

SYLLABUS BIO 141:

DRUGS, BIOCHEMISTRY AND CELLS

A broad foundational course such as BIO 141 cannot possibly cover the myriad of topics within the field of cellular biology. In addition, content-heavy courses tend to emphasize memorization, not analysis and understanding. You cannot analyze and understand something without a modicum of memorization of facts, however. So, this course is designed to allow you to use facts and content to explain and understand biochemical and cellular mechanisms. But, not all biochemical and cellular mechanisms! If you can learn how to take factual knowledge of a single system or topic and integrate it into a whole story, then you can do this on your own for any mechanism. Since we all use drugs every day, whether you are aware of this or not, I chose to focus this course around the biochemistry and cellular biology of drugs.

My doctorate is in pharmacology, the study of drugs. I am very interested in how drugs affect cells (the target), how drugs can be used to moderate a particular mechanism (the treatment of a disease or ailment), and how drugs can produce off-target effects (the side-effects). There are over 10,000 drugs available throughout the world according to DrugBank (<https://www.drugbank.ca/stats>); 5,000 of these are experimental. A couple hundred are illicit drugs, and just over a hundred are called “nutriceutical drugs”. Although it would be a treat, or onerous perhaps, to examine the targets, mechanisms, and side-effects of all of these, I have narrowed down this enormous list to just a few. We will concentrate on drugs that affect membrane transport systems, drugs that impact the nervous system, and drugs that are used as chemotherapy. Conveniently, these three drug types fit into each week of the course.

INSTRUCTOR INFORMATION:

Barbara Christie-Pope, PhD

Office: 205 Russell Hall, x-4395

Email: bchristie-pope@cornellcollege.edu

Feel free to come by my office any time. I am usually in my office from 11-12 after morning class and 3-4 in the afternoon. You can also e-mail me to set-up an appointment. Please do not wait to contact me if you are having problems in the course.

Shea-Lynn Putz

Office: Russell Hall, x-4155

Email: sputz@cornellcollege.edu

LEARNING GOALS

My goals for you in BIO 141 are:

1. for you to begin to understand some of the fundamental processes of molecular and cellular biology.
2. for you to understand the process of science including experimental design, analysis of experimental data, and communication within the sciences.
3. to allow you to interpret and evaluate critically scientific literature and experimentation.

4. for you to realize the dependence of scientific knowledge on many disciplines and understand the collaborative nature of science.

This course supports the Educational Priorities and Outcomes of Cornell College with emphases on knowledge, inquiry, reasoning, and communication.

These goals will be achieved through discussions that examine the content of cellular and molecular biology, exams that evaluate your comprehension of this content, and a research project that you design, conduct and evaluate, culminating in an abstract.

COURSE INFORMATION:

Meeting Times: 9:00-11:00 am and 12:30-3, Monday through Friday, or as indicated on the course schedule.

TEXTBOOKS AND MATERIALS: NONE! Wow, I just saved you a fortune! There are wonderful, and accurate, internet sites for this material. (My apologies to the publishers who have excellent textbooks that cover this material. I love printed material including texts, but no single text covers precisely the content of this course; most cover too much and in too much depth.) I do, however, have specific sites listed on the schedule that I want you to review and study. Review these sites PRIOR to class for that particular day. Remember that you will be quizzed on the material PRIOR to discussion of it. I will use images and information from these sites during discussions. I will also use images from textbooks in biology. The PowerPoint presentations I use will be available on Moodle the morning before the lecture. Access to these PowerPoint presentations requires that you use them wisely! They are convenient study guides but unless you take notes during discussions, these presentations will do you no good on exams.

GRADING:

NOTE: You cannot withdraw from this course on the 15th day unless you complete all the requirements for quizzes, presentations and exams on the assigned day. You will make an F in this course if you fail to turn in all assignments (and make a reasonable effort on all graded materials).

QUIZZES (20% OF GRADE): MAKE SURE YOU HAVE A BLACK **AND** A BLUE PEN

Standing in front of you and lecturing every day for 3.5 weeks would be an onerous task for me, let alone a boring one for you! So, I have chosen to place a great deal of responsibility on you that requires your active engagement. You have daily readings or internet sites to examine the evening before we discuss a particular topic the next day. There will be quizzes over these materials prior to the discussion of that day. My goal is to incentivize you to examine these materials carefully and thoroughly. Take notes over the materials; **you may use your notes for the quizzes**. We will use these quizzes to begin our discussions for the day. Quizzes begin at 9AM, and you will have 15-20 minutes (depending on quiz) to take it. If you arrive at 9:10, you still have to take the quiz but will only have 5-10 minutes to complete it. If I were you, I would not be late.

