Bi 281H: Biochemistry and Cell Physiology Course Information Fall 2013

Professor: Karen Sprague kus@uoregon.edu

Office Hours: Wednesday 11:00 AM – 12:30 PM, 21 Klamath; Additional Office Hours, by appointment

Course web site: http://biology.uoregon.edu/classes/bi281hf13/default.htm

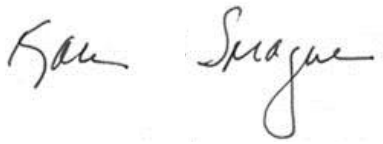
Overview of the Honors Biology sequence: This sequence will introduce you to the full range of biology – and will emphasize cellular, molecular and genetic mechanisms. Throughout the sequence, we want you to understand the fundamental principles that explain much of the biology we see every day, and we also want you to appreciate how those principles were arrived at. All three courses emphasize scientific reasoning, and will give you practice in this kind of thinking. The labs associated with each course are especially useful for this because we have deliberately linked the main ideas in the lectures and labs so that you can apply the same concepts in different settings. The Honors sequence is ideal for pre-medical students and for students planning post-graduate work in any biological science.

Honors Biology I (Bi 281H) begins the sequence by asking how cells work. To answer this question, you will first learn about the properties of proteins that make them effective as the principal structural elements and catalysts within cells. You will learn the distinctive physical characteristics of the 20 different amino acids that make up proteins -- things like size and shape, relative hydrophobicity, and positive or negative electrical charge. The purpose is to understand how these simple characteristics account for the complex structures and remarkable activities of proteins. You will then investigate the central challenge to cells: the need to convert food energy into a form that is capable of driving the energy-requiring reactions that life depends on. Finally, you will learn now cells co-ordinate their repertoire of chemical reactions so as to be both energetically efficient and able to respond effectively to changes in their surroundings – for example, the supply of food.

Honors Biology II (Bi 282H) asks where proteins come from and how their production is regulated. You will examine the role of DNA and RNA as informational molecules that direct the synthesis of proteins, and transmit genetic information to subsequent generations. You will also dissect the mechanisms by which cells respond to changing conditions by altering the pattern of proteins they produce. You will learn about current research, particularly the elegant experiments that underlie our present understanding of gene regulation and embryonic development.

Honors Biology III (Bi 283H) synthesizes ideas from the first two courses to explain the remarkable biological diversity that characterizes our planet. You will build on your understanding of embryonic development from Bi 282H to consider developmental variations that generate different body plans – the bilateral symmetry of humans compared with the radial symmetry of starfish, for example. You will then learn how genetic variation and natural selection lead to evolution and biological diversity, and you will examine the interactions of organisms with each other, and with their environments, that create complex ecosystems.

More specifically -- what I hope you'll learn in Bi 281H and how to do it



September 27, 2013

What will you learn? As I said above, this course is about how cells work – that is, how the remarkable complexity of a living cell can be explained by the fundamental principles of chemistry and physics that govern the rest of the universe. As we work toward understanding this, we'll emphasize some big, unifying ideas. You may understand and be able to apply these already, but most people don't grasp them through one exposure. Whatever your situation, I hope that working with the following ideas throughout the course will be enlightening:

1. **Differences in affinity explain many biological phenomena**. For example,
   a. Differences in affinity for protons are what make some molecules acids and others bases. Moreover, the capacity of weak acids and bases to bind or release protons appropriately underlies phenomena as different as oxygen transport and ATP synthesis.
   b. Differences in affinity allow proteins to distinguish their target molecules from all others. As a result, enzymes are able to catalyze the chemical reactions actually needed by cells and genetic regulatory proteins can turn on certain genes, but not others.

2. **Living things don't violate the laws of thermodynamics!** When you look at the orderliness of a cell and consider the accuracy with which it operates, it's tempting to think that something special is at work here – some process that's not derailed by entropy, for example. Remarkably, that's not so. The same rules apply to living cells and to gasoline engines, and the same overall reactions release energy from fuel in both cases. How cells manage the conversion of energy into forms that are useful to them, including the linkage of energy-generating reactions to energy-requiring ones, is one of the insights I hope you gain in this course.

3. **Cells are able to sense their environments and respond appropriately.** Not only are cells wonderfully complex and energetically sophisticated, they're able to change as their environments change. A detailed understanding of all of the machinery involved is beyond the scope of this course – or maybe of any course, since much of it is still unknown. Still, you will learn about the kinds of strategies cells employ to sense what's going on inside and around them – and to regulate individual biochemical reactions, whole pathways and overall physiological states, appropriately.

