Physical Biochemistry II BIOC446, MCB446, CHEM472 Spring 2019

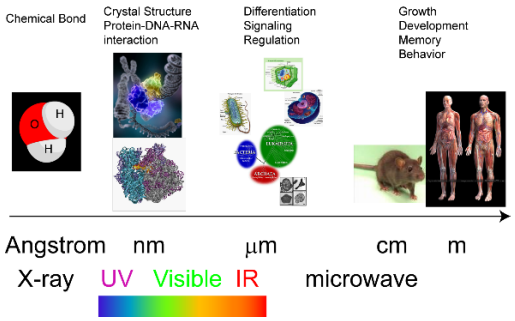
Instructor: Kai Zhang Tuesday Thursday 11-12:20 pm at 253 MEB

Course learning goal

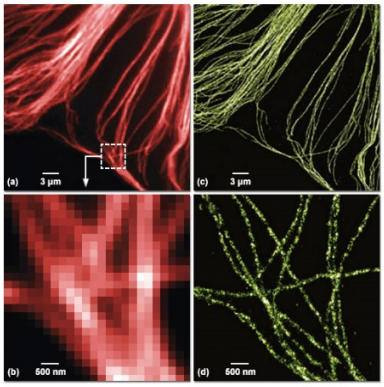
The course primarily covers fundamental principles and applications of commonly used physical, biophysical, and biochemical approaches in the study of biological sciences. We will focus on spectroscopic, hydrodynamic, and structural techniques used to obtain information about the structure and dynamics of biological macromolecules. This course covers fundamental concepts and mechanisms of wave-matter interaction processes such as light absorption and emission, nuclear magnetic resonance, X-ray diffraction (X-ray crystallography), and electron absorption and scattering (CryoEM). In addition, this course also integrates state-of-the-art biophysical and biochemical technologies including single-molecule fluorescence microscopy, super-resolution imaging, dynamic light scattering, surface plasmon resonance, and optogenetics. We will use recent literature to showcase how these experimental approaches can be utilized to study macromolecular structure and interaction and how signal transduction can be monitored and manipulated in live cells. By using the iClicker interactive devices, this class involves in-class discussion and feedback during lecture delivery. All course materials including textbook, lecture notes, and problem sets will be hosted in the compass-2g space. The ultimate goal of this course is to expose students with knowledge of fundamental physical biochemistry, to highlight how fundamental principles are applied to advance our understanding of biological systems, and to encourage students to develop their own critical thinking, problem solving, and scientific communication skills.

Who should take this course?

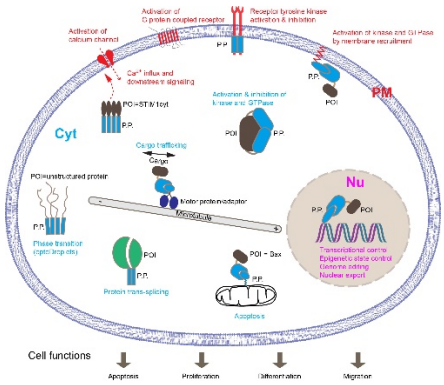
Undergraduate (junior or senior) or graduate students who are interested in understanding fundamental concepts and applications of physical biochemistry.



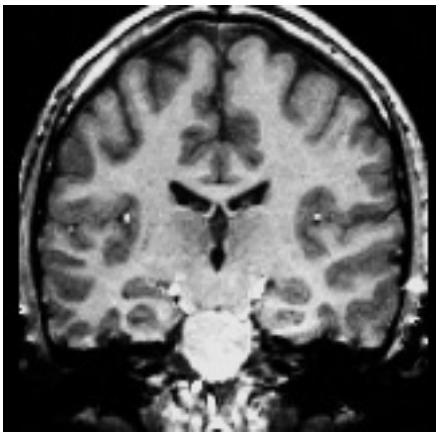
Scales of matter and wave



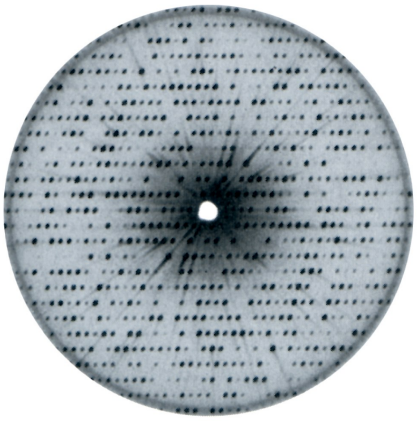
Super-resolution imaging



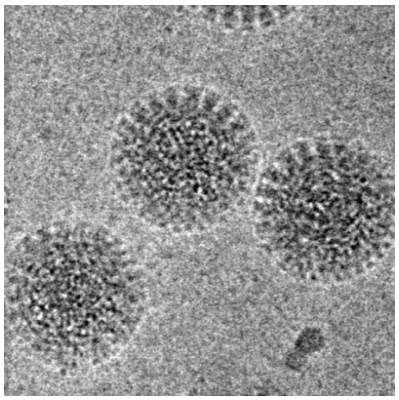
Optogenetic control of cell functions



MRI of a brain section



X-ray diffraction pattern



Single-particle CryoEM imaging

General Information

When and Where
Tuesday and Thursday 11-12:20 pm at MEB 253

Course website
Hosted in compass2g, login using netID

Instructor:
Prof. Kai Zhang
Email: kaizkaiz@illinois.edu
Phone: 217-300-0582
Office: 314B Roger Adams Laboratory
Office Hour: Friday 4-5 pm

