

Bio12: Cell Structure and Function

Spring 2024

M, W, F 10:10-11:15 AM, X-hour: Th 12:15-1:05 PM
Room 200, Class of 1978 Life Sciences Center (LSC)

Instructors: **Professors Bing He**, Ph.D., **Dipon Ghosh**, Ph.D.

bing.he@dartmouth.edu, dipon.ghosh@dartmouth.edu

Laboratory Director: **Jessica DeSimone Warren**, Ph.D., jessica.desimone.warren@dartmouth.edu

Graduate Teaching Assistants:

Katherine Doss, katherine.e.doss.gr@dartmouth.edu

Himanshu Ballav Goswami, himanshu.ballav.goswami.gr@dartmouth.edu

Sadia Islam Kana, sadia.islam.kana.gr@dartmouth.edu

Melanie Peck, melanie.c.peck.gr@dartmouth.edu

Christopher (Chris) Tanner, christopher.d.tanner.gr@dartmouth.edu

John Zientko, john.zientko.gr@dartmouth.edu

Teaching Science Fellow: **Jiaming Ma**, '22, jiaming.ma@dartmouth.edu

COURSE GOALS & LEARNING OBJECTIVES

- 1. Become conversant in Cell Biology.** This will involve learning a vocabulary relating to this field of study and using this vocabulary correctly. Developing a complete vocabulary is necessary to discuss cellular processes accurately. Moreover, having information readily available in one's mind is required in order to quickly make mental connections that lead to new insights and facilitate problem solving.
- 2. Understand the experimental methods used to study cells.** We will discuss a broad range of techniques including different types of microscopy, biochemical and molecular analyses, and genetic approaches—all of which are routinely used by scientists to dissect how cells function. You will need to develop a thorough understanding of the underlying theory as well as the technical application of these techniques. A solid background in this area will allow you to apply this information to a diverse set of circumstances, including interpretation of experimental data and the ability to propose new experiments to answer specific questions.
- 3. Gain a working knowledge of cellular organization and function.** Our work in this course will allow you to gain a mastery of membrane structure and function and how cellular compartments are formed, how cells generate and utilize energy, how proteins are trafficked to the correct location and/or organelle within the cells, how cells respond to their environment, how signaling pathways within the cell elicit specific cellular responses, how cytoskeletal components are assembled and how they regulate cell shape and motility, how the cell duplicates and divides, how cells are organized into tissues, and how disruption of many of the above cellular processes can lead to cancer.
- 4. Develop the analytical skills of a Cell Biologist.** Cell Biology is a science and we will be asking you to think like scientists, whether it be critical analysis of data or the execution and/or interpretation of a scientific experiment. Furthermore, you will gain experience approaching cell biology as a problem-solving endeavor in which you interpret microscopic images and/or utilize your knowledge of the mechanistic details of cellular processes. Class discussion and exam questions will give you the opportunity to take what you have learned about a normal cellular process and predict a logical outcome when specific parameters are altered (i.e. by experimental manipulation, mutation, drugs).
- 5. Discover the inner beauty of the cell.** Cells are incredibly complex but also innately beautiful. Throughout the term you will frequently be viewing amazing images (and movies!) generated by diverse microscopy techniques. Even without a molecular understanding of how cells work, one can appreciate their beauty. Learning about their structure and function adds an extra dimension to this beauty.

CLASS SCHEDULE

How do we view cells?

- | | | | | |
|----|----|------|--|------------|
| 1. | M | 3/25 | Course Logistics & Introduction to Cell Architecture | Chapter 1 |
| 2. | W | 3/27 | Microscopy | Chapter 18 |
| 3. | Th | 3/28 | Microscopy | Chapter 18 |

How do we analyze cells?

- [Review Chemistry ppt presentation on Canvas before 3/29/24 class](#)
- | | | | | |
|----|----|------|------------------------------|------------|
| 4. | F | 3/29 | Protein Structure & Function | Chapter 2 |
| 5. | M | 4/1 | Experimental Approaches | Chapter 18 |
| 6. | W | 4/3 | Experimental Approaches | Chapter 18 |
| | Th | 4/4 | In-class activities and Q&A | |

How are cell compartments built?

