Biology 3550/Biology 3551(3 Cr)
Physical Principles in Biology

Fall Semester - 2016

Course Description (from the University Catalog):

Principles from physics and chemistry are explored in the context of biological processes, especially at the molecular and cellular level. Topics covered include random walks, thermodynamics, molecular recognition, dynamic processes, optics and spectroscopy. Quantitative treatments are emphasized and computer simulation and applications are used extensively.

Special note for Biol. 3551 (honors):

Biol. 3551 is designated as an Honors class and enrollment is restricted to students in the Honors College. However, the two classes meet together and their requirements and policies are identical. Furthermore, there is no distinction in grading for students enrolled in Biol. 3550 or Biol. 3551. The distinction is entirely administrative and is intended to ensure that spaces are available to all students.

Course Objectives

This course is designed to help students understand and appreciate the many connections between the physical and biological sciences, and also develop their skills in quantitative problem solving. Many of the most exciting scientific advances now taking place involve the application of principles from chemistry and physics to biological problems, and students who are broadly educated in the sciences will be especially well prepared to participate in these advances. At the end of the course, students will have explored several biophysical concepts in depth and will be able to apply these concepts to new situations, using appropriate quantitative and mathematical tools.

Instructor:

David P. Goldenberg
Office: 306 Aline Skaggs Biology Building (ASB)
Telephone: 581-3885
E-mail: goldenberg@biology.utah.edu

Office hours:
Tuesdays: 9:30 - 11:00 AM
Wednesdays: 2:00 - 3:00 PM
Other times by appointment. The best way to contact me is by e-mail.

Special note: My office is about to move, and I should be in ASB 306 by the beginning of classes. But, if you don't find me there, try ASB 326.

Teaching Assistant

Daniel Brown
E-mail: daniel.brown@utah.edu

Prerequisites:

One semester of biology: BIOL 1210 or 2020
One semester of chemistry *or* physics: CHEM 1210 *or* PHYS 2010, 2120 or 2210
One semester of calculus: MATH 1170, 1210, 1250 or 1270

Class Sessions:

Monday, Wednesday, Friday
9:40 –10:30 AM
Room 340 Alfred Emory Building

No classes on: Monday, 5 Sept. (Labor Day), 10-14 October (Fall Break),
Friday, 25 November (Thanksgiving Day break).

Regular class attendance is expected of all students. The class sessions will have a mixed lecture-discussion format, and engaged participation is essential for learning. Although notes and slides from many of the lectures will be posted on the class web site, these should not be viewed as a substitute for attending class.

Clickers

An audience response system (clickers) will be used to facilitate interactive learning during the lectures. Some responses will be graded and will count for 5% of the course grade. Clickers can be purchased from the University Campus Store and can be sold back to the store at the end of the semester. Either the older NXT or newer QT/QT2 devices should work.

For this class, you do not need a TurningPoint account or license, and you should not try to register your clicker for this course through the Turning Point Cloud service, though you may need to do this for other courses. You will need to register your clicker through an "assignment" on Canvas.

Although there is a TurningPoint smart-phone app (ResponseWare) that can, in principle, be used instead of a clicker, my experience with it has not been good, and it will not be supported for this class.

Text:

There is no assigned textbook. Readings and handouts will be posted on the course web site (see below).

Course Web Site:

Materials for this course will be distributed via a web site:
`http://courses.biology.utah.edu/goldenberg/biol3550`
Regularly posted material will include lecture notes and slides, problem sets and updated scheduling information. The web site also includes links to a variety of internet resources we will use during the course. Check the site frequently for updates!

Canvas:

Canvas will be used for submitting homework assignments and recording grades. If you haven't already, please login to Canvas to register your clicker.

Homework Assignments:

Problem solving is a major element of this class. Approximately 6 graded problem sets will be assigned during the course of the semester. The lowest homework score will be dropped in calculating final grades.

Homework will be submitted electronically via Canvas and must be typed. **Do not submit scans of handwritten work! Work submitted this way will not be graded.** Entering

mathematical expressions on a computer can be difficult at first, but it is an important skill to learn and will be required for this class. Your work must be clear and legible! The instructor and TA reserve the right to refuse to grade work that is too difficult to read.

Students are encouraged to work together on the homework assignments and to use outside resources, including the internet. However, the work you turn in must be your own! Any text must be clearly distinguishable from that of other students, and other sources must be properly cited. Text from other sources must be clearly identified by quotation marks. Furthermore, extensive quotations, even with proper citation, will not be considered satisfactory answers to questions. Copying and pasting does not demonstrate mastery of the material!

If two or more students turn in work that that is identical, their action will be considered academic misconduct and appropriate sanctions will be imposed. At a minimum, the sanction will include the loss of credit for the copied work, and more severe sanctions may be imposed for more extensive infractions. (See additional information below regarding Academic Conduct.)

Quizzes and Exams:

- There will be five 25-minute quizzes, given in the second half of regular lecture sessions on the following Fridays:
  2 Sept., 23 Sept., 28 Oct., 18 Nov., 2 Dec.

  Each quiz will cover the class material presented since the previous quiz (or mid-term exam). The lowest quiz score will be dropped in calculating the final grade.

- There will be one mid-term exam.This exam will cover all of the material previously presented in class.

- A final, cumulative, exam will be given during the regularly-scheduled 2-hour exam period: 8:00 AM, Monday, 12 December. This exam will cover everything covered in class.

- The schedule for quizzes and the mid-term exam is subject to change. The date of the final exam is not!

Grading Policy:

The final numerical grade for the class will be based on the homework, quiz and exam scores, weighted as follows:

Clicker responses: 5%
Homework: 30%
Quizzes: 30%
Mid-term exam: 15%
Final exam: 20%

The following represent maximum cutoffs for determining class letter grades:

A: 92–100% (including A-)
B: 82–91% (including B- and B+)
C: 70–81% (including C- and C+)
D: 60–69%
E: $< 60\%$

Depending on how things go, the grade cutoffs *may* be revised downwards, *i.e.* to make the grading more generous. The cutoffs will not be moved to make the grading less generous. Grading will be identical or students enrolled in Biol. 3550 and 3551 (honors).

Important Dates:

- First day of classes: Monday, 22 August
- Last day to add, elect CR/NC, or audit classes: Friday, 2 September
- Last day to drop (delete) classes: Friday, 2 September (No tuition penalty; class does not appear on record.)
- Last day to withdraw from classes: Friday, 21 October (No tuition refund, "W" appears on transcript.)
- Last day to reverse CR/NC option: Friday, 2 December
- Last day of classes: Thursday, December 8
- Final exam: Monday, 12 December, 8:00 AM

Excused Absences

If you must miss a lecture because of illness, family emergency or an official University of Utah activity, please notify the instructor. Any clicker points missed because of an authorized absence will not be included in calculating the average for your clicker responses.

Expected Learning Outcomes Students completing this course will gain an appreciation for the connections among mathematics, the physical sciences and biology and enhanced understanding of:

- Quantitative problem solving.
- Probability and the nature of random processes.
- Computer simulations of random processes.
- Diffusion and its role in biological processes
- Principles of thermodynamics and their applications in biology
- Properties of light and its interactions with matter.
- Optical image formation in vision and microscopy.
- Mechanisms of molecular motors and methods for studying them.

Special Accommodations:

The University seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in this class, reasonable prior notice needs to be given to the instructor and to the Center for Disability Services, 162 Olpin Union Building, 581-5020 (V/TDD) to make arrangements for these accommodations. All written information in this course can be made available in alternative format with prior notification.

Faculty and Student Responsibilities:

All students are expected to maintain professional behavior in the classroom setting, according to the Student Code, spelled out in the Student Handbook. Students have specific rights in the classroom as detailed in Article III of the Code. The Code also specifies proscribed conduct (Article XI) that involves cheating on tests, plagiarism, and/or collusion, as well as fraud, theft, etc. Students should read the Code carefully and know they are responsible for the content. According to Faculty Rules and Regulations, it is the faculty responsibility to enforce responsible classroom behaviors, beginning with verbal warnings and progressing to dismissal from class and a failing grade. Students have the right to appeal such action to the Student Behavior Committee.

Title IX: Addressing Sexual Misconduct:

Title IX makes it clear that violence and harassment based on sex and gender (which Includes sexual orientation and gender identity/expression) is a civil rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veterans status or genetic information. If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action (`http://oeo.utah.edu/`, 135 Park Building, 801-581-8365), or the Office of the Dean of Students (`http://deanofstudents.utah.edu`, 270 Union Building, 801-581-7066). For support and confidential consultation, contact the Center for Student Wellness (`http://wellness.utah.edu`, 426 SSB, 801-581-7776). To report to the police, contact the Department of Public Safety (`http://dps.utah.edu`, 801-585-2677(COPS)).

Academic Conduct

In order to ensure that the highest standards of academic conduct are promoted and supported at the University, students must adhere to generally accepted standards of academic honesty. Acts of academic misconduct include cheating, plagiarizing, research misconduct, misrepresenting one's work, and inappropriately collaborating. Suspected cases of academic misconduct will be dealt with according to the rules found in the Student Code (`http://regulations.utah.edu/academics/6-400.php#section_5`). Instances of academic misconduct are recorded in a University database, which is shared by all academic units on campus.

Final Note:

This syllabus is not a binding legal contract. It may be modified by the instructor when the student is given reasonable notice of the modification.

Tentative Lecture Schedule

Week of:	Topic
22 Aug.	Introduction to class; The scale of things - units and dimensions; Introduction to probability
29 Aug.	More on probability; Simulating random processes
5 Sept.	Random walks in one, two and three dimensions; Average end-to-end distances
12 Sept.	Random walks continued; Distribution of end-to-end distances; The Gaussian distribution
19 Sept.	Diffusion; Fick's laws; Molecular motion
26 Sept.	Biological applications of diffusion: Water loss from plants and chemotaxis
3 Oct.	Thermodynamics: Energy, heat, work and entropy
10 Oct.	Fall Break!
17 Oct.	Thermodynamics continued: Free energy and chemical thermodynamics
24 Oct.	Water and hydrophobicity; lipids and biological membranes
31 Oct.	Protein folding: Energetics, mechanism and when things go wrong
7 Nov.	Optics: Reflection, refraction and lenses
14 Nov.	Optics continued: The diffraction limit; The human eye and vision
21 Nov.	Microscopy: Fluorescence, super-resolution microscopy and other special techniques
28 Nov.	Molecular motors
5 Dec.	Molecular motors continued