

Course Structure

This three-credit course will be given as three hour-long lectures per week (MWF at 9:10 a.m.) Optional homework assignments will be posted on the course website (Angel). These assignments will be neither collected nor graded. Nevertheless, the problem sets are an essential part of the course, and completion will prepare students for the exams. Working in groups on the problem sets is encouraged. There are also questions in the textbook at the end of each chapter. It is urged that students study them (the answers are provided in the back of the book).

Important course materials, including homework, changes to the course notes, and study aids such as practice quizzes and old exams, will be posted on the Angel website. Students are expected to check this site regularly for newly posted material.

Course Objectives

BMB 461 is the first semester of the undergraduate series, BMB 461-462, which provides students with an introduction to biochemistry at the advanced undergraduate level. BMB 461 reintroduces basic biochemistry concepts including protein structure and function and focuses on carbohydrate and energy metabolism. The following topics will be discussed during this term:

- Buffers, pH
- Protein Structure
- Protein Purification
- Protein-Ligand Binding
- Enzyme Catalysis and Mechanism
- Enzyme Kinetics
- Carbohydrates
- Glucose Metabolism
- Pentose Phosphate Pathway
- Glycogen metabolism and regulation
- Citric Acid Cycle, Glyoxylate Cycle
- Electron Transport, Oxidative Phosphorylation
- Photosynthesis

Textbook

Nelson, D.L. and Cox, M.M. *Lehninger Principles of Biochemistry*, the new 5th ed. (2008). W.H. Freeman, New York. 1158 pages

Note on Introductory Material

BMB461 is an integrative course that draws on material covered in undergraduate biology, introductory chemistry, and organic chemistry. Chapter 1 of your textbook (*Lehninger Principles of Biochemistry*, D.L. Nelson and M.M. Cox, 5th ed.) provides a useful review of several topics from these prerequisite courses. We will not cover this material directly in lecture, but students who encounter difficulty with terms, concepts, or calculations encountered in class are encouraged to consult this section of the book for a useful review.

Lecture Notes

We will not assemble a printed course pack in advance. Instead, we will heavily rely on Angel for postings of materials. Lecture notes will be posted in advance of the lectures. You can print them out in your preferred format and bring them to class. Many of the slides will be identical to figures in the book and you might consider bringing your book instead. You should consult the figure legends in the book and the relevant text for studying purposes.

Course Recordings

We will be recording the audio and projected material from each lecture using the “Camtasia” system and posting the recordings on the course Angel site. Keep in mind that it is at the instructor’s discretion to turn on the recording only after announcements regarding exams, etc. have been made. It is important to emphasize that BMB461 is *not* an online course. We strictly recommend against relying on the recordings as a substitute for lecture attendance. Technical issues with Camtasia may occasionally cause the recording and/or posting of lectures to fail, and such events are not considered an excuse for missing the covered material. More importantly, research shows that the best way to use Camtasia is to attend the live lecture, take good notes, and then use the recordings as a resource to go back over material you may have missed or not completely understood. It helps to mark down the time during lecture at which you have trouble understanding, such that you can later skip quickly to the section in question.

Clickers

This course will use i-clickers to facilitate active learning. Clickers may be registered at the beginning of lecture any time during the first two weeks of the semester. If you do not register your clicker during this time you may not receive credit for previous clicker questions. During each lecture you will have one or more opportunities to answer questions using the clicker. You will receive 9/10th of a point for sending in any answer and an additional 1/10th of a point for sending in the correct answer. Some questions are designed to generate discussion and may not have a correct answer. In this case, you will receive one point for any answer. If you receive 90% of the possible clicker points from material for a particular exam, you will receive full credit for the clicker portion of your grade. Clicker points covering material from each exam will be worth 1% of your exam grade, making the clicker points worth 4% of your final grade. It is your responsibility to understand the feedback lights on your clicker and verify that your answers are received. If your clicker malfunctions during class, please notify the TA immediately. It is your responsibility to bring your clicker to class each day and if you forget to bring your clicker or miss class for any reason, you will receive no points for that day. Because you only need 90% to get full credit, you can miss class for the occasional emergency without seriously impacting your clicker scores.

Exams and Grades

The grade in BMB461 will be based on three exams given during class and a *noncumulative* fourth exam given during finals week (see course schedule). All exams are multiple choice. Each exam will be worth 100 points (99 points plus 1 point for the clicker points) and count for 25% of the final score (400 points total in the course). An additional two bonus points can be earned at the end of the semester by filling in an anonymous online course evaluation form.

The grading scale shows the exam average or the percent rank (as calculated from the overall distribution of undergraduate scores using the percentrank function in Excel) you must receive in BMB461 to guarantee a particular grade. Whichever scale gives you the higher grade will be used to assign final grades. Grades for graduate students will be determined from the undergraduate distribution. *There will be no rounding.*

| Grade | Exam Average | Class Percentile Ranking |
|-------|--------------|--------------------------|
| 4.0 | ≥ 85.00 | ≥90.00 |
| 3.5 | ≥ 78.00 | ≥75.00 |
| 3.0 | ≥ 70.00 | ≥55.00 |
| 2.5 | ≥ 60.00 | ≥35.00 |
| 2.0 | ≥ 50.00 | ≥20.00 |
| 1.5 | ≥ 42.00 | ≥10.00 |
| 1.0 | ≥ 35.00 | ≥ 5.00 |
| 0.0 | < 35.00 | < 5.00 |

Rules for the Exams

To ensure fairness of the exam, we have developed a set of rules. Exams will be given in two rooms, B108 Wells Hall and E100 Veterinary Medical Center (VMC). Students who have an odd number as the final digit of their PID (1,3,5,7,9) should report to VMC, and those with an even final digit (0,2,4,6,8) to Wells Hall. Unless an explicit exception is given by the instructor giving the exam, students *must* report to the appropriate room in order to receive full credit for the examination. We use four forms per exam. You will enter the room through one specified door and will be handed your exam and scantron and *will be assigned to a seat by the instructor*. Nothing may be placed on the seat next to you. *All bags, jackets, etc. must be placed on the floor*. Books, notes and other papers need to be in your bag before you enter the room. Once you are in the room, refrain from talking to your classmates. You may start filling in the scantron sheets, but you must keep the exams face down. Do not turn them over until instructed. Exam time is 50 min. You will get warnings 15 min and 5 min prior to the end of the exam. Your scantron and exam has to be in the designated box by the end of the exam time. *Filling in any part of the scantrons after the end of the official exam time is considered cheating and will be dealt with accordingly!* When finished, drop both the exam and the scantron into appropriate boxes at the front of the room. There should be *no talking* until you have left the exam room. A copy of the exam with key will be posted on Angel when the grades are available.

The use of calculators, notes, or any other aids is NOT permitted on any of the exams.

Academic Integrity

Academic honesty is expected. As discussed in the Spartan Life Student Handbook General Student Regulation Part 1, PROTECTION OF SCHOLARSHIP AND GRADES:

“The principles of truth and honesty are fundamental to the educational process and the academic integrity of the University; therefore, no student shall:

1.01 claim or submit the academic work of another as one’s own.

1.02 procure, provide, accept or use any materials containing questions or answers to any examination or assignment without proper authorization.

1.03 complete or attempt to complete any assignment or examination for another individual without proper authorization.

1.04 allow any examination or assignment to be completed for oneself, in part or in total, by another without proper authorization.”

You are authorized and encouraged to discuss clicker questions and homework questions with your classmates. However, you must actually send in clicker answers with your own clicker. Using multiple clickers to send in answers for classmates who are not present is academic dishonesty. Exams are an individual effort, and you should neither give nor receive help during an examination. Policies to ensure academic integrity will be strictly enforced. Any instance of academic dishonesty will result in a failing grade for that assessment and may result in a failing grade for the course.

Excused Absences

Only illness or a death in the student's immediate family will be considered a legitimate excuse for absence from an exam. In order to be considered for a make-up exam, it is the student's responsibility to contact the instructor **within 24 hours** of the missed exam and to provide adequate written documentation of the illness or death. Make-up exams are administered at the instructor’s convenience, typically **within 72 hours of the original exam**. Make-up exams may consist of essay questions or multiple choice questions at the instructor’s discretion.

Honors Option

Students may elect to take BMB461 with the H-option provided they obtain a 3.0 grade or higher in the course. The honors option consists of a term paper on some aspect of biochemistry related to material presented in BMB461. The topic should relate to a process described in BMB461. It should not be on any material covered in BMB462, i.e., molecular biology, genetics or gene expression, signal transduction, amino acid metabolism, or lipid metabolism.

The term paper should address an unsolved biochemical question related to one of eight topics provided by the instructors. The question should be clearly stated and experimental efforts by others to answer it should be discussed. The student is required to consult at least four original research papers, not reviews, published in journals covering biochemistry (at least two of which should be from 2004 or later), which must be cited in the reference section of the term paper as well as in the text. Papers from several different research groups and drawing on several different methodologies or approaches should be consulted. The honors paper is *not* to be an overview of the current understanding of the topic, but instead a focused, critical, and in-depth discussion of a particular unanswered question of current research interest. To receive credit, papers should demonstrate critical analysis of the material, for example, arguing one side or the other of a controversial issue, synthesizing available data into a novel model, or identifying key experiment(s) that should be done next in order to address the unsolved question.

An acceptable honors paper must be substantially free of grammatical and spelling errors – i.e., it should have a professional look – and it should be referenced appropriately. The inclusion of figures is strongly encouraged. You must present the material within 7 to 10 double-spaced pages; figures and references are *not* included in the page limit.

