

Faculty of Science Course Syllabus
Department of Biochemistry & Molecular Biology
BIOC 4702/5702 & CHEM 4602/5602
Biophysical Characterization of Macromolecules
Winter 2023

Dalhousie University is located in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq. We are all Treaty people.

We acknowledge the histories, contributions, and legacies of the African Nova Scotian people and communities who have been here for over 400 years.

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Lectures: Monday/Wednesday 2:35-3:55 pm – Tupper Building (Link) L10

Course Description:

This course covers methods allowing determination of global structuring and state; molecular interactions; and, supramolecular assembly of biomacromolecules including: calorimetry, fluorescence and electronic circular dichroism spectroscopy; hydrodynamics measurements and scattering; and, single molecule methods.

Course Prerequisites/Restrictions:

[BIOC 3700.03](#); or ([CHEM 3601](#) AND [CHEM 2301](#) AND [CHEM 2304](#)), or instructor's consent.
Recommended: PHYC 1190.03/1290.03 or 1310.03/1320.03

Student Learning Outcomes:

- 1) **Understand** the thermodynamic factors that stabilize proteins, protein-protein, and protein-ligand complexes.
- 2) **Demonstrate** understanding of thermodynamics and the applicability of calorimetric methods to characterizing protein interactions and folded state.
- 3) **Draw** energy level diagrams showing the quantum mechanical basis of electronic absorption and emission spectroscopy with specific reference to the Franck-Condon principle
- 4) **Analyze** optical spectra (absorption, emission, fluorescence anisotropy, CD) with respect to polypeptide structure and environment and with relation to quantum mechanical basis of a given spectroscopic technique

- 5) **Compare** and **contrast** ensemble measurements to single molecule measurements, with emphasis on experimental approaches allowing observation of single molecules and information uniquely obtainable by single molecule measurements
- 6) **Understand** fundamental underpinnings and **demonstrate** application of 1D and 2D ^1H - ^{15}N correlation NMR spectroscopy-based methods that allow interactions with macromolecules to be characterized.
- 7) **Demonstrate** understanding of hydrodynamic characterization through NMR spectroscopy and scattering methods
- 8) **Understand** the benefits and limitations of several biophysical methods.
- 9) **Interpret** data to develop working models of protein systems.

Course Materials

Textbook: No required book; some good books are on reserve and you may want to pick one or more of these up from Chapters/Amazon etc. *You will also end up with copious course notes!*

Recommended books:

“Biophysical Chemistry” by Klostermeier and Rudolph – **one copy on reserve in Kellogg**. *Good theoretical overview of many of the techniques covered in lecture.*

“Principles of Physical Biochemistry”, 2nd Edition by van Holde, Johnson and Ho – **one copy on reserve in Kellogg**. *A decent “long term” reference to have on your bookshelf, but written at a highly technical and theoretical (vs. practical) level so definitely not to everyone’s taste!*

“Principles of fluorescence spectroscopy” by Joseph R. Lakowicz (3rd edition - 2006, Springer; older editions also good) – **available online from Dal library; one copy also on reserve at Kellogg**. *If you see yourself doing a lot of fluorescence, this is a great (although pricey) book to pick up.*

Course Assessment – BIOC 4702/CHEM 4602

Component	Weight (% of final grade)	Date
Tests	2x15% ¹	<i>Feb. 6 & Mar. 13, 2023</i> In class; 80 minutes
Final exam	30% (<i>pass required to pass course</i>)	<i>Scheduled exam period</i> 3 hours (cumulative)
Assignments	20%	Throughout term
Critique of article	15%	<i>To be assigned starting week of March 20th</i>
Peer feedback/questions	5%	<i>During student presentations</i>

Note applicable to BIOC/CHEM 4X02 grading only:

¹ *If your final exam mark is higher than the mark on a written test (i.e., you cannot simply skip a test), your lowest test mark will be replaced with the final exam mark.*

Course Assessment – BIOC 5702/CHEM 5602

Component	Weight (% of final grade)	Date
Tests	2x12.5%	<i>Feb. 6 & Mar. 13, 2023</i> In class; 80 minutes
Final exam	25% (<i>pass required to pass course</i>)	<i>Scheduled exam period</i> 3 hours (cumulative)
Assignments	20%	Throughout term
Self-study Project	25%	<i>To be assigned starting week of March 20th</i>
Peer feedback/questions	5%	<i>During student presentations</i>

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)	

Notes: Letter grade assignment in BIOC 4702/CHEM 4602 and in BIOC 5702/CHEM 5602 will follow the Faculty of Science recommendation that numbers falling in the interval between letter grades be rounded up if the fraction is 0.5 or greater. Students in BIOC 5702/CHEM 5602 should note that the Faculty of Graduate Studies requires that students must achieve a letter grade of B- or higher to pass. Any numerical grade below 69.5 for BIOC 5702/CHEM 5602 will therefore result in an F.

Course Content & Approximate Timing

Class	Lecture	Date	Topic	Lecturer	Klostermeier & Rudolph
1	1	09-Jan	Protein structure, stability, interactions & equilibria	DL	Ch. 16
2	2	11-Jan	ITC (theory & examples)	DL	Ch. 27
3	3	16-Jan	DSC (theory & examples)	DL	Ch. 27
4	4	18-Jan	SPR (theory & examples)	DL	Section 26.3
5	5	23-Jan	Intro to scattering	DL	Ch. 21
6	6	25-Jan	DLS/SLS	DL	Ch. 21
7	7	30-Jan	SAXS/WAXS	DL	Ch. 21
8	8	01-Feb	Scattering wrap-up/Review	DL	Ch. 21
9	MT1	06-Feb	Test 1 - Covering lectures 1-8		
10	9	08-Feb	Fluorescence spectroscopy (theory & examples)	JR	Ch. 19
11	10	13-Feb	Anisotropy + time-resolved fluorescence processes	JR	Ch. 19
12	11	15-Feb	Single molecule fluorescence	JR	Section 23.1
--		20-Feb	Break		
--		22-Feb	Break		
13	12	27-Feb	CD spectropolarimetry (theory & examples)	JR	Ch. 19
14	13	01-Mar	NMR theory & background	JR	Ch. 20
15	14	06-Mar	NMR experiments - description & key building blocks	JR	Ch. 20
16	15	08-Mar	NMR titrations	JR	Ch. 20
17	MT2	13-Mar	Test 2 - Covering lectures 9-15		
18	16	15-Mar	Probing intermolecular interactions by NMR (STD, WaterLOGSY, trNOE, etc.)	JR	--
19	17	20-Mar	Pulsed field gradient diffusion NMR	JR	--
20	18	22-Mar	Presentations (4X02 - Article critiques; 5X02 - Project)	JR/DL	
21	19	27-Mar	Presentations (4X02 - Article critiques; 5X02 - Project)	JR/DL	
22	20	29-Mar	Presentations (4X02 - Article critiques; 5X02 - Project)	JR/DL	
23	21	03-Apr	Correlative applications of techniques & Further presentations, if needed based on enrolment	JR/DL	
24	22	05-Apr	Correlative applications of techniques & Further presentations, if needed based on enrolment	JR/DL	
		Exam period	Final examination: Cumulative of <u>all</u> lecture content; including questions about 5X02 Projects		

Notes: Lecturer: DL – David Langelaan; JR – Jan Rainey. References from Klostermeier & Rudolph are starting points for background reading, which may not cover all topics of a given lecture. Lectures will be posted to Brightspace before class.

Course & Departmental Policies

****YOU MUST PASS THE FINAL EXAM TO PASS THE COURSE**

Assignments must be submitted either in class (preferably) or in person to the indicated professor no later than 5:00 pm on the designated due date. Extension of the due date may be granted upon submission of a Student Declaration of Absence Form (protocol detailed below) or by consulting with the instructors. Extension of the due date will not normally exceed 7 calendar days. **In all other cases, a grade of 0 will be received for that assignment.**

Department of Biochemistry & Molecular Biology Policy on missed examinations/mid-terms and assignments

A student who misses an evaluation component of the course (midterm test, assignment, presentation, lab, etc.) due to illness should, if possible, notify the instructor, course coordinator, or department office either prior to, or within 48 h of the scheduled time or due date for that component. The student must also submit a **Student Declaration of Absence Form** (through the course Brightspace page) within three **(3) calendar days** following the last day of absence. Special 'make-up' tests (if offered) will normally be written within 7 calendar days after the missed test. A missed evaluation component 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 instructor(s) 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 instructor(s)' discretion to disallow any further Student Declarations and deny alternate coursework arrangements.

Department of Biochemistry & Molecular Biology Statement on Plagiarism

What is plagiarism?