What kind learning will this be? This course will introduce you to the most important characteristic of Honors Biology courses – that is, their emphasis on reasoning, rather than memorization. Although you will need to commit some facts and new terminology to memory (*e.g.* the names and distinctive properties of amino acids), what's most important is to understand what the facts mean and how they fit together. That is, after all, what science is and probably what intrigued you about this subject in the first place. I hope so. You'll be disappointed if you're looking for what some students call a "terms course -- memorize 50 terms and you've got an A". In Bi 281H, we'll give you lots of practice with scientific reasoning – that is, using scientific principles to reason from specific information that you may not have encountered before. That's what you'll be doing when you're working in the laboratory and when you're solving problems from the packet. In addition to the principles you'll learn in this course, you'll be applying principles you learned in your chemistry courses. The most important ones will be the principles that govern the following:

- the equilibrium positions of chemical reactions (including dissociation of weak acids)
- the contributions of changes in entropy (ΔS) and enthalpy (ΔH) to changes in free energy (ΔG)
- the rates of chemical reactions
- the energy changes that accompany loss or gain of electrons (that is, oxidation or reduction)

What will your grades mean? I hope your focus won't be entirely on your grade, but it's human nature to pay attention to such things and I hope it will help you to understand what grades in this course mean. You will earn points based on exams and lab work. The details about how the points are distributed and how they will be converted to letter grades are given under "Organization and Grading" below. Here I want to explain what kind of work will earn grades of A, B, etc. In general, if you are conscientious about your Pre-lab and Lab Reports and you prepare for the lab quizzes, you should be able to earn most of the lab points. On exams, there will be a mixture of questions that require only recall and others of varying difficulty that ask you to put information together or apply principles to solve problems you haven't seen before (synthesis and application questions). You can get a feel for the kinds of questions I'm talking about by working the problems on the old exams in your packet. On an exam, it's unlikely you'll be able to answer every question you encounter, but don't be discouraged about that. Here's the kind of work that will correspond to each grade:

A

- Lab work
  - Reports: Pre-labs and Lab Reports are on time, complete and carefully thought through.
  - Quizzes: Answers to quiz questions are correct, clear and show good comprehension of the concepts being tested.
- Exams
  - Recall questions: Nearly all of these are answered correctly. (I'm allowing for a few silly mistakes here and there. We all make them.)
  - Synthesis and application questions: A substantial proportion of these are answered correctly, and where explanations are asked for, they are clear and logical.

B

- Lab work
  - Reports: Pre-labs and Lab Reports are on time and complete.
  - Quizzes: Most answers to quiz questions are correct, clear and show good comprehension of the concepts being tested.
- Exams
  - Recall questions: Nearly all of these are answered correctly. (I'm allowing for a few silly mistakes here and there. We all make them.)
  - Synthesis and application questions: Some of these are answered correctly, and where explanations are asked for, they include the relevant information, but are not as clear and focused as they could be.

C

- Lab work
  - Reports: Pre-labs and Lab Reports are on time and most of them are complete.
  - Quizzes: Most answers to quiz questions contain correct information, but are not as clear as they could be.
- Exams
  - Recall questions: Many of these are answered correctly.
  - Synthesis and application questions: Few of these are answered correctly, and where explanations are asked for, many are incomplete or unclear.

D

- Lab work
  - Reports: Pre-labs and Lab Reports are on time, but are incomplete or contain errors of comprehension.
  - Quizzes: A substantial proportion of quiz answers are incorrect, indicating a tenuous grasp of the concepts being tested
- Exams
  - Recall questions: A substantial proportion of these are answered incorrectly.
  - Synthesis and application questions: These questions are rarely answered correctly, and where explanations are asked for, most are incorrect.

F

- Lab work
  - Reports: Pre-labs and Lab Reports are missing, are incomplete or contain major errors of comprehension.
  - Quizzes: Many answers to quiz questions are missing or incorrect, indicating little grasp of the concepts being tested
- Exams
  - Recall questions: Few of these are answered correctly.

- Synthesis and application questions: These questions are almost never answered correctly, and where explanations are asked for, they are usually incorrect.

Hints for Success

Working lots of problems is the best possible way to study for this course: Simply reading the textbook, even several times over, won't do the trick. If you want to understand the material at the level required for success, you need to work problems. Several years ago, a student took a course like Bi 281H twice – first, working few problems and doing poorly, and then again, working lots of them and doing well. Here's the email I received after the second round: "I must say, this class was just as challenging the second time around. The key to success, which you state pretty clearly in the syllabus, is doing the problem sets. That helped with the final and midterms." Nuf ced.

The problems we recommend may strike you as unusual – different from the ones you're accustomed to in Chemistry courses. Many are "word problems" that won't have been worked out in class. When you first read a problem like this, you may not immediately see how to solve it, but that's OK. Keep at it. Try to re-formulate the question in your own words, ask questions in office hours, discuss the problem with other students. You'll find that trying to solve problems of this kind may take a while, but the process will help you identify the fuzzy areas in your thinking and get rid of them.

