

BIOLOGY 40 WINTER 2021—Biochemistry—G. Eric Schaller

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 metabolism. The course concludes with an analysis on how metabolism is integrated.

Lecture (Zoom): MWF 10:20-11:25, X (TH 12:30-1:20) used as indicated in syllabus

Discussion (Zoom): W 2:30-3:30 or Th 2:45-3:45 (you may attend either section)
Used for going over methods for biochemical problem solving and problem sets. Also to discuss relevant research papers.

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Office Hours: MW 4-5 PM EST, and by arrangement

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Office hours: Tues 11-12 AM EST, and following Discussions

Recommended 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).

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

Prerequisites: Biology 12/19 (Cell Structure/Function), Chemistry 52/58 (Organic Chemistry), or permission of instructor

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|---------------------------|--------------|------------|
| Exams and grading: | Exam 1 | 100 points |
| | Exam 2 | 100 points |
| | Exam 3 | 100 points |
| | Final Exam | 120 points |
| | Problem sets | 10 points |
| | Quizzes | 10 points |

The first three exams cover lectures for each section (see Class Schedule for dates and Exams and Grading Policies for format). The final exam is semi-comprehensive, with emphasis is on 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 (i.e. a percentage based on a total of 440 available points). **Method 2:** dropping the lowest of the first three exam grades (i.e. a percentage based on a total of 340 points). In both cases the final exam is always counted.

Lectures and Exams:

| Date | Lect # | Topic | Reading |
|------------------|--------|--|-------------------------|
| X Jan 7 | 1 | Introduction | 1-11, pdfs |
| F Jan 8 | 2 | Properties of water | 23-41 |
| M Jan 11 | 3 | Amino acids | 80-96 |
| W Jan 13 | 4 | Primary protein structure and purification | 97-108, 119-126 |
| X Jan 14 | 5 | Sequencing; 3-D protein structure | 110-119, 131-179 |
| F Jan 15 | 6 | 3-D protein structure (cont) | |
| M Jan 18 | | <i>No class (MLK day)</i> | |
| W Jan 20 | 7 | Proteins: Myoglobin and hemoglobin | 180-200 |
| X Jan 21 | 8 | Proteins: Myoglobin and hemoglobin (cont) | |
| F Jan 22 | 9 | Enzyme Introduction and Kinetics | 11-20, 322-330, 361-382 |
| M Jan 25 | | Exam Review Session | |
| M Jan 25 | | Exam 1 (5 PM EST) covers Lectures 1-8 | |
| W Jan 27 | 10 | Enzyme Kinetics (cont) | |
| X Jan 28 | 11 | Enzymatic catalysis | 330-339 |
| F Jan 29 | 12 | Enzyme Reaction Mechanisms | 345-355 |
| M Feb 1 | 13 | Enzyme Regulation | 355-357, 382-391 |
| W Feb 3 | 14 | Lipids | 245-258 |
| X Feb 4 | | <i>Reserve for class use as needed</i> | |
| F Feb 5 | 15 | Membranes and Membrane Transport | 259-276, 293-318 |
| M Feb 8 | 16 | Metabolism and Bioenergetics | 442-477 |
| W Feb 10 | 17 | Metabolism and Bioenergetics (cont) | |
| X Feb 11 | | Exam Review Session | |
| X Feb 11 | | Exam 2 (5 PM EST) covers Lectures 9-15 | |
| F Feb 12 | 18 | Carbohydrates | 221-244 |
| M Feb 15 | 19 | Glycolysis | 478-497 |
| W Feb 17 | 20 | Entry and exit from glycolysis | 497-502, 508-512 |
| X Feb 18 | 21 | Gluconeogenesis | 544-549 |
| F Feb 19 | 22 | Regulation of glycolysis and gluconeogenesis | 502-507, 549-551 |
| M Feb 22 | 23 | Glycogen; pentose phosphate pathway | 523-544, 512-517 |
| W Feb 24 | 24 | The Citric Acid Cycle | 558-587 |
| X Feb 25 | | <i>Reserve for class use as needed</i> | |
| F Feb 26 | 25 | Oxidative Phosphorylation | 588-628 |
| M March 1 | | Exam Review Session | |
| M March 1 | | Exam 3 (5 PM EST) covers Lectures 16-23 | |

