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BCH 482.01: Advanced Biochemistry II

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BCH482 Advanced Biochemistry II

Spring 2022

Contact and basic information:

Instructor: Dr. Stephen Lodmell

Class time/place: MW 10:00-10:50am in Forestry 301

Optional open discussion session: Thursdays 5-6pm room CHCB230

Office: CHCB 202 Office hours: 11-12 MW and by appointment

Phone: 243-6393

email: stephen.lodmell@umontana.edu

Text: Garrett and Grisham Biochemistry, any edition (4th ed. is supplied on Moodle).

Overview:

Advanced Biochemistry II builds on the foundation laid by BCH480 in Fall semester. In the second semester, we will explore enzyme kinetics and mechanisms, then we will learn about all of the major metabolic pathways, i.e. the chains of reactions and processes and the mechanisms by which these reactions occur, that are conserved across the tree of life and study how they integrate in living systems.

Prerequisites:

BCH480 (or equivalent) and a good foundation in organic chemistry are the prerequisites for this course. Students with weak preparation in organic chemistry have a more difficult time with biochemistry than those with a solid background. It is easier to see the logic behind biochemistry if you understand the underlying chemical principles. It is a good idea to review basic organic principles and reactions prior to embarking on the biochemical pathways.

Requirements:

The following components are general requirements for success in this course.

- Attend class. Listening, interacting, and asking questions are important for mastery of the material. In general, topics that are emphasized in class are also merit a greater proportion of the material covered on quizzes and exams.
- Read and study the textbook and supplemental materials. Unless otherwise specified, you are responsible for reading and understanding all of the material in covered chapters.
- You should work assigned problems at the end of each chapter of Garrett & Grisham. These problems will not be collected or graded, but they may resemble questions on upcoming quizzes or exams, so familiarity with them will be advantageous to you.
- Tests and quizzes: There will be a weekly quiz most Fridays, three midterm exams, and a comprehensive final exam. Each exam counts as 20% of your final grade (your lowest of the three midterm scores will be dropped). The average of your quizzes will count as 20% of your final grade. You may drop your two lowest quiz scores and your lowest midterm score (including any missed quizzes or exam), but makeup quizzes or midterm exams will not generally be given except in extraordinary circumstances or with advanced arrangement. The final exam is comprehensive and mandatory and counts as 20% of your final grade.
- Writing assignment: There will be one major writing assignment split into several smaller components that will constitute 20% of your final grade. This paper will be handed in as a series of first drafts (not a *rough* drafts!), and will be returned with comments and suggestions for revisions that should be incorporated in the final draft (See "Review a current research article" section below). This assignment will require reading articles from the recent scientific literature that I have placed online on Moodle. You will make use of online resources such as PubMed to find ancillary relevant materials that you may want to use in your introduction, or to bolster a point you are trying to make. Although

there are many other online resources that are useful to varying degrees, you should use the primary research literature as your principal source of information. To substantiate arguments and points in your written assignments, you must use and cite the primary research articles that are directly relevant to your topic. Details of the writing assignment are below and will be discussed further in class.

Grading:

Your final grade comprises the average of your best quizzes (dropping the lowest (or missed) two), your best two midterms, the final exam, and your paper. The letter grade breakdown is based on 90-80-70-60% system with pluses and minuses for the highest and lowest margins of the score brackets. Note that an "A" grade requires demonstrably *exceptional* quality work.

Graduate credit:

If you are taking this course for graduate credit, you are required to do an extra increment of work. To satisfy this increment you will give an oral presentation to the class about your own research, emphasizing connections to material covered in class. Alternatively, you may present a lecture about a realm of research from the current literature that is relevant to the course content. Please see me to arrange the presentation.

Notes and Moodle:

Class notes and PowerPoint presentations will be posted on the course Moodle site. Remember that these notes are what I use as an outline for class preparation. They are not intended to be used as a substitute for coming to class or for studying the text; both of these activities are required for success in the course.

Accessibility, disabilities, and special accommodations:

The University of Montana assures equal access to instruction through collaboration between students with disabilities, instructors, and the Office for Disability Equity (ODE). If you anticipate or experience barriers based on disability, please contact the ODE at: (406) 243-2243, ode@umontana.edu, or visit www.umt.edu/disability for more information. Retroactive accommodation requests will not be honored, so please, do not delay. As your instructor, I will work with you and the ODE to implement an effective accommodation, and you are welcome to contact me privately if you wish. Any questions please contact me.

