University of Nevada, Las Vegas – Spring, 2022
CHEM 474/674: Biochemistry I

Professor: Dr. Hong Sun
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Lecture: **Tuesday, Thursday 1:00 pm – 2:15 pm Web Live Remote Learning**

Remote Learning: Each class is expected to run synchronously for 75 min via Zoom meeting, and students are expected to participate in each class during the lecturing hours.

Zoom Meeting: Join Zoom Meeting

https://us06web.zoom.us/j/87640235050?pwd=cm1zbWtldCtJT0RWeGE4bG5iR1M2QT09

Meeting ID: 876 4023 5050
Passcode: xBiJz6

Office Hours: Tuesday, Thursday: 2:30 pm - 4:30 pm via WebCampus/WebEx, appointments are needed via WebEx/Appointments
Additional office hours can be scheduled by email (hong.sun@unlv.edu)

Course Web Page: http://webcampus.nevada.edu (choose UNLV, log in, and choose CHEM 474/674 Spring 2022)

Textbook Web Page: http://www.macmillanlearning.com/Catalog/product/biochemistry-eighthedition-berg (This companion site for our textbook contains some free and open resources, including "conceptual insights," "living figures," animations, and sample quizzes for each chapter.)

Required Text: *Biochemistry* by Berg, Tymoczko, Gatto & Stryer, 8th Edition (recommended), while either the 7th edition or the 9th edition should work fine.

Other Materials: During the semester, you will complete a number of online homework assignments. The dates on which these assignments are due are listed in this syllabus. You will access these homework assignments through the MacMillan Learning Achieve website. You will need to create an Achieve Account, select university and course, and purchase access to their homework site ($42 for 1 semester).

1) https://store.macmillanlearning.com/us/product/Biochemistry/p/1319114679
2) Choose Achieve Essentials (for Homeworks)
   Select the option of either 1 term access for $42 or 2-term access for $64
3) Enter course ID:
   a2utxd
4) Purchase access

Special Notes: Information about UNLV's official policies about Academic Misconduct, Copyright, the Disabilities Resource Center, Religious Holidays, tutoring, the UNLV Writing Center, and Rebelmail are located on the last page of this syllabus.

Acknowledgement: I would like to thank Drs. Hui Zhang, Gary Kleiger and MaryKay Orgill for kindly supplying syllabus templates used to create this one, the learning objectives, and lecture notes that were used in the preparation of this course. I am indebted to them for their excellent guidance and suggestion!

CATALOG DESCRIPTION
Fundamentals of biochemistry with emphasis on the structure-function relationships of proteins, enzymes, carbohydrates, lipids and nucleic acids; bioenergetics; and intermediary metabolism and the mechanisms of its regulation.
Credits: 3

Prerequisites: CHEM 242

COURSE OBJECTIVES

Upon completion of this course, you will be able to:

1. apply concepts from general and organic chemistry to the understanding of the structures and functions of biomolecules;
2. draw the structures of 20 common amino acids and determine how they are ionized at different pHs;
3. describe the primary, secondary, tertiary, and quaternary structures of proteins and the effect of specific amino acid side chains on protein structure;
4. explain techniques used to analyze proteins and interpret the results of tests using such techniques;
5. describe the cooperative binding of oxygen to hemoglobin and determine the effects of changing pH on oxygen binding;
6. draw the monomers of DNA and RNA and describe the different structural variations of these molecules;
7. describe the basic process by which genetic information in DNA is transcribed and translated into expressed protein and use the genetic code to determine the protein sequence resulting from the transcription and translation of a particular segment of DNA;
8. describe the processes by which enzymes increase biochemical reaction rates;
9. use the Michaelis-Menten Model to describe the kinetics of enzyme-catalyzed biochemical reactions;
10. construct double-reciprocal plots to determine mechanisms of enzyme inhibition;
11. characterize the chemical catalytic strategies utilized by enzymes;
12. understand the major allosteric control systems utilized by enzymes;
13. analyze and reproduce the reactions by which the cell extracts energy and reducing power from glucose (glycolysis and the citric acid cycle);
14. describe the regulation and inhibition of glycolysis, gluconeogenesis, the citric acid cycle and oxidative phosphorylation;
15. explain the coupling of electron transport to oxidative phosphorylation; and
16. describe the mechanism of ATP formation by ATP synthase.

