher); CHEM 2401.03 and CHEM 2402.03; BIOC 2300.03 and BIOC 2610.03; or instructor's consent. Exclusions: None.

Course Structure

Lectures:

M W F 9:35-10:25 AM Dentistry Building, Room 3156

Lectures will be delivered synchronously, in-person. In-person attendance is strongly encouraged. Lectures will be recorded and posted on Brightspace (managed by MedIT) as a supplemental resource. However, programming errors can occur, resulting in missed recordings. All midterms and exams will take place in-person.

Laboratories:

B01 (Wednesdays) 2:35-5:25 PM Tupper, Room 8J-01

B02 (Thursdays) 2:35-5:25 PM Tupper, Room 8J-01

Weekly 3-hr laboratory sessions will take place on Wednesdays (B01) or Thursdays (B02) in the Tupper Building. The first lab sessions will take place on Wednesday **September 9 (B01)** and Thursday **September 10 (B02).** Students must attend the section in which they are registered. More information regarding the lab schedule, lab manual, and lab assessment will be provided on Brightspace.

Course Materials

Laboratories:

The laboratory manual will be provided on Brightspace. A new section of the manual will be released each week prior to the lab. Students will need to provide their own lab coat and safety glasses, which can be purchased from the University Bookstore. Students may bring their own lab notebook or use a blank 'exam booklet' provided in the lab. For safety purposes, all labs will require appropriate attire including ankle-length clothing and closed-toe shoes. Students are required to have completed the WHMIS online safety training within the past 3 years.

Recommended Textbook and Course Slides:

Course lecture slides will be available on Brightspace.

Recommended textbook: *Cox, Doudna, and O'Donnell: Molecular Biology (Principles and Practice), 2nd Edition (2015).*

Paper and digital copies of the textbook are available through the Dalhousie bookstore. The textbook is not required for the course.

Lectures will be drawn from this textbook, along with other texts and resources. Students may choose to refer to other modern biochemistry/ molecular biology textbooks including the following (or older editions of the following):

- Lodish et al.: Molecular Cell Biology (9th edn., 2021)
- Nelson and Cox: Lehninger Principles of Biochemistry (8th Edn, 2021)
- Voet and Voet: Biochemistry (4th Edn, 2011)

Student Resources

Dr. Polvi will be available for drop-in hours every **Thursday from 10:00 AM – 12:00 PM in Tupper 8J-01** (teaching lab near the computers), beginning October 8. Students are welcome to ask questions, work or study independently, or work in groups. (Note that eating and drinking are not permitted in this space). Dr. Polvi is also available to meet by appointment.

Dr. Davey will be available for drop-in hours on **Wednesdays and Thursdays from 2:30 - 4:00 PM in Tupper 10M** during the Theme 1 section of the course (September 9 to October 2).

Dr. Pringle will be available to meet by appointment.

Office hour availability with the lecturers may be increased ahead of midterms and exams and will be announced on Brightspace.

Peer Mentorship sessions may take place throughout the term in which upper-year students offer group sessions focused on study strategies, problem-solving techniques, and professional development. Details about the topics, location, and timing of these sessions will be communicated.

Course Communication

Important updates about the course (lectures and labs) will be posted as 'Announcements' on the course Brightspace page.

The course instructors will aim to respond to emails within 24 hours, except on weekends and holidays.

A Brightspace Discussion Board will be available for students to ask questions about course content, practice questions etc. Directing course questions to the discussion board is helpful to ensure that all students receive the same answer and access to information. Course instructors will aim to review and respond to queries in a timely manner. Students are also invited to respond to their peers' questions. Please always be respectful when posting on the discussion board. Assume best intentions, and never use sarcastic, harsh, or offensive language.

Please use email for personal questions (absences, personal circumstances, etc).

Assessments

Conversion of numerical grades to final letter grades follows the undergraduate 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)	

Assessment	Weight (% of overall)	Date
Midterm 1	15	(50 min; in class) October 2
Midterm 2	15	(50 min; in class) October 30
Lab component	30	See lab details on Brightspace
Final exam	40	(3 hours) Scheduled by the Registrar

Midterm Tests:

Midterms are closed book and will occur during regular class time (50 minutes). The content tested by each midterm is outlined in the *Lecture Schedule*, below. Midterms will include short answer questions and may include multiple choice and true/false questions. While Midterm 2 is not explicitly cumulative, students will be expected to know and apply foundational information from Midterm 1. (See also: *Midterm Weight Transfer Policy*, below)

Lab Component:

A detailed outline of the grades associated with the lab component will be provided on Brightspace and communicated during the lab. Students will usually work in groups to complete in-lab experiments. Assessments will include pre-lab preparation, written presentation of experimental results, and a written paper.

