BIOPHYSICS 242: Special Topics in Biophysics

Spring 2023 Course

Syllabus

Tuesdays & Thursdays 3:00-4:15 pm
Folin Wu Room, Building C, Room 137
240 Longwood Avenue, Boston MA 02115
Harvard Medical School Campus

Head Instructor: Dr. Sahand Hormoz

1st Topic Block: Instructor: Dr. Sahand Hormoz

1st: January 24th - February 9th

Week 1:
Lecture 1: Tuesday, January 24th
Lecture 2: Thursday, January 26th

Week 2:
Lecture 3: Tuesday, January 31st
Lecture 4: Thursday, February 2nd

Week 3:
Lecture 5: Tuesday, February 7th
Lecture 6: Thursday, February 9th

Course Block Topic and Student Assignments /Assessment /Expectations:

Making Sense of High-Dimensional Data. High-dimensional data sets, such as single-cell RNA sequencing data, are routinely generated by biologists. We will build intuition for what high-dimensional data sets look like and learn the mathematics required for reducing their dimensionality and interpreting them. We will mainly focus on visualizing such data sets in two or three dimensions so that we can "see" the data.

There will be one problem set at the end of the block. Grades for the block will be assessed based on the performance on this problem.

Topic Block: Problem set to be completed and returned to Dr. Hormoz by February 23rd, 2023.

2nd Topic Block: Instructor: Dr. Haribabu Arthanari

2nd: February 14th- March 7th*†

Week 1:
Lecture 1: Tuesday, February 14th
Lecture 2: Thursday, February 16th

Week 2:

Lecture 3: THURSDAY, February 23rd
Lecture 4: TUESDAY, February 28th

Week 3:
Lecture 5: Thursday, March 2nd
Lecture 6: Tuesday, March 7th

Course Block Topic and Student Assignments /Assessment /Expectations:

Structure, or the Lack Thereof and Its Relationship to Function- Seen Through an Atomic Lens. This module will introduce the three primary techniques to obtain atomic level structural information: X-Ray crystallography, NMR, and Cryo-EM. We will then delve into how structure related to function looking at both classical systems that have well-folded structure, and disordered and dynamic systems that have a multitude of functions in a context dependent manner.

Topic Block Assignment: At the end of the module, students will be asked to use their creativity and knowledge to design a molecular machine with new function. Think of going into your virtual molecular workshop, combining different modules with triggers and effectors to design a new protein that has an interesting function. Think 'Transformers", but with proteins.

Assignment to be turned in to Dr. Arthanari by March 21st, 2023.

3rd Topic Block: Instructor: Dr. Radhika Subramanian

3rd: March 9th - April 4th (includes one week of spring recess from March 14th-18th)

Week 1:
Lecture 1: Thursday, March 9th
Lecture 2: Tuesday, March 21st

Week 2:
Lecture 3: Thursday, March 23rd
Lecture 4: Tuesday, March 28th

Week 3:
Lecture 5: Thursday, March 30th
Lecture 6: Tuesday, April 4th

Course Block Topic and Student Assignments /Assessment /Expectations:

Single-Molecule Biophysics.
In this module, we will introduce single-molecule imaging studies with a focus on experimental design, unique insights, and practical challenges. We will then focus on its application to molecular motors *in vitro* and in cells.

Topic Block Assignment: Students will be reviewing a paper. Expectation is participation in the class and completing the assignment. Goal is for everyone to participate in the scientific discussion and to feel comfortable sharing their ideas with fellow classmates and the instructor.

Assignment to be returned to Dr. Subramanian by April 18th, 2023.

4th Topic Block: Instructors: Dr. Mark Andermann & Dr. Michael Do

4th: April 6th - April 25th

Week 1:
Lecture 1: Thursday, April 6th *(Michael Do Lecture)*
Lecture 2: Tuesday, April 11th *(Michael Do Lecture)*

Week 2:
Lecture 3: Thursday, April 13th *(Michael Do Lecture)*
Lecture 4: Tuesday, April 18th *(Mark Andermann Lecture)*

Week 3:
Lecture 5: Thursday, April 20th *(Mark Andermann Lecture)*
Lecture 6: Tuesday, April 25th *(Mark Andermann Lecture)*

Course Block Topic and Student Assignments /Assessment /Expectations:

Special Topics in Neuroscience: The module will have 2 arcs, one concerning the generation and processing of electrical signals in the nervous system for vision (Dr. Michael Do), and one concerning the use of modern tools for long-term imaging of the activity of neurons *in vivo*, and examples of how these tools are used to study brain-body communication (Dr. Mark Andermann).

Topic Block Assignment: Each arc has three components:

1. The first introduces students to fundamental knowledge and techniques. Assignment: Students complete homework questions that help ensure they have learned the most relevant points.
2. The second focuses on one thread in the field, highlighting recent discoveries and specific, open questions. Assignment: Each student prepares a specific aim that they will present in the next class (5 min, chalk talk format).
3. Students present and discuss one another's aims. The instructor provides insight into how ideas and grants develop together within an actual lab.

Students are assessed on the quality of their homework, specific aims, and participation.

Dr. Michael Do Lectures:

1. Electrophysiological analysis of the nervous system
2. Neural mechanisms for sensing the external world
3. Discussion/critique of student aims in advancing sensory neuroscience

Dr. Mark Andermann:

1. Optical interrogation of brain function
2. Neural circuits for perceiving and regulating the needs of the body
3. Discussion/critique of student aims in advancing the study of brain-body communication

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Assignment to be returned to Drs. Andermann and Do by May 9th, 2023