**********Tentative Schedule**********

Dates	*Textbook*	*Lecture Topic*	*Online Homework*
01/18/2022	Chapter 1	Biochemistry: An Evolving Science	
01/20/2022	Chapter 2	Protein Composition and Structure	Online Homework Assignment 1 due before 11:55 p.m. on Sunday, Jan. 30th.
01/25/2022	Chapter 2	Protein Composition and Structure	
01/27/2022	Chapter 2	Protein Composition and Structure	Online Homework Assignment 2 due before 11:55 p.m. on Sunday, Jan. 30th
02/01/2022	Chapter 3	Exploring Proteins and Proteomes (Protein Techniques)	Online Homework Assignment 3 due before 11:55 p.m. on Sunday, Feb. 6th
02/03/2022	Chapter 7	Hemoglobin: Portrait of a Protein in Action	
02/08/2022	Chapter 7	Hemoglobin: Portrait of a Protein in Action	Online Homework Assignment 4 due before 11:55 p.m. on Sunday, Feb. 13th
02/10/2022	Chapter 4	DNA, RNA, and the Flow of Information	
02/15/2022		*Review Session for Chapter 1, 2, 3, 7*	
02/17/2022	**Exam I**	**Chapters 1, 2, 3, 7**	
02/22/2022	Chapter 4	DNA, RNA, and the Flow of Information	Online Homework Assignment 5 due before 11:55 p.m. on Sunday, Feb. 27th
02/24/2022	Chapter 8	Enzymes: Basic Concepts and Kinetics	
03/01/2022	Chapter 8	Enzymes: Basic Concepts and Kinetics	
03/03/2022	Chapter 8	Enzymes: Basic Concepts and Kinetics	
03/08/2022		*Review Session for Chapter 4 & 8*	Online Homework Assignment 6 due before 11:55 p.m. Wednesday, March. 9th
03/10/2022	**Exam II**	**Chapters 4 & 8**	
03/15/2022	-	Spring Break, no class	
03/17/2022	-	Spring Break, no class	
03/22/2022	Chapter 9	Catalytic Strategies	
03/24/2022	Chapter 9	Catalytic Strategies	
03/29/2022	Chapter 9	Catalytic Strategies	Online Homework Assignment 7 due before 11:55 p.m. on Sunday, April. 3rd
03/31/2022	Chapter 10	Regulatory Strategies	
04/05/2022	Chapter 15	Metabolism: Basic concepts and design	Online Homework Assignment 8 due before 11:55 p.m. on Sunday, April. 10th
04/07/2022	Chapter 16	Glycolysis	
04/12/2022	Chapter 16	Glycolysis (Gluconeogenesis)	Online Homework Assignment 9 due before 11:55 p.m. on Tuesday, April. 17th
04/14/2022		*Review Session for Chapter 9, 10, 15, 16*	
04/19/2022	**Exam III**	**Chapters 9, 10, 15, 16**	
04/21/2022	Chapter 17	The Citric Acid Cycle	
04/26/2022	Chapter 17	The Citric Acid Cycle	Online Homework Assignment 10 due before 11:55 p.m. on Sunday, May 1st
04/28/20212	Chapter 18	Oxidative Phosphorylation	
05/03/2022	Chapter 18	Oxidative Phosphorylation	Online Homework Assignment 11 due before 11:55 p.m. on Sunday, May. 8th
05/05/2022		*Review Session for Chapter 17 & 18*	
05/10/2022 (1:00 pm - 3:00 pm)	**Exam IV (final exam)**	**Chapters 17 & 18**	**Check MyUNLV for Final Exam Dtae and Time**

***With the exception of the exam dates, this schedule is subject to change (especially for the online HW assignments). Students should verify the content covered by each exam (learning objectives will be provided for each chapter).**

LECTURE
Attendance at lectures is essential and expected. You are responsible for all announcements and concepts covered in lecture. The lecture schedule above, with the exception of exam dates, is subject to change.

RECOMMENDED PRACTICE PROBLEMS
On the last page of the syllabus, I have included recommended practice problems for each chapter. The purpose of these practice problems is to allow you to practice the kinds of questions that will help you gauge your understanding of the material. The suggested problems are the ***minimum*** number of problems that you should work in order to master the course material.

