From Atoms to Molecules — Biochem 729, Section 006

MWF 8:50-9:40AM — 1116 DeLuca Biochemistry Building

This course is required for first semester IPiB graduate students. In addition to providing a foundation of biochemical knowledge, it is designed to help you make the transition from an undergraduate consumer of knowledge to a graduate student and future independent scientist who will discover and add new knowledge.

Objectives:
- To develop basic knowledge of the chemical principles underlying the structure, dynamics, interaction, and function of biological molecules.
- To learn how experimental data is analyzed, interpreted, tested and shared.
- To understand how biochemical knowledge develops from experimental data.

Textbook: The Molecules of Life: Physical and Chemical Principles
Kuriyan, Konforti & Wemmer
2013
Note: Chapters 7-10.C cover basic physical chemistry principles. I assume that you know this material, but please review it if your background is weak in this area.

Assignments: Are due at the beginning of class on the assigned due date!

Grading: Problem sets and quizzes assigned by instructors (20%)
Paper presentation and written review (20%)
Three take-home midterm exams (20% each)

I expect that you will attend the IPiB retreat (all day on 9/9) and Biochemistry seminars (3:30 pm on Mondays in 1211 HF DeLuca Biochemical Sciences Building).

Protein Structure (4.A-C) (Ivan)

9/7	Examining protein structure: the PDB
9/8 1pm**	Assessing the quality of a crystal structure
9/12	Structure determination by cryoEM
9/14	Comparison of X-ray and CryoEM
9/19	Structure determination by NMR (Katie)
9/21	Protein structure prediction and design (Katie)

Protein Folding (Katie)

9/23	Monitoring protein folding and folding thermodynamics
9/26	What does "unfolded" really mean? IDPs
9/28	Folding kinetics & intermediates
9/30	Folding kinetics & effect of mutagenesis)
10/3	Folding *in vivo*

Student Presentations:

10/5	Fischer, N., Konevega, A. L., Wintermeyer, W., Rodnina, M. V. & Stark, H. Ribosome dynamics and tRNA movement by time-resolved electron cryomicroscopy. *Nature* **466,** 329–333 (2010).
10/7	Kerner, M. J. *et al.* Proteome-wide analysis of chaperonin-dependent protein folding in Escherichia coli. *Cell* **122,** 209–220 (2005).

Membrane Structure & Assembly (Katie)

10/10	*Take-home Midterm 1 due*
10/10	Lipids & membrane material properties
10/12	Membrane protein structure & folding
10/14	Assembling asymmetry in biological membranes

Nucleic Acid Structure & Folding (Jim)

10/17	DNA structure
10/19	RNA structure
10/21	RNA folding

Protein-Ligand Interaction (Jim)

10/24	Thermodynamics of protein-ligand interaction
10/26	Kinetics of protein-ligand interaction
10/28	Protein-nucleic acid recognition: affinity vs specificity

Protein Dynamics (Katie)

10/31	MD simulations
11/2	Time and length scales of motion & experimental methods
11/4	Single molecule methods vs bulk
11/7	Examples: Phosphorylation as an on/off switch

Student Presentations:

11/9	Dynamics of the Ribosome Ning, W., Fei, J. & Gonzalez, R. L. The ribosome uses cooperative conformational changes to maximize and regulate the efficiency of translation. *Proceedings of the National Academy of Sciences* **111,** 12073–12078 (2014).
11/11	Ulmschneider, M. B. *et al.* Spontaneous transmembrane helix insertion thermodynamically mimics translocon-guided insertion. *Nat Commun* **5,** 4863– (2014).

Catalysis (Ivan)

11/14	*Take-home Midterm 2 due*
11/14	Enzyme Kinetics: Michaelis Menten
11/16	Enzyme Inhibition
11/18	Catalysis Theory
11/21	Catalysis Chemistry
11/23	Allostery
11/28	Kinases
11/30	Pre-steady state kinetics
12/2	Ribozymes (Jim)

Energy in Biology (Katie)

12/5	Redox reactions in biology – generating ATP
12/7	Active transport
12/9	Ion channels and electrochemical gradients

Student Presentations:

12/12	Dangkulwanich, M. *et al.* Complete dissection of transcription elongation reveals slow translocation of RNA polymerase II in a linear ratchet mechanism. *eLife* **2,** e00971 (2013).
12/14	Busch, F. *et al.* Ancestral Tryptophan Synthase Reveals Functional Sophistication of Primordial Enzyme Complexes. *Cell Chem Biol* **23,** 709–715 (2016).
12/14	*Take-home Midterm 3 due, Term papers due*