**Biochemistry**
**404**
**CRN 10308**
**Proteins**
**Course Outline - Fall 2020**

**Instructors:** Dr. Alisdair ("Al") Boraston (coordinator)
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Dr. Stephen Evans
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This course is aimed at understanding the detailed connection between the *structure* and the *function* of macromolecules. Part 1 (Dr. Boraston) is focused on understanding specific methods of quantifying *function.* Part 2 (Dr. Evans) is focused on understanding methods of determining *structure*, and on protein folding.

*** Please note that to assist in suppressing the potential spread of COVID-19 this course will be delivered online.**

- **No formal lectures will be given during the assigned class time.**
- **Lecture videos will be posted on Brightspace in advance of the assigned class time.**
- **Students will have the opportunity to meet with the instructor during the assigned class time to discuss content and ask questions. Specific details regarding this are as follows:**
  - *Each Instructor will establish a standing video conference link (via Zoom) for 9 am to 9:50 am on Mondays and Thursdays during the academic term (excluding holidays and Reading Break) to discuss specific questions related to the video lectures.*
  - *A schedule providing information on which lectures to be covered in each video meeting will be posted, giving every student several opportunities to ask general content-related questions.*
  - *These meetings may be beneficial but are NOT mandatory. Attendance will not be taken. Questions can also be asked* via *email or requested video-conference meetings.*
  - *All evaluations (assignments, tests, etc.) will be "open-book" and either "take-home" or written through the Brightspace portal; specific instructions for completing and submitting evaluations will be provided.*

**Part 1 – Dr. Boraston (September 10 – October 19)**

Molecular Interactions: Theoretical and Practical Aspects

1. Properties and isolation of proteins (~4.5 hours)
   - Review of general protein properties
   - Recombinant protein production
   - Methods of protein purification
2. Detecting and quantifying protein-ligand interactions. (~7 hours).
   - Overview of protein-ligand interactions.

- What is a ligand and why is their interaction with proteins important?
- Overview of high resolution vs. medium vs. low resolution methods
- Discussion of selected methods.

3. Binding equilibria (~5 hours).

   - Symbolic equilibrium expressions: representing simple and complex equilibria.
   - Mathematical modeling of binding equilibria and analysis of binding data.
   - Diagnosing complex binding.

4. Structural methods of detecting and examining molecular interactions – an intro (~2 hours)
   - Brief introduction to structure determination.
   - Hydrogen-deuterium exchange coupled with mass spectrometry.
   - Small-angle X-ray scattering.

**Part 2 - Dr. Evans (October 22 – December 3)**

1. Review of protein and peptide structure (1.5 hours)

   - Secondary structures as a structural biologist looks at them. STRUCTURE ≡ FUNCTION, peptide bonds & Ramachandran plots, complementarity and the $\alpha$-helix: 4-helix bundle, globin fold, $\beta$-sheets, $\beta$-bulges, $\gamma$-turns, antibody fold, Rossmann fold, jellyroll, TIM barrels, etc.

2. Introduction to structure determination by protein crystallography (9 hours)

   - Crystal symmetry: What are crystals? Why use crystals?
   - X-ray scattering of a crystal: Bragg's law.
   - Crystal quality & data resolution.
   - What information can be obtained from each determination?
   - The phase problem: Heavy atoms, MAD & molecular replacement.
   - Electron density maps.
   - Data collection & structure fitting.
   - Refinement of protein structures & indicators of 'correctness'.

3. Introduction to structure determination by NMR (1.5 hours)

   - Larmour frequency & proton coupling.
   - Comparison of NMR of small molecules and proteins.
   - Fourier Transform methods for data collection.
   - NOE and multi-dimensional NMR.
   - Comparison of X-ray and NMR methods.

4. Introduction to of protein folding (3.0 hours)

   - Levinthal paradox & the protein folding problem.
   - Methods to characterize protein folding: UV-Vis; NMR; X-ray scattering, enzyme activity.
   - Isomerization of peptide bonds as a rate-limiting step in protein folding.
   - Disulfide bond formation as a rate-limiting step in protein folding.
   - Cellular strategies: enzymes, chaperones & chaperonins.
   - Simple concepts of proteins folding, including the 'molten globule', nuclear condensation, hydrophobic collapse, etc.
   - Introduction to Φ-value analysis.

5. Real-world examples (3.0 hours)

   - Literature examples of structure determination and examples of how macromolecular structure determines function.

**Assessment of Student Performance**

(1) **Techniques to be used in assessment of student's performance in course**:

- Grading of multiple choice, short answer and/or essay questions. Assignments may comprise essay questions, answering specific questions based on a project, or writing on an assigned topic.