LEARNING OBJECTIVES
At the beginning of each chapter, I will provide a list of learning objectives for the chapter on the WebCampus site under "Course Material." This list will give you an idea of the concepts and skills that I believe are important for you to understand or have. You can think of these lists as study guides for the chapters. **I often model exam questions after the questions in the Learning Objectives documents.** I suggest that you print out the lists before we cover the topics in lecture so you can mark your notes in accord with the learning objectives.

COURSE GRADES

Exam 1	100 points
Exam 2	100
Exam 3	100
Exam 4 (given during final exam week)	100
Class Participation (polls via Zoom or Slido)	50
Online Homework	100
Total	550 points possible

- *Exams:* You will complete a total of four exams over the course of the semester. Four 100-point exams will be given during the semester. There will not be a cumulative "final" exam. **There are no make-up exams**.
- *Special Circumstances:* An alternate exam may be administered prior to the scheduled time *only* in cases where travel for a university sanctioned business or function, which cannot be rescheduled, interferes with an exam date. *If such plans do interfere with an exam date, then it is your responsibility to schedule an alternate exam date prior to the scheduled date. This alternate date must be finalized* ***at least two weeks prior to the scheduled exam date.*** You must show proper documentation from the appropriate university official for an early exam to be administered. Extraordinary health issues with proper documentation will also be allowed. It is solely the right of the instructor to determine whether the documentation and/or reason for rescheduling an exam are[appropriate.
- *Online Homework:* During the semester, you will complete a number of online homework assignments (due in most non-exam weeks). The dates on which these assignments are due are listed in this syllabus. You will have access to each homework assignment the Friday before it is due.
  - *Accessing your online homework assignments:* You will access these homework assignments through the Sapling Learning website. You will need to create a MacMillan Learning Achieve Account and purchase access to their homework site ($42 for 1 semester). Instructions for creating a Achieve Learning Account are included below:
    1) https://store.macmillanlearning.com/us/product/Biochemistry/p/1319114679
    2) Choose Achieve Essentials (for Homeworks)
       Select the option of either 1 term access for $42 or 2-term access for $64
    3) Enter course ID:
       a2utxd
    4) Purchase access

    Alternatively, you can follow the link below to create an account and sign-up the Course:
    https://achieve.macmillanlearning.com/courses/a2utxd

  - Once you have registered and enrolled, you can log in at any time to complete or review your homework assignments.
  - During sign up - and throughout the term - if you have any technical problems or grading issues, check the following link: https://macmillan.force.com/macmillanlearning/s/chat-with-us

The course grade will be based on the following scale:

%	100-93	92-91	90-89	88-81	80-79	78-77	76-69	68-67	66-65	64-57	56-0
Grade	A	A–	B+	B	B–	C+	C	C–	D+	D	F

*Although I will never raise the grading scale, I reserve the right to lower it at the end of the semester. After each exam, I will explain how I will determine grades and post a grade breakdown to show you where you stand in class.

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RECOMMENDED PRACTICE PROBLEMS FROM THE BERG, TYMOCZKO & STRYER TEXTBOOK