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|---|----------|----|----------------------------------|---------|
| W | March 3 | 26 | Fatty acid metabolism | 664-700 |
| X | March 4 | 27 | Fatty acid metabolism (cont) | |
| F | March 5 | 28 | Amino acid metabolism | 718-746 |
| M | March 8 | 29 | Integration of Metabolism | 773-800 |
| W | March 10 | 30 | Integration of Metabolism (cont) | |

Final Exam (semi-comprehensive with emphasis on recent material): Sunday, March 14, 11:30 AM EST.



Advice about learning, from Leonardo da Vinci:

We know for certain that sight is one of the most rapid actions we can perform. In an instant, we see an infinite number of forms; still, we only take in thoroughly one object at a time.

Suppose that you, Reader, were to glance rapidly at this entire written page. You would instantly perceive that it was covered with various letters; but you could not, in that short time, recognize what the letters were, or what they were meant to tell. Therefore, you would need to see them word-by-word, line-by-line, to be able to understand the letters. Again, as another example, if you wish to go to the top of a building, you must go up step by step; otherwise, it will be impossible for you to reach the top.

Thus I say to you, whom nature prompts to pursue this art, if you wish to have a sound knowledge of the forms of objects, begin with the details of them, and do not go on to the second

step until you have the first step well fixed in memory and in practice. And if you do otherwise, you will throw away your time, or certainly greatly prolong your studies.

Course Goals and Learning Objectives:

1. To gain a solid foundation in biochemistry. Biochemistry synthesizes material from courses you previously took and should put both biological and chemical aspects of these courses into context (e.g. suddenly the phrase “nucleophilic attack upon a carbonyl” will assume an unprecedented relevance to your life). Biochemistry provides the background required for upper-level courses (e.g. BIOL69: Cell Signaling and BIOL78: Molecular Mysteries of Human Biology). Biochemistry provides the background for medicine and graduate studies.

2. To improve quantitative skills. Math skills are essential to science and many other disciplines, but it was discovered that these skills had been waning in recent years because not adequately emphasized at the college level. A student once asked me why I took off points for an exam answer when s/he had set up the answer correctly but had “just made a math error.” An example of why such an error is important can be found at <http://abcnews.go.com/Health/Story?id=4299616&page=1>. You can find other similar stories by performing a Google search with keywords such as ‘baby’ ‘error’ and ‘dose’.

3. To improve learning skills. Like many biology courses, biochemistry requires learning a ‘vocabulary’ and then applying this vocabulary to scientific questions. For example, you will need to memorize structures of amino acids, the glycolytic pathway, and several enzymatic reaction mechanisms for this course (the vocabulary). We are sometimes asked as to why we consider such memorization an important skill. For those going on the medical school, memorization is a key skill to develop, and is emphasized in medical programs, again for the obvious reason that one has to know what to do in immediate response to a crisis, without losing the time it would take to look something up in a text or on-line. Beyond that one has to have information in mind in order to be able to make the mental connections that lead to new insights. Applying the biochemical vocabulary is the next step 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.

Expectations:

Here’s what we expect from you:

1. To take detailed notes while you are listening to synchronous lectures and recorded videos
2. To attend and participate in W/Th discussions, mentally prepared to think about
3. Biochemistry
4. To be willing to ask questions and participate in class activities
5. To listen to pre-lecture videos and complete quizzes as scheduled
6. To utilize active learning techniques to master course material
7. To work on the problem set questions and turn them in every week
8. To observe and follow the academic Honor Principle

Here’s what you can expect from the TA and me:

1. To bring expertise and enthusiasm to the class
2. To be willing to answer questions and facilitate discussions

3. To challenge you to stretch beyond your comfort zone
4. To encourage you to try new approaches for studying and learning that are “active”
5. To provide opportunities for you to practice problem solving

Course Structure:

Using Zoom, we will meet synchronously for lectures on MWF and Th (during X-hour) at the normal meeting times for the Period C timeslot. Discussion sessions will be led by TA and will meet synchronously via Zoom on W (2:30-3:30 PM EST) and Th (2:45-3:45 PM EST). You may attend either or both discussion sessions. Discussion sessions will be used for going over selected problems related to the problem sets, or for discussion of research papers relevant to the current exam unit. The synchronous Zoom lectures and Zoom discussion sessions will be recorded and posted on Canvas. Be sure to read the “Consent to Record” section, since you are agreeing to this by enrolling in the class.

