Supplemental Material

CBE—Life Sciences Education

Woodbury and Offerdahl

Mind the Gap Supplement – TBL Exam Model Tables, Multicollinearity Tables, Course Grading Scheme.

Exam Models

The final model for Exam 1 was the initial model with the Semester random factor removed, as other models did not reduce the AIC by 2.

The initial model for Exam 2 can be found in the table below. The Semester factor was removed before modeling of the fixed factors began. The Gender*HM interaction and Gender*Generation factors were removed (in that order) from the final model.

Table: Initial regression model explaining student outcomes on Exam 2

Factor	B	SE
Intercept	48.0	6.39
iRAT Average†	0.49	0.08
Gender	-2.56	2.77
HM Status	-1.88	3.56
Generation	-2.62	3.96
Gender*HM Status	-1.60	5.18
Gender*Generation	-1.19	5.30

N = 134; Adjusted R^2 = 0.24

†$p < 0.001$

The initial model for Exam 3 was the initial model including the Semester random factor, as other models with individual factors removed did not reduce the AIC by 2.

The final and initial models for the BCI Normalized Change statistic can be found in the table below. The Semester random factor was removed before modeling of the fixed factors began. The Gender*HM interaction and Gender*Generation interaction factors were removed to reach the final model.

Table: Final regression model explaining student outcomes on the BCI Normalized Change statistic

Fixed Factors	B	SE
Intercept	-0.20	0.23
iRAT Average†	0.0059	0.029
Gender	-0.027	0.399
HM Status	0.098	0.078
Generation	-0.032	0.08

N = 131, Adjusted R^2 = 0.015

†p < 0.001

Table: Initial regression model explaining student Biochemistry Normalized Change outcomes

Factor	B	SE
Intercept	-0.19	0.23
iRAT Average†	0.006	0.003
Gender	-0.02	0.08
HM Status	0.07	0.11
Generation	0.08	0.12
Gender*HM Status	0.07	0.16
Gender*Generation	-0.10	0.16

N = 131; Adjusted R^2 = 0.003

†p < 0.001

Course Grades and BCI Normalized Change Models

The final and initial models for the Course Grades outcome can be found in the table below. The Semester, Generation, Gender*HM interaction, and Gender*Generation interaction factors were removed to reach the final model.

Table: Final regression model explaining student course grade outcomes

Fixed Factors	B	SE

Intercept	78.77	4.43
iRAT Average	0.10	0.056
Gender	-1.35	1.32
HM Status	-0.59	1.52

N = 134, Adjusted R^2 = 0.0167

Table: Initial regression model explaining student outcomes on course grades

Factor	B	SE
Intercept	78.5	4.53
iRAT Average	0.10	0.06
Gender	-0.49	1.66
HM Status	0.09	2.14
Generation	1.56	2.37
Gender*HM Status	-1.12	3.12
Gender*Generation	-2.58	3.19

N = 134; Adjusted R^2 = 0.005

In all of the initial and final models explaining student exam performance, only iRAT average significantly explained student outcomes. In the final models explaining the BCI Normalized Change statistic and students' course grades, none of the selected factors significantly explained student outcomes. In only the third, comprehensive exam model was Semester a significant factor in explaining students' outcomes.

Variance Inflation Factors

We calculated Variance Inflation Factors (VIF) to assess the degree of multicollinearity among our selected factors. For the BCI, Course Grades, and one of the exam models, VIF was calculated for each factor and the two selected interactions. A VIF larger than 10 is a strong signal of multicollinearity (Neter J, Wasserman W, Kutner MH. (1990). Applied linear statistical

models: Regression, analysis of variance, and experimental design, third edition. Burr Ridge, IL: Irwin.).

BCI Model VIFs:

Generation	HM Status	iRAT Average	Gender	Generation*Gender	HM*Gender
2.233525	1.938244	1.031432	1.586471	2.590432	2.186439

Grade Model VIFs

Generation	HM Status	iRAT Average	Gender	Generation*Gender	HM*Gender
2.357107	1.993474	1.039443	1.602359	2.767426	2.269271

Exam 1 Model VIFs

Generation	HM Status	iRAT Average	Gender	Generation*Gender	HM*Gender
2.356555	1.995678	1.109932	1.615771	2.776459	2.283426

Exam 2 Model VIFs

Generation	HM Status	iRAT Average	Gender	Generation*Gender	HM*Gender
2.361100	1.998396	1.030608	1.609353	2.763275	2.262445

Exam 3 Model VIFs

Generation	HM Status	iRAT Average	Gender	Generation*Gender	HM*Gender
2.439404	2.158879	1.021910	1.597901	3.022203	2.490767

Out of all of the calculated VIFs, only the Gender:Generation VIF exceeded 3 in only the Exam 3 model, where a VIF of 10 indicates a serious issue with multicollinearity. No concerns with multicollinearity are present in our models.

