University of Guelph
College of Biological Science
Molecular and Cellular Biology

COURSE OUTLINE
MCB*4050 - Protein and Nucleic Acid Structure - F15

Course description (from calendar)
This course explores the relationship between the functions and the three dimensional structures of DNA, RNA and proteins. Topics covered include how these structures are determined, the principles governing their folding and architecture, why some proteins don't fold at all, and the use of these structures to guide drug discovery. Practical skills are emphasized, including the use of bioinformatics and visualisation tools to analyse sequences and structures.

Prerequisite
BIOC*3560

Learning goals and rationale
By the end of this course students should be able to:
1. Describe the energetic basis of protein folding and function.
2. Describe the levels of protein structural organization.
3. Describe how proteins fold, including the role of chaperones, and the roles of proteins that do not fold spontaneously into well-ordered structures.
4. Analyse a protein's sequence and structure with a variety of bioinformatics and visualization tools.
5. Describe how novel protein structures are determined experimentally
6. Describe the organization of nucleic acid structures, and the ways they interact with their cognate protein partners
7. Describe the role structural biology plays in drug discovery

Teaching team

Professor: Dr. Matthew Kimber
Office: Rm. 2254 Summerlee Science Complex (2nd floor, West end of North wing)
Email: mkimber@uoguelph.ca

Office hours

I do not have regular office hours for this course. Office hours will be arranged prior to the midterm, assignment and final. Email me if you wish to meet otherwise.

Course schedule

Lectures: Tues. & Thurs. 2:30 – 3:50 p.m.
Venue: ANNU 156

Course Resources

Courselink will be used as the primary repository for course materials.
Assignments and tutorials will be posted on Courselink; completed assignments should be submitted on Courselink

Textbook

There is no textbook assigned for this course.

Lecture format

Lectures will be presented primarily using Powerpoint presentations. Complete lecture materials will be made available on CourseLink as pdf files no later than the night before the lecture for download.

PyMol will be used extensively for illustrating and exploring individual structures, and key save (.pse) files will be uploaded to CourseLink; students are encouraged to download these files and explore the structures being discussed in class.

Course Content

	Topics	Detailed content
1.	The physical underpinnings of structural biology	The amino acids, electrostatic forces, dipoles, van der Waals interactions, H-bonds, properties of water as solvent, hydrophobic interactions
2.	Motifs of Protein Structure	Helices and β-strands, loops and turns, domain organization, and emergent themes in protein organization
3.	Protein Folding	Energetics and mechanisms of the protein folding, barriers to protein folding and how cells overcome the folding obstacles, models of protein folding, computational simulation of folding
4.	Oligomers, multimers and supermolecular complexes	The formation of protein oligomers, patterns of oligomerization, organization of fibers and virus shells, and the functioning of large, supermolecular machines
5.	Bioinformatics I: Tools for working with text and sequences	Text-based database searching, single and multiple sequence alignments, blast searches, predicting secondary structure, molecular evolution & phylogeny
6.	Bioinformatics II: tools for understanding and interpreting structure	Tools for comparing folds and superposing weakly similar structures, projecting sequence conservation, electrostatics and residue type on structure
7.	Structure determination methods	The methodology, theoretical underpinnings, uses and limitations of x-ray crystallography, NMR spectroscopy electron microscopy for determining experimental structures
8.	Nucleic acid structure	Forces and interactions that govern nucleic acid structure, DNA double helices, non-canonical nucleic acid structures, RNA based machines, and DNA recognition by DNA binding proteins
9.	Intrinsically unstructured proteins	Proteins that do not form a well defined hydrophobic core and proteins that fold only upon binding, the functional roles of IUPs, bioinformatics means of detecting unstructured regions of proteins
10.	Structural biology in drug discovery	The process of drug discovery, the structural basis of drug action, virtual screening, computational chemistry and structure guided drug discovery

Methods of Assessment

Form of Assessment	Weight of Assessment	Due Date of Assessment	Learning Outcome Addressed
PyMOL Assignment	Ungraded requirement	Sep 24th	4
Midterm	30 %	Oct 22nd	1, 2, 3
Structure Analysis Assignment	25 %	Nov 19th	4
Final Examination	45 %	Dec 18th	4, 5, 6, 7

Assignments and evaluations

Midterm: An in-class midterm covering the first four lecture topics will be administered in class **Thursday October 22nd**. This midterm covers topics 1 through 4, and is worth **30% of the final grade**.