You will assess your own answers after you have completed the quiz. You will share your answer with a team of students. I may or may not agree with your assessment, which means that I will be grading your quiz also. You must take the quiz with a **black ink pen**. You will grade your own quiz with a **blue ink pen**. This ensures I know what was your original answer and what was your correction.

You may skip 3 of the quizzes but you must inform me by 8:30AM via email on the day of the quiz that you choose to skip the quiz that day. If there is no quiz that particular day, your skip still counts as one of

the 3. Choose carefully! If you email me at 8:31, you have to take the quiz. You may not see the questions, then decide not to take the quiz. If you decide to take every quiz and not skip any, I will drop your 3 lowest scores as long as the three lowest scores **are equal to or above 60%**. A grade below 60% will not be dropped and will be used to average your grade on all the quizzes. For example, you made a 60%, a 45%, a 25%, and a 60% on 4 quizzes. None of these will be dropped; all will be averaged together. If, however, you made a 60%, an 80%, a 75%, and a 60%, the two 60% scores will be dropped and the rest averaged together. This encourages you, and rewards you, for always making 60% or higher on quizzes. If you have a score below 60% on a single quiz, this does not apply, and all quizzes are averaged together.

Exams (45% of grade)

Exams last approximately 2 hours but you will have 3 hours from 9AM to 12PM. Exams consist of short answer and essay questions. Read the questions and your answers carefully; you will be graded on your knowledge of the material and your ability to present that knowledge clearly and concisely. Contrary to quizzes, exams are closed book and without notes. Exams will be given on the day scheduled only. I will accommodate a legitimate reason from missing an exam, but I determine whether or not the reason is legitimate. I use the following grading scale on exams:

100-90 A

89-85 A-

84-80 B+

79-75 B

74-70 B-

69-65 C+

64-60 C

59-55 C-

54-50 D+

49-45 D

44-40 D-

Presentation of Journal Article (10% of grade)

See description in course Moodle file.

Laboratory (25% of grade)

Presentation of Experimental design (5%)

[Lab notebook](#) (5%) Follow the format for [Keeping a Lab Notebook](#) found on this website. Your grade will determine by adherence to the instructions.

Abstract and Figures for Experiment (15%)

Learning about a drug is not simply done by reading about it in the Physician's Desk Reference (PDR or Prescriber's Digital Reference or in Drugs.com, or even in "the bible of pharmacology": Goodman & Gilman's, The Pharmacological Basis of Therapeutics. Learning about a drug must be accompanied by studying the actual effect of the drug on living cells. The laboratory in this course is devoted to just that: testing the effect of a drug on either the development of zebrafish embryos or on living cancer cells (breast cancer cell line) or on planaria. Models such as this can allow us to investigate the cellular effects of toxins, either endogenous or exogenous, the mechanisms of actions of drugs and pharmaceuticals, and the ultimate source for all human diseases, the cell.¹

¹ Virchow, Rudolf. Die Cellularpathologie in Ihrer Begründung auf Physiologische und Pathologische Gewebelehre. (Cellular pathology as based upon physiological and pathological histology) Philadelphia: J.B. Lippincott, 1863.

The class will be divided into research teams; each team will be assigned a particular substance and a model which may be zebrafish embryos, human breast cancer cells or planaria. Testing the drug on zebrafish embryos will determine potential developmental toxicity, and exposing breast cancer cells to a drug will ascertain potential cytotoxicity. Using planaria will determine any behavioral effects of the drug. Teams with the same drug, yet a different model, should discuss their results together. Perhaps the drug causes developmental delays but is not cytotoxic. Perhaps the drug causes no problems during development but displays cytotoxicity at the concentrations examined. The drug may cause developmental delays but no behavioral problems. I have no idea what your results will be but that is what makes science exciting!

