

**Biol 443**  
**THE BIOLOGY AND BIOCHEMISTRY OF PROTEINS**  
The Department of Biological Sciences  
University of Mary Washington

Spring Semester, 2007

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### **I. COURSE INSTRUCTOR & OFFICE HOURS**

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Office Hours:  
MTWF 9:00 - 10:30 AM  
All other times by appointment

### **II. MEETING TIMES**

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Lecture: MWF, 2:00 - 2:50 PM, 209 DuPont

### **III. COURSE DESCRIPTION**

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Proteins are unique among all classes of biological macromolecules in their ability to perform a wide variety of specialized actions. Thus, proteins are those amazing molecular machines that perform the specialized functions of living systems. This new course is focused on the study of proteins as machines! It is a relatively advanced study of the cellular biology & structural biochemistry of proteins. We set the ground work for understanding how these machines work by examining the principles of protein structure. From there, we go into the cell, where we examine the cellular biology of protein folding, sorting and routing, and degradation. This all builds t an examination of the amazing molecular motions underlying the operation of many of the most important molecular machines of the cell, including protein kinases, dehydrogenases, photosynthetic reactions centers, ion channels, DNA synthesizers, molecular motors, signal transduction receptors, electrochemical transducers, and many more.

### **IV. COURSE PREREQUISITES**

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Prerequisites: Biology 211 (Cell Biology) & Chem 211 (Organic Chemistry I) - or -  
(Chem 317 (Biochemistry I)).

### **V. REQUIRED TEXT**

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Branden C. and Tooze J. Introduction to Protein Structure. 2<sup>nd</sup> edition. Garland Science Publishing.

Required reading assignments from the text will be given frequently to supplement lecture. These required readings should be treated as lecture material and be studied as thoroughly as the lecture notes. Otherwise, while it is not required, it is suggested that students read alone as the chapters in the book are covered in lecture.

## VI. BLACKBOARD

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This course utilizes UMW's Blackboard Web portal for the dissemination of course materials. The course will be listed on the Blackboard page of all enrolled students. To get to the login page for the College's Blackboard site, go to <http://blackboard.umw.edu>.

All lectures are presented in Powerpoint. The Powerpoint presentation for each lecture will be posted in Adobe's Portable Document Format (PDF) on the Blackboard site well in advance of each lecture, and it is highly recommended that you print out each lecture's handout before the day of lecture so you are not tied-up in printing traffic right before class. To access the lecture slides and handouts, you will need Adobe Reader installed on your computer. If you do not have Adobe Reader installed, you can get a free download using the link on the course Blackboard page. If you live off campus and access blackboard via dial-up access, you might find download speeds for some of the lecture handouts to be slow, and you might find it necessary to print materials on-campus.

The course's blackboard site will NOT be used to announce ALL course announcements. While some course announcements may be posted on-line, others may not. The only reliable source for course announcements is lecture. **You are responsible for all course announcements and course materials distributed in lecture whether you are in attendance or not.**

## VII. GRADING

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Your final grade in the course will be based on grades earned in examinations and assignments. Fifty (50) % of your final grade will be based on your average examination grade , and 50% will be based on assignment grades.

The following grading scale and grade definitions will be applied to the final grade:

93 - 100 %	A	unusual excellence
90 - 92 %	A-	
87 - 89 %	B+	
83 - 86 %	B	work distinctly above average
80 - 82 %	B-	
77 - 79 %	C+	
70 - 76 %	C	work of average or medium quality
65 - 69 %	D+	
55 - 64 %	D	the lowest passing mark, work of below average quality
<55 %	F	failure (result: no course credit)

The instructor reserves the right to curve the grading scale downwards.

## **VIII. EXAMINATIONS**

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There will be three mid-semester exams. All will be take-home exams. The first mid-semester exam will cover part 1 of the course, the second mid-semester exam will cover part 2 of the course, and the third will cover part 3 of the course. Examination grades will constitute 50% of each student's final grade.

## **IX. ON-LINE ASSIGNMENTS**

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This course is designed with significant attention paid to student activities and projects. Each student will engage in 5 - 6 out-of-class projects designed to provide students with some experience using on-line protein databases and resources. Students will be expected to complete 5 - 6 web-based assignments. The last project will require students to produce a comprehensive bioinformatics profile of a particular protein of their choice. The average grade on these four activities will make up 50% of the final grade.