Personal Responses via PollEverywhere:

We will be using the technology called PollEverywhere in our course this term to present “clicker” questions during lectures. One purpose for polling during class 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 if ALL of you participate (instead of just the ones who are willing to virtually “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 method to respond to polls is with a smartphone. Please download the Poll Everywhere app to do this.

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. Our class response URL will be: [POLLEV.COM/bio40](https://pollev.com/bio40) If you have any technical questions or problems, please contact edtech@dartmouth.edu - they will be able to assist.

Problem Sets and Research Papers:

Problem sets will be posted each week to help you develop and hone your skill in solving biochemical questions—these problem sets will incorporate problems from the book as well as additional relevant problems. Sometimes, there will be a questionnaire about a relevant research article – selected from the literature to enhance your understanding of a relevant biochemical topic - will be posted instead of problem set questions. We will use the Discussion sections to cover some representative problems from the problem sets (usually the tougher ones), as well as the research articles.

We will assign a subset of the biochemical problems to be completed prior to the Discussion sections as homework. These are to be completed and submitted through Canvas before going to the Discussion session as part of your participation grade (see Exams and Grading). To receive credit, you must submit the homework by the specified date and time. Late submission will not receive any points. These assignments will not be graded, but we will use

them (1) to help us assess your understanding of the material and (2) to ensure that you are prepared before coming to the Discussion session.

Pre-lecture Quizzes:

I will use short videos to present introductory or supplementary material that is important for in-class Zoom lecture meetings. **Part of your participation grade will be based on short quizzes that you will complete after viewing the pre-lecture recordings.** To receive credit, you must complete the quiz by 11:59 PM EST the day before the specified Zoom lecture class meeting. I will use these quizzes (1) to help me assess your understanding of the material and (2) to ensure that you watch the pre-lecture recordings before class. While taking the quiz you may refer to any notes you took while watching the video.

Exams and Grading Policies:

The exams will be a mixture of testing your mastery of the information and applying your knowledge to problem solving. The exam will be available for you to take on the Canvas site on the day of the exam.

The following points summarize the grading procedures with respect to exams for BIOL 40:

1. After 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. Prepare an electronic cover page (file format: Word or PDF) and name the file as “Error correction request – your name”. Specify the page and the question number you are requesting for error correction.
 - b. 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.
 - c. Email your typed cover page to Professor Schaller (George.e.schaller@dartmouth.edu) within 7 days after you receive the graded exam. We will not accept questions regarding errors in grading after the deadline. The error correction process will take a few days. You will be notified through email after the reevaluation is completed.

Missing an Exam:

In case of documented illness, family emergency, or academic conflict, special arrangements for taking the examination can be made, but only if (1) you notify me in advance prior to the scheduled time for the exam, and (2) your need to take the exam at other than the scheduled time is clearly justified. **Failure to take an exam at the scheduled time, or failure to submit the exam within the allotted time, will result in a grade of zero for that exam.** In the event you are ill and unable to prepare for or write an exam, you must seek medical attention to determine if you need treatment; this is for your own health and for the health of others around you.

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 points. 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”.

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 as applied to BIOL40 affects exams and exam regrades.

Examinations 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.**

I allow for re-submission of exams for potential re-grading within one week of when they are returned to the class. Any alteration of the answers between the time when the graded exams were returned to the student and the time when the exam was submitted for re-grading constitutes a breach of the Academic Honor Principle. **To deter this possibility, we copy exams after 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 Committee on Standards.

