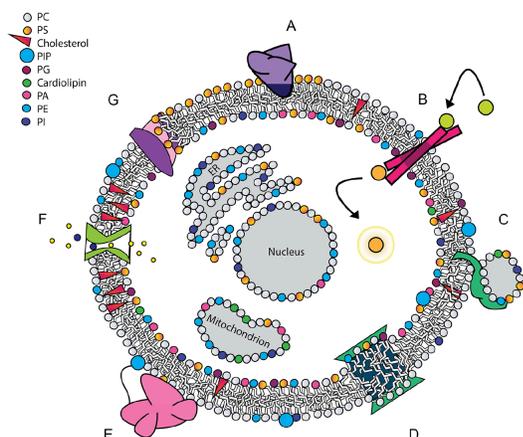




School of Molecular & Cellular Biology

CHEM440B / BIOC 440B, Fall 2021

Physical Chemistry Principles, 4 Credit Hours



Instructor/Instructional Team

Instructor:

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Class Meeting Schedule

Tue/Thu 9:30 – 11:00 am classes held in 0035 Campus Instruction Facility.

Additional discussion session, held this semester online through four ZOOM sessions per week:
Mon 6-7 pm, Tue 6-7 pm, Thu 6-7 pm, and Fri 4-5 pm.

Office Hours: Held 4 times a week, primarily using ZOOM: Mon 6-7 pm, Tue 6-7 pm, Thu 6-7 pm, and Fri 4-5 pm. If you intend to make an in person visit with the TAs, make sure you coordinate with them in advance.

Course Overview and Description

Biochemistry and biochemical reactions and processes regulating living cells are governed by the same basic physicochemical principles applied to chemical reactions. However, given the complexity of biochemical processes, the application of the same physical chemistry principles to them requires a thorough understanding of the rules in the context of specific biochemical problems. The course combines the description of basic physical chemistry principles, e.g., those in thermodynamics and kinetics, with their direct application to biochemical processes. Examples include protein and DNA structure and stability principles, quantitative relationship governing membrane transport in a living cell, and thermodynamic factors determining the direction of chemical reactions in energy conversion.

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

Basic Algebra and Calculus. While the course will review the derivation of some of the relationship, the emphasis is on their application to biochemical problems.

Student Learning Outcomes (a list of at least 3)

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

- Understand the physical chemistry principles governing biochemical reactions and processes such as those involved in, e.g., membrane transport, bioenergetics of a living cell, and protein structure and stability, among others.
- Analyze the literature describing quantitatively (or qualitatively) such basic concepts in molecular sciences in general, and in biochemistry in particular
- Apply quantitative relationship established during the course to biochemical problems and to determine and identify useful values describing their values.

Course Text/Materials Information (both required and recommended)

Biophysical Chemistry - Foundations and Applications of Physical Biochemistry
Robert B. Gennis, in the process for publication. Pdf of all chapters are available in the web page of the course.

Course Website, Course Tools (Canvas, Moodle, LON-CAPA, Zoom, etc.)

<https://learn.illinois.edu/mod/page/view.php?id=6409536>

Students enrolled in the course will have access to the web page and material in there bu logging in using their UI NetID and password.

Grading Information and Breakdown

Grading will use the usual scale, with + and - grades, e.g., A⁺, A, A⁻, B⁺, ...

10-12 Problem Sets (Total: 25%)

- Problem set answers due on the following week on Thursdays (in class) or as indicated.
- NO LATE homework without valid excuse; otherwise, ZERO credit.
- 10 points (max) for each homework

3 In-class Exams (~25% each)

EXAMINATION 1: - Covering Lectures 01 - 08

EXAMINATION 2: - Covering Lectures 09 - 16

EXAMINATION 3: - Covering Lectures 17 - 25

Course Calendar with Daily Schedule of Topics, Readings and Assignment Due Dates

The course can be generally divided into 4 modules/part:

PART I: The principles of thermodynamics applied to biochemical reactions

8 lectures

- Equilibrium, driving forces, free energy and the chemical potential
- The Boltzmann distribution
- Electrochemistry
- The thermodynamics of transport across membranes

Part II: Structure and stability of macromolecules

9 lectures

- The hydrophobic force, micelles and the lipid bilayer
- Protein structure and stability
- RNA and DNA structure and thermal stability

Part III: Molecular interactions and ligand binding

4 lectures

- Diffusion, on-rates and off-rates
- Binding isotherms: Model-independent and model-dependent binding equations
- Allostery: classical and modern treatments and examples

Part IV: The principles of kinetics applied to biochemistry

4 lectures

- Enzyme kinetics
- Kinetics of protein folding

Lectures:

Tue 8/24: Lecture 01, Introduction
Thu 8/26: Lecture 02, Enthalpy
Tue 8/31: Lecture 03, Boltzmann Distribution
Thu 9/02: Lecture 04, Free Energy & Chemical Potential
Tue 9/07: Lecture 05, Equilibrium Constant
Thu 9/09: Lecture 06, Redox Reactions
Tue 9/14: Lecture 07, Membrane Transport
Thu 9/16: Lecture 08, Oxidative Phosphorylation
Tue 9/21: Lecture 09, Biomolecular Stability

Thu 9/23: Special Lecture, An Introduction to visualizing proteins with VMD
We will be giving a demo on the molecular visualization program VMD to display, animate, and analyze large biomolecular systems. Students are encouraged to bring a laptop but are not required. Students are also encouraged to download and install VMD before class.

Tue 9/28: Lecture 10, Micelle and Protein Structure

Thu 9/30: EXAM I in class (Lectures 01-08)

Tue 10/05: Lecture 11, Protein Folding Thermodynamics
Thu 10/07: Lecture 12, Mutations, Denaturants, and Protein Folding Stability
Tue 10/12: Lecture 13, Electrostatics
Thu 10/14: Lecture 14, Physical Chemistry of Water
Tue 10/19: Lecture 15, DNA Structure and Topology
Thu 10/21: Lecture 16, RNA Structure
Tue 10/26: Lecture 17, Kinetics Principles I

Thu 10/28: EXAM II in class (Lectures 09-16)

Tue 11/02: Lecture 18, Kinetics Principles II
Thu 11/04: Lecture 19, Multiple Equilibrium
Tue 11/09: Lecture 20, Cooperativity
Thu 11/11: Lecture 21, Allostery
Tue 11/16: Lecture 22, Enzyme Kinetics I
Thu 11/18: Lecture 23, Enzyme Kinetics II
Tue 11/30: Lecture 24, Protein Folding I
Thu 12/02: Lecture 25, Protein Folding II - Experimental Measurements
Tue 12/07: Review

Tue 12/14: EXAM III in class (Covering Lectures 17-25)

Course Policies (should address the following topics; see below for sample policies)

Contacting Course Personnel:

- 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.

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.

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/>

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- 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 you 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.
 - Take the time to learn the different ways to leave your building **before** there is an emergency.
 - Evacuations are mandatory for fire alarms and when directed by authorities! No exceptions!
 - Evacuate immediately. Pull manual fire alarm to prompt a response for others to evacuate.
 - Take critical personal items only (keys, purse, and outerwear) and close doors behind you.
 - Assist those who need help, but carefully consider whether you may put yourself at risk.
 - Look for **Exit** signs indicating potential egress/escape routes.
 - If you are not able to evacuate, go to an Area of Rescue Assistance, as indicated on the front page of this plan.
 - Evacuate to Evacuation Assembly Area, as indicated on front page of this plan.
 - Remain at Evacuation Assembly Area until additional instructions are given.
 - 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.

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- 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: http://oior.illinois.edu/sites/prod/files/SexualMisconduct_ResourceGuide.pdf

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

LGTB 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