## **X. HONOR SYSTEM**

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The MWC honor system is in effect at all times.

## **XI. COURSE CONTENT**

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The course will be divided into three basic parts: Part 1, The Structure of Proteins; Part 2, The Cellular Biology of Proteins, and Part 3, Proteins as Machines: The Molecular Operation of Specific Proteins.

### Part 1: The Structure of Proteins

The first approximately one-third of the course will consist of **Monday, Wednesday and Friday lectures** on the structural biochemistry of proteins, including the following topics:

- Biochemistry of Amino Acids
- The Primary Structure of Peptides and Proteins
- Secondary Structural Elements of Proteins
- Protein Structural Motifs
- Protein Structural Domains

### Part 2. The Cellular Biology of Proteins

During the approximately middle-third of the course, every **Monday and Wednesday** will be spent discussing the following topics.

- Protein Folding
- Predicting Protein Structure from Sequence Analysis
- Principles of Chaperonin-Dependent Protein Folding
- Principles of Protein Sorting and Routing in the Cell
- Protein Glycosylation
- Targeted Protein Degradation
- Regulation of Protein Activity

**Fridays** during this time frame will be spent examining on-line resources in protein science. We will look at many of the most-popular on-line databases and engage in a few web-based activities that will demonstrate how to use these databases in preparation for the final project.

### Part 3. Proteins as Machines: The Molecular Operation of Representative Proteins

The final approximately one-third of the course will consist of **Monday, Wednesday and Friday lectures** examining the structure and molecular operation of several specific proteins in an attempt to understand how these amazing machines work. The lectures will also serve as a model for the type of information students need to include in their final project. During this time, each student will work on their final project, using many of the on-line resources examined in part 2 of the course.

A short list of possible proteins to be studied can be found on the next page.

*Enzymes*

The Photosynthetic Reaction Center

Dehydrogenases

Kinases

P-type ATPases (Na-K ATPase)

*DNA-Binding Proteins*

DNA Polymerase

Transcription Factors

*Channel Proteins*

Water Channel Proteins (Aquaporins)

Voltage-Gated Ion Channels

F-type ATPases

*Receptor Proteins*

G-proteins

Tyrosine Kinase

Adhesion

*Molecular Chaperones*

HSP 60 & HSP 70 Family

*Motor Proteins*

Myosin

Dynein

Kinesin

*Fibrous / Structural Proteins*

Actin

Tubulin

## TENTATIVE LECTURE SCHEDULE

### Part I: The Structure of Proteins

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- Jan 15 Introduction to Proteins  
17 Biochemistry of the Amino Acids  
19 Biochemistry of the Amino Acids  
22 The Peptide Bond  
24 Secondary Structures: The Alpha Helix  
26 On-line Posts  
29 Secondary Structures: The Beta Strand and the Beta Turn  
31 Tertiary Substructures: Simple Motifs I
- Feb 02 Tertiary Substructures: Simple Motifs II  
05 Tertiary Substructures: alpha domains  
07 Tertiary Substructures: beta domains I  
09 Tertiary Substructures: beta domains II  
12 Tertiary Substructures: alpha-beta domains I  
14 Tertiary Substructures: alpha-beta domains II  
16 Review;  
19 Handout Exam 1

### Part II: the Cellular Biology of Protein Folding

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- 21 Methods Used to Determine Protein Structure  
23 Protein Folding Theory  
26 Protein Folding Theory  
28 Online Databases, I
- Mar 02 Protein Folding in the Cell  
12 Protein Folding in the Cell  
14 Protein Folding in the Cell  
16 Online Databases, II  
19 Protein Folding in the Cell  
21 Protein Folding in the Cell  
23 Online Databases, III  
26 Protein Folding in the Cell  
28 Protein Folding in the Cell  
30 Online Databases, IV; Handout Exam II

### Part III: Proteins as Machines

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- Apr 02 Serine Proteases
- 04 Serine Proteases
- 06 Ca<sup>++</sup> binding Proteins
- 09 Ca<sup>++</sup> binding Proteins, Troponin
- 11 Actin
- 13 Tropomyosin
- 16 Myosin
- 18 DNA-binding Proteins
- 20 DNA binding Proteins
- 23 Photosynthetic Reaction Center
- 25 Photosynthetic Reaction Center
- