Faculty of Science Course Syllabus  
Department of Biochemistry & Molecular Biology  
BIOC 4700/5700  
Proteins  
Fall term, 2019

Instructor(s):  
P. Liu (Coordinator) paul.liu@dal.ca Tupper 9M1 494-1208  
V. Ewart vewart@dal.ca Tupper 9S1 494-3149  
C. Blouin cblouin@dal.ca Goldberg 321 494-6702

Lectures: Wednesday & Friday, 10:00 - 11:30 AM  Tupper Building 14B02  
Laboratories: n/a  
Tutorials: n/a

Course Description

Our theme is the relationship between structure and function. The kinetic and thermodynamic determination of the protein fold is explored. Specific details of how form determines function in binding other molecules both small and large in membranes, and in energy transduction are provided. Protein evolution and turnover are examined.

Topics covered will include fundamental protein structures, protein purification and measurement, and protein-ligand interaction; protein thermodynamics and stability, states, equilibria and kinetics of protein structures, intrinsic disorder and quinary structures, replicating protein folding in silico, molecular simulation of slow processes, engineering structural innovation, classification and modularity in proteins, rational and directed evolution of new proteins; production and engineering of recombinant proteins through post-translational modification, directed evolution, protein splicing, and fibre formation.

NOTE: Some weeks, in addition to lectures, students will independently research and write about specialized topics suggested by the instructor and occasionally present these to a class in discussion group format.

Course Prerequisites

BIOC 3700 or (CHEM 3601 AND CHEM 2301 AND CHEM 2304), all with grades of B or higher or instructor's consent.
Course Objectives/Learning Outcomes

At the end of the course, students should be able to do the following:
- Describe the structures of proteins at the primary, secondary, tertiary and quaternary levels
- Summarize the life cycle of proteins and their post-translational covalent modifications
- Describe sources of proteins and expression systems to produce recombinant proteins
- Describe methods for protein measurement and purification
- Describe the detection and measurement of protein-ligand interaction
- Apply the above knowledge to answering questions or solving problems
- Explain protein conformation and dynamics by applying fundamental thermodynamic principles
- Relate theory in protein stability and its implementation as a simulation in molecular dynamics
- Assess the methodology used to define protein structure taxonomies
- Assess methodologies in the design of large-scale protein engineering strategies
- Describe methods of incorporating site-specific chemical modification and unnatural amino acids into recombinant proteins.
- Explain major types of protein splicing and their reaction mechanisms.
- Describe protein splicing methodologies for protein semi-synthesis, cyclization, segmental labeling, and site-specific chemical modification.
- Explain principle and basic design of directed evolution for improved and new protein functions.
- Describe examples of directed evolution including miniature antibody, protein aptamer, and catalytic enzymes.
- Explain structure and formation of protein fibers including spider silks as exceptionally strong biomaterial.
- Critically assess, integrate and review scientific papers on a protein-relevant topic
- Communicate the above research topic as a formal essay in the style of a scientific paper, and communicate the same as a short formal presentation (for undergraduate students) or a research seminar (for graduate students).

Course Materials

There will be no textbook. All learning materials will be provided in the course or are available at the Dalhousie library. The course website will be provided on the first day of classes.
Course Assessment

Undergraduates
- 25% Midterm exam #1 (Sept. 25, Ewart lectures)
- 25% Midterm exam #2 (Oct. 18, Blouin lectures)
- 15% Essay (Due date: Nov 20)
- 10% Classroom presentation (Nov. 22 – 29)
- 25% Final exam (Liu lectures)

Graduates
- 23% Midterm exam #1 (Sept. 25, Ewart lectures)
- 23% Midterm exam #2 (Oct. 18, Blouin lectures)
- 15% Essay (Due date: Nov 20)
- 16% Classroom presentation (Nov. 22 – 29)
- 23% Final exam (Liu lectures)

Other course requirements
n/a

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

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>A+</td>
<td>90-100</td>
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<tr>
<td>A</td>
<td>85-89</td>
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<tr>
<td>A-</td>
<td>80-84</td>
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<tr>
<td>B+</td>
<td>77-79</td>
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<tr>
<td>B</td>
<td>73-76</td>
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<tr>
<td>B-</td>
<td>70-72</td>
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<tr>
<td>C+</td>
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<td>C</td>
<td>60-64</td>
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<td>C-</td>
<td>55-59</td>
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<td>D</td>
<td>50-54</td>
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<td>F</td>
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Course Policies

Policies on missed examinations, assignments, etc. — A student who misses an evaluation component of a 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 hrs 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 or to their instructor via e-mail) 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. Absence for non-medical reasons is not ordinarily acceptable unless prearranged with the instructor. 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. Laboratory assignments must be submitted to the professor/instructor as specified in the lab manual.

Assignments Submission: All essays are to be submitted to the specific SafeAssign link on the class website by the deadline. You must always ensure that you are submitting the latest version of your completed work. It is the student's responsibility to keep backup copies of all submitted class work. All assignments will be considered late if submitted after the deadline, and a 10% penalty per day is levied on late assignments.

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Course Content

<table>
<thead>
<tr>
<th>DATE</th>
<th>DAY</th>
<th>TOPIC (Lecture)</th>
<th>LECTURER</th>
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<tbody>
<tr>
<td>Sept</td>
<td>4</td>
<td>Introduction; Amino acids, amino acid analysis</td>
<td>V. Ewart (VE)</td>
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<tr>
<td></td>
<td>6</td>
<td>Primary, secondary and tertiary structures</td>
<td>VE</td>
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<td>11</td>
<td>Protein sources, production and purification</td>
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<td>13</td>
<td>Introduction to protein interaction</td>
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<td>18</td>
<td>Protein interaction - methodology</td>
<td>VE</td>
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<td>20</td>
<td>Protein interaction – new developments</td>
<td>VE</td>
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<td>25</td>
<td>Midterm exam #1</td>
<td>VE</td>
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<td>27</td>
<td>Prot. folding equilibria and kinetics from 1st principles</td>
<td>C. Blouin (CB)</td>
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<td>Oct</td>
<td>2</td>
<td>Paper: Intrinsic disorder and specific binding</td>
<td>CB</td>
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<td>4</td>
<td>Simulating proteins: how good is our theory</td>
<td>CB</td>
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<td>9</td>
<td>Paper: Designing proteins for biotechnology</td>
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<td>11</td>
<td>Natural Innovation and modularity</td>
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<td>16</td>
<td>Rational design and directed evolution of nanomaterial</td>
<td>CB</td>
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<td>18</td>
<td>Midterm exam #2</td>
<td>CB</td>
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<td></td>
<td>23</td>
<td>Essay topics and expectations; potential lab visits</td>
<td>P. Liu (PL)</td>
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<td></td>
<td>25</td>
<td>Structure-function of post-translational modifications</td>
<td>PL</td>
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<td>30</td>
<td>Chemical and enzymatic methods of modifications</td>
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<td>Nov</td>
<td>1</td>
<td>Protein splicing types and reaction mechanisms</td>
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<td></td>
<td>6</td>
<td>Protein splicing methods for protein engineering</td>
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<td>8</td>
<td>Protein improvement through directed evolution</td>
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<td>11-15</td>
<td>NO LECTURE (Study Break)</td>
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<td></td>
<td>20</td>
<td>Protein directed evolution and fiber formation</td>
<td>PL</td>
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<td></td>
<td>22</td>
<td>Student presentations</td>
<td>CB, PL</td>
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<td></td>
<td>27</td>
<td>Student presentations</td>
<td>CB, PL</td>
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<tr>
<td></td>
<td>29</td>
<td>Student presentations</td>
<td>CB, PL</td>
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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 the office (Rm 3037, McCain Building), e-mail (elders@dal.ca) or leave message (902-494-6803). Information: https://www.dal.ca/campus_life/communities/native.html

Important Dates in the Academic Year (including add/drop dates)
https://www.dal.ca/academics/important_dates.html

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/academic-advising.html
- Aboriginal Student Centre: https://www.dal.ca/campus_life/communities/native.html
- Black 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

Other supports and services
- Student Health Services: https://www.dal.ca/campus_life/health-and-wellness/health-services/services.html
- Counselling: https://www.dal.ca/campus_life/health-and-wellness/counselling.html
- Student Advocacy: https://www.dsu.ca/services/community-student-services/student-advocacy-service

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