TA
Savanna Sharum

Textbook: Physical Biochemistry written by Dr. Robert Gennis. The pdf version of textbook will be provided together with the lecture notes.

Course policies

Total points: 1000

I-clicker: 100 pts

Homework: 300 = 6 x 50 points each

Exams: 600 = 3 x 200 points/exam

I-clicker: Two to three questions will be asked during each lecture. For each question, you get 1 point if you participate but with wrong answer; you get 2 points if you get the answer correct.

Grading: Letter grade with +/-.

Homework: All homework will be online (compass2g). No late homework. Answers will be posted one day after the due day.

Exams: Three non-cumulative exams. Any make-up exam needs to be taken before the following Tuesday. Appropriate documentation (doctor's note) is required to schedule make-up exams.

Emergency responses:

Run-Hide-Fight

http://police.illinois.edu/emergency-preparedness/run-hide-fight/

Campus building floor plans:

http://police.illinois.edu/emergency-preparedness/building-emergency-action-plans/

Course schedule

Part I: Spectroscopy

Jan 21, 2020 (Tu) Lecture 1: Classical and quantum mechanical description of light
Jan 23(Th) Lecture 2: Wave-particle duality and Schrodinger's equation
HW 1 assigned: covers lectures 1-5
Jan 28 (Tu) Lecture 3: Absorption Spectroscopy I
Jan 30 (Th) Lecture 4: Absorption Spectroscopy II (spectrum broadening)
Feb 4 (Tu) Lecture 5: Chirality (CD, ORD)
Feb 6 (Th) Lecture 6: Fluorescence spectroscopy I
(HW 1 due)
HW 2 assigned: covers lectures 6-9

Feb 11 (Tu) Lecture 7: Fluorescence quenching
Feb 13 (Th) Lecture 8: Fourier transform vibrational spectroscopy (FTIR)
Feb 18 (Tu) Lecture 9: Optical microscopy
Feb 20 (Th) Lecture 10: Review session (TA)
(HW2 due)
Feb 25 (Tu) Lecture 11: Single-molecule microscopy and super-resolution imaging
Feb 27 (Th) **Midterm Exam 1 (covers lectures 1-8)**
Mar 3 (Tu) Lecture 12: Nonlinear optical microscopy
HW 3 assigned: covers lectures 10-14

Mar 5 (Th) Lecture 13: Fluorescence force-spectroscopy
Mar 10 (Tu) Lecture 14: FRET, BRET, and split GFP assay
Mar 12 (Th) Lecture 15: hydrodynamics I – fluorescence correlation spectroscopy
(HW 3 due)
HW 4 assigned: covers lectures 15-17

March 14-22 Spring break. No lectures

Mar 24 (Tu) Lecture 16: hydrodynamics II - fluorescence anisotropy
Mar 26 (Th) Lecture 17: Motor protein and protein trafficking
Mar 31 (Tu) Lecture 18: Surface plasma resonance and pharmacology
April 2 (Th) Lecture 19: Optogenetic and optochemical approaches
In-class debate: Optogenetic vs. Optochemical approaches in biomedical research

(HW4 due)
Apr 7 (Tu) Lecture 20: Review session
HW 5 assigned: covers lectures 18-19

Part II: Structure determination

Apr 9 (Th) + NMR basics
(HW 5 due)
HW 6 assigned: covers lectures 20-26
Apr 14 (Tu) Midterm Exam 2 (covers lecture 9-19)
Apr 16 (Th) Lecture 21: Nuclei electron interaction
Apr 21 (Tu) Lecture 22: Dipole-dipole coupling
Apr 23 (Th) Lecture 23: MRI and brain imaging
Apr 28 (Tu) Lecture 24 X-ray crystallography 1
Apr 30 (Th) Lecture 25 X-ray crystallography 2
May 5 (Tu) Lecture 26 CryoEM basics
May 7 (Th) Reading day (No lecture)
(HW 6 due)
May 8-15 (Finals week)* Final Exam 3 (covers lectures 20-26)

*Note: The exact final exam schedule (date, time, and room) will be announced by the Office of Registrar. https://courses.illinois.edu/schedule/2019/spring/BIOC/446