A passing grade in the lab component (50%) is required to pass the course.

Final Exam:

The final examination is closed book (3 hours) and will occur during the December exam period, scheduled by the Registrar's Office. The final exam is **cumulative**. It will cover content from the entire course, with an emphasis on material not previously tested on the midterms. Further detail will be provided in class and on Brightspace. The final exam will include short answer questions and may include multiple choice and true/false questions.

A passing grade in the final exam (50%) is required to pass the course.

Midterm Weight Transfer Policy:

The weight of a **maximum of one (1)** midterm test may be transferred to the cumulative final exam in either of the following circumstances:

- The student's final exam grade is higher than their grade on a midterm test. If the final exam grade is higher than both midterm test grades, the weight of the midterm with the lower grade (including a grade of '0') will be transferred to the final exam.
- If the student misses a midterm test and its alternative make-up test, the weight of that missed midterm will be transferred to the cumulative final exam (see *Missed or Late Academic Requirements,* below)

Department of Biochemistry & Molecular Biology Policy for students repeating a BIOC course with an integral lab component (ie. BIOC 3400, BIOC 3700):

Students who have previously taken 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 syllabus for the course in the year it is retaken.

Missed or Late Academic Requirements

Student Declaration of Absence Forms:

The Student Declaration of Absence (SDA) form may be submitted up to **two (2) separate times** per course during a term. This includes lab and lecture components. Students who exceed this limit may be denied alternate coursework arrangements. The student should inform their course coordinator to ensure that appropriate academic supports are in place to support the student's ongoing academic success.

When submitting an SDA for missed BIOC 3400 academic components:

1. Submit the signed SDA form to the "Student Declaration of Absence Forms" Dropbox (Found on the BIOC 3400 Brightspace under Assessments > Assignments).

AND

2. Email the relevant coordinator within 3 calendar days.
   elizabeth.polvi@dal.ca for missed midterm components.
   eric.pringle@dal.ca for missed lab components.

Missed Midterm:

A student who misses a midterm test due to illness or emergency should notify the course coordinator by email (elizabeth.polvi@dal.ca) as soon as possible, and within 3 calendar days of the missed midterm. The student must also submit a signed SDA form (see above). An alternative make-up test time will be available in the evening, approximately one week after the original midterm date.

If the student also misses the alternative midterm test, the student must submit a second Student Declaration of Absence Form and the weight of that midterm will be transferred to the cumulative final exam (see *Midterm Weight Transfer Policy,* above).

Missed or Late Laboratory Work:

Attendance in the weekly lab is required. If a lab cannot be attended due to illness, email the lab coordinator as soon as possible and within 3 calendar days (eric.pringle@dal.ca). The student must also submit a signed SDA form (see above).

Prelab work must be submitted on Brightspace prior to the lab. Additional late submission policies will be outlined on Brightspace.

Missed Final Exam:
(See also University Policy - Requests for an Alternative Final Examination Time, 2026/2027)

In the event of an exceptional circumstance that prevents the student from writing the final exam at the time scheduled by the registrar, the student should notify the course coordinator by email. Students should email (elizabeth.polvi@dal.ca) as soon as possible, and within 3 calendar days of the missed exam. Qualified individuals will be notified of the alternative final exam date.

Use of Generative AI

With a Dalhousie University account, students have access to Microsoft 365 Copilot Chat, which complies with Dalhousie standards for data privacy. In general, students should be mindful about their use of Generative AI (GenAI) and use it to enhance their learning rather than to replace the learning process. In all cases, students are responsible for evaluating AI-generated content for accuracy and relevance. Dalhousie's Library Guide on Generative AI is a helpful resource for more information about topics related to GenAI use including ethics, academic integrity, copyright, and additional resources.

In assessment:

Students may use GenAI to assist with the preparation of laboratory assignments (for planning, brainstorming, editing grammar, paragraph structure etc.), but the ideas presented should be the student's own and should accurately represent the student's own knowledge and understanding. The use of the GenAI tool must be clearly acknowledged with a formal citation, and a description of how the tool was used. Details about the required citation style will be provided in the lab. Students are responsible for all work that they produce and submit. Failure to attribute authorship is considered plagiarism.

Midterm tests and the final exam are closed book examinations, and no resources (including GenAI) are permitted when writing the tests.

In learning:

Students may use GenAI to support their learning and studying (for generating practice questions, creating summaries, etc.). However, students should be aware that AI-generated content may be inaccurate or false. Students should also recognize that engaging with complex concepts and thinking independently are essential components of the learning process.