Final exam: a final exam will be **2:30 – 4:30 pm, Friday 18th December 2015, venue TBA**. The exam will cover topics 5 through 10, and will be worth 45% of the final grade.

PyMOL is a program that interprets and displays pdb (protein database) files to produce dynamic, interactive three-dimensional representations of molecular structures. You will be downloading and then using this program throughout this course for both exploring the course material and completing the structure annotation assignment. Therefore, you are asked to complete a tutorial (available on CourseLink) teaching you how to use this program. A short assignment will give you the opportunity to practice your skills by replicating a series of figures from recent publications. **Completion of this tutorial is due Thursday, Sept 24th at 2:30 p.m. and is ungraded requirement for the course.** Note that you will need access to a computer with an internet connection in order to complete the Pymol assignment and the structure analysis assignment.

The Protein Structure Analysis Project: Students will be asked to analyse aspects an experimental structure that has recently been determined and deposited in the main structural archive (the pdb) but for which there is no published analysis. The assignment answers will need to be given as though they were individual sections of a paper intended for publication. This assignment will require using a variety of sequence and structural bioinformatics tools to make useful inferences as to what the function of the protein is, and how it might function. Students will also be required to submit publication quality figures generated in PyMol and other tools.

The Protein Structure Analysis Assignment is due on the 19th Nov 2015 at 2:30 p.m. and is worth 25% of the final grade.

Key dates:

Item	Date
First day of class	Sep 10th
PyMOL Assignment	Sep 24th
Midterm	Oct 22nd
Last day to drop	Nov 6th
Structure Analysis Assignment	Nov 19th
Last lecture	Dec 3rd
Final Examination	Dec 18th

Course and University Policies

When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons, please advise the course instructor in writing, with your name, id#, and e-mail contact. See the undergraduate calendar for information on regulations and procedures for Academic Consideration.

Accessibility

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability or a short-term disability should contact Student Accessibility Services (formerly the Centre for Students with Disabilities) as soon as possible.

For more information, contact Student Accessibility Services at 519-824-4120 ext. 56208 or email csd@uoguelph.ca.

Academic Misconduct

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

The Academic Misconduct Policy is detailed in the Undergraduate Calendar.

E-mail Communication

As per university regulations, all students are required to check their <uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its students.

Drop Date

The last date to drop one-semester courses, without academic penalty, is the 40th class day. To confirm the actual date please see the schedule of dates in the Undergraduate Calendar. For regulations and procedures for Dropping Courses, see the Undergraduate Calendar.

Copies of out-of-class assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

Recording of Materials

Presentations which are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, a classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

Grading

Assignments will be submitted to Courselink. Penalties for late submission are 10 % of final grade per day, up to a maximum of 50 %. Assignments more than five days late will be assigned a mark of zero.

Campus Resources

If you are concerned about any aspect of your academic program:

Make an appointment with a Program Counsellor in your degree program.

If you are struggling to succeed academically:

There are numerous academic resources offered by the Learning Commons including, Supported Learning Groups for a variety of courses, workshops related to time management, taking multiple choice exams, and general study skills. You can also set up individualized appointments with a learning specialist.

If you are struggling with personal or health issues:

Counselling services offers individualized appointments to help students work through personal struggles that may be impacting their academic performance.
Student Health Services is located on campus and is available to provide medical attention.
For support related to stress and anxiety, besides Health Services and Counselling Services, Kathy Somers runs training workshops and one-on-one sessions related to stress management and high performance situations.

If you have a documented disability or think you may have a disability:

Student Accessibility Services (SAS) formerly Centre for Students with Disabilities can provide services and support for students with a documented learning or physical disability. They can also provide information about how to be tested for a learning disability.