Week 1:

1. Find out all you can about your substance/drug.

- a. Why study the substance? What is the “BIG PICTURE”; why is the study of this substance relevant?
- b. What is the mechanism of action at the biochemical and cellular level? Notice that this is at the biochemical/cellular level, not the clinical level. For example, do not state that the drug causes an increase in heart rate state instead that the drug binds to beta-1 adrenergic receptors which leads to a signal transduction cascade that increases calcium ions in cardiac myocytes.
- c. What prior research has been done on the substance and what were the results of this research?
- d. What concentration of the substance was used during the study? (Pay attention to studies that also used your particular model.)
- e. How is the substance solubilized or dissolved?
- f. How long should living cells, either embryos or cancer cells or planaria, be exposed to the substance?

2. Use the information above to design your experiment.

- a. What is your hypothesis? What are you testing, and why are you doing this?
- b. What is/are your predictions?
- c. Perhaps the most important: What is your control????
- d. What analysis should be done? For example, embryos can be photographed over a time period to determine effects on development; embryos can also be observed for any behavioral changes such as increase/decrease in swimming behavior. Cultured cells can also be photographed for morphological changes; toxicity due to the substance can be determined by a cell-toxicity assay that will give you the percentage of living vs dead cells.

3. Present your experimental design as a PowerPoint presentation on the first Friday.

Weeks 2 and 3:

- a. Perform your experiment. Most of this can be done during lab time throughout the day; however, you may have to devote time during the evenings or weekends depending on your experiment.
- b. Collect your data.
- c. Analyze your data/results. You will need to schedule time with the Quantitative Reasoning Studio (<http://www.cornellcollege.edu/LIBRARY/ctl/qr/index.shtml>) for assistance with analyzing and interpreting your data. DO NOT WAIT UNTIL THE LAST WEEKEND TO DO THIS! The Studio fills-up appointment slots very quickly the final week of the block. It is not the

responsibility of the Studio to make time for you, but for you to plan on completing your data collection with enough time for an appointment and time for interpreting your results.

Models: Multiple factors will determine which model you will use for your experiment. Planaria are collected from Abby Creek which may be frozen or snowed over. The number of fertilized zebrafish eggs depends on breeding. Sometimes eggs are obtained, sometimes not. We will have access to the breast cancer cells. If we cannot obtain planaria or z-fish eggs, then every team will use cancer cells.

Z-fish development:

1. Notice any developmental anomalies such as enlarged hearts or defects in tail or facial features. This may be difficult to quantify if you observe only one embryo with a defect, but the defect is important and should be discussed.
2. The following are quantitative data that the Studio can assist you with by determining whether or not a result is significant.
3. Keep track of numbers of dead vs living embryos in treated and control groups. Be sure to note the Hour Post-Fertilization (hpf) or Day Post-Fertilization (dpf) when death occurred.
4. Measure the length of the treated embryos and compare this to the length of untreated embryos of the same developmental age.
5. Scale any swimming behavioral changes. Determine your own scale prior to data collection!
6. **DO NOT DISCUSS SEPARATE TRIALS!** If you performed your experiment twice using the same concentrations of your drug, add up the numbers from each experiment. If you examined 20 embryos exposed to some concentration during the first experiment and 23 embryos exposed to the same concentration during a second experiment, you have an $n=43$! Trial is synonymous with experiment but you are conducting ONE experiment; you just did it twice. That is unless you changed something in the second experiment. Then, discuss 2 different experiments, not two different trials.

Breast cancer cells:

1. Notice any morphological changes to the cells. Take photographs of each condition, i.e. control, drug concentration(s), every 24 hours. **YOU MUST INCLUDE THE MAGNIFICATION FOR ALL PHOTOS IN YOUR FIGURE LEGENDS!** Morphological changes could be a change in size of the cells such as enlargement or shrinkage. Cell size can be measured on a photograph; be sure to use metric measurements. Another morphological change might be an increase/decrease in the length of processes extending from the cells. Length can also be measured on photographs. The actual shape of the cell can be noted: are the cells more fusiform or spindly than control? Measurements can be analyzed quantitatively.
2. Determine the number of living vs dead cells (cell viability) in the cultures under control and treatment conditions. You can use a couple of techniques such as an MTT assay or a trypan-blue counting assay. The assay you use depends on how you set-up your cells to begin with. **AND NEVER MENTION "WELLS" IN YOUR PRESENTATION OR IN YOUR ABSTRACT!!!!** A single well containing cells is an $n=1$ (number=1); if you treated 3 wells, then state that your n was 3, or $n=3$. If you repeated your experiment more than once, add up the control groups and treatment groups from each experiment. For example, if you treated 3 wells in the first experiment and 3 wells in the second, then your $n=6$. Avoid the use of the word "trials"!!!! If you had to change your experimental design based on your first experiment, then discuss two different

experiments, not two different trials. Obviously, viability is quantitative and can be analyzed as such.