Learning outcomes for Advanced Biochemistry II

Upon completion of this course:

1. Through directed readings, students will explore, reflect and write about ethical issues related to biochemical advances that have the potential to alter the ways human patients are treated for certain diseases.
2. Students will be able to describe the molecular details of Translation/protein synthesis including selection of the ribosome binding site on the mRNA, binding and selection of tRNAs, elongation of the peptide chain, and termination of the completed peptide chain. Students will be able to draw comparisons and contrasts between eukaryotic and prokaryotic translation initiation mechanisms.
3. Students should be able to understand and articulate theoretical and practical aspects of enzyme kinetics, inhibition, mechanisms, and regulation. Students should recognize the common features as well as the distinctions between abiotic chemical catalysis and biological reactions.

4. Students should be able to understand and describe the components, general thermodynamics, and mechanisms of the main biological molecular motors, i.e. dyneins/kinesins, actin/myosins, FOF1ATP synthase, and bacterial flagellar motors.
5. Students should be able to understand and articulate general features of nutrient cycling in the biosphere and relate these to cellular anabolic and catabolic pathways.
6. Students should be able to understand the roles of different dietary fuel types, and be able to demonstrate the chemical roles of coenzymes and vitamins for common metabolic reactions.
7. Students should be able to diagram major metabolic pathways and have knowledge of key structures, chemistry, and regulation of the reactions in these pathways. These pathways include glycolysis, gluconeogenesis, the pentose phosphate pathway, glycogen metabolism, lipid metabolism, and selected examples of amino acid metabolism.
8. Students should have a global understanding of the regulation of metabolism at the organism level, including how hormones affect nutrient utilization in health and disease.
9. Students should have an understanding of major cellular signal transduction pathways in cells.
10. Students will gain experience in reading and reviewing the primary biochemical literature and will learn to improve their scientific expository writing skills. Special emphasis will be placed on understanding molecular mechanisms of action of uncoupler proteins. As an upper division writing course, the student will be expected on his/her writing assignments to:
 - Identify and pursue sophisticated questions for academic inquiry
 - Find, evaluate, analyze, and synthesize information effectively from diverse sources
 - Manage multiple perspectives, as appropriate
 - Recognize the purposes and needs of discipline-specific audiences and adopt the academic voice necessary for the chosen discipline
 - Use multiple drafts, revision, and editing in conducting inquiry and preparing written work
 - Follow the conventions of citation, documentation, and formal presentation appropriate to that discipline
 - Develop competence in information technology and digital literacy

General University Policies

University policies on drops, adds, changes of grade option, or change to audit status will be strictly enforced in this course. These policies are described in the current UM catalog. Briefly:

Dropping Classes

Through the 15th instructional day, **ALL** classes are dropped in CyberBear.

From the 16th through the 45th instructional day, all classes must be dropped using Drop forms (instructor signature required, advisor signature required for undergraduates). **\$10 fee applies.**

From the 46th to the last instructional day prior to finals week, classes must be dropped using the Drop form (instructor and Dean signatures required, advisor signature required for undergraduates). **\$10 fee applies.**

Changing Grade Option

Through the 15th instructional day, all grade options are changed in CyberBear.

Changes to/from Audit **MUST** be completed by the 15th instructional day.

From the 16th instructional day to the last instructional day prior to finals week, all grade options must be changed using an Add/change form (instructor signature required, advisor signature required for undergraduates).

Variable Credit Change

Through the 15th instructional day, variable credits are changed in CyberBear.

From the 16th instructional day to the last instructional day prior to finals week, variable credits must be changed using an Add/change form (instructor signature required, advisor signature required for undergraduates).