- | | | | | |
|-----|----|------|------------------------------------|-----------|
| 7. | F | 4/5 | Thermodynamics & Enzymes | Chapter 3 |
| 8. | M | 4/8 | Membrane Structure and Composition | Chapter 4 |
| 9. | W | 4/10 | Transport Across Membranes | Chapter 4 |
| 10. | Th | 4/11 | Transport Across Membranes | Chapter 4 |
| | F | 4/12 | Review session | |

M 4/15 EXAM 1, 7:00-9:00 PM, LSC 200, Lectures #1-10 (including Chemistry)

How do cells generate and utilize energy?

- | | | | | |
|-----|----|------|----------------------------------|---------------|
| 11. | W | 4/17 | Glycolysis & Aerobic Respiration | Chapters 3, 5 |
| 12. | Th | 4/18 | Photosynthesis | Chapter 6 |

How do proteins know where to go in the cell?

- | | | | | |
|-----|----|------|-----------------------------|-----------|
| 13. | F | 4/19 | Protein Sorting | Chapter 8 |
| 14. | M | 4/22 | Protein Sorting | Chapter 8 |
| 15. | W | 4/24 | Protein Sorting | Chapter 8 |
| | Th | 4/25 | In-class activities and Q&A | |
| 16. | F | 4/26 | Protein Sorting | Chapter 8 |

How do cells receive, integrate and process information?

- | | | | | |
|-----|----|------|-----------------------|------------|
| 17. | M | 4/29 | Cell Signaling | Chapter 15 |
| 18. | W | 5/1 | Cell Signaling | Chapter 15 |
| 19. | Th | 5/2 | Cell Signaling | Chapter 15 |
| | F | 5/3 | Review session | |

M 5/6 EXAM 2, 7:00-9:00 PM, LSC 200, Emphasis on Lectures #11-19

How do cells regulate cell shape and motility?

- | | | | | |
|-----|----|------|---------------------------------------|-----------|
| 20. | W | 5/8 | Cytoskeleton – Actin | Chapter 9 |
| 21. | Th | 5/9 | Cytoskeleton – Actin | Chapter 9 |
| 22. | F | 5/10 | Cytoskeleton – Microtubules | Chapter 9 |
| 23. | M | 5/13 | Cytoskeleton – Microtubules | Chapter 9 |
| 24. | W | 5/15 | Cytoskeleton – Intermediate Filaments | Chapter 9 |
| | Th | 5/16 | In-class activities and Q&A | |

How do cells duplicate?

- | | | | | |
|-----|---|------|---|------------|
| 25. | F | 5/17 | The Cytoskeleton in Action during Cell Division | Chapter 14 |
| 26. | M | 5/20 | The Cell Cycle | Chapter 14 |

27. W 5/22 The Cell Cycle Chapter 14

How do cells form tissues?

28. Th 5/23 Connections between Cells Chapter 7

What happens when cell biology “fails”?

29. F 5/24 Cancer Chapter 16

M 5/27 MEMORIAL DAY -- no class

W 5/29 **Review Session**

FINAL EXAM, Friday, May 31, 3:00 – 6:00 PM, LSC 200, Emphasis on Lectures #20-29

LAPTOP-CLOSED POLICY:

In general, there will be no laptops in class unless we announce in advance that we will be using them for an in-class exercise. Numerous recent papers in the psychology literature have shown that being behind a laptop interferes with efficient learning. It has been shown that taking notes by hand improves learning, that any pause in focus due to jumping between windows on a laptop or device interrupts learning, and that there is a second-hand deleterious effect in which students beside another student with a laptop are impacted negatively in focus and concentration. For these reasons, Bio12 will be a laptop-closed class.

OFFICE HOURS:

Professor He: LSC 352, Mon 3 -4 PM, Thu 1:30-2:30 PM

Professor Ghosh: To be disclosed.

Note that the instructors are generally available to answer questions before or after lecture.

The scheduled review sessions are also good times to have your questions answered.

EXPECTATIONS

Here's what we expect from you:

- 1) To print out the powerpoint slides and bring them to class to take notes
- 2) To come to every class, mentally prepared to think about Cell Biology
- 3) To be willing to ask questions and participate in class discussions and exercises
- 4) To listen to pre-lecture recordings BEFORE class, when required
- 5) To utilize active learning techniques to master course material
- 6) To arrive to laboratory exercises on time, and prepared
- 7) To use your cell phone during class ONLY for course related activities

Here's what you can expect from us:

- 1) To bring expertise and enthusiasm to the classroom
- 2) To be willing to answer questions and facilitate classroom 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

TEXTBOOK

Karp's Cell and Molecular Biology, 8th or 9th Edition by Iwasa and Marshall.

(Two copies of the 9th edition have been placed on reserve in Baker/Berry Library for four-hour loan).

An important note about the textbook: You are not required to purchase the textbook. Exams will cover material that is presented in class, provided in pre-lecture recordings (when applicable), or covered in the classroom exercises. The textbook can be used as a reference to help clarify your understanding of this material. Some students find this very helpful, other students don't use the textbook at all. In deciding whether or not to purchase the textbook, consider what study strategies are most productive for you. Also, if you intend to apply to med school, vet school or graduate school then you may find having the textbook will be useful as a familiar source of information when you begin to review what you have learned in preparation for the MCAT or GRE exams.

Additional Textbooks on Reserve: For those wishing to supplement the lectures with reading from additional textbooks, the following are also on reserve in Baker/Berry Library or Dana Biomedical Library. All reading in the following textbooks is optional.

Essential Cell Biology, 4th edition (2014) by Alberts et al. This text has been the Bio12 textbook in past years but is in many ways too simplistic. If you need more background before diving into Karp, try this book.

Molecular Cell Biology, 8th (2016) or 9th (2021) edition by Lodish *et al.* This textbook contains more material than Karp. Some students find the additional level of detail in this textbook useful.

VOCABULARY TERMS

In order to help you develop the language necessary to accurately discuss experiments and cellular processes, we will be posting a list of important vocabulary terms for each module. We encourage you to use your lecture powerpoints and the textbook to write out definitions, make sure you understand these terms and can use them appropriately. Many students find flashcards a useful strategy. The online resource "Quizlet" <https://quizlet.com/> will let you easily generate electronic flash cards.

CLICKER QUESTIONS

We also will be utilizing an interactive technology in Bio12 that will allow you to communicate your answer to clicker questions that we will pose in class throughout the term. One purpose of using clicker questions is that it allows me to gauge your understanding in real time. The best way for me to gain an accurate appraisal is if the majority of the class answers each of the clicker questions. **Additionally, research has demonstrated that clicker questions help students to actively engage with the course material, and this facilitates learning and synthesis.**

You will be "clicking" anonymously—we will not see what answers you give. The data will be tabulated for the entire class, not for individual students. Although your grade will not depend on clicker question participation, we hope all of you will participate fully throughout the term. We will be using the technology called **PollEverywhere** to present "clicker" questions during lectures. 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/binghe422**. If you have any technical questions or problems, please contact dartmouth.services@dartmouth.edu for assistance.

FACILITATING YOUR LEARNING PROCESS

Several lines of evidence indicate that certain activities promote learning and retention MUCH better than re-reading your notes. If you would like to learn more about the most effective strategies for studying and learning (and the research underlying these recommendations), we highly recommend the book "**Making it Stick: The Science of Successful Learning**" by Brown, Roediger III, and McDaniel.

METHODS OF ASSESSMENT AND GRADES

| | |
|------------|-----|
| Exam 1 | 25% |
| Exam 2 | 25% |
| Final Exam | 25% |
| Lab grade | 25% |

Exams will be an even mixture of testing your mastery of the information and applying your knowledge to problem solving.

Barring documented illness, family emergency or academic conflict, **failure to take an exam at the scheduled time will result in a grade of zero.** You must alert the course instructors in advance of the exam if you are unable to take the exam at the scheduled time.

EXAMS and GRADING POLICIES

The exams will be taken in-person on the dates and times indicated in the Class Schedule. Once completed, hand in your exam to the Professors. The exams will be scanned and posted to Gradescope on Canvas. Grading of exams will be done through Gradescope. Hard copy exams will be retained should there be a problem with any of the pages scanned to Gradescope.

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

- [1] After the exam has been graded and returned, a copy of the answer key will be posted on the Bio12 Canvas site. Review this answer key carefully and be sure to 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 before the deadline (see below), 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 question number you are requesting for error correction.
 - b) If you find an addition error, indicate on the cover page that an addition error has occurred. Specify the question number.
 - c) 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 what makes your answer correct.
 - d) Email your typed cover page to Professor He (bing.he@dartmouth.edu) and Professor Ghosh (dipon.ghosh@dartmouth.edu) within 7 days after you receive the graded exam. The deadlines for **EXAM Error correction requests** are:

First Exam: 12:00PM (Noon) on Wednesday, May 1

Second Exam: 12:00PM (Noon) on Wednesday, May 22

We will not accept questions regarding errors in grading after these deadlines.

The error correction process will take a few days. You will be notified by email after the re-evaluation is completed.

A final word about grades and exams:

You are not competing against each other for grades in Bio12. We want to be very clear about that and reiterate this point: You are not competing for grades in this class with anyone but yourself. All grades, up until the final letter grades are decided, are recorded as numerical grades, from 0% to 100%. We do NOT assign letter grades to individual exams. Here are two important points about grades in Bio12:

[i] **A grade of 90% or above will always be at least an A minus** No one is ever penalized for learning what we teach them. Thus, it is entirely possible for everyone in the class to receive a grade of A minus or better. However, our experience suggests to us that this will not happen.

[ii] **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.

ACADEMIC HONOR:

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."

There are a number of situations in which a student in Bio12 might find themselves tempted to violate the Academic Honor Principle. These situations include (but are not limited to) the following:

- a) Examinations must be completed without reference to materials other than those provided with the exam paper and must be completed without communication with anyone else, including the internet (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.
- b) Science is a collaborative field and we encourage collaboration for many aspects of the course while still requiring demonstration that each individual has an understanding of key concepts. You will work with a partner during the laboratory sessions to perform all in-lab activities including microscopy, data collection, and hypothesis generation. There are three types of laboratory assignments: Pre-lab quizzes, In-Lab team assignments, and Lab summary assignments. **Only** In-Lab "team" assignments may be completed with your lab partner, for which a single team assignment is submitted with both your names. Pre-lab quizzes must be completed on your own. The written Lab summary assignments submitted for grading must represent the **original** words of the student submitting that report - do not copy directly from the lab manual, and do not share electronic data, textual or graphical files.

Honesty is the foundation of the academic pursuit of knowledge. In recognition of this, the faculty will not overlook any violations of the Academic Honor Principle. Indeed, the Faculty Handbook of Dartmouth College states explicitly that **College faculty are obligated to report potential violations of the Academic Honor Principle to the Dartmouth College Committee on Standards.**

For more information, see <https://policies.dartmouth.edu/policy/academic-honor-principle-1>

NOTE TO STUDENTS WITH PHYSICAL OR LEARNING DISABILITIES:

Students requesting disability-related accommodations and services for this course are required to register with Student Accessibility Services (SAS; [Apply for Services webpage](#); student.accessibility.services@dartmouth.edu; 1-603-646-9900) and to request that an accommodation email be sent to me in advance of the need for an accommodation. Then, students should schedule a follow-up meeting with me to determine relevant details such as what role SAS or its [Testing Center](#) may play in accommodation implementation. This process works best for everyone when completed as early in the quarter as possible. If students have questions about whether they are eligible for accommodations or have concerns about the implementation of their accommodations, they should contact the SAS office. All inquiries and discussions will remain confidential.

RELIGIOUS OBSERVANCES:

Dartmouth has a deep commitment to support students' religious observances and diverse faith practices. 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 us as soon as possible—before the end of the second week of the term at the latest—to discuss appropriate course adjustments.

MENTAL HEALTH:

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/>).

We want you to be aware of these resources and encourage you to use them as needed.

TITLE IX:

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 faculty members, we are 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 (Kristi.L.Clemens@Dartmouth.edu) (and deputies if appropriate).

LABORATORY INFORMATION:

Please refer to the BIOL12 Lab Syllabus for additional details.

BIOL12 Labs will be held in the Life Sciences Center (LSC 202/204).

Lab sections will be offered during the following times:

Section 1: Tuesday 9:00 AM – 1:00 PM

Section 2: Tuesday 1:30 PM – 5:30 PM

Section 3: Tuesday 6:00 PM – 10:00 PM

Section 4: Wednesday 2:30 PM – 6:30 PM

Laboratory attendance is mandatory. *Attendance at your scheduled lab section is required for all sessions throughout the term. You must attend your regularly scheduled lab section in its entirety to receive credit for the BIOL12 lab.* An unexcused lab absence will result in a grade of zero on the pre-lab quiz and a grade of zero for any written assignment associated with the lab that was missed.

LABORATORY EXERCISES:

Laboratory 1 – Transmitted Light Microscopy (April 2nd/3rd)

During this laboratory session, students will be trained in the proper use of the light microscope. Students will learn about the components in the transmitted light path that are required for Brightfield, Phase Contrast, and DIC microscopy.

Laboratory 2 – Protein Purification and Quantitative Analysis (April 9th/10th)

Students will perform ion-exchange chromatography to separate proteins in a protein mixture. Students will determine the amount of protein present in their eluted column fractions using a Bradford assay.

NO LAB (April 16th/17th) – Week of Exam 1

TA Office Hours for Lab Summary Assignment held on April 18th & 19th (details on Canvas)

Laboratory 3 – Qualitative Analysis of Protein Purification (April 23rd/24th)

Continuing from Lab 2, students will assess the efficacy of their protein purification procedure by performing an SDS-PAGE experiment with their eluted column fractions. Students will also perform a functional assay to test for lysozyme activity.

Laboratory 4 – The Hill Reaction in Isolated Chloroplasts (April 30th/May 1st)

Students will isolate chloroplasts from spinach using differential centrifugation and measure the rate of the Hill Reaction under various conditions using a colorimetric reporter (DCIP) and spectrophotometer.

NO LAB (May 7th/8th) – Week of Exam 2

TA Office Hours for Lab Summary Assignment held on May 9th & 10th (details on Canvas)

Laboratory 5 – Fluorescence Microscopy and Mitosis (May 14th/15th)

Students will use fluorescence microscopy to examine a population of fixed, bovine pulmonary artery endothelial (BPAE) cells. Using these prepared slides, students will identify the cellular features that define the different stages of mitosis and determine the mitotic index for this cell population.

Laboratory 6 – Cytoskeleton and Cell Growth Fluorescence Experiment (May 21st/22nd)

Students will use fluorescence microscopy to study the role of the cytoskeleton in polarized cell growth using *Ashbya gossypii* as a model system.

LABORATORY ASSIGNMENTS:

The laboratory portion of BIOL12 is worth 25% of your total BIOL12 grade.

The point breakdown for specific assignments is as follows:

| | |
|---|-----------|
| Pre-lab Quizzes | 16 points |
| Lab 1: In-lab Team Assignment | 7 points |
| Lab 2: In-lab Team Assignment | 7 points |
| Lab Summary Assignment I (Protein Purification) | 10 points |
| Lab 3: In-lab Team Assignment | 7 points |
| Lab Summary Assignment II (Protein Analysis) | 10 points |
| Lab 4: In-lab Team Assignment | 4 points |
| Lab Summary Assignment III (The Hill Reaction) | 20 points |
| Lab 5: In-lab Team Assignment | 7 points |
| Lab 6: Post-lab Assignment | 12 points |

- **Pre-lab Quizzes:** There will be 6 quizzes that must be completed independently before the start of your lab section. Pre-lab quizzes are completed on Gradescope.
- **In-lab Team Assignments:** There will be 5 team assignments that will be completed with your lab partner(s) during the laboratory session. These assignments must be submitted on Gradescope before the end of your lab section.
- **Post-lab Assignment:** The Lab 6 assignment will be completed independently and will be due one week (7 days) after your lab section on Gradescope.
- **Lab Summary Assignments:** There will be 3 lab summary assignments during the term. The graduate TAs will hold office hours a few days before these assignments are due (refer to the lab schedule for specific dates/times).

LABORATORY ACCOMODATIONS:

Students requesting disability-related accommodations and services for the laboratory portion of this course are required to register with Student Accessibility Services (SAS; [Getting Started with SAS webpage](#); student.accessibility.services@dartmouth.edu; 1-603-646-9900) and to request that an accommodation email be sent to Dr. Warren in advance of the need for an accommodation. Then, students should schedule a follow-up meeting with Dr. Warren to determine relevant details such as what role SAS or its [Testing Center](#) may play in accommodation implementation. This process works best for everyone when completed as early in the quarter as possible. If students have questions about whether they are eligible for accommodations or have concerns about the implementation of their accommodations, they should contact the SAS office. All inquiries and discussions will remain confidential.