Planaria:

Planaria will respond to substances in their environment by changing how they move. Some substances might even cause rhythmic movements indicative of seizures in these animals. You can quantify these changes. See comment on “trials” in Z-fish development.

Week 4:

1. Although you are working in a research team, each member of the team will write their own abstract and figures/tables. AND DO NOT PLAGIARIZE YOUR PARTNERS! THIS IS YOUR OWN WORK! The results and analysis may be similar but not exact. Your abstract is due the final Wednesday of the block. Due to the block schedule, your third exam is on the final Monday and team journal article presentation is on the following Tuesday or Wednesday. This is a lot for the final week of the course but doable if you gauge your time appropriately. You can actually write most of your abstract during weeks 2 and 3, leaving only your results and discussion until the final weekend. Read my warnings about how to write your abstract/figures and things NOT to do! See further instructions for writing the abstract and designing the figures/tables on Moodle.
2. Each research team will present a recent, primary research article (less than 10 years old) about the drug/substance used in the experiment. See instructions regarding how to do this on Moodle.

ATTENDANCE:

Attendance is required for all scheduled class times. Call before you miss a morning or afternoon session. Realize that “sleeping-in” or a “defunct alarm clock” is not a valid excuse for missing class. Five percent will be removed from your cumulative total for each unexcused absence. If you are absent 3 or more times without a valid excuse, I will not allow you to withdraw on the 15th day, and the highest grade you can hope for is a C-, regardless of your cumulative total. In addition, class starts at 9am or 12:30pm, not at 9:05am or 12:35pm. Obviously, this means BE ON TIME! I will deduct 5% from your grade for each time you are late to class.

CLASSROOM BEHAVIOR:

Decorum in the Classroom: Please play an active role in this course by asking questions or responding to questions. However, refrain from eating (our classroom is NOT a cafeteria), reading materials not related to the course, and conversing with your fellow classmates during discussions. Coffee, tea, water are allowed. You may bring a small snack during exam periods, but not a full breakfast or lunch!

Leave your iPods, MP3 players, other musical devices, cell phones, pagers, anything with an on/off button in your room or, at least, turned off and out of sight. You will not use them in class or during class time. You will place ALL OF your cell phones on the front desk during exams. Please remember to pick them back up after the exam. You will not have access to it at any time for any reason during an exam.

Personal electronic devices can be very disruptive to you and to your classmates. Using these devices during instructional times is a clear sign of disrespect to both me and to your classmates. Every student has the right to learn in a nondisruptive environment. I want you to take hand-written notes. Using a

laptop does not engage your brain as fully as writing. If you must use a laptop, I may ask to see your notes. You may not record my lectures unless you have an accommodation to do so.

DROP POLICY:

College policy states that you may drop at any time during the first three days of class. If you want or need to drop this course on the 15th day, you must have attended class and completed all assignments/exams due or administered by that day.

ACCOMMODATIONS:

Cornell College makes reasonable accommodations for persons with disabilities. Students should notify the Coordinator of Academic Support and Advising and **their course instructor of any disability related accommodations within the first three days of the term** for which the accommodations are required, due to the fast pace of the block format. For more information on the documentation required to establish the need for accommodations and the process of requesting the accommodations, see <http://www.cornellcollege.edu/academic-support-and-advising/disabilities/index.shtml>.

ACADEMIC HONESTY EXPECTATIONS:

Cornell College expects all members of the Cornell community to act with academic integrity. An important aspect of academic integrity is respecting the work of others. A student is expected to explicitly acknowledge ideas, claims, observations, or data of others, unless generally known. When a piece of work is submitted for credit, a student is asserting that the submission is her or his work unless there is a citation of a specific source. If there is no appropriate acknowledgement of sources, whether intended or not, this may constitute a violation of the College's requirement for honesty in academic work and may be treated as a case of academic dishonesty. The procedures regarding how the College deals with cases of academic dishonesty appear in The Compass, our student handbook, under the heading "*Academic Policies-Honesty in Academic Work.*"