Students interested in the honors option should make their intention known to Ms. Mary Villarreal (villar20@msu.edu) by September 9. Students are encouraged to consult with Prof. Benning or Prof. Hegg on the suitability of a proposed topic and possible approaches to their research. A one-page proposal/outline is due on October 1, including a precise definition of the topic to be covered, an idea of the points to be made, and ideally a full or partial list of references to be used. A complete draft of the honors option paper (E-mail attachment) should be submitted by November 18. The instructors will return this draft to the student as soon as possible with a response detailing the changes necessary for credit to be granted. The final version of the paper (both an electronic and hard copy) is due on the Friday of finals week. This detailed schedule is designed to provide multiple opportunities for instructor-to-student feedback to ensure that final paper is easily acceptable for honors credit. In particular, failure to submit a *complete* draft for evaluation and suggestions will preclude the submission of a final version for credit. Further consultation with the instructors at any point on requirements and expectations is encouraged.

Lecture Schedule

| Date | Lecture | Topic | Reading, Nelson & Cox |
|------------|---------|--|------------------------|
| 9/2 | 1 | Aqueous solutions and pH & Buffers; Solving acid/base problems | 41-52; 54-66 |
| 9/4 | 2 | Amino acids and peptides | 71-85 |
| 9/7 | | Labor Day – University Closed (No Class) | |
| 9/9 | 3 | Protein purification | 85-92 |
| 9/11 | 4 | Proteins: Primary structure and evolution | 92-107 (skim 98-102) |
| 9/14 | 5 | Proteins: Secondary structure | 113-122 |
| 9/16 | 6 | Proteins: Three-dimensional structure | 123-140 (skip 132-134) |
| 9/18 | 7 | Proteins: Structure and folding | 132-134; 140-148 |
| 9/21 | 8 | Protein-ligand binding Myoglobin and hemoglobin | 153-169 |
| 9/23 | 9 | Enzymes: The basics | 183-194 |
| 9/23 | | Recitation by Instructor BPS 1410 6:10p – 7:40p | |
| 9/25 | | Exam I: Lectures 1-8 | |
| 9/28 | 10 | Introduction to enzyme kinetics | 194-201 |
| 9/30 | 11 | Enzymes and inhibition | 201-205 |
| 10/2 | 12 | Catalytic strategies | 205-213 |
| 10/5 | 13 | Regulation of enzymes | 220-228 |
| 10/7 | 14 | Enzymology and medicine: The cytochrome P450 system | -- |
| 10/9 | 15 | Carbohydrates: I | 235-244 |
| 10/12 | 16 | Carbohydrates: II | 244-257 |
| 10/14 | 17 | Bioenergetics: The basics | 485-501 |
| 10/16 | 18 | Bioenergetics: Phosphoryl transfer | 501-511 |
| 10/19 | 19 | Bioenergetics: Redox reactions | 512-521 |
| 10/21 | 20 | Glucose metabolism: Glycolysis and gluconeogenesis | 527-558 |
| 10/21 | | Recitation by Instructor BPS 1410 6:10p – 7:40p | |
| 10/23 | | Exam II: Lectures 9–19 | |
| 10/26 | 21 | Glucose metabolism | 527-558 |
| 10/28 | 22 | Glucose metabolism | 527-558 |
| 10/30 | 23 | Glucose metabolism | 527-558 |
| 11/2 | 24 | Pentose phosphate pathway | 558-563 |
| 11/4 | 25 | Pentose phosphate pathway | 558-563 |
| 11/6 | 26 | Glycogen metabolism and regulation | 569-577 |
| 11/9 | 27 | Glycogen metabolism and regulation | 582-609 |
| 11/11 | 28 | Glycogen metabolism and regulation | 582-609 |
| 11/13 | 29 | Citric acid cycle | 615-638 |
| 11/16 | 30 | Citric acid cycle | 615-638 |
| 11/18 | 31 | Citric acid cycle Glyoxylate cycle | 615-638 638-640 |

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|--------------|----|--|---------|
| 11/18 | | Recitation by Instructor BPS 1410 6:10p – 7:40p | |
| 11/20 | | Exam III: Lectures 20-28 | |
| 11/23 | 32 | Electron transport | 707-722 |
| 11/25 | 33 | Electron transport | 707-722 |
| 11/26 | | Thanksgiving Break– University Closed (No Class) | |
| 11/30 | 34 | Oxidative Phosphorylation | 723-738 |
| 12/2 | 35 | Oxidative Phosphorylation | 723-738 |
| 12/4 | 36 | Photosynthesis | 742-764 |
| 12/7 | 37 | Photosynthesis | 742-764 |
| 12/9 | 38 | Photosynthesis | 773-794 |
| 12/11 | 39 | Photosynthesis | 773-794 |
| 12/11 | | Recitation by Instructor BPS 1410 4:00p – 5:30p | |
| 12/18 | | Exam IV (Final): Lectures 29-39 Noncumulative 7:45 a.m. – 9:45 a.m. | |