Section Changes (changing section for SAME class only)

Through the 7th instructional day, section changes can be added one of three ways:

1. Directly in CyberBear
2. Registration override forms (instructor signature required)
3. Electronic overrides

From the 8th instructional day to the last instructional day prior to finals week, all section changes must be added using an Add/change form (instructor signature required, advisor signature required for undergraduates). **\$10 fee applies.**

Academic honesty

In working through homework and writing assignments, students are encouraged to work together to solve problems, to share information or resources, and to test each other's understanding of the material. Those are all acceptable forms of collaboration. However, the written work that each student turns in must be his or her own. Only in this way can faculty judge individual understanding of concepts or information. A good rule of thumb for students to follow is to work together up to the point of committing words to paper. At that stage, each student must work independently. A second key guideline is that once a student has written an out-of-class assignment, it must not be shown to another student in the course. Assignments from two or more students that have significant overlap, in the professional judgment of the faculty member, will be regarded as reflecting a violation of the expectation that students turn in independent assignments. Please note that direct copying of sentences from any published without proper citation is considered plagiarism. **THIS INCLUDES THE INTERNET.** Be sure to put the information in your own words and be aware that the instructor will check literary and Internet resources. Violations will be dealt with according to the Student Conduct Code.

Instructions for the major writing assignment:

Review a current research article:

First, **choose one** of the several recent primary research articles pertaining to mammalian thermogenesis and/or the control of lipid metabolism (for the eventual goal of treating obesity and metabolic disorders) **that have been uploaded onto the course Moodle site**. You will write a short paper summarizing this article. The final version will be maximum ~7 pages, 1.5 line spaced, plus one page summary of your revision efforts. If you use sources other than the research article to write your paper, you should also include a bibliography page, which does not count toward your page total. You will hand in individual components (introduction section, results section, and interpretation/ conclusions/ discussion section; see below) of the paper at defined times during the semester for feedback and grading. An important grading criterion will be how well you targeted your anticipated audience. **Your audience is your peer group**, i.e. a group that is generally knowledgeable about biology/biochemistry/chemistry, but who is unfamiliar with the specifics of the area covered by your research article. This means you can assume familiarity with basic techniques (e.g., electrophoresis and gene cloning/expression, western blotting, etc.), and that the paper should stand alone and be readable and understandable by someone who has not read this article or related literature.

Your review of the article must be biochemically-oriented. This means that *it must address structure and function of biomolecules*, not just overall effects in cell culture or in an animal model. Note that to write this paper in the time frame stipulated in the syllabus, you will have to do some independent learning of subject matter using the textbook and other sources before we get to it in class. It's a good idea to get an early start on this! There is further guidance on this assignment below. Engagement with UM's Writing and Public Speaking Center to give you help with your writing and organization is strongly encouraged. Documented interaction with the WPSC will earn you up to 5% extra credit.

Your paper will be graded and comments and suggestions provided based on scientific content as well as appropriate English usage, style, organization and appropriate targeting to your audience. You will use the comments provided on the individual components to revise your paper and hand it in for a second assessment. 75% of the grade will come from the first draft, and 25% is based on the final revised version and your summary of revisions.

Tips and specific instructions for writing your review of a research article:

Most important, consider (and be considerate of) your audience/ reader. Who are they? What background are they likely to have? Think about what terms would need to be defined so that the reader has the tools (background and terminology) to understand what you are saying. Remember, you are writing for a scientifically literate reader, but not for someone who is an expert in the field or who has read the article you are talking about. Make the whole topic understandable to your audience.

- Assignment 1: Introduction. Introduce the subject (1- 1.5 pages). Frame the research in ‘big picture’ terms: Why is the subject important and interesting to study? What knowledge gaps remain? State broadly what approaches the authors used to address some aspect of the problem at hand. Look ahead at the more technical material you will have to present in your paper for the results and conclusions sections and anticipate what kind of background information and context your reader will need. You have a limited amount of space here, so use it wisely! If you use sources (review articles, textbooks, other research articles, online sources, etc., to help you write your paper, please cite these sources and include a separate bibliography page at the end, which does not count toward your page limit.

- Assignment 2: Go through the experimental data in the paper and make a critical assessment about which of the experiments (usually figures and tables) from the paper are the most crucial for the authors to be able to draw their most important conclusions in the paper. This will be a judgment call on your part since the size constraint of the paper will not allow you to go into great depth on *all* of the figures. Describe each of these experiments / data in detail. What was each experiment designed to show? How was it done, i.e. what techniques were used (uncommon experimental techniques require more description)? What was the outcome, and how did the data obtained shed light on the overall problem? For each assertion you make, make sure to support it with examples, data, or analogies. Do not leave points that you are trying to make unsubstantiated. A major objective of this assignment is to demonstrate the relationship between actual experimentation and overall conclusions and concepts. Heavy emphasis is placed on your description of the experiments at a level that allows your audience to understand them without having read the article. The data taken from the experiments are subsequently pooled together to make overall conclusions in the next section. Use 2-2.5 pages for the experimental/Results section.

