

Faculty of Science Course Syllabus
Department of Biochemistry & Molecular Biology
BIOC 4702/5702 & CHEM 4602/5602
Biophysical Characterization of Macromolecules
Fall 2016

Instructor: Jan K. Rainey E-mail: jan.rainey@dal.ca Office: Tupper 10N1 (10th floor)

Lectures: Tuesday/Thursday 2:35-3:55 pm – Hicks 217

Laboratories: One lecture will be substituted with a laboratory demonstration in the NMR³ facility

Tutorials: 2 review-based tutorials taking the place of regular lecture material

Course Description:

This course covers methods allowing determination of sub-molecular and atomic-level structure and dynamics of biomacromolecules in physiological settings (e.g. solution-state or lipid bilayers) including: fluorescence, electronic circular dichroism and NMR spectroscopy; and, single molecule methods.

Course Prerequisites/Restrictions:

[BIOC 3700.03](#); or ([CHEM 3601](#) AND [CHEM 2301](#) AND [CHEM 2304](#)), all with grades of B or higher or instructor's consent. Recommended: PHYC 1280.03/1290.03 or 1300.06

Student Learning Outcomes:

- 1) **Discriminate** and **quantify** the components of the NMR Hamiltonian in terms of their contribution to the experimental observable in the solution- and solid-state
- 2) **Use** vector diagrams to **explain** the major NMR experiments employed for protein NMR
- 3) **Describe** effects of spin-relaxation phenomena upon the experimental observable and the manner in which these are modulated by dynamic processes
- 4) **Assign** two-dimensional homonuclear and heteronuclear NMR data for a polypeptide and **apply** these assignments for structure determination
- 5) **Draw** energy level diagrams showing the quantum mechanical basis of electronic absorption and emission spectroscopy with specific reference to the Franck-Condon principle
- 6) **Analyze** optical spectra (absorption, emission, fluorescence anisotropy, LD, CD) with respect to polypeptide structure and environment and with relation to quantum mechanical basis of a given spectroscopic technique.
- 7) **Demonstrate** understanding of hydrodynamic characterization by NMR (DOSY and spin relaxation), fluorescence spectroscopy, analytical ultracentrifugation, and single molecule methods
- 8) **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

Course Materials

Website: <http://www3.biochem.dal.ca/4702/>

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

Recommended books:

“Spin Dynamics – Basics of Nuclear Magnetic Resonance” by Malcolm H. Levitt (2002 or 2008 editions, Wiley) – **2nd edition available online from Dal library**. *Worth picking up if you are planning to do a lot of NMR in future.*

“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**. *If you see yourself doing a lot of fluorescence, this is a great (although pricey) book to pick up.*

“Fundamentals of protein NMR spectroscopy” by Rule and Hitchens – **2006 edition is available online from Dal library**. *Good source of more protein-specific discussion.*

“Protein NMR Spectroscopy – Principles and Practice” by Cavanagh, Fairbrother, Palmer, Rance and Skelton – **2nd edition is available online from Dal library**. *Highly referred to in the field, but of limited utility for this course since the level of the discussion is quite technical.*

Course Assessment – BIOC 4702/CHEM 4602

Component	Weight (% of final grade)	Date
Tests	2x15% ¹	Oct. 11, 2016 & Nov. 17, 2016
Final exam	30%	<i>(Scheduled by Registrar)</i>
Assignments	20% ²	Throughout term
Paper	20%	Due: Nov. 24, 2016

Notes 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.

² You have the option of not handing in up to two assignments over the term. Note, however, that any assignment handed in will be graded.

Course Assessment – BIOC 5702/CHEM 5602

Component	Weight (% of final grade)	Date
Tests	2x10%	Oct. 11, 2016 & Nov. 17, 2016
Final exam	20%	<i>(Scheduled by Registrar)</i>
Assignments	25%	Throughout term
Project – seminar	10%	Week of Nov. 22
Project – write-up	25%	Due: Dec. 6, 2016

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 Policies

Department of Biochemistry & Molecular Biology Policy on Missed Examinations and Assignments

A student who misses an examination (midterm test etc.) due to illness must notify the professor or department office within 48 h and provide a valid medical certificate no more than one week after the scheduled examination (see Dalhousie Calendar section 18.8). Special “make-up” examinations will normally be written within 7 calendar days after the missed examination. Absence for non-medical reasons is not ordinarily acceptable unless prearranged with the professor. A missed examination for which no satisfactory arrangement has been made will be given a mark of zero.

Assignments should be submitted in class but must be submitted to the professor no later than 5:00 pm on the designated due date. Extension of the due date will be granted only in the case of medical illness supported by a valid medical certificate presented to the professor within one week of the due date. Other reasons, such as excessive workload, are not normally acceptable. Extension of the due date will not normally exceed 7 calendar days. **The grade for assignments/projects will be reduced by 10% for each day after the due date.**

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, 2016/2017, University Regulations, Intellectual Honesty.

Course Content

Approximate Timeline: Fall 2016 (May be subject to change!)			
Class	Lecture	Date	Topic
1	1	06-Sep	Spectroscopy, NMR Hamiltonian, nuclear spin & the observable (<i>Le1,2,5,8</i>)
2	2	08-Sep	Anatomy of NMR spectrometer, quadrature detection, Primer in quantum mechanics for spectroscopy (<i>Le4,5,9</i>)
3	3	13-Sep	Quantum continued, Hamiltonian: Chemical shift, dipole-dipole & quadrupole coupling (<i>Le4,5,9</i>)
4	4	15-Sep	J-coupling, Spin-rotation, total Hamiltonian, Chemical vs. magnetic equivalence, longitudinal relaxation (<i>Le9,14,17,20</i>)
5	5	20-Sep	Transverse relaxation, 2D-NMR, TOCSY (<i>Le20,5,18</i>)
6	6	22-Sep	nOe and NOESY, Protein NMR intro (NOE restraints) (<i>Le20</i>)
6	7	27-Sep	Protein NMR: J-coupling, CSI, RDCs, exchange, simulated annealing, dynamics
7	Demo	29-Sep	<i>Solution-state NMR laboratory demonstration</i>
8	8	04-Oct	Dynamics & solids (<i>Le19,20</i>)
9	Rev 1	06-Oct	Solids & midterm review
10	Test 1	11-Oct	Test 1 – NMR
11	9	13-Oct	Absorption spectroscopy: electronic vs. rotational vs. vibrational energies, Franck-Condon principle, collisions, Beer-Lambert law vs. Einstein relation (<i>vH8,9</i>)
12	10	18-Oct	Protein UV-Vis absorption; Emission spectroscopy: Jablonski diagram, quantum yield, Stokes' shifts (<i>vH9,11;La1,6</i>)
13	11	20-Oct	Stokes' shifts, quenching (static vs. dynamic vs. fractional) (<i>La6,8</i>)
14	12	25-Oct	Time-resolved fluorescence, FRET, photobleaching, FRAP (<i>La4,9,13,23.5,24.5</i>)
	13	27-Oct	Polarization spectroscopy intro; LD & fluorescence anisotropy (<i>vH10,La10</i>)
15	14	01-Nov	Circular dichroism - theory & background (<i>vH10</i>)
16	15	03-Nov	Circular dichroism - near vs. far-UV and applications (<i>vH10</i>)
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17	Rev 2	15-Nov	Optical spectroscopy review
18	Test 2	17-Nov	Test 2 - optical spectroscopy
19	12	22-Nov	Introduction to hydrodynamics; analytical ultracentrifugation (<i>vH5</i>)
20	13	24-Nov	Diffusion NMR methods. (<i>BIOC/CHEM 4X02 – Paper due</i>)
21	14	29-Nov	Introduction to single molecule measurements; TIRF (<i>La23</i>) vs. confocal
22	15	01-Dec	smFRET, fluorescence correlation spectroscopy, single molecule hydrodynamics (<i>La23,24</i>)

Note: Literature references are starting points for background reading, which may not cover all topics of a given lecture. Le = Levitt; vH = van Holde; La = Lakowicz. Number = chapter (or section).

ACCOMMODATION POLICY FOR STUDENTS

Students may request accommodation as a result of barriers related to disability, religious obligation, or any characteristic protected under Canadian Human Rights legislation. The full text of Dalhousie's Student Accommodation Policy can be accessed here:

http://www.dal.ca/dept/university_secretariat/policies/academic/student-accommodation-policy-wef-sep--1--2014.html

Students who require accommodation for classroom participation or the writing of tests and exams should make their request to the **Advising and Access Services Centre (AASC)** prior to or at the outset of the regular academic year. More information and the ***Request for Accommodation*** form are available at www.dal.ca/access.

ACADEMIC INTEGRITY

Academic integrity, with its embodied values, is seen as a foundation of Dalhousie University. It is the responsibility of all students to be familiar with behaviours and practices associated with academic integrity. Instructors are required to forward any suspected cases of plagiarism or other forms of academic cheating to the Academic Integrity Officer for their Faculty.

The Academic Integrity website (<http://academicintegrity.dal.ca>) provides students and faculty with information on plagiarism and other forms of academic dishonesty, and has resources to help students succeed honestly. The full text of Dalhousie's ***Policy on Intellectual Honesty*** and ***Faculty Discipline Procedures*** is available here:

http://www.dal.ca/dept/university_secretariat/academic-integrity/academic-policies.html

STUDENT CODE OF CONDUCT

Dalhousie University has a student code of conduct, and it is expected that students will adhere to the code during their participation in lectures and other activities associated with this course. In general:

"The University treats students as adults free to organize their own personal lives, behaviour and associations subject only to the law, and to University regulations that are necessary to protect

- the integrity and proper functioning of the academic and non – academic programs and activities of the University or its faculties, schools or departments;
- the peaceful and safe enjoyment of University facilities by other members of the University and the public;
- the freedom of members of the University to participate reasonably in the programs of the University and in activities on the University's premises;
- the property of the University or its members."

The full text of the code can be found here:

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

SERVICES AVAILABLE TO STUDENTS

The following campus services are available to help students develop skills in library research, scientific writing, and effective study habits. The services are available to all Dalhousie students and, unless noted otherwise, are free.

Service	Support Provided	Location	Contact
General Academic Advising	Help with <ul style="list-style-type: none"> - understanding degree requirements and academic regulations - choosing your major - achieving your educational or career goals - dealing with academic or other difficulties 	Killam Library Ground floor Rm G28 Bissett Centre for Academic Success	In person: Killam Library Rm G28 By appointment: <ul style="list-style-type: none"> - e-mail: advising@dal.ca - Phone: (902) 494-3077 - Book online through MyDal
Dalhousie Libraries	Help to find books and articles for assignments Help with citing sources in the text of your paper and preparation of bibliography	Killam Library Ground floor Librarian offices	In person: Service Point (Ground floor) By appointment: Identify your subject librarian (URL below) and contact by email or phone to arrange a time: http://dal.beta.libguides.com/sb.php?subject_id=34328
Studying for Success (SFS)	Help to develop essential study skills through small group workshops or one-on-one coaching sessions Match to a tutor for help in course-specific content (for a reasonable fee)	Killam Library 3rd floor Coordinator Rm 3104 Study Coaches Rm 3103	To make an appointment: <ul style="list-style-type: none"> - Visit main office (Killam Library main floor, Rm G28) - Call (902) 494-3077 - email Coordinator at: sfs@dal.ca or - Simply drop in to see us during posted office hours All information can be found on our website: www.dal.ca/sfs
Writing Centre	Meet with coach/tutor to discuss writing assignments (e.g., lab report, research paper, thesis, poster) <ul style="list-style-type: none"> - Learn to integrate source material into your own work appropriately - Learn about disciplinary writing from a peer or staff member in your field 	Killam Library Ground floor Learning Commons & Rm G25	To make an appointment: <ul style="list-style-type: none"> - Visit the Centre (Rm G25) and book an appointment - Call (902) 494-1963 - email writingcentre@dal.ca - Book online through MyDal We are open six days a week See our website: writingcentre.dal.ca