Use labs to understand concepts from lecture: Bi 281H includes both lectures and a weekly 3-hour lab period. The main ideas in the lectures and the lab exercises are tightly linked so as to allow you to grapple with the same concepts in different ways. The lab work is not meant to teach techniques. Rather, the exercises are designed to minimize technical manipulations, and allow you to concentrate on what the lab is really about. Both faculty and student teaching assistants are available in the labs throughout the 3 hours. Talk to them about what you're doing – even (or especially) if you're confused. One of my colleagues in Math tells his students that Math isn't meant to be understood instantly. I think the same is true of Biochemistry. On the other hand, if you're mentally engaged during the lab period, and take advantage of the lab teaching staff, you'll emerge with insight.

Don't get lost in the textbook: Biochemistry textbooks typically contain more detail than is useful for an introduction to the subject. Pratt and Cornely does a better job than most in presenting key principles clearly, but I've still suggested a path through the book *via* the specific, weekly reading assignments on the Lecture/Lab Outline. You'll find that these assignments do not simply go through the book, chapter by chapter, as is typical in high school courses and in some college freshman courses. That's because Bi 281H, as a true university-level course, is organized around a set of concepts rather than a series of facts. To help you understand these concepts, I've made the text fit the lectures as closely as possible by identifying the specific sections of chapters that are closest to the

material in each of my lectures. Initially, it may be disconcerting to find that you are reading parts of widely separated chapters in the same week (*e.g.* Chapters 1,2 and 4 in Week 1), but I think you'll see that this approach makes the text and lectures reinforce each other. You may find it helpful to read quickly through an entire chapter and then focus on the section that's particularly relevant to the lecture. That way, you'll get an initial overview before focusing on the particular concepts of the week.

Organization and Grading

Format: 3 lectures (10 AM Mon. Wed. Fri.) each week in 101 Knight Library
1 three-hour lab session each week in 21 Klamath

Course Material

In UO Bookstore: Pratt and Cornely, *Essential Biochemistry*, 2014 3rd Edition (1st or 2nd editions are OK, too)
Problems and Old Exams
Lab Manual

On course website (http://biology.uoregon.edu/classes/bi281hf13/default.htm) : Lecture Diagrams

Exams and Grading:

There will be two hour-exams plus a comprehensive final exam. The exams are not open book, but some factual information will be provided. Look at the back of the Old Exams packet to see exactly what factual information you'll be given.

Your grade for the course will depend on the combination of your performance in these exams (400 points possible) plus your work in the labs (270 points possible). **Total possible course points (exams + lab) = 670**

Scores will be determined by 2 methods for each student:

			Points	**% total course pts**
Method 1				
2 Hour-exams	100 + 100	=	200	30
Final exam			200	30
Lab			270	40
	Total		**670**	**100**

Method 2

1 Hour-exam (highest score)	100 x 1.33	=	133	20
Final exam	200 x 1.33	=	267	40
Lab		=	270	40
	Total		**670**	**100**

Points for lab work will be calculated as follows:

Self-help Quiz (pts for taking)		=	10
Quizzes (8 x 15 pts/quiz)	120 x 1.3	=	156
Lab reports (8 x 8 pts/report) + pre-labs (8 x 2 pts/pre-lab)	80 x 1.3	=	104
	Total		**270**

2 letter grades will be assigned on the basis of the Method 1 and Method 2 scores. If the two grades differ for an individual student, the higher letter grade will be awarded. Letter grades are determined only after the **total** course points have been calculated, not after individual hour exams. The percentages of total course points that correspond to particular letter grades vary somewhat from year to year, but are approximately: 85% = low A, 75% = low B, 60% = low C, 50% = D. Since grades are not assigned strictly on the basis of a statistical distribution about a mean, the opportunities to earn good grades in this course are not restricted and you are not in competition with other students for a fixed number of top grades. In general, letter grades in this course mean that you have mastered the course material at the following levels:

A: You understand the concepts so well that you can regularly apply them to solve problems you haven't seen before.
B: You understand the concepts quite well and can sometimes use them to solve unfamiliar problems.
C: You understand the concepts partially, and can apply them appropriately in problems like those you've already encountered .
D: You understand only a few of the concepts and have a difficult time applying them.

Re-grading: Exams will be returned to you during your lab period. If you wish to have an exam answer re-graded, you must WRITE a logical explanation for why your answer merits a higher score, attach it to the exam, and submit both the explanation and the exam to the course instructors. Well thought-out arguments will be carefully considered, but other questions on the exam may be re-graded as well, and requests that we simply "look again" at an answer will not be honored. **To be considered for re-grading, your exam and explanation must be submitted by the announced deadline – which is typically, though not always, at the beginning of your lab period, within one week of your receipt of the graded exam. Be sure to check the actual re-submission deadline for each exam.**

Missed exams: No make-up exams will be given. If you miss an exam for a valid (usually medical) reason, you should provide written documentation of that reason, and your grade will be based on the other exams you have taken. In the event of a major flu outbreak, the kind of documentation required may change and we will communicate this to you.

Disabilities: If you have a documented disability and anticipate needing accommodation in this course, please make arrangements to meet with me. When you come to that meeting, please bring a letter in which a Disabilities Services counselor has verified your disability.