BIOLOGY 121 (FALL 2016): THE MOLECULAR BIOLOGY OF LIFE

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LECTURES:
10 LL, MWF 10-11

FACULTY-LED DISCUSSIONS:
10 LL, W 9-10

DESCRIPTION:

This introductory lecture course emphasizes mechanistic approaches in modern biology. We consider how molecular methods and principles contribute to our understanding of biochemistry, cell biology and genetics, in the context of evolutionary, developmental and physiological processes. The course provides insight into how biological systems work and classic experiments underlying our current understanding. Topics include: protein structure; enzymes; lipids and membranes; membrane proteins; membrane transport; cellular respiration; ion channels; receptors and signal transduction; protein and vesicular traffic; the cytoskeleton; cell cycle and cell division; DNA replication and repair; transcription, translation and mutations; model organisms and genomics; gene regulation; Mendelian and population genetics.

BIOL 121 is a challenging course. We assume that you are familiar with basic biology and chemistry from high school (or are prepared to catch up if necessary). There are no specific pre-requisites, but we recommend that you spend some time with the textbooks, which are a fair representation of the level of the course, to make sure that you are prepared for it.

GUEST LECTURES:

In addition to the lectures given by Drs. Goulian and Lampson, there are two guest research lectures. These guest lecturers give excellent presentations and are at the forefront of the research they describe.

TEXTBOOKS:

Becker's World of the Cell, 9th edition, by Hardin and Bertoni, Published by Benjamin Cummings. For some of Dr. Lampson's lectures, additional reading assignments will be posted on the BIOL 121 Canvas site.

Supplemental readings that are recommended as an additional resource but not required will also be posted on the Canvas site.

WEB-SITES AND EMAIL:

The Canvas site (accessed from https://upenn.instructure.com/) contains information such as the lecture schedule, slides from the lectures, audio recordings of the lectures, additional reading, problem sets, old exams, and course announcements. Only students registered for BIOL 121 have access to the Canvas site. If you cannot access this site and you know that you are registered for these courses (check Penn InTouch to confirm this), contact Dr. Christopher Jang (cjang@sas.upenn.edu). We may also distribute messages or documents by email. Since we will use the course listserv for this purpose, be sure that the email address listed on Penn InTouch is the one you look at regularly or that any email sent to your listed email is automatically forwarded to your preferred email address.

REVIEW SESSIONS:

One review session, which will be led by faculty responsible for the previous week's lectures, will be held on Wednesday's from 9:00-10:00 am in LL 10 immediately before lecture. These sessions are most productive if students have answered the weekend question(s), have reviewed the material, and come armed with questions. Remember that your questions will benefit not only you but also other students who likely have similar questions. An additional review session will typically be scheduled before each examination.

EXAMINATIONS AND GRADING:

You are responsible for material covered in the lectures and in the assigned reading. The exams focus primarily on lecture material but may draw on the reading as well. When it comes to studying for the exam, you should not waste time memorizing facts or topics from the reading that were not covered in lecture. However, you are expected to have understood all of the material in the assigned reading. We might ask a question that draws from material covered in the reading that we did not explicitly cover in class. Such a question would be designed so that you should be able to answer it using only what you learned from lecture, but you will very likely find the question much easier if you had done the reading. For example, we may use a figure from the reading in an exam question, and it will benefit you to already be familiar with the figure. To help you prepare, old examinations are posted on Canvas and serve as a resource for gauging the level and style of questioning for this course. Keep in mind that previous semesters of this course may have covered slightly different topics or covered topics in a different order. It is up to you to determine which of the questions are relevant for the current course.

This course is graded on a 350-point scale. There will be three **100-point mid-term** examinations. Each mid-term will cover **one-third** of the course. The exams will be designed so that you should be able to finish them in 50-60 min. However, you will have 110 minutes to take the exams because all of the midterms are scheduled for Wednesdays from 9:00-10:50 am, so you should not be pressed for time**.** In calculating your overall grade for the course, the lowest of your three normalized mid-term scores will be dropped. No make-up exams will be offered for the mid-term examinations; if you miss an exam, that one will be automatically dropped. The **final** will be a

comprehensive examination that all students must take. It will count for **150 points** of the overall course grade and will be scheduled for the exam period determined by the registrar's office. The final exam is designed to take 60-80 min to complete, although you will have 120 min.

Exams in this course are closed-book and closed-note. Penn's Code of Academic Integrity is taken seriously and students **must sign each exam** confirming their compliance. Students who use pencils on exams waive their right to a re-grade request (see below); thus it is recommended that students write using black or blue ink. Students must write their names at the top of each page of the exam and their laboratory section number must be indicated on the first page.

Questions about examination grading will be considered only during a **one-week** interval after the graded exams are first returned to the students. Note that when an exam is re-graded, it is re-graded in its entirety, which can (and frequently does) result in downward as well as upward score changes for other parts of the exam. **After** consulting the key, if you feel there was an error in the grading of your exam worth at least 1% of the aggregate score for the class (3.5 points or more on mid-term exams), **legibly** describe (typed or neatly handwritten) the issues with the points in question (precisely identified and justified) on a separate piece of paper and staple it to the front of your exam. That sheet should also include your full name, e-mail address and laboratory section number (if you are currently enrolled in BIOL-123). Turn in your request directly to one of the teaching assistants or place it in Dr. Christopher Jang's mailbox (Leidy Laboratories, Room 116, located BELOW the name label). (Accounting errors by graders can always be addressed regardless of the point amount, provided that the student follows the regrade request procedure described above.)

STRATEGIES FOR SUCCESS:

1. Come to lecture.

2. Review each week and come to the Wednesday morning review sessions with questions.

It is important to keep up with the work on a regular basis. We recommend doing the assigned reading before the lectures and reviewing your lecture notes some time later in the same day in order to consolidate your learning and clarify principles and details while the material is still fresh in your mind. In addition, previewing and reviewing this material helps to identify any questions that you may wish to ask in lecture or at one of the weekly review sessions. There will be audio recordings of the lectures, which usually appear on the Canvas site on the morning of the day after the lecture. The recordings are intended as a resource to help you review the material covered in lecture, but they do occasionally fail for technical reasons beyond our control. We do not recommend using the recordings as a substitute for attending the lectures in person. Similarly, the slides posted on Canvas are neither a substitute for the lectures nor intended to be stand-alone study devices. We do use the (old-fashioned) blackboard in lecture, which is not captured in either the audio recordings or the slides.

The faculty-led discussion sessions are your best resource for additional help in this course. These discussion sessions provide an opportunity to ask questions, hear difficult topics discussed in more detail, listen to other students' questions and ideas, and review old exam questions. The best way to use this resource is to review the material each week and come with questions.

3. Test yourself. Do assigned problems, posted exam questions and other problems to be found in books and on the internet without looking at answers/keys. If you are unsure of your response, go back to you notes, readings and lecture materials to review before trying again. Only once you are confident in your answer, then check for

correctness. This method will help you more accurately assess abilities and direct your studying to help use your time efficiently.

4. **Take every midterm exam seriously.** Although your lowest midterm score will be dropped, you should not use this policy as an opportunity to skip or avoid studying for an exam. The midterm exam drop policy is intended to help you in extreme situations—e.g. if you are ill or struggle on an exam for unanticipated reasons. We have seen many cases of students who did not bother studying for a midterm, with the intention of dropping that score, and who ended up with a poor final grade because they didn't do as well as they expected on another exam. Also, remember that the final exam covers all of the material in the course.

5. Form study groups for help with the material and to test each other.

If you are encountering difficulties, you can also turn to the TAs, or the faculty instructors for help with the subject matter or for more general advice. In addition, you may contact the Academic Support Programs Office for tutoring or help with studying and test-taking skills (http://www.college.upenn.edu/academic-support).

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LECTURE SCHEDULE

day	Date		Lecture	Text	Supplemental Reading
Wednesday	31-Aug	Goulian	Course introduction The chemistry of biology	Becker Ch 2: 21-30, 32-36, Ch 3: 62-66	
Friday	2-Sep	Goulian	Proteins: cellular workhorses	Becker Ch 2: 36-38, Ch 3: 42-57	
Monday	5-Sep	Labor Day			
Wednesday	7-Sep	Goulian	Thermodynamics, Enzyme Kinetics I	Becker Ch 5: 104-116, Ch 6: 127-137, Ch 9: 215-220	
Friday	9-Sep	Goulian	Enzyme Kinetics II	Becker Ch 6: 137-148	Changeux, J-P. (1965) The control of biochemical reactions. *Sci Am*. April: 244-253.
Monday	12-Sep	Goulian	Lipids and membranes	Becker Ch 2: 31-32, Ch 3: 66-71, Ch 7: 152-171	
Wednesday	14-Sep	Goulian	Diffusion and membrane transport	Ch 8: 185-209	
Friday	16-Sep	Goulian	Glycolysis, fermentation and the TCA cycle: substrate-level phosphorylation	Becker Ch 9: 220-231, 235-236; Ch 10: 242-259	Krebs, H.A. (1953) Nobel Lecture
Monday	19-Sep	Goulian	Electron transport chain and ATP synthase: oxidative phosphorylation	Becker Ch 10: 260-279	Harold, F.M. (2001) Gleanings of a chemiosmotic eye. *BioEssays*. 23: 848-855.
Wednesday	21-Sep	Goulian	Photosynthesis: chemical energy from light energy	Becker Ch 11: 283-305	
Friday	23-Sep	Goulian	DNA I - Nucleic Acids, DNA as the genetic material, genomes	Becker Ch. 3: 58-62, Ch. 16: 431-443	Watson JD, Crick FH (1953). Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid. Nature 171: 737–738
Monday	26-Sep	Goulian	DNA II - DNA replication	Becker Ch. 17: 464-484	Watson JD, Crick FH (1953). Genetical implications of the structure of deoxyribonucleic acid. Nature 171: 964-7.
Wednesday	28-Sep	Goulian	DNA III - DNA replication continued, DNA repair	Becker Ch. 17: 484-493	
Friday	30-Sep	Goulian	Central dogma, the genetic code, mutations	Becker Ch. 18: 499-510, Ch. 19: 551-553	
Monday	3-Oct	Goulian	Gene expression I - Transcription	Becker Ch. 18: 510-516, 525-531	