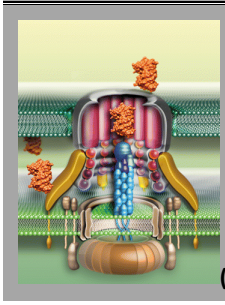
Course Grading Scheme

Each component of TBL included in the course: student iRATs, tRATs, and team exercises, carried weight in students' final grades. The distribution of the different assessments in students' grades was as follows:

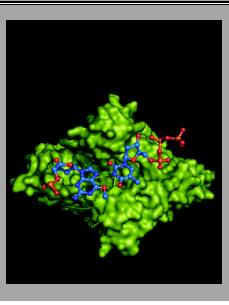
Activity	% of Final Grade
iRATs	10%
tRATs	10%
Team exercises	15%
Quizzes	20%
Exams (Total)	40%
Exam 1	10%
Exam 2	10%
Final Exam	20%
Peer evaluation	5%

General Biochemistry I

MBioS 413/513 **MWF, 11:10 am - 12:00 p.m.**
Fall 2021 3 credits **Spark 235**



(a)



(b)

Figure 1. (a) Gram-negative bacterial machinery for transport of proteins across their double-membrane envelope via secretion. (b) The structure of DNA polymerase in complex with O6-methylguanine demonstrates Hoogsteen base-pairing in the DNA polymerase active site.

Course description

Biochemistry is the study of chemical processes within biological systems. In this course, students will integrate their chemical and biological knowledge to gain deeper understanding of those processes. We will study the structure and function of the molecules of living cells, with a particular emphasis on enzymes. The semester will include the structure and function of biomolecules, an examination of the generation and use of metabolic energy, biosynthesis, and metabolic regulation.

Course Learning Outcomes

After completing this course, students will be able to:

- Describe the structures and functions of the macromolecules of living systems across levels of biological organization (i.e., molecular to cellular to physiological).
- Use thermodynamic principles to explain the structure, stability and function of macromolecular structures.
- Apply principles and concepts from general and organic chemistry to explain the kinetic and catalytic mechanisms of enzymes.
- Use thermodynamic principles to explain the biochemical processes of cellular metabolism.
- Construct the fundamental connections between the energetics, chemistry and kinetics in animal metabolism.
- Describe the fundamental operating principles of modern biochemical techniques employed in the study of macromolecular structure and function.

Prerequisites

- 1 semester of organic chemistry (Chem 345 or the equivalent). A second semester is highly recommended (Chem 348 or the equivalent)
- 1 semester introductory biochemistry (MBioS 303 or the equivalent)

Instructors

Erika Offerdahl, PhD
[redacted]
Student hours: Fridays 2:00 – 2:50 p.m.
Other pop-up student hours, to be announced

James MacLean, PhD
[redacted]
Office hours: Wednesday 1:10 p.m. – 2:00 p.m.

Note: University email is the preferred mode of contact, but you can also leave a message on our office phones. Always email BOTH instructors of the course for absences or emergency situations.

Required Materials

Textbook. Nelson and Cox, *Lehninger Principles of Biochemistry*, 6th or 7th Edition.
Course resources. The majority of assignments, study materials, and supplemental information will be posted on our Canvas site (https://learn.wsu.edu). Lecture slides will be posted here, but it is expected students will take additional notes during class and while reading the textbook. Please check Canvas regularly.
Calculator. Small handheld calculator with log and ln function keys for exams and quizzes.
Notebook/Paper. Most of our in-class time will be spent actively developing our understanding of biochemistry. Yet there will still be short (5-15 minute) periods of lecture each day. Please use a notebook or some other tool for writing notes (e.g., iPad, tablet) and to organize your lecture materials. We strongly encourage you to summarize in your own words the take home lesson after class immediately (if possible) or at least before you go to bed that night. Neuroscience research tells us this is important for reinforcing learning.

Our Learning Environment

Throughout the semester, we will work together to create and sustain an environment that deepens our understanding of biochemistry and its applications. Therefore, we will strive to exhibit:

Intellectual curiosity and tolerance. Be open to new ideas. Be brave. Ask questions when you're not sure you understand. Reflect on what you are learning. Try thinking about things in new ways.

Analytic thinking. Look for hidden assumptions. Compare and contrast perspectives. Check ideas against your own experience. Notice inconsistencies in arguments. Entertain counter-arguments.

Academic discourse. Share your thoughts. Listen carefully to the thoughts of your peers. Be respectful towards other students' ideas, especially when you disagree. Participate in discussions and small group tasks. Address your comments/questions to each other as much as to the instructors. Learn from each other.