(2) **BIOC 404 - Evaluation and weighting**:

- Boraston's section:
  - Assignment 1 – Due September 28 15%
  - Assignment 2 – Due October 8 20%
  - Assignment 3 – Due October 19 15%
- Dr. Evans' section:
  - Online quizzes 10%
  - Assignment 10%
  - Final examination (2 hours): 30%

**UVic Grading Scheme**

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|---|---|---|---|---|---|---|---|
| **A+** | 90 -100 | **B+** | 77 - 79 | **C+** | 65 - 69 | **F** | < 50 |
| **A** | 85 - 89 | **B** | 73 - 76 | **C** | 60 - 64 | **N **** | < 50 |
| **A-** | 80 - 84 | **B-** | 70 - 72 | **D** | 50 - 59 | | |

** N grades

Students who have completed the following elements will be considered to have completed the course and will be assigned a final grade:

- *All assignments, online quizzes, and final examination.*

Failure to complete one or more of these elements will result in a grade of "N" regardless of the cumulative percentage on other elements of the course. An N is a failing grade, and it factors into a student's GPA as 0. The maximum percentage that can accompany an N on a student's transcript is 49.

**DEPARTMENT INFORMATION AND POLICIES**

1. The Department of Biochemistry and Microbiology upholds and enforces the University's policies on academic integrity. These policies are described in the current University Calendar. All students are advised to read this section.

2. Cell phones, computers, and other electronic devices must be turned off at all times during live class sessions unless being used for the purpose of connecting and engaging with the class.

3. No recordings of live lectures are permitted without permission of the instructor. Many online courses will be recorded by the instructor for accessibility for students unable to attend. If you do not wish to be recorded, contact your instructor to determine if alternative arrangements can be made.

4. Course materials, such as notes, problem sheets, quizzes, examinations, example sheets, or review sheets, may not be redistributed without the explicit written permission of the instructor.

5. Students are expected to be available for all exams. Instructors may grant deferrals for midterm examinations for illness, accident, or family affliction. Although students do not require documentation, students must contact their instructor and BCMB office (biocmicr@uvic.ca) with the reason for their absence within 48 hours after the midterm exam. The Department will keep a record of the absences. It is the responsibility of the student to ensure all required components are complete, and to arrange deferred exams/assignments with the instructor, which normally should occur within one week of the original exam date.

6. The Department of Biochemistry and Microbiology considers it a breach of academic integrity for a student taking a deferred examination to discuss the exam with classmates. Similarly, students who reveal the contents of an examination to students taking an examination are considered to be in violation of the University of Victoria policy on academic integrity (see current University Calendar). Students must abide by UVic academic regulations and observe standards of scholarly integrity (no plagiarism or cheating). Online exams must be taken individually and not with a friend, classmate, or group, nor can you access notes, course materials, the internet, or other resources without the permission of the instructor. You are prohibited from sharing any information about the exam with others. Use of unauthorized electronic devices and accessing the internet and class material during exams is prohibited unless permission is granted by the instructor. Instructors may use Browser Lockdown Software to block access during classes and exams.

7. Deferral of a final exam must be requested with an Academic Concession form and submitted directly to Undergraduate Records. Deferred final exams for fall term courses will be arranged by the instructor. Deferred final exams or spring term courses will be arranged through Undergraduate Records and must be written before the end of the summer term as stipulated in the University Calendar.

6. Requests for review/remark of a midterm exam must be made within one week of the exam being returned.

7. The instructor reserves the right to use plagiarism detection software or other platforms to assess the integrity of student work.

8. Supplemental exams or assignments will not be offered to students wishing to upgrade their final mark.

9. Anonymous participation in online classes is not permitted without permission of the instructor.

The current pandemic is placing added stressors- financial, mental, and physical- on everyone. Your wellbeing is of foremost importance. If you are experiencing difficulties coping, the University has resources to help. Reach out to Counselling Services, the Centre for Academic Communication, or Learning Assistance Program for assistance.

**Centre for Accessible Learning**
Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability/health consideration that may require accommodations, approach the Centre for Accessible Learning (CAL) as soon as possible in order to assess your specific needs. https://www.uvic.ca/services/cal/index.php

**Course Experience Survey (CES)**

We value your feedback on this course. Towards the end of term you will have the opportunity to complete a confidential course experience survey (CES) regarding your learning experience. The survey is vital to providing feedback to us regarding the course and our teaching, as well as to help the department improve the overall program for students in the future. When it is time for you to complete the survey, you will receive an email inviting you to do so. If you do not receive an email invitation, you can go directly to your CES dashboard. You will need to use your UVic NetLink ID to access the survey, which can be done on your laptop, tablet or mobile device. We will remind you nearer the time but please be thinking about this important activity.