Course Accessibility

Refer to the Student Accommodation Policy for information on how Dalhousie instructors and staff work collaboratively with students to create and sustain an accessible educational environment. More information about student support and accessibility and accommodations is available.

- If there are aspects of this course, including but not limited to its design, teaching approaches, learning activities, and assessments, that result in barriers to your learning or do not align with your formal academic accommodations, reach out to the course coordinator (elizabeth.polvi@dal.ca) so that we can collaboratively find a solution that meets your needs.
- You are eligible for accommodations based on protected characteristics such as religion and disability. If you have religious, cultural, or community-significant observances that conflict with course requirements, reach out to me to collaboratively find alternatives for completing the course requirements.
- To begin the process of requesting a formal academic accommodation, students can book an appointment or contact the Student Accessibility Centre (access@dal.ca).

Academic Integrity

Dalhousie expects all students to be responsible learners, demonstrating the values of intellectual honesty, trust, fairness, and respect in your work. Key aspects of academic integrity include, but are not limited to: avoiding plagiarism, not engaging in cheating, submitting original work, and acknowledging sources of information and ideas when they are not your own. Refer to the Statement on Intellectual Honesty for definitions of various academic offences. Failure to meet Dalhousie's academic integrity standards will result in appropriate disciplinary and/or corrective measures.

Course Content

Dalhousie Important Dates 2026/2027

Tentative BIOC 3400 Lecture Schedule - Fall 2026 (schedule may be subject to change)

DATE	DAY	THEME	LECTURE #	TOPIC	CHAPTERS[1]	LECTURER[2]
9-Sep	Wed	**Theme 1.** DNA structure, replication, and repair	1	Molecular basis of genetics	Ch. 2	JD
11-Sep	Fri		2	The molecular structure of nucleotides	Ch. 3, 6	JD
14-Sep	Mon		3	The molecular structure nucleic acids	Ch. 1, 6	JD
16-Sep	Wed		4	Biological process of DNA replication	Ch. 9, 11	JD
18-Sep	Fri		5	Topoisomerase and DNA replication	Ch. 9, 11	JD
21-Sep	Mon		6	Biochemistry of DNA polymerization	Ch. 11	JD
23-Sep	Wed		7	DNA repair (I)	Ch. 12	JD
25-Sep	Fri		8	DNA repair (II)	Ch. 12	JD
28-Sep	Mon		9	Review	N/A	JD
30-Sep	Wed		**NO LECTURE (National Day for Truth and Reconciliation)**			
2-Oct	**Fri**		**MIDTERM 1 (Covers Theme 1: Lectures 1 - 9)**			
5-Oct	Mon	**Theme 2.** Analyzing and manipulating nucleic acids	10	Nucleic acid denaturation and hybridization	Ch. 6, 7	EP
7-Oct	Wed		11	PCR	Ch. 7	EP
9-Oct	Fri		12	Sequencing	Ch. 7	EP
12-Oct	Mon		**NO LECTURE (Thanksgiving)**			
14-Oct	Wed		13	Restriction enzymes & restriction analysis	Ch. 7	EP
16-Oct	Fri		14	Molecular cloning	Ch. 7	EP
19-Oct	Mon		15	Large-scale analyses	Ch. 8	EP
21-Oct	Wed	**Theme 3a.** Transcription (introduction and prokaryotes)	16	Introduction to transcription and gene structure	Ch. 15, 16, 19	EP
23-Oct	Fri		17	Transcription (prokaryotes) (I)	Ch. 15, 19,20	EP
26-Oct	Mon		18	Transcription (prokaryotes) (II)	Ch. 15, 19,20	EP
28-Oct	Wed		19	Review	N/A	EP
30-Oct	**Fri**		**MIDTERM 2 (Covers Theme 2 and 3a: Lectures 10 - 19)**			
2-Nov	Mon	**Theme 3b.** Transcription (eukaryotes)	20	Transcription (eukaryotes) (I)	Ch. 10, 15, 16, 19, 21	EP
4-Nov	Wed		21	Transcription (eukaryotes) (II)	Ch. 10, 15, 16, 19, 21	EP
6-Nov	Fri		22	Splicing (I)	Ch. 16	EP
			NO LECTURES (November 9-13: Fall study week)			
16-Nov	Mon		23	Splicing (II)	Ch. 16	EP