Evaluation

1. **Individual Readiness Assessments (iRATS).** In preparation for class on Mondays and Fridays, there will be a pre-class quiz posted on Canvas. These quizzes are designed to (a) assess your mastery of basic information from the readings that we ***will then use in class*** or (b) review material from the previous class in preparation for the upcoming class. There will be no make-up iRATS, even for excused absences, because the *five lowest scores will be dropped*. iRATs will be posted no later than 5 p.m. the day before class, and due by 10 a.m.
2. **Team Readiness Assessments (tRATS).** On Mondays and Fridays, the lecture period will begin with a team quiz over similar material as the iRAT. Generally, your group will be given 5-8 minutes to complete the tRAT. The tRAT helps the instructors and students assess the degree to which the class has the basic information needed for the day's team exercise.
3. **Team Exercises**. Each day in class you will work with your team to complete exercises that give you the opportunity to apply knowledge from the readings, analyze data, and synthesize your biochemical knowledge. Demonstrating your thought process is often more important than arriving at an answer, therefore grading will often focus on effort as much or more than correctness.
4. **Quizzes.** There will be nine short quizzes (2-3 questions each). Your highest two quiz scores will be doubled and added to your total quiz points. As a result, there are no make-up quizzes.
5. **Peer evaluation.** There will be two peer evaluation assignments: 1) the week before the first exam, and 2) the last week of class. Via an on-line survey, you will provide anonymous positive feedback and constructive criticism to each of your teammates. Furthermore, you will rate your teammates on a scale of 1 to 10, with 10 representing the highest level of contribution to the team (i.e., attendance, preparedness, participation).
6. **Exams**. There will be two 50-point hour exams and a 100-point cumulative final exam. Exams generally include multiple choice, short answer, and calculation questions.
7. ***MBioS 513 students only****: There is an additional class requirement worth 50 points, bringing the total points possible for the graduate course to 500. Dr. MacLean will communicate these requirements to 513 students.*

All team members present that day will earn the same score for tRATs and team exercises. Absent team members will receive no score for the day's tRAT and/or team exercise. IF the student notifies the instructors BEFORE class of an excusable absence, the missed assignment will be dropped. Excused absences are restricted to travel for professional reasons, illness, or family emergencies. The bar for an excusable absence is not high except for the requirement of pre-class notification.

Final Grade Distribution	
A	100 – 93.0
A-	92.9 – 90.0
B+	89.9 – 87.5
B	87.4 – 82.5
B-	82.4 – 80.0
C+	79.9 – 77.5
C	77.4 – 72.5
C-	72.4 – 70.0
D+	69.9 – 67.5
D	67.4 – 60.0
F	< 60.0

Activity	% of final grade
iRATS	10%
tRATS	10%
Team exercises	15%
Quizzes	20%
Exams	40%
Peer Evaluation	5%

Students with Disabilities
Reasonable accommodations are available for students with a documented disability. If you have a disability and need accommodations to fully participate in this class, please either visit (Washington Building 217) or call (509-335-3417) the Access Center (http://accesscenter.wsu.edu) to schedule an appointment with an Access Advisor. All accommodations MUST be approved through the Access Center. For more information contact a Disability Specialist (access.center@wsu.edu).

Safety and Emergency Notification
Classroom and campus safety are of paramount importance at Washington State University, and are the shared responsibility of the entire campus population. WSU urges students to follow the "Alert, Assess, Act," protocol for all types of emergencies and the "Run, Hide, Fight" response for an active shooter incident. Remain ALERT (through direct observation or emergency notification), ASSESS your specific situation, and ACT in the most appropriate way to assure your own safety (and the safety of others if you are able).

Please sign up for emergency alerts on your account at MyWSU. For more information on this subject, campus safety, and related topics, please view the FBI's Run, Hide, Fight video and visit the WSU safety portal.

Academic Responsibility
Academic integrity is the cornerstone of higher education. As such, all members of the university community share responsibility for maintaining and promoting the principles of integrity in all activities, including academic integrity and honest scholarship. Academic integrity will be strongly enforced in this course. Students who violate WSU's Academic Integrity Policy (identified in Washington Administrative Code (WAC) 504-26-010(3) and -404) will receive fail the assignment and will not have the option to withdraw from the course pending an appeal, and will be reported to the Office of Student Conduct.

Cheating includes, but is not limited to, plagiarism and unauthorized collaboration as defined in the Standards of Conduct for Students, WAC 504-26-010(3). You need to read and understand all of the definitions of cheating: http://app.leg.wa.gov/WAC/default.aspx?cite=504-26-010. If you have any questions about what is and is not allowed in this course, you should ask course instructors before proceeding.

If you wish to appeal a faculty member's decision relating to academic integrity, please use the form available at conduct.wsu.edu.

COVID-19 Statement
Per the proclamation of Governor Inslee on August 18, 2021, masks that cover both the nose and mouth must be worn by all people over the age of five while indoors in public spaces. This includes all WSU owned and operated facilities. The state-wide mask mandate goes into effect on Monday, August 23, 2021, and will be effective until further notice.
Public health directives may be adjusted throughout the year to respond to the evolving COVID-19 pandemic. Directives may include, but are not limited to, compliance with WSU's COVID-19 vaccination policy, wearing a cloth face covering, physically distancing, and sanitizing common-use spaces. All current COVID-19 related university policies and public health directives are located at https://wsu.edu/covid-19/. Students who choose not to comply with these directives may be required to leave the classroom; in egregious or repetitive cases, student non-compliance may be referred to the Center for Community Standards for action under the Standards of Conduct for Students.

Course Schedule

The following schedule is *tentative*. Ordering and selection of topics are subject to change in response to the progress of student learning. Exam and quiz dates are fixed and will not change. Topics not covered at the time of the exam will not be included on the exam.

Week	Date	Topic	Reading: Lehninger 7th ed
1	23 Aug	Welcome and Introduction	
	25 Aug	The role of water in biochemical processes; Acid-base properties	Ch 2.1-2.3
	27 Aug	Thermodynamic principles	Ch 1.2, 1.3, 13.1
2	30 Aug	Thermodynamic principles	Ch 1.2, 1.3, 13.1
	1 Sept	Amino acids **QUIZ #1**	Pg. 75 & Ch 3.1
	3 Sept	Amino acids & 1^o protein structure	Ch 3.1, 3.2, 3.4 ; pg. 1110-11 & 228-9
3	6 Sept	**NO CLASS – Labor Day**	
	8 Sept	2^o protein structure **QUIZ #2**	Ch 4.2
	10 Sept	2^o protein structure	Ch 4.2

4	13 Sept	3^o protein structure	Ch 4.3; pg 130-143
	15 Sept	3^o and 4^o protein structure **QUIZ #3**	Ch 4.3; pg 130-143
	17 Sept	4^o protein structure	Ch 4.3; pg 130-143
5	20 Sept	Protein folding and stability	Ch 4.4
	22 Sept	Protein folding and stability	Ch 4.4
	24 Sept	**EXAM #1**	
6	27 Sept	Protein function: ligand binding	Ch 5.1, 5.2
	29 Sept	Protein function: myoglobin/hemoglobin	Ch 5.1
	1 Oct	Working with proteins (overview of methods)	Ch 3.3, Fig 4-10, Box 4-5
7	4 Oct	Introduction to enzymes	Ch 6.1, 6.2
	6 Oct	Catalytic players and types of reactions **QUIZ #4**	Ch 6.2, 13.2
	8 Oct	Michaelis-Menten Kinetics	Ch 6.3, pg 201-4
8	11 Oct	Michaelis-Menten Kinetics	Ch 6.3, pg 201-4
	13 Oct	Enzyme Inhibition **QUIZ #5**	Ch 6.3, pg 204-7
	15 Oct	Enzyme Inhibition	Ch 6.3, pg 204-7
9	18 Oct	Enzyme inhibition and mechanisms	Ch 6.3, 6.4
	20 Oct	Enzyme Mechanisms **QUIZ #6**	Ch 6.4
	22 Oct	Enzyme Mechanisms	Ch 6.4
10	25 Oct	Allostery & cooperativity	Ch 6.5
	27 Oct	Allostery & cooperativity	Ch 6.5
	29 Oct	**EXAM #2**	
11	1 Nov	Structures of lipids and membranes	Ch 11.1, 11.2
	3 Nov	Membrane dynamics and membrane proteins	Ch 11.2
	5 Nov	Membrane function: transport	Ch 11.3
12	8 Nov	Carbohydrates	Ch 7.1-7.4
	10 Nov	Carbohydrates **QUIZ #7**	Ch 13.3, 13.4
	12 Nov	Overview, integration, & regulation of metabolic pathways	Ch 13.3, 13.4, 15.1-15.3, 15.5, 16.3
13	15 Nov	Glycolysis	Ch 14.1
	17 Nov	Gluconeogenesis **QUIZ #8**	Ch 14.5
	19 Nov	TCA Cycle	Ch 16.1, 16.2
22 to 26 Nov		**NO CLASS – Thanksgiving Break**	
14	29 Nov	Respiratory chain and oxidative phosphorylation	Ch 19.1-19.3
	1 Dec	Respiratory chain and oxidative phosphorylation **QUIZ #9**	Ch 19.1-19.3
	3 Dec	Respiratory chain and oxidative phosphorylation	Ch 19.1-19.3
15	6 Dec	Glycogen metabolism	Ch 15.4
	8 Dec	Glycogen metabolism	Ch 15.4, 15.5
	10 Dec	Integration and regulation of metabolic pathways	Ch 15.1-15.3, 15.5, 16.3, 17.2: pg 661-4
	14 Dec	**FINAL EXAM 10:30 AM – 12:30 PM**	