**BIOLOGY 40 FALL 2019 — Biochemistry — Wei-Lih Lee**

BIOL 40 involves studies of molecular structure and function from a biochemical point of view, emphasizing the biochemistry of proteins, lipids, and carbohydrates. Topics include protein structure and function, enzymes and enzyme kinetics, lipids and membranes, and carbohydrates and cell walls. The participation of these biomolecules in metabolism is also examined, with an emphasis upon carbohydrate, fatty acid, and amino acid metabolism. The course concludes with an analysis on how metabolism is integrated.

**Lecture (LSC 200):** MWF 10:10-11:15 AM, X (TH 12:15-1:05 PM) used as indicated in syllabus

**Discussion (LSC 200):** W 2:15-3:15 PM or Th 2:15-3:15 PM (you may attend either section)
Used for going over problem sets (these are not graded but there will be exam questions based on the problem sets). Also used for discussion of relevant research papers.

**Instructor:** Wei-Lih Lee, Life Sciences Center Room 224, Phone: 646-8706
Email: wei.lih.lee@dartmouth.edu
Office Hours: M 3:30-4:30 PM (LSC 352) and W 3:30-4:30 PM (LSC 238) and by arrangement

**Teaching Assistant:** Thomas Torng
Email: Thomas.L.Torng.GR@dartmouth.edu
Office hours: Tu 3:30-4:30 PM (Remsen 228) and by arrangement

**Required Text:** Fundamentals of Biochemistry by D. Voet, J.G. Voet, and C.W. Pratt (5th edition, 2016) ISBN: 978-1-118-91840-1 hardcover (or binder-ready ISBN: 978-1-118-91843-2; ebook ISBN: 978-1-119-42357-7). (*Please let me know if you encounter financial challenges related to purchasing textbook for this class*)

**Available:** Lecture notes and powerpoint presentations will be posted to Canvas.

**Prerequisites:** BIOL 12 (Cell Structure/Function) and CHEM 52 or CHEM 58 or permission of instructor

**Exams and grading:**

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|---|---|
| Exam 1 | 100 points |
| Exam 2 | 100 points |
| Exam 3 | 100 points |
| Final Exam | 120 points |

The first three exams are scheduled in the evenings (7:00-9:00 PM, see Class Schedule for dates and rooms). The final exam is semi-comprehensive, with emphasis on the last section of the course but it will incorporate major information from earlier in the course. Your grade will be calculated using two different methods and you will receive the highest grade of the two. METHOD 1: total out of all three exams and the final exam (i.e. a percentage based on a total of 420 available exam points). METHOD 2: dropping the lowest of the first three exams (i.e. a percentage based on a total of 320 points). In both cases, the final exam is always counted. Missed exams can be made up in the case of health or family emergency, as described later in this syllabus.

