MB&B 302b- Principles of Biophysics 1:00 – 2:15 pm, Mondays & Wednesdays, Spring '18

LOCATION: Bass 405

INSTRUCTORS:
Enrique M. De La Cruz (EDLC) and Peter B. Moore (PBM)

TEACHING ASSISTANTS:
Rajshekhar Basak <rajshekhar.basak@yale.edu> and Megan Brady <megan.brady@yale.edu>

WEB SITE: Access the course Web site via the Yale Canvas site (canvas.yale.edu). We will post problem sets, answer keys, announcements, etc.

EXAMS will be based exclusively on the material discussed in the main lectures. No information in the assigned readings that is not discussed in lectures will be on the exams.

Mid-term: 25% of final grade. Exam will be administered during class hours.
Final exam: 25% of final grade. The Final Exam is not cumulative. Date/location TBA, 2 hours
Problem sets: 25% of final grade.
Participation in Research Paper Discussions: 20% of final grade. There may be an unannounced 10 min quiz at the beginning of some sessions. Participation in the discussions will count towards the final grade.
Class participation: 5% of final grade.

Requests for regrading must be submitted in writing within a week of receipt of the graded copy, stating the reason for the request. Should other issues arise during regrading, the instructors reserve the option to amend scores as appropriate.
Make-ups to the mid-term exam (by Dean's excuse only) will be given orally; a written make-up for the final exam will be given in May.

GRADING:
The final distribution will be at the discretion of the instructors.

PROBLEM SETS:
Posted on the class website on Thursdays, due in class (hand them to a TA) the next Wednesday at the beginning of class. Problem sets received after the beginning of Wednesday class will receive a score of zero (your answers can be handed in by a classmate or emailed to Professor and TAs if you will not be present at the time they are due). Answers (or perhaps just hints) are posted the on the web site the same week. Your scores on these problems make up 25% of your final grade. The problem sets will cover the lectures up to the Wednesday before they are handed out. Problem sets and their answers will be discussed at discussion sections.

DISCUSSION SECTIONS:
There will be one discussion section each week (time to be confirmed, location TBA). Attendance is strongly recommended. Alternative meeting times will be considered according to demand.

TEXT:

There is no required textbook for this course. The textbooks below could serve as useful references throughout the semester and are on reserve at Medical Library. Relevant reading material tailored to the course will be available as a pdf file on the Yale Canvas website. Lecture notes for each lecture will be posted on the Classes v2 website on the day of the lecture at the beginning of class.

1. Berg, Howard (1983) *Random Walks in Biology.*
2. Howard, Jonathan (2001) *Mechanics of Motor Proteins and the Cytoskeleton.*
3. Dill, Ken A. & Bromberg, Sarina (2003) *Molecular Driving Forces.*
4. Phillips, R., Kondev, J. & Theriot, J.A. (2009) *Physical Biology of the Cell.*
5. Nelson, Philip (2008) *Biological Physics.*
6. Ferscht, Alan (1999) *Structure and Mechanism in Protein Science.*
7. Creighton, Thomas E. (1993) *Proteins: Structure and Molecular Properties.*
8. Wyman, Jeffries & Gill, Stanley J. (1990) *Binding and Linkage.*
9. Lakowicz, Joseph R. (1999) *Principles of Fluorescence Spectroscopy.*
10. Serdyuk, I.N., Zaccai, N.R. & Zaccai, J. (2007) *Methods in Molecular Biophysics*.
11. Moore, P (2012) *Visualizing the Invisible: Imaging Techniques for the Structural Biologist*

ACADEMIC INTEGRITY:

"Academic integrity is a core institutional value at Yale. It means, among other things, truth in presentation, diligence and precision in citing works and ideas we have used, and acknowledging our collaborations with others. In view of our commitment to maintaining the highest standards of academic integrity, the Graduate School Code of Conduct specifically prohibits the following forms of behavior: cheating on examinations, problem sets and all other forms of assessment; falsification and/or fabrication of data; plagiarism, that is, the failure in a dissertation, essay or other written exercise to acknowledge ideas, research, or language taken from others; and multiple submission of the same work without obtaining explicit written permission from both instructors before the material is submitted. Students found guilty of violations of academic integrity are subject to one or more of the following penalties: written reprimand, probation, suspension (noted on a student's transcript) or dismissal (noted on a student's transcript)."

INCLUSIVITY:

This class strives to be an inclusive community, learning from the many perspectives that come from having differing experiences, backgrounds, beliefs, education, etc... We expect that faculty, students and teaching assistants will strive to create an environment that facilitates inquiry and self-expression, while also demonstrating diligence in understanding how others' viewpoints may differ.

MB&B 302b- Principles of Biophysics - Syllabus in Brief

I. Physical Principles & Relevance to Biological Macromolecules

January 17 – (EDLC) Class syllabus & logistics; Physical Principles: Force & Energy

January 19 – (EDLC) Diffusion, random walks and Brownian motion

January 22 – (EDLC) Chemical forces & equilibria

January 24 – (EDLC) Research Paper Discussion 1 – Diffusion in Cells

II. Experimental Measurement of Macromolecular Interactions

January 29 – (EDLC) Equilibrium Binding I: Single site interaction and thermodynamics

January 31 – (EDLC) Equilibrium Binding II: Multiple sites, cooperativity and allostery

February 5 – (EDLC) Transient kinetics I: Chemical relaxations, rate and rate constants, simple reactions

February 7 – (EDLC) Transient kinetics II: Diffusion-limited reactions, multi-step reactions and simulations

February 12 – (EDLC) Transient kinetics III

February 14 – (EDLC) Research Paper Discussion 2 – Equilibrium and Kinetics

III. Mechanical Properties of Biological Polymers and Cells

February 19 – (EDLC) No class

February 21 – (EDLC) Biopolymer Mechanics

February 26 – (EDLC) Research Paper Discussion 3 – Polymer and cell mechanics

February 28 – (EDLC) Applications of course material so far to active research problem

March 5 – (TAs; EDLC) Single Molecule (SM) Methodologies/Molecular Mechanics (MM) and Dynamics (MD)

March 7 – (EDLC, TAs) **MID TERM EXAM** – covers through February 21

SPRING BREAK

IV. Introduction to Biomolecular Structure

March 26 - (PBM) Structural basis of protein folding and protein-protein interactions

March 28 (PBM) Introduction to Electromagnetic Scattering by Macromolecules;

April 2 – (PBM) Research Paper Discussion 4 – SM Methodologies, & MM

V. Determining the Structures of Biological Macromolecules

April 4 – (PBM) X-ray Crystallography I: The Phase Problem and How To Solve It

April 9 – (PBM) X-ray Crystallography II: Modern Phasing Methods: MAD and Molecular Replacement

April 11 – (PBM) X-ray Crystallography III: How to analyze & interpret crystal structures.

April 16 – (PBM) How microscopes work.

April 18 – (PBM) Cryo-Electron Microscopy I: Using electromagnetic lenses to form images; "contrast transfer function"

April 23 – (PBM) Cryo-Electron Microscopy II: High-resolution 3D structure determination by cryo-EM

April 25 – (PBM) Research Paper Discussion 5 – Macromolecular crystallography/microscopy

FINAL EXAM (covers March 5 and March 26–April 25 material only) – Date & location TBA