Syllabus: General Biochemistry BB450/550 Winter 2016

Professor: Phil McFadden, office 2151 ALS. Office hours MWF 10 - 10:45 (any changes of office hours will be announced on Canvas). Email: mcfaddep@onid.orst.edu

Teaching Assistants: James Miyasaki, Shauna Otto, Lillian Padgitt-Cobb (the office hours of our TA's and their contact information will be provided at the first recitation meeting)

Course Prerequisites: Two terms of organic chemistry (CH 331 and CH 332 or CH 334, CH 335, and CH 336).

COURSE SCHEDULE and GRADING

Lectures will be held MWF at 9 am in Gilbert Hall 224. All exams, including the final exam, will be given in Gilbert Hall 224.

Weekly recitations conducted by our TA's will provide help in understanding language, concepts and relevant problem solving.

The course will be presented in three successive learning units as follows:

Unit 1: Proteins

Nine lectures plus recitations. *Main topics*: Protein and macromolecular behavior in aqueous systems. Relationship between pH and protein electrical charge. Amino acids and the peptide bond. Hierarchy of protein structure and folding. Experimental characterization of protein molecules. The 3D structures of myoglobin and hemoglobin.

Textbook chapters: 1, 2, 3 and 7.

Exam 1: **Friday, January 29 at 9 am in Gilbert Hall**. Will test your comprehension of vocabulary, concepts and problems in Unit 1.

Unit 2: Enzymes

Nine lectures plus recitations. *Main topics*: Quantitative models of oxygen binding to myoglobin and hemoglobin. Substrates, products and active sites of enzymes. Thermodynamics of enzyme reactions. Enzyme kinetics and inhibition. Example mechanisms of enzyme catalysis. Allosteric enzyme regulation. Enzyme regulation by covalent modification. Enzyme-mediated signal cascades.

Textbook chapters: 7, 8, 9, and 10.

Exam 2: **Friday, February 26 at 9am in Gilbert Hall**. Will test your comprehension of vocabulary, concepts and problems in Unit 2. Assumes background knowledge going back to the first day of class.

Unit 3: Metabolic pathways

Nine lectures plus recitations. *Main topics*: Carbohydrate fuel metabolism, including glycolysis, gluconeogenesis, and our glycogen fuel reserve. Simple- and complex-carbohydrate structure (assumes background knowledge from prerequisite courses in organic chemistry). Energetics of oxidative pathways. Energy capture by ATP and electron carriers. Reciprocal strategies of catabolism and anabolism. Signal cascades in carbohydrate metabolism.

Textbook chapters: 11, 15, 16, 21, and selected topics from 14.

Exam 3: **Thursday, March 17 at 2pm in Gilbert Hall**. Will test your comprehension of vocabulary, concepts and problems in Unit 3. Assumes background knowledge going back to the first day of class.

Final letter grades: Each of the three exams is worth 100 points. There are 300 points possible in the course. The final grade for BB450 students will be determined solely according to performance on those three exams. Exams will be offered only on the announced dates. Excused absences are stringently limited to university rules for documented doctor-confirmed illnesses, dire family-related issues, and a limited set of other university-approved situations.

BB 550 students will have additional requirements as explained to them individually; BB550 students are required to contact the course instructor prior to the first exam.

LEARNING RESOURCES

Textbook: *Biochemistry Seventhe (2012)* or *Eighth Edition (2015)* by Berg, Tymoczko, Gatto and Stryer.

Chapter number and title	Stryer (7th edition) pages	Pages (Stryer 8th edition)
1. The Molecular Design of Life	1-24	1-25
2. Protein Composition and Structure	25-64	27-64
3. Exploring Proteins and Proteomes	65-108	65-104
7. Hemoglobin	195-218	191-214
8. Enzymes	219-252	215-250
9. Catalytic Strategies	253-288	251-284
10. Regulatory Strategies	289-317	285-313
11. Carbohydrates	319-344	315-340
14. Signal-Transduction Pathways	401-426	397-422
15. Metabolism	427-451	423-448
16. Glycolysis & Gluconeogenesis	453-496	449-493
21. Glycogen Metabolism	615-638	617-642

I will post on Canvas a detailed table of contents with yellow highlights to steer you toward the precise sections of the book I am planning to emphasize. The Valley Library will have two copies of the above textbook on reserve. If you have a copy of an older edition of the textbook you will find that many of the readings are similar but possibly out-of-date. Many of the chapter problems have also changed as the textbook has gone through succeeding editions.

Lecture notes: I will post my lecture notes on Canvas. These notes will undoubtedly not include

every detail of what I say, so I strongly suggest taking your own supplementary notes.

Problem solving: I will post on Canvas a selection of practice problems and solutions.

Exams from previous years: These will be posted as guides to the style and format of the exams. Occasionally the basic form of a classic exam question is repeated from one year to the next, but even so, the details of the questions will be completely new this year.

EXPECTATIONS

What am I looking for from you?

I expect you to diligently study *vocabulary*, *concepts* and *problem-solving techniques* related to the science of biochemistry. I expect you to be able to demonstrate your learning on three written exams. A complex topic like biochemistry requires considerable work prior to coming to class or recitation, a determined effort to listen actively in class, and sufficient time and effort to put all the strands together to master the material.

What can you expect to learn?

- By the end of *Course Unit 1* you can expect to have studied all the amino acid structures and how they are chemically linked together in proteins. You should be able to recognize the main primary, secondary, tertiary and quaternary structural elements in any protein molecule displayed in standard formats such as those in the biochemical literature and in publicly accessible internet sources such as the protein data bank. You should also have gained an understanding of how the functional chemical groups of protein molecules affect their folding in the watery conditions of living cells. As a case in point for quantitatively relating structure and function, you will learn how to use the Henderson Hasselbalch equation to predict protein charge and functional properties as the pH of the solution is varied. Finally, you can expect to gain an appreciation of the machine-precision of protein function by studying *hemoglobin* as a well-described example of how an important protein function -- oxygen binding -- is dramatically tuned by subtle structural changes, including minor amino acid substitutions, subunit-subunit cooperativity, and the binding of small molecules such as carbon dioxide.
- From *Course Unit 2* you can expect to practice how to quantitatively portray any enzyme reaction as a chemical interconversion between substrates and products, with modulation by activators and inhibitors. You will learn how constant terms (including Km and Vmax) convey useful *qualitative* rules-of-thumb that you can use to compare the catalytic power of enzymes. You will also learn how to use Km and Vmax in a steady state kinetic model (the Michaelis Menten equation) to *quantitatively* predict how the speed of an enzyme reaction varies with the concentrations of substrates, products and inhibitors. By studying the mechanisms of a few well-understood enzymes, you will gain an understanding of how the chemical features of an enzyme active site govern the making and breaking of bonds as substrate is turned to product. By studying some additional examples of enzymes whose reaction is turned on and off according to physiological needs, you will learn about allosteric regulation and regulation by post-translational covalent modification. Finally, you will learn how proteins pass information to each other in signal transduction cascades, and you can expect to be able to trace the flow of several such cascades along segments that are currently well understood.

- *Course Unit 3* builds from the above concepts toward your understanding of how enzymes are functionally tied together into regulated metabolic pathways. Specifically, you will study how sugar molecules are metabolized by the two centrally important pathways, glycolysis and gluconeogenesis. You can expect to learn how the ten enzymatic reactions of glycolysis work in concert in the cytoplasm of all organisms for the purpose of capturing chemical energy from food sugar. From there you will study how various organisms and cells employ glycolysis to serve their varied needs. Finally, by learning to appreciate the important distinction between catabolic and anabolic pathways, you can expect to be able to logically predict when (and why) various tissues such as liver and muscle turn-on and turn-off their specialized pathways of sugar metabolism (including glycolysis, gluconeogenesis, glycogen breakdown, and glycogen synthesis).

UNIVERSITY POLICIES

The goal of Oregon State University is to provide students with the knowledge, skill and wisdom they need to contribute to society. Our rules are formulated to guarantee each student's freedom to learn and to protect the fundamental rights of others. People must treat each other with dignity and respect in order for scholarship to thrive. Behaviors that are disruptive to teaching and learning will not be tolerated, and will be referred to the Student Conduct Program for disciplinary action. Behaviors that create a hostile, offensive or intimidating environment based on gender, race, ethnicity, color, religion, age, disability, marital status or sexual orientation will be referred to the Affirmative Action Office.

The Department of Biochemistry/Biophysics strictly follows the above university policy on student conduct. Behaviors disruptive to the learning environment will not be tolerated and will be referred to the Office of Student Conduct for disciplinary action. **Use of cell phones and excessive talking between neighbors is prohibited in the classroom.**

Cheating or plagiarism by students is subject to the disciplinary process outlined in the Student Conduct Regulations (see http://oregonstate.edu/admin/stucon/regs.htm). Students are expected to be honest and ethical in their academic work. Academic dishonesty is defined as an intentional act of deception in one of the following areas:

- cheating- use or attempted use of unauthorized materials, information or study aids
- fabrication- falsification or invention of any information
- assisting- helping another commit an act of academic dishonesty
- tampering- altering or interfering with evaluation instruments and documents
- plagiarism- representing the words or ideas of another person as one's own

Finally, please note: "Students with documented disabilities who may need accommodations, who have any emergency medical information the instructor should know, or who need special arrangements in the event of evacuation, should make an appointment with the instructor as early as possible, no later that the first week of the term. In order to arrange alternative testing, the student should make the request at least one week in advance of the test. Students seeking accommodations must be registered with the Office of Services for Students with Disabilities."