**Class Schedule:**

| Date | Lect # | Topic | Reading |
|---|---|---|---|
| M Sept 16 | 1 | Introduction | 1-11, PDFs |
| W Sept 18 | 2 | Bonds, properties of water, buffers | 23-41 |
| X Sept 19 | | Buffers (cont) | |
| F Sept 20 | 3 | Amino acids | 80-96 |
| M Sept 23 | 4 | Primary protein structure and purification | 97-108, 119-126 |
| W Sept 25 | 5 | Sequencing; 3-D protein structure | 110-119, 131-179 |
| X Sept 26 | 6 | 3-D protein structure (cont) | |
| F Sept 27 | 7 | Proteins: Myoglobin and hemoglobin | 180-200 |
| M Sept 30 | 8 | Proteins: Myoglobin and hemoglobin (cont) | |
| W Oct 2 | 9 | Enzyme Introduction and Kinetics | 11-20,322-330,361-382 |
| X Oct 3 | | Exam Review Session | |
| **X Oct 3** | | **Exam 1 (7-9 pm) covers Lectures 1-8, LSC 100** | |
| F Oct 4 | 10 | Enzyme kinetics (cont) | |
| M Oct 7 | 11 | Enzymatic catalysis | 330-339 |
| W Oct 9 | 12 | Enzyme Reaction Mechanisms | 345-355 |
| X Oct 10 | | Reaction Mechanisms (cont) | |
| F Oct 11 | 13 | Enzyme Regulation | 355-357, 382-391 |
| M Oct 14 | 14 | Lipids | 245-258 |
| W Oct 16 | 15 | Membranes and Membrane Transport | 259-276, 293-318 |
| X Oct 17 | 16 | Metabolism and Bioenergetics | 442-477 |
| F Oct 18 | 17 | Metabolism and Bioenergetics (cont) | |
| M Oct 21 | | Exam Review Session | |
| **M Oct 21** | | **Exam 2 (7-9 pm) covers Lectures 9-15, LSC 100** | |
| W Oct 23 | 18 | Carbohydrates | 221-244 |
| X Oct 24 | 19 | Glycolysis | 478-497 |
| F Oct 25 | 20 | Entry and exit from glycolysis | 497-502, 508-512 |
| M Oct 28 | 21 | Gluconeogenesis | 544-549 |
| W Oct 30 | 22 | Regulation of glycolysis and gluconeogenesis | 502-507, 549-551 |
| X Oct 31 | | Regulation of gluconeogenesis (cont) | |
| F Nov 1 | 23 | Glycogen; pentose phosphate pathway | 523-544, 512-517 |
| M Nov 4 | 24 | The Citric Acid Cycle | 558-587 |
| W Nov 6 | 25 | Oxidative Phosphorylation | 588-628 |
| X Nov 7 | | Exam Review Session | |
| **X Nov 7** | | **Exam 3 (7-9 pm) covers Lectures 16-23, LSC 100** | |
| F Nov 8 | 26 | Oxidative Phosphorylation (cont) | |
| M Nov 11 | 27 | Fatty acid metabolism | 664-700 |
| W Nov 13 | 28 | Fatty acid metabolism (cont) | |
| X Nov 14 | 29 | Amino acid metabolism | 718-746 |
| F Nov 15 | 30 | Integration of Metabolism | 773-800 |

M Nov 18 31 Integration of Metabolism (cont)

**Final Exam (semi-comprehensive with emphasis on recent material)**
Friday, November 22, 2019, 8:00 AM

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**Course Goals and Learning Objectives:**

1. *Gain a solid foundation in biochemistry.* This course synthesizes material from courses you previously took and will put both biological and chemical aspects of what you have learned into context. Biochemistry provides the background required for upper-level courses (*e.g.*, Biol 69: Cell Signaling, Biol 74: Advanced Neurobiology, and Biol 71: Current Topics in Cell Biology), as well as for medical, dental, and graduate level studies.

2. *Develop the quantitative skills needed to understand biochemical reactions in living cells.* Quantitative skills are essential to science and many other disciplines. We will develop and hone our math skills by solving biochemical reactions (through practice questions and problem sets) relevant to all living organisms.

3. *Become conversant in biochemistry.* Like many biology courses, biochemistry requires learning a "vocabulary" and then applying this vocabulary to biological questions. For this reason, you will need to commit to memory structures of amino acids, the glycolytic pathway, and several enzymatic reaction mechanisms for this course (the vocabulary!). Beyond knowing the vocabulary, one has to be able to apply the knowledge in order to gain new insights, and for this reason, exam questions will sometimes go beyond what was directly discussed in class and ask you to apply information from the course to novel questions.

**Poll Everywhere:**
I will occasionally use Poll Everywhere to present "clicker" questions in class. One purpose of in-class questions is that it allows me to gauge your understanding in real time. The best way for me to gain an accurate assessment is if the majority of the class answers each of the in-class questions. Additionally, research has demonstrated that in-class questions help students to engage with the course material, and this facilitates learning and synthesis. It will help me to get ALL of you to think about a problem (instead of just the ones who are willing to raise their hands). You will be answering anonymously – I will not see what answers you give. Although your grade will not depend on clicker question participation, I hope all of you will participate fully throughout the term.

The easiest and most convenient way to respond to "clicker" questions is to use your smartphone. If this is your first time using Poll Everywhere, please download the app here:
iOS: https://itunes.apple.com/us/app/poll-everywhere/id893375312
Android: https://play.google.com/store/apps/details?id=com.polleverywhere.mobile
If you are not able to use a smartphone to respond, you may use another internet-enabled device such as a tablet or a laptop. In the app, type POLLEV.COM/biol40 to join the presentation. If you have any technical questions or problems, please contact edtech@dartmouth.edu - they will be able to assist.