"Dalhousie University defines plagiarism as the submission or presentation of the work of another as if it were one's own[†]." The Department of Biochemistry & Molecular Biology is committed to protecting honest students against the devaluation of their work by students who resort to plagiarism.

Some examples of plagiarism include (but are not restricted to):

- > Submitting as your own work any material created, in whole or in part, by someone else, including **material created in collaboration with other students**, unless specifically allowed by the class instructor and credited appropriately.
- > Paraphrasing extensively or copying from sources such as the Internet, journal articles, or books (including textbooks) without crediting the original author or source.
- > Using another student's laboratory data, unless specifically allowed by the lab instructor and credited appropriately.
- > Submitting, in whole or in part, any work that has been submitted in another class, or re-submitting the same work in different years of the same class.

How can plagiarism be detected?

If required by the Instructor, work submitted for credit must be submitted in electronic as well as hard copy form. Submissions may be screened by one or both of the following methods:

- > A pattern recognition program that compares all submissions with one another as well as submissions from previous years. Every individual has a unique pattern of writing. This program will detect submissions that are derived from a common source, even if words or phrases have been changed.
- > A third-party computer-based assessment system that compares submissions against a large database including previous submissions and Internet sources.

What are the consequences of plagiarism?

“Plagiarism is considered a serious academic offence that may lead to the assignment of a failing grade, suspension or expulsion from the University. If a penalty results in a student no longer meeting the requirements of a degree that has been awarded, the University may rescind that degree.”[†] At Dalhousie University, the Department is obligated to refer any cases of suspected plagiarism to an Academic Integrity Officer, who will then conduct a hearing to evaluate the innocence or guilt of students alleged to have committed an act of plagiarism.

How can accusations of plagiarism be avoided?

You can avoid accusations of plagiarism by:

- > Preparing all submissions independently and ensuring that they are expressed in your own unique writing style.
- > Never sharing any written or electronic material with other students. You may not work with another student while preparing materials you are planning to hand in.
- > Acknowledging any material paraphrased extensively or copied from sources such as the Internet, journal articles or textbooks. Paraphrasing of short phrases from the class textbook need not be acknowledged.
- > Guarding all your work, both drafts and final submissions, to ensure that no one else can copy it. If you provide access to your work and someone (including a student taking the same class in a future year) copies it, then you may be aiding in the commission of an academic offence. If you suspect that someone has taken any of your work, notify your class instructor immediately.
- > Using only laboratory data that you actually collected in the lab. Altering laboratory data is not permitted. If your data are unusable, you must still report your own data along with any explanation as to why the data are unusable. You may then use data supplied by the lab instructor for analysis, but you must acknowledge such use.

[†] Dalhousie University Undergraduate Calendar, 2022/2023, University Regulations, Intellectual Honesty.

University Policies and Statements

This course is governed by the academic rules and regulations set forth in the University Calendar and by Senate

Academic Integrity

At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect (The Center for Academic Integrity, Duke University, 1999). As a student, you are required to demonstrate these values in all of 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.

Information: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Advising and Access Services Centre is Dalhousie's centre of expertise for student accessibility and accommodation. The advising team works with students who request accommodation as a result of a disability, religious obligation, or any barrier related to any other characteristic protected under Human Rights legislation (Canada and Nova Scotia).

Information: https://www.dal.ca/campus_life/academic-support/accessibility.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.

Code: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

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

Statement: <http://www.dal.ca/cultureofrespect.html>

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 (1321 Edward St) (elders@dal.ca).

Information: https://www.dal.ca/campus_life/communities/indigenous.html

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

<https://academiccalendar.dal.ca/Catalog/ViewCatalog.aspx?pageid=viewcatalog&catalogid=117&chapterid=-1&topicgroupid=31821&loadusercredits=False>

University Grading Practices

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

Student Resources and Support

Advising

General Advising https://www.dal.ca/campus_life/academic-support/advising.html

Science Program Advisors: <https://www.dal.ca/faculty/science/current-students/undergrad-students/degree-planning.html>

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

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

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

Academic supports

Library: <https://libraries.dal.ca/>

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

Studying for Success: https://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html

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

Fair Dealing Guidelines <https://libraries.dal.ca/services/copyright-office/fair-dealing.html>

Other supports and services

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

Student Advocacy: <https://dsu.ca/dsas>

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

Safety

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

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

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

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

Dalhousie COVID-19 information and updates: <https://www.dal.ca/covid-19-information-and-updates.html>