Wednesday	5-Oct	**EXAM 1**			
Friday	7-Oct	Fall Break			
Monday	10-Oct	Goulian	Gene expression II - Translation	Becker Ch. 19: 535-551	
Wednesday	12-Oct	Goulian	Gene regulation in prokaryotes	Becker Ch. 20: 569-581	
Friday	14-Oct	Doms	HIV and Aids	Becker Ch. 4: 99-100	
Monday	17-Oct	Goulian	Gene regulation in eukaryotes	Becker Ch. 16: 446-450; Ch. 20: 581-595, 603-612	
Wednesday	19-Oct	Goulian	Analysis of genes and genomes	Ch. 21: 616-637	
Friday	21-Oct	Lampson	Mendelian genetics	Griffiths Ch. 2 (online reading)	
Monday	24-Oct	Lampson	Chromosomal theory of inheritance	Griffiths Ch. 3 (online reading)	Miko, I. (2008) Thomas Hunt Morgan and sex linkage. O'Connor and Miko (2008) Developing the chromosome theory.
Wednesday	26-Oct	Lampson	Linkage and recombination	Griffiths Ch. 5 (online reading)	Kandel, E. Thomas Hunt Morgan at Columbia University
Friday	28-Oct	Lampson	Population genetics I - Hardy-Weinberg	Griffiths Ch. 24 (online reading)	
Monday	31-Oct	Lampson	Population genetics II - natural selection	Griffiths Ch. 26 (online reading)	Mayr, E. (2000). Darwin's influence on modern thought. *Sci. Am.*, July: 78-83
Wednesday	2-Nov	Lampson	Population genetics III - genetic drift		Duret, L. (2008) Neutral Theory: the null hypothesis of molecular evolution
Friday	4-Nov	Lampson	Population genetics IV - human evolution		Schaffner and Sabeti (2008) Evolutionary adaptation in the human lineage
Monday	7-Nov	Lampson	Life is cellular: prokaryotes and eukaryotes	Becker Ch. 4	
Wednesday	9-Nov	**EXAM 2**			
Friday	11-Nov	Jang	TBA		
Monday	14-Nov	Lampson	Ion Channels	Becker Ch. 22: 658-671	MacKinnon, R. (2003) Nobel Lecture
Wednesday	16-Nov	Lampson	Receptors and signal transduction	Becker Ch. 23.1, 23.3, 23.4	Varmus, H. (1989) Nobel Prize lecture

Friday	18-Nov	Lampson	Protein and Vesicular Traffic I	Becker Ch. 12.4 and 12.5, Ch. 19.5	Blobel, G. (1999) Nobel Lecture
Monday	21-Nov	Lampson	Protein and Vesicular Traffic II		Brown and Goldstein (1985) Nobel Lecture
Wednesday	23-Nov	Lampson	Cytoskeleton	Becker Ch. 13.1, 13.2	
Friday	25-Nov	Thanksgiving			
Monday	28-Nov	Lampson	Cell Cycle and Cell Division I	Becker Ch. 24.1, 24.2	Nurse, P. (2001) Nobel Lecture
Wednesday	30-Nov	Holzbaur	Axonal transport in neurons: extreme sport for molecular motors		
Friday	2-Dec	Lampson	Cell Cycle and Cell Division II	Becker Ch. 24.3	
Monday	5-Dec	Lampson	Cell Cycle and Cell Division III	Becker Ch. 25.1, 25.2, 25.3, 25.4	
Wednesday	7-Dec	**EXAM 3**	EXAM 3		
Friday	9-Dec	Lampson	Evolution of Sex I		Otto, S. (2008) Sexual Reproduction and the Evolution of Sex
Monday	12-Dec	Lampson	Evolution of Sex II		Colegrave, N. (2012) The evolutionary success of sex