**An important note about usage of phone and laptop:** During class, please use your cell phone or laptops only for "communicating" your answers to "clicker" questions. At all other times, your laptop should remain closed and cell phone should remain face down on your desk or put away.

**Missing an Exam:**
In case of a health problem, family emergency, or academic conflict, special arrangements for taking the examination can be made, but only if the course instructor (Professor Lee) is notified prior to the exam, and your need to take the exam at other than the appointed time is clearly justified. Failure to take an exam at the scheduled time will result in a grade of zero. In the event you are ill and unable to prepare for or write an exam, you must contact Dick's House to determine if you need treatment; this is for your own health and for the health of others around you.

**Exams and Grading Policies:**
The following summarizes the grading procedures with respect to exams for Biol 40:

1. Once the exam has been graded and returned, a copy of the answer key will be posted on the Canvas site. Please review the answer key carefully and make sure that you understand the errors in your exam and why you made them.
2. The number of points given for each answer is final. If, after reviewing your answers and comparing them to the posted answer key, you find an arithmetic error or detect an omission by the grader for one of the questions, you must observe the following procedures for error correction:
   a) Do not write on the exam. Any alteration of the answers may constitute a breach of the Academic Honor Principle.
   b) Prepare a typed cover page with your name. Specify the page and the question number you are requesting for error correction.
   d) If you determine that your answer contains all of the information indicated in the answer key, but you did not receive full credit, simply indicate the number of the question to be re-evaluated and state in one or two short, descriptive sentences (must be typed) what makes your answer correct.
   e) Attach the typed cover page to your complete exam and return it before the following deadline to the course instructor:
      First Exam: 11:15PM on Oct 16
      Second Exam: 11:15PM on Nov 1
      Third Exam: 11:15PM on Nov 18
      I will not accept questions regarding errors in grading after these deadlines. The error correction process will take a few days. You will be notified after the re-evaluation is completed.

**A final note about exams and grades:** You are not competing against each other for grades in Biol 40. All grades, up until the final letter grade is decided, are recorded as numerical grades, from 0% to 100%. I do not assign letter grades to individual exams. Here are three important points about grades in Biol 40:

(a) A grade of 90% or above will always be at least an "A-". No one will be penalized for learning what I teach them. Thus, it is entirely possible for everyone in the class to receive a grade of "A-" or better.
(b) In order to receive a D, you have to achieve a final grade of at least 50%. In other words, a final grade less than 50% is an E.
(c) The median grade for this course will most likely be a B. That means if the median numerical score for the course were 65%, then a grade of 65% is a B.

**Accessibility Needs:**
I encourage students who may need disability-related academic adjustments to see me privately as early as possible in the term, preferably before the end of the first week. Students requiring disability-related academic adjustments and services must consult the Student Accessibility Services office (Carson Hall, Suite 125, 646-9900). Once SAS has authorized services, students

must show the originally signed SAS Services and Consent Form and/or a letter on SAS letterhead to me. As a first step, if students have questions about whether they qualify to receive academic adjustments and services, they should contact the SAS office. All inquiries and discussions will remain confidential.

**Religious Observances:**
Some students may wish to take part in religious observances that occur during this academic term. If you have a religious observance that conflicts with your participation in the course, please meet with me before the end of the second week of the term to discuss appropriate accommodations.

**Academic Honor Principle:**
The Dartmouth College Student Handbook states "Fundamental to the principle of independent learning are the requirements of honesty and integrity in the performance of academic assignments, both in the classroom and outside. Dartmouth operates on the principle of academic honor, without proctoring of examinations. Students who submit work which is not their own or who commit other acts of academic dishonesty forfeit the opportunity to continue at Dartmouth."

The Honor Principle (http://www.dartmouth.edu/judicialaffairs/honor/index.html) as applied to BIOL 40 affects exams and exam re-submission requests.