Schedule continues on the next page

Continued from the previous page

DATE	DAY	THEME	LECTURE #	TOPIC	CHAPTERS[1]	LECTURER[2]
18-Nov	Wed	**Theme 4.** Translation and Regulation	24	Genetic code	Ch. 17	EP
20-Nov	Fri		25	Transfer RNA (tRNA)	Ch. 17, 18	EP
23-Nov	Mon		26	Ribosome	Ch. 18	EP
25-Nov	Wed		27	Translation (I)	Ch. 18	EP
27-Nov	Fri		28	Translation (II)	Ch. 18	EP
30-Nov	Mon		29	Translation (III)	Ch. 18	EP
2-Dec	Wed		30	Post-translational modification and protein transport	Ch. 18	EP
4-Dec	Fri		31	Non-coding RNAs	Ch. 22	EP
7-Dec	Mon		32	Regulating gene expression: Overview	Ch. 19 and various	EP
9-Dec	Wed		33	Review	N/A	EP
Exam period (Dec 11 - Dec 20) **FINAL EXAM (covers all lectures with an emphasis on Theme 3b and Theme 4: Lectures 20 - 33)**						

[1] **NOTE:** The CHAPTERS refer to textbook chapters from *Cox Molecular Biology 2e* (2015) that are relevant to the lectures. Not all material within the chapter is covered, and additional resources will also be used.
[2] **NOTE: JD** (Dr. James Davey); **EP** (Dr. Elizabeth Polvi)

Learning Objectives

THEME 1:

1. Interpret and describe the experimental evidence demonstrating the molecular basis for heredity.
2. Describe and distinguish the molecular structures and properties of nucleotides that compose DNA and RNA using accurate biochemical nomenclature.
3. Apply knowledge of nucleotide properties to devise experimental methods for their isolation and analysis.
4. Interpret and describe the experimental evidence required to elucidate the structure of DNA and RNA.
5. Describe and distinguish the molecular structures and properties of DNA and RNA.
6. Interpret and describe the experimental evidence describing the mechanism of DNA replication.
7. Describe and compare the biological function of topoisomerases.
8. Apply knowledge of thermodynamics to describe the DNA polymerization reaction.
9. Describe and distinguish the molecular structure and function of various DNA polymerases.
10. Describe and distinguish the chemical/biological mutation of DNA using accurate biochemical nomenclature.
11. Apply knowledge of DNA repair processes to describe and compare their biological mechanisms.

THEME 2:

12. Describe factors that impact nucleic acid duplex stability and apply knowledge of hybridization to different techniques (Southern blot, northern blot, microarray, PCR, etc).
13. Explain the steps involved in PCR and design primers to amplify a given genomic region.
14. Explain the process and nucleotide chemistry involved in different sequencing techniques (eg. chain termination sequencing and reversible terminator sequencing). Differentiate between various sequencing technologies and strategies.
15. Describe the functions and uses of restriction enzymes and apply knowledge to analyze banding patterns and generate a restriction map.
16. Explain molecular cloning and describe important elements of cloning vectors. Apply cloning knowledge to design a cloning strategy.
17. Describe genomic libraries and other strategies for large-scale analysis of biological molecules.

THEME 3:

18. Compare and contrast gene structure and genome organization in prokaryotes and eukaryotes.
19. Explain the roles of the major proteins involved in transcription and differentiate key differences between eukaryotes and prokaryotes.
20. Compare and contrast the processes of DNA synthesis and RNA synthesis.
21. Compare and contrast the strategies used by prokaryotes and eukaryotes to regulate gene expression (including the contribution of DNA packaging/chromatin to gene expression).
22. Explain RNA processing and the steps involved in the splicing mechanism. Provide evidence for the role of catalytic RNA.

THEME 4:

23. Explain key features of the genetic code and describe experimental evidence that led to its interpretation.
24. Predict the mRNA and the amino acid sequence given a DNA sequence.
25. Explain the structure, function, and processing of tRNAs molecules and their role in protein synthesis.
26. Explain the structure, function, and processing of rRNAs and ribosomes, and their role in protein synthesis.
27. Explain the roles of the major proteins involved in translation (initiation, elongation, and termination) and identify key differences between translation in prokaryotes and eukaryotes.
28. Explain the peptidyl-transferase reaction.
29. Explain post-translational modifications.
30. Describe protein sorting and transport to organelles and explain the mechanisms used to target proteins to different destinations (eg. secreted, nucleus, other organelles, etc).
31. Explain how different types of non-coding RNAs regulate gene expression (eg. RNAi pathway).

Syllabus Appendix

(Formerly University Policies and Statements)

Syllabus Appendix: Student Supports & University Statements, Policies, and Guidelines