Note to Students with Physical or Learning Accessibility Needs:

Students with disabilities who may need disability-related academic adjustments and services for this course are encouraged to schedule a phone/video meeting with me privately as early in the term as possible, preferably before the end of the second week of classes. This conversation will help to establish what supports are built into our online course. In order for accommodations to be authorized, students are required to consult with Student Accessibility Services (SAS; student.accessibility.services@dartmouth.edu; SAS website; 603-646-9900) and to email us their SAS accommodation form. We will then work together with SAS if accommodations need to be modified based on the online learning environment. If students have questions about whether they are eligible for accommodations, they should contact the SAS office. All inquiries and discussions will remain confidential.

Wellness concerns:

We 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 to take care of yourself throughout the term.

Safety and inclusivity:

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>

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.

Consent to Recording:**(1) Consent to recording of course and group office hours**

- a) By enrolling in this course, you affirm your understanding that the instructor may record this course and any associated **group** meetings involving students and the instructor, including but not limited to scheduled and ad hoc office hours and other consultations, within any digital platform used to offer remote instruction for this course.

- b) By enrolling in this course, you further affirm that the instructor owns the copyright to their instructional materials, of which these recordings constitute a part, and your distribution of any of these recordings in whole or in part without prior written consent of the instructor may be subject to discipline by Dartmouth up to and including expulsion.

(2) Requirement of consent to one-on-one recordings

By enrolling in this course, you hereby affirm that you will not under any circumstance make a recording in any medium of any one-on-one meeting with the instructor without obtaining the prior written consent of all those participating, and you understand that if you violate this prohibition, you will be subject to discipline by Dartmouth up to and including expulsion, as well as any other civil or criminal penalties under applicable law.

Remote Learning Plan - Canvas and Zoom:

We have created a Remote Learning Plan for this course, available on Canvas. This document outlines the expected changes to our course content and structure this term, describes the methods and technologies we will use to support online learning (and how to get them installed and running on your devices), and explains what good participation looks like in a remote learning context. Please review this document as soon as you can and follow the steps for technological onboarding before our first class meeting.

Course materials will be made available and assignments will be submitted via Canvas, as usual. Class meetings and office hours will be held via Zoom. You may need to use Dartmouth's VPN client to access campus resources. If you have any difficulties accessing these technologies or are unsure of how to use their necessary features, please reach out.

Access to Campus Resources:

Many of you may be facing greater challenges than usual given the sudden changes to your living and learning environment, public health concerns, and a host of other factors (e.g., housing or food insecurity, new or changing caregiving responsibilities, visa and accessibility concerns, access to health and mental health support, and so on). We want you to be aware of the campus resources available to support your needs. While the situation is constantly evolving, many offices are prepared to meet with you via phone or Zoom. For concerns about health and wellness, you may reach out to the [Dartmouth Health Service](#) (603-646-9400 or Secure Message in DartHub), [Counseling Services](#) (603-646-9442), and the [Student Wellness Center](#). For academic needs, you may contact your [undergraduate dean](#) (603-646-2243), [Student Accessibility Services](#) (603-646-9900), and the [Academic Skills Center](#) (603-646-2014). Students with concerns related to campus employment may connect with the [Student Employment Office](#) (603-646-3641). Those with visa-related concerns may reach out to the [Office of Visa and Immigration Services](#) (603-646-3474). We encourage you to take advantage of these resources, and to speak with us if you need support in the class.

Ten recommendations for taking the course:

1. Keep up with readings in the text. Read the text before class. Do problem sets and recommended problems in the text. 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. Use PollEverywhere in class. Besides allowing for group participation and immediate feedback, the physical act of responding with your device has been shown to improve comprehension and learning of material. Make it work for you.
5. Attend discussion. The recitation will be used to go over problems and discussion 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 gone over in the discussion section.
6. Come to office hours and use Piazza. I approach office hours as a way to have smaller discussions on the areas that you find most important or troublesome. The Piazza Q and A on Canvas offers another way to engage in Discussions with students, the TA, and your profs.
7. Form study groups. Working with other people on problems and concepts invariably helps with learning the material.
8. Use information on Canvas. Posted under Syllabus, Lectures (Powerpoints, Class notes, and sample Exam questions), and Problem Sets (Problem sets, Readings).
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. Think about how the material applies to your own life. Some examples will be brought up in class, but you may find other examples at home and play. Feel free to share these with me.