(a) Exams must be completed without reference to written materials other than those provided with the exam paper and must be completed without communication with anyone or anything else (the only permissible exception is that students may request clarification of any exam question from the course instructor who is present expressly for that purpose). The answers that you provide must be entirely your own work. Any communication prior to the examination with anyone having knowledge about the content of the exam would constitute a breach of the Academic Honor Principle.

(b) Our policy permits the re-submission of exams for potential error correction by the course instructor. Any alteration of the answers between the time when the graded exams were returned to the student and the time when the exam was re-submitted for error correction constitutes a breach of the Academic Honor Principle. To prevent this possibility, we scan exams before grading them.

Violations of any of the above will result in a grade of zero for the exam with the exam also counting toward your final grade in the course. Potential honor code violations will also be reported to the Dartmouth College Committee on Standards.

**Mental Health:**
I recognize that the academic environment at Dartmouth is challenging, that our terms are intensive, and that classes are not the only demanding part of your life. There are a number of resources available to you on campus to support your wellness, including: your undergraduate dean (http://www.dartmouth.edu/~upperde/), Counseling and Human Development (http://www.dartmouth.edu/~chd/), and the Student Wellness Center (http://www.dartmouth.edu/~healthed/). I encourage you to use these resources and come speak with me in order to take care of yourself throughout the term.

**Sexual Respect, Safety, and Well-Being:**
At Dartmouth, we value integrity, responsibility, and respect for the rights and interests of others, all central to our Principles of Community. We are dedicated to establishing and maintaining a safe and inclusive campus where all have equal access to the educational and employment opportunities Dartmouth offers. We strive to promote an environment of sexual respect, safety, and

well-being. In its policies and standards, Dartmouth demonstrates unequivocally that sexual assault, gender-based harassment, domestic violence, dating violence, and stalking are not tolerated in our community.

The Sexual Respect Website (https://sexual-respect.dartmouth.edu) at Dartmouth provides a wealth of information on your rights with regard to sexual respect and resources that are available to all in our community.

Please note that, as a faculty member, I am obligated to share disclosures regarding conduct under Title IX with Dartmouth's Title IX Coordinator. Confidential resources are also available, and include licensed medical or counseling professionals (e.g., a licensed psychologist), staff members of organizations recognized as rape crisis centers under state law (such as WISE), and ordained clergy (see https://sexual-respect.dartmouth.edu/reporting-support/all-resources/confidential-resources).

Should you have any questions, please feel free to contact Dartmouth's Title IX Coordinator or the Deputy Title IX Coordinator for the Guarini School. Their contact information can be found on the sexual respect website at: https://sexual-respect.dartmouth.edu/reporting-support/all-resources/campus-resources

**Top 10 suggestions for surviving BIOL 40:**

1. Keep up with the assigned readings. Read the text before class, or soon after class. Do the problem sets and recommended problems in the textbook. Go over the material again the same day as covered in lecture.
2. Attend lectures. The lectures do not simply re-iterate material from the text. Exams are primarily based on material from the lectures and problem sets.
3. Ask questions in class. If you have a question, someone else probably also has the same question.
4. Response to Poll Everywhere questions during class. Besides allowing for group participation and immediate feedback, the physical act of responding to polls may stimulate thinking and improve comprehension and learning of new materials. Make it work for you.
5. Attend discussion section. The weekly discussion section (run by TA) will be used to go over problems and to discuss papers not covered in the lecture. You will not necessarily be able to do every problem in the problem sets before discussion, but examples of the most important problems will be covered in the discussion section.
6. Come to office hours and use Piazza. I use office hours as a way to have smaller discussions on the areas that you find most important or troublesome, especially relating to lecture slides. Piazza on Canvas offers another way to engage in Discussions with other students and TA.
7. Form study groups. Studying and working with other people on problems and concepts invariably helps with learning the material.
8. Use information on Canvas. Posted under Syllabus, Lectures, and Problem Sets.
9. Be well rested before taking the exams. When tired, one can sometimes remember information memorized from an all-nighter, but it will be almost impossible to apply that to a novel situation.
10. Review your own exams. The exams will build on each other in terms of the types of material one needs to master, so it is important to stay on top of the material in order to do well on subsequent exams. I recommend that, after the exam has been graded and returned to you, work through the questions treating it as open book/notes so that you can effectively review the material in preparation for the next exam(s).