- Assignment 3: Discussion/Conclusions (about 1- 1.5 pages). What did the experimental results tell us about the research problem at hand? What is the significance of these new results? You may also want to discuss whether the authors’ conclusions match your own in light of the experimental results presented. Remember that interpretation of experimental results can be subjective. If the authors’ interpretations of the data are different than your own, this is a good place to talk about it.

- Proofread your paper carefully! This serves two purposes:
 - You will locate and correct typographical errors and awkward sentence constructions.
 - As you are reading, you should ask yourself: "If I read this paper for the first time, without any additional outside reading, would I be able to understand it? Would I be convinced of points being made in the paper?" If there are places where this is unclear, you should rewrite to clarify and support as necessary.

Each of these assignments will be collected, graded, and returned to you with comments. When you turn in your final paper, it will consist of the revised Introduction, Results, and Discussion/Conclusion sections PLUS one summary/reflection page that describes the changes you made in response to comments by me (and by the Writing and Public Speaking Center, if used), as well as the changes you made to the overall assembled document once you have had a chance to re-read it, reflect on it, and get feedback from peers or the Writing and Public Speaking Center. The total length of the final draft must be 7 pages of your paper, plus no more than one page of your own comments on how you have revised the paper.

○ ***You are encouraged to avail yourself to the services of the UM Writing and Public Speaking Center! Given enough time, they can go through your paper help you with your writing in general. Since one of the purposes of this assignment is to practice and improve your writing, the more critical feedback you get, the better. Extra credit will be allocated to students who show evidence that their paper was reviewed by the Writing Center. Note that the Writing and Public Speaking Center has limited staff and resources, so you will need to plan ahead to get an appointment with them. You cannot expect that they will be available to help you in the day or two before this assignment is due, so plan ahead!***

Tentative class topics schedule:

- Jan 19- Jan 21 Intro, *organic chemistry basics, Enzyme specificity and kinetics (Ch 13)*
- **Due (upload online) Jan 25 (Tuesday)- Reading & reflection assignment due: CRISPR/ ethics**
- Jan 24- Jan 28 *Enzyme specificity and kinetics (Ch 13) and Enzyme mechanism (Ch 14)*
- Jan 31- Feb 4 *Enzyme mechanism (Ch 14) and Enzyme regulation (Ch 15)*
- Feb 7- Feb 11 *Enzyme regulation (Ch 15) and Molecular Motors (Ch 16)*
- Feb 14- Feb 18 *Overview of metabolism (Ch 17)*
- **Feb 16 (Wednesday)- First midterm exam during class time**
- Feb 21 No class: Presidents Day
- Feb 23- Feb 25 *Glycolysis (Ch 18)*
- **Due Feb 28 (Monday)- First part of writing assignment "Introduction" due- upload on Moodle**
- Feb 28- Mar 4 *Gluconeogenesis, glycogen metabolism, PPP (Ch 22)*
- Mar 7- Mar 11 *Tricarboxylic Acid cycle (Ch 19)*
- **March 11 (Friday)- Second writing assignment "Results" due- upload on Moodle**
- Mar 14- Mar 18 *Electron Transport (Ch 20)*
- **March 16 (Wednesday)- Second midterm exam during class time**
- Mar 21- Mar 25 **Spring Break- no classes!**
- Mar 28 – Apr 1 *Electron Transport and Photosynthesis (Ch 20-21)*
- **April 4 (Monday)- Third writing assignment due: Conclusions/Discussion section- upload to Moodle**
- Apr 4- Apr 8 *Fatty Acid catabolism (Ch 23)*
- Apr 11 – Apr 15 *Lipid biosynthesis (Ch 24)*
- Apr 18 – Apr 22 *Nitrogen and amino acid metabolism (Ch 25)*
- **Apr 20 (Wednesday) – Third midterm exam during class time**
 - **Apr 25 (Monday)- Final draft of paper due: 7 pages + 1 page revision summary (& biblio.)-Moodle**
- Apr 25-29 *Signal transduction (Ch 32)*
- May 2-6 TBA and course review
- Thurs May 12: BCH482 *Final exam (comprehensive) 10am-12noon F301*