School of Molecular & Cellular Biology  
BIOC/MCB 446, CHEM 472 Spring 2022  
Physical Biochemistry II, Course Credit Hours: 3

Course Graphic

- Scales of matter and wave
- Super-resolution imaging
- Optogenetic control of cell functions

Instructor/Instructional Team

Instructor:
Prof. Kai Zhang  
Email: kaizkaiz@illinois.edu  
Phone: 217-300-0582  
Office: 314B Roger Adams Laboratory  
Office Hour: Friday 11-12 pm

TA
Kritika Mehta  
Email: kritika4@illinois.edu  
Office Hour: Mondays 10:00AM – 11:00AM

Class Meeting Schedule
Tuesday and Thursday 11-12:20 pm

Course Overview and Description
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.

Course Prerequisites, Requirements met (general education, major, minor)

Student Learning Outcomes
At the end of the course, through assignments, discussions, activities, and assessments, students will be able to:

- Understand Fundamental knowledge of Physical Biochemistry
- Develop critical thinking and problem-solving skills.
- Develop effective scientific communication skills

Course Text/Materials Information (both required and recommended)

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

Course Website, Course Tools
The course site will transit to Canvas by Spring 2022
In case of remote learning, zoom links for lecture, office hours, and exams will be sent out before the first lecture.

Grading Information and Breakdown
Total points: 1000
Homework: 400 = 8 x 50 points each
Exams: 600 = 3 x 200 points/exam
If returned to in-person, HW will be adjusted to 6x50 = 300 points, and iClicker questions will be 100 points.

Grading: Letter grade with +/-.
A+ 950-1000; A: 900-949; A-: 850-899; B+: 800-849; B: 700-799; B- 650-699; C+ 600-649; C550-599; C-501-549; F: <500.

Homework: All homework will be online (compass2g). No late homework. Answers will be posted 1 pm on 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.
Course Schedule

**Part I: Spectroscopy**

Jan 18, 2022 (Tu)  Lecture 1: Classical and quantum mechanical description of light
Jan 20 (Th)  Lecture 2: Wave-particle duality and

*HW 1 assigned: covers lectures 1-3*

Jan 25 (Tu)  Lecture 3: Schrodinger’s equation
Jan 27 (Th)  Lecture 4: Absorption Spectroscopy I

*HW 2 assigned: covers lectures 4-6*

Feb 1 (Tu)  Lecture 5: Absorption Spectroscopy II (spectrum broadening)
Feb 3 (Th)  Lecture 6: Chirality (CD, ORD)

*HW 3 assigned: covers lectures 7-9*

Feb 8 (Tu)  Lecture 7: Fluorescence spectroscopy I
Feb 10 (Th)  Lecture 8: Fluorescence quenching
Feb 15 (Tu)  Lecture 9: Fourier transform vibrational spectroscopy (FTIR)
Feb 17 (Th)  Lecture 10: Review Session (TA)

*HW 3 due*

Feb 22 (Tu)  Lecture 11: Optical microscopy
Feb 24 (Th)  Midterm Exam 1 (covers lectures 1-9)

Mar 1 (Tu)  Lecture 12: Single-molecule microscopy and super-resolution imaging

*HW 4 assigned: covers lectures 11-14*

Mar 3 (Th)  Lecture 13: Nonlinear optical microscopy
Mar 8 (Tu)  Lecture 14: Fluorescence force-spectroscopy
Mar 10 (Th)  Lecture 15: FRET, BRET, and split GFP assay

*HW 5 assigned: covers lectures 15-17*

Mar 12-20  Spring break

Mar 22 (Tu)  Lecture 16: hydrodynamics I – fluorescence correlation spectroscopy
Mar 24 (Th)  Lecture 17: hydrodynamics II - fluorescence anisotropy
Mar 29 (Tu)  Lecture 18: Motor protein and protein trafficking
Mar 31 (Th)  Lecture 19: Surface plasma resonance and pharmacology

*HW 6 assigned: covers lectures 18-19*

**Part II: Structure determination**

Apr 5 (Tu)  Lecture 20: Optogenetic and optochemical approaches
Apr 7 (Th)  Lecture 21: Review Session

*HW 6 due*

April 12 (Tu)  Lecture 21 NMR basics
Course Policies (should address the following topics; see below for sample policies)

- Contacting Personnel
- Religious Observances and Practices
- Disability Resources and Educational Services (DRES) Accommodations
- Class Absences
- Exam Absences
- Exam Conflicts
- Final Exam Absence
- Final Exam Conflict
- Grades
- Academic Integrity
- Electronic Media Use
- Course material
- University Information of Student Safety
- Resources

MCB Curriculum Policies

For non-academic campus assistance and support:

- See Office of Diversity, Equity and Access (ODEA) information at the end of this document.

Student Advocacy Resources:

- For student-centered advocacy programs and services visit: mcb.illinois.edu/undergrad/advising/resources.
- https://mcb.illinois.edu/undergrad/advising/faq/
Contacting MCB Course Personnel:
- MCB course personnel are more than happy to assist students.
- Emails to instructors, TAs, or course coordinators will only be answered if they come from an @illinois.edu account. We will only use this account in order to protect your educational information and profile. As a student, please remember that when you email a staff member, it is important to include all pertinent information so that we can assist you in the most efficient and effective manner possible. This information includes:
  - The course rubric in the subject line
  - Your full first and last name
  - Your NetID (the first part of your illinois.edu email account)
  - Your UIN (9 digit number that can be found on your ICard)
  - The course that you are concerned about (the course personnel often work with multiple courses)
  - Your section letter/number
  - The previous email "thread" or previous communicated information pertinent to the situation
- Your cooperation will help us respond much more quickly to your concerns.

Policies:
- Unfamiliarity with policies is not a defense for not knowing what they cover.

Adding the Course after the Semester Starts:
- We understand that the University has an add deadline 10 days into the semester, but the University lets individual courses and/or programs determine their policies for late adds. We feel that students who choose to add a course late do so at their own discretion with knowledge that there may be points lost in the process.

Religious Observances and Practices:
- Students are required to submit the Request for Accommodation for Religious Observances Form (which can be found at www.odos.illinois.edu/.../Religious_Observance_Accommodation_Request_Form.docx) to their instructors and the Office of the Dean of Students requesting accommodation by the end of the second week of the course. Requests that are not submitted within this time frame may not be granted. Information about accommodations can be found in the Student Code: http://studentcode.illinois.edu/.

DRES Accommodations:
• We are committed to providing a learning environment where our students can succeed. If you require special accommodations, please contact us and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak Street, Champaign, call 217.333.4603, or email disability@illinois.edu. We will try to meet all accommodations once the process has started. Please note that accommodations are not retroactive to the beginning of the semester, but begin the day you contact your professor, instructor or coordinator with a current letter of accommodation from DRES.

• If a student believes that they need DRES accommodations, they should contact DRES at disability@illinois.edu.

Class Absences:

• Regular class attendance is expected of all students at the University. ([http://odos.illinois.edu/studentAssistance/absence/revised_code.asp](http://odos.illinois.edu/studentAssistance/absence/revised_code.asp))

• If you find yourself ill, you must submit confirmation of a visit with a medical practitioner within 24 hours of your absence. The confirmation cannot be provided by a relative, even if the relative is a practitioner.

• The Office of the Dean of Students will only provide informative letters to instructors for protracted illness of 3 or more days, certain emergencies and to be present during the serious illness of immediate family members (parents, legal guardian, spouse/partner, siblings, children, or grandparents). These letters do not excuse you from class but merely provide information for the instructor to consider with regard to excusing the absence and permitting make-up work. Students must request absence letters from the Office of the Dean of Students after the student has returned to class but not more than 10 business days after the last date of absence.

• Absences that may be excused without a letter include circumstances beyond the student’s control such as medical treatment, surgery related to prolonged illness or injury, pregnancy, legal matters, citizenship or naturalization processes, or acts of nature which cause destruction to a primary residence or disrupt air travel. All will require documentation.

• Absences that may also be excused without a letter include a conference or job, graduate or professional school interviews, though a best effort should be made to schedule these events to minimize class attendance disruption. All will require documentation.

• Absences planned for the items listed in previous bullet point must be communicated to your instructor or course coordinator at least two weeks in advance of the absence. Failure to do so may result in the loss of opportunity to reschedule the missed class period and the portion of the grade associated with this class period.

• Absences that will not be excused include family events such as reunions or weddings, or presence during serious illness of extended family members (aunt, uncle, niece, nephew, or cousin).
• Unplanned absences may result in the loss of opportunity to reschedule the missed class period and, therefore, the portion of the grade associated with this class period.
• Absences will be handled according to individual course policy.

Exam Absences:
• If you must miss an exam due to unforeseen circumstances, you are required to contact your instructor or course coordinator within 24 hours of the absence. You will then have 48 hours from the absence in which to submit documentation to your instructor or course coordinator. You must also submit an online Absence Form if one is available on your course website. Course personnel will evaluate documentation and decide whether or not there will be an option to compensate for the missed exam through either a make-up exam or proration. Failure to follow this procedure will result in a zero for the exam.
• If you find yourself ill, you must submit confirmation of a visit with a medical practitioner within 24 hours of your absence. The confirmation cannot be provided by a relative, even if the relative is a practitioner.
• If you must miss an exam for a conference or job, graduate or professional school interviews, the exam may be prorated. A best effort should be made to schedule these events around exams. You will need to be mindful that only one exam may be prorated in a semester for any and all absences. All will require documentation.
• There will be instances when the student must make an individual choice about their ability to perform on an exam and will need to accept any and all consequences for that choice.
• If the absence is a result of a protracted illness of 3 days or more, you should follow the procedure for obtaining a letter from the Office of the Dean of Students. The request may be made once the student returns to class but not more than 10 business days after the last date of absence.

Exam Conflicts:
• If you have a regularly scheduled University course that conflicts with the exam, you should complete the online Conflict Exam Request Form on the course website. This request must be made by 5:00 pm not less than 3 business days prior to the exam. Requests made after 5:00 pm and less than 3 business days prior to the exam will not be granted. See course policies for a specific deadline for your course.
• Work schedules should be adjusted, if at all possible, in order to eliminate a conflict with scheduled exams. Please plan accordingly at the beginning of the semester. If eliminating a conflict is not possible, the student should complete the online Conflict Exam Request Form on the course website. This request must be made by 5:00 pm not less than 3 business days prior to the exam.
Requests made after 5:00 pm and less than 3 business days prior to the exam will not be granted.

- Students that are formally participating in officially recognized groups, such as athletic teams and performing groups, with a conflict should request a conflict exam by 5:00 pm not less than 3 days prior to the exam via the online Conflict Request Form. Formal participation does not include general meetings of RSOs or any other recognized groups. Documentation of the event will be required prior to scheduling the conflict exam. Requests made after 5:00 pm and less than 3 business days prior to the exam will not be granted.
- Students with DRES accommodations should also submit the online Conflict Request Form by 5:00 pm no later than 3 business days prior to the exam. Requests made after 5:00 pm and less than 3 business days prior to the exam will not be granted.

**Final Exam Absence:**

- If you must miss a final exam due to unforeseen circumstances, you are required to contact your instructor or course coordinator within 24 hours of the absence. You must also contact the Dean of your college. Finally, you must submit an online Absence Form if one is available on your course website. You will receive an ABS (absent) in the course if you miss the final exam. This ABS will result in an F in the course unless action is taken. The Dean can approve the change of the ABS to an Incomplete, which then allows a limited window of time for you to complete the final exam and earn a grade in the course.
- There will be instances when the student must make an individual choice about their ability to perform on an exam and will need to accept any and all consequences for that choice.
- If the absence is a result of a protracted illness, you should follow the procedure for obtaining a letter from the Office of the Dean of Students. The request may be made once the student recovers but not more than 10 business days after the date of absence.
- Information about final exams can be found in the Student Code: http://studentcode.illinois.edu/.

**Final Exam Conflict:**

- Conflict final exams may only be granted for any one of the following situations:
  - Students with three final exams scheduled within a 24 hour period as defined in Section 82.A.4). Final Examinations of the Code of Policies and Regulations Applying to All Students which can be found at: www.illinois.edu/admin/manual/code/
  - Students who have two final exams scheduled at the same time. Final conflict exam requests should be made to the course with larger enrollment. Course personnel can assist with information to determine which course this would be.
Students who have a verified personal problem, and who have received written permission to take a conflict final exam from a dean in their college.

Students who have DRES academic accommodations.

- Students that find themselves in any of the above situations should complete the online Conflict Final Exam Request Form which can be found on the course website. This request must be made by 5:00 pm on the last day of class in order for the request to be granted. Any requests made after this time may not be granted. If a conflict final exam is granted, it may be scheduled at any time during the final examination period and is at the discretion of the instructor or course coordinator.

Grades:

- Each course has a grade scale. The grade you earn in the course will be based on the points that you earn. Effort is reflected in points earned. We will adhere to the grade scale when assigning grades in order to avoid capriciousness and to adhere to fairness and equity for all students.

Academic Integrity:

- The Code of Policies and Regulations Applying to All Students will be applied in all instances of academic misconduct committed by students. This applies to all exams, presentations, assignments and materials distributed or used in this course. You can review these policies at the following website: http://admin.illinois.edu/policy/code/index.html and specifically here: http://studentcode.illinois.edu/article1/part4/1-401/

- Science cannot exist without honesty. The faculty and staff in MCB require students, as scientists-in-the-making, to hold the highest standards of scientific and academic conduct. Any form of cheating on any graded work in courses is unacceptable.

- We require that all graded work be entirely your own, and that anything you write using the words of other writers be correctly attributed. Some specific points follow.

- On exams, the answers that your turn in for grading must be your own, formulated during the exam from your own understanding of the material and without any supporting information, be it written, verbal or electronic. Copying the work of another student, or allowing another to copy your work, or copying work from any other source, is unacceptable. Since we cannot always monitor you as you complete your work, we must rely upon appearance of your work from which to judge. If the work you submit resembles that of another student or another source too closely, we may conclude that it was not your original work. Always make a conscious effort to complete your work on your own and to protect it from the view of others, in order to ensure that it will be seen as your own. Failure to
adhere to these standards for any portion of an exam may result in a grade of zero for the entire exam or quiz for all persons involved.

- Texting, or the use of a cell phone or any other device for any purpose, during a quiz or exam is prohibited. Doing so may earn you a zero or a more extreme penalty on the quiz or exam at the discretion of the instructor.

- Use of any social or electronic media to share information, request information or make confidential information public is prohibited. Any use of this type may earn you a zero on the exam or a more extreme penalty at the discretion of the instructor.

- On written or electronic assignments, the answers that you turn in for grading must be written in your own words, formulated from your own understanding of the material. While you may be working with other students in the course, you must formulate and submit your own answers. Copying or paraphrasing the work of another student, or allowing another to copy or paraphrase your work, is unacceptable. Since we cannot monitor you as you complete your work, we have only the appearance of your work from which to judge. If the work you submit resembles that of another student too closely, we may conclude that it was not your original work. Always make a conscious effort to complete your work on your own and to protect it from the view of others, in order to ensure that it will be seen as your own. You must also make a conscious effort to protect your passwords and accounts. Failure to adhere to these standards may result in a grade of zero for the entire assignment for all persons involved.

- On written or electronic assignments, if you use a statement taken directly from any book or other publication, including the course textbook, you must provide a citation. That is, you must put the text in quotes and put the author of the publication in parentheses after the quotation. Failure to do so will result in zero credit for that answer. Further, using only the words of another author as your entire answer or as the majority of your answer to any question is never sufficient to earn credit. If the majority of your work has been taken directly from a publication, you are likely to receive no credit for the work, since you would not be demonstrating knowledge beyond the ability to copy. Even if you quote another, your answer must be substantially your own words, drawn from your own understanding of the material.

**Electronic Media/Device Use:**

- Use of any social or electronic media to share course information, request course information or make confidential course information public is prohibited. Any use of this type may earn you a zero on an assignment or exam or a more extreme penalty at the discretion of the instructor.

- Any violation of the social media policy **on your account** may result in a zero on an assignment or exam or a more extreme penalty at the discretion of the instructor.

- Any social media sites created in relation to MCB courses must grant access to course personnel upon request. Failure to provide access will result in a failing grade in the course for the group/site’s administrator(s).
• No electronic devices, including smart watches, are allowed at exams.

Course Material:
• Students are welcome and encouraged to make audio recordings of course lectures.
• The material recorded is intellectual and copyrighted property of the University of Illinois Board of Trustees and may be made for personal use only.
• Video recordings of any kind are strictly prohibited.
• Posting of audio recordings or transcriptions on social or electronic media platforms is strictly prohibited.
• Posting or redistributing of course material in any format is strictly prohibited.

University Information of Student Safety – Active Threats:
• General Emergency Response Recommendations (Emergency Response Guide):
  • Security Threat. The Department of Homeland Security and the University of Illinois at Urbana-Champaign Office of Campus Emergency Planning recommend the following three responses to any emergency on campus: RUN > HIDE > FIGHT

  • Only follow these actions if safe to do so. When in doubt, follow your instincts - you are your best advocate!

  • RUN — Action taken to leave an area for personal safety.
    o Take the time to learn the different ways to leave your building before there is an emergency.
    o Evacuations are mandatory for fire alarms and when directed by authorities! No exceptions!
    o Evacuate immediately. Pull manual fire alarm to prompt a response for others to evacuate.
    o Take critical personal items only (keys, purse, and outerwear) and close doors behind you.
    o Assist those who need help, but carefully consider whether you may put yourself at risk.
    o Look for Exit signs indicating potential egress/escape routes.
    o If you are not able to evacuate, go to an Area of Rescue Assistance, as indicated on the front page of this plan.
    o Evacuate to Evacuation Assembly Area, as indicated on front page of this plan.
    o Remain at Evacuation Assembly Area until additional instructions are given.
    o Alert authorities to those who may need assistance.
- Do not re-enter building until informed by emergency response personnel that it is safe to return.
- Active Threat: IF it is safe to do so, run out of the building. Get as far away as possible. Do NOT go to the Evacuation Assembly Area.

- **HIDE** — Action taken to seek immediate shelter indoors when emergency conditions do not warrant or allow evacuation.
  - Severe Weather:
    - If you are outside, proceed to the nearest protective building.
    - If sheltering-in-place due to severe weather, proceed to the identified Storm Refuge Area or to the lowest, most interior area of the building away from windows or hazardous equipment or materials.
  - Active Threat:
    - Lock or barricade your area.
    - Get to a place where the threat cannot see you.
    - Place cell phones on silent.
    - Do not make any noise.
    - Do not come out until you receive an Illini-Alert advising you it is safe.

- **FIGHT** — Action taken as a last resort to increase your odds of survival.
  - Active Threat: If you cannot run away safely or hide, be prepared to fight with anything available to increase your odds for survival.

**Student Resources/Where to go for Help:**
**We Care at Illinois**
- For sexual misconduct support, response and prevention visit: wecare.illinois.edu

*Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, etc. If you or someone you know has been harassed or assaulted, you can find the appropriate resources here:*

**Safety and Emergency**
*University Police Department, Emergency, 9-911; Non-emergency, 217-333-8911*
University Fire Department Emergency, 9-911
Crisis Line, 217-359-4141
Emergency Dean, 300 Turner Student Services Bldg., 610 E. John St., 217-333-0050
Counseling Center, 110 Student Services Bldg., 610 E. John St., 217-333-3704
McKinley Health Center, General Information, 217-333-2701
McKinley Mental Health Center, 1109 S. Lincoln, 217-333-2705
Dean of Students, 300 Turner Students Services Bldg, 610 E. John St., 217-333-0050
Local Sexual Assault Center, RACES, 217-384-4444
Women’s Resources Center, 703 South Wright Street, 2nd Floor, 217-333-3137
Rape Crisis 24-hour Hotline, 217-384-4444
Suicide & Psychological Emergency, Suicide Prevention Team, 217-333-3704
SafeRides (free nighttime campus ride program), 217-265-RIDE (265-7433)
SafeWalks (free walking escort service by Student Patrol), 217-333-1216

Student Services and Advocacy
Office of the Dean of Students, 300 Student Services Bldg., 610 E. John St., 217-333-0050

Classroom Support, Teaching Skills, and Instructional Strategies
Center for Innovation in Teaching & Learning, 249 Armory Building, 217-333-1462

Counseling Services
Counseling Center, 110 Student Services Bldg., 610 E. John St., 217-333-3704
McKinley Mental Health Center, 1109 S. Lincoln Ave., 217-333-2701
Psychological Services Center, 3rd Floor, 505 E. Green St., 217-333-0041

Disability Services
Disability Resources and Educational Services (DRES), 1207 S. Oak St., 217-333-1970

Lesbian, Gay, Bisexual, Transgender Resource Center
LGBT Resource Center, 323 Illini Union, 1401 W. Green St., 217-244-8863

Veterans Services
Veteran Student Support Services, Office of the Dean of Students, 610 E. John St., 217-333-0050
Center for Wounded Veterans in Higher Education, 908 W. Nevada St., 217-300-3515

General Study Skills Assistance
Office of Minority Student Affairs, 130 Student Services Bldg., 610 E. John St, 217-333-0054
Office of Minority Student Affairs Tutoring Services, 701 S. Gregory Dr., Suite 1, 217-333-7547
Writer’s Workshop, 251 Undergraduate Library, 1402 W. Gregory Dr., 217-333-8796
**Additional academic assistance may be available through individual departments

Health Resources
Health Education, McKinley Health Center, 1109 S. Lincoln Ave., 217-333-2701
Alcohol & Other Drug Office, 2nd Floor Counseling Center, 610 E. John St., 217-333-7557
Sexual Health Educator, McKinley Health Center, 1109 S. Lincoln Ave., 217-333-2714
Dial-A-Nurse, McKinley Health Center (24-hour), 1109 S. Lincoln Ave., 217-333-2700
Health Resource Center, McKinley Health Center, 1109 S. Lincoln Ave., 217-333-6000
Health Resource Center, Room 40 Illini Union, 1401 W. Green St., 217-244-5994
McKinley Health Center, General Information, 1109 S. Lincoln Ave., 217-333-2701

Sexual Harassment/Assault & Acts of Intolerance/Hate Crimes
Office of the Dean of Students, 300 Students Services Bldg., 610 E. John St., 217-333-0050
The Office of Diversity, Equity and Access (ODEA):

- For non-academic support visit: diversity.illinois.edu
  - Discrimination & Harassment Prevention
  - Title IX
  - Accessibility & Accommodations
  - Inclusive Illinois