Chapter 1	1, 3, 6, 7, 12, 14, 16, 24 (These problems should mostly be review from general chemistry. If you don't remember how to solve them, please come in for help!)
Chapter 2	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 14, 15, 17, 18, 19, 21, 22, 25, 28 **Comments:** *About problem 2.2a:* The answer to part (a) should be A and C. *About problem 9:* The structure shown in the back of the book is missing a negative charge on the side chain carboxyl group.
Chapter 3	1, 3, 5, 6, 9, 10, 11, 13, 17, 21, 22, 26, 27
Chapter 7	7, 8, 9, 10, 11, 13, 14a, 15, 16
Chapter 4	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 15, 16, 17, 18, 20, 24, 25, 26, 29, 32, 33, 34, 35, 36, 38, 39, 43, 44, 45
Chapter 8	1, 2, 3, 4, 5, 6, 7, 8, 15, 16, 17, 18, 19, 21, 22, 23, 25 (parts a and b only), 29, 30, 35, 38, 41 **Comments:** *About problem 7:* The answer given in the back of the book is correct; however, you should also realize that ΔG depends only on the initial and final states of the reaction ($G_{products}$ and $G_{reactants}$) and not on the reaction mechanism/pathway ($\Delta G^{\ddagger}$). *About problem 8:* "Thermodynamically unstable" means that a reaction has a positive ΔG. *About problem 17:* I calculate $\Delta G^{o'}$ to be -7.30 kJ/mol (which is slightly different than the answer in the back of the book). I agree with the book's value of K'_{eq}. *About problem 21:* The answer shown in the back of the book is not entirely correct. When [S] = $10K_M$, V_0 = $0.91V_{max}$. When [S] = $20K_M$, V_0 = $0.95V_{max}$. According to the Michaelis-Menten equation, V_{max} is never reached (just "approached"). "So any Michaelis-Menten curves showing that the enzyme actually attains V_{max} are pernicious lies." *About problem 25:* The answers to part (a) shown in the back of the book are incorrect. K_M = 9.9 μM and V_{max} = 8.9 μmol/min. *General comment:* Pay close attention to units when determining kinetic parameters from double-reciprocal plots!
Chapter 9	3, 4, 6, 7, 9, 11, 13, 15, 16 **Comments:** *About problem 3:* To answer this question, you should consider the fact that subtilisin is an enzyme that has a catalytic triad in its active site.
Chapter 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 14, 16
Chapter 15	1, 2, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 19, 21, 22, 23, 25, 26, 27, 28, 29 **Comments:** *About problem 4:* There is a typo in part 4. Please remove the word "reaction" from the phrase. The phrase should say "Catabolic electron carrier." *About problem 8*: Remember that, in reactions that involve the hydrolysis of ATP, the true substrate is the ATP-Mg^{2+} complex (even though the magnesium isn't shown as part of the reaction in problem 8). So, by increasing the [Mg^{2+}], the reaction can be made more spontaneous. *About problem 11:* Remember, the change in free energy tells you if the reaction is spontaneous (whether it will happen), but it does not tell you anything about the speed of the reaction. *About problem 19:* There is a typo in this problem. The problem says that you should calculate the "ratio of reactants to products." You should calculate the ratio of "products to reactants" in this problem. *About problem 21:* You will need to calculate the value of Q in order to solve each part of this problem. Remember that Q is the ratio of the MOLAR concentrations of products to reactants (not the ratio of millimolar concentrations). You will need to change the concentrations that are given in the problem to molar concentrations before you solve the problem. *About problem 22*: Several of the structures shown in this problem are incorrect. Some electrons in double bonds are shown as being delocalized when they are not. In part b, in the structure of pyruvate, the carbonyl on the

	right should be a double bond. In part d, in the structure of oxalosuccinate, the carbonyl at the top of the structure should be a double bond. In part e, in the structure of oxaloacetate, the carbonyl at the top of the structure should be a double bond. In part f, in the structure of pyruvate, the carbonyl on the right should be a double bond. *About problem 29:* "Exergonic" refers to the fact that ΔG is negative for this reaction. ΔG determines if a reaction is spontaneous (if it will happen), but it is not related to the speed of the reaction, which is affected by the activation energy.
Chapter 16	1, 2, 3 (only parts a-c), 6, 7, 8, 9, 10, 11, 12, 14, 16, 17, 23, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 38, 40 **Comments:** *About problem 6:* Hint: This reaction requires NAD^+. *About problems 11 and 27:* Lactic acid is a *relatively* strong acid, not a strong acid. *About problem 17:* The balanced equation in part (a) should be: Glucose + $2P_i$ + 2ADP → 2lactate + 2ATP + $2H_2O$. For the calculations in part (b), you can assume that the reaction occurs at 298K. The value of $\Delta G^{o'}$ is -123.1 kJ/mol. The value of ΔG under the conditions listed in the problem is -113.5 kJ/mol. *About problem 29:* Remember that glucose 6-phosphate is not a substrate for the transport proteins that shuttle glucose across cell membranes. Therefore, if the glucose 6-phosphate cannot be dephosphorylated, it cannot be transported across cell membranes.
Chapter 17	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 13, 15, 16, 18, 19, 20, 21, 22, 23, 25 **Comments:** *About problem 8:* The answer for this problem in the back of the book doesn't correspond with the question! The answer should be that the enzymes of the citric acid cycle are physically associated with each other. They are organized into a multienzyme complex called a "metabolon." *About problem 16*: For the calculation in part (b), assume that the reaction occurs at 298K. Also, as long as a biochemical reaction occurs at pH 7, the hydrogen ion concentration is not included in the calculation of Q, the reaction quotient.
Chapter 18	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 14, 16, 17 (only parts a, c, d, and f), 19, 20, 32, 33, 34, 38, 41

OFFICIAL UNLV POLICIES

Academic Misconduct – Academic integrity is a legitimate concern for every member of the campus community; all share in upholding the fundamental values of honesty, trust, respect, fairness, responsibility and professionalism. By choosing to join the UNLV community, students accept the expectations of the Academic Misconduct Policy and are encouraged when faced with choices to always take the ethical path. Students enrolling in UNLV assume the obligation to conduct themselves in a manner compatible with UNLV's function as an educational institution. An example of academic misconduct is plagiarism. Plagiarism is using the words or ideas of another, from the Internet or any source, without proper citation of the sources. See the *Student Academic Misconduct Policy* (approved December 9, 2005) located at: http://studentconduct.unlv.edu/misconduct/policy.html.

Copyright – The University requires all members of the University Community to familiarize themselves and to follow copyright and fair use requirements. You are individually and solely responsible for violations of copyright and fair use laws. The university will neither protect nor defend you nor assume any responsibility for employee or student violations of fair use laws. Violations of copyright laws could subject you to federal and state civil penalties and criminal liability, as well as disciplinary action under University policies. Additional information can be found at: http://www.unlv.edu/committees/copyright/.

Disability Resource Center (DRC) – The Disability Resource Center (DRC) determines accommodations that are "reasonable" in promoting the equal access of a student reporting a disability to the general UNLV learning experience. In so doing, the DRC also balances instructor and departmental interests in maintaining curricular standards so as to best achieve a fair evaluation standard amongst students being assisted. In order for the DRC to be effective it must be considered in the dialog between the faculty and the student who is requesting accommodations. For this reason faculty should only provide students course adjustment after having received this "Academic Accommodation Plan." If faculty members have any questions regarding the DRC, they should call a DRC counselor. UNLV complies with the provisions set forth in Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990. The DRC is located in the Student Services Complex (SSC-A), Room 143, phone (702) 895-0866, fax (702) 895-0651. For additional information, please visit: http://drc.unlv.edu/.

Religious Holidays Policy – Any student missing class quizzes, examinations, or any other class or lab work because of observance of religious holidays shall be given an opportunity during that semester to make up missed work. The make-up will apply to the religious holiday absence only. It shall be the responsibility of the student to notify the instructor no later than the last day of late registration of his or her intention to participate in religious holidays which do not fall on state holidays or periods of class recess. This policy shall not apply in the event that administering the test or examination at an alternate time would impose an undue hardship on the instructor or the university which could have been avoided. For additional information, please visit: http://catalog.unlv.edu/content.php?catoid=4&navoid=164.

Tutoring – The Academic Success Center (ASC) provides tutoring and academic assistance for all UNLV students taking UNLV courses. Students are encouraged to stop by the ASC to learn more about subjects offered, tutoring times and other academic resources. The ASC is located across from the Student Services Complex, #22 on the current UNLV map. Students may learn more about tutoring services by calling (702) 895-3177 or visiting the tutoring web site at: http://academicsuccess.unlv.edu/tutoring/.

UNLV Writing Center – One-on-one or small group assistance with writing is available free of charge to UNLV students at the Writing Center, located in CDC-3-301. Although walk-in consultations are sometimes available, students with appointments will receive priority assistance. Appointments may be made in person or by calling 895-3908. The student's Rebel ID Card, a copy of the assignment (if possible), and two copies of any writing to be reviewed are requested for the consultation. More information can be found at: http://writingcenter.unlv.edu/

Rebelmail – By policy, faculty and staff should e-mail students' Rebelmail accounts only. Rebelmail is UNLV's Official e-mail system for students. It is one of the primary ways students receive official university communication such as information about deadlines, major campus events, and announcements. All UNLV students receive a Rebelmail account after they have been admitted to the university. Students' e-mail prefixes are listed on class rosters. The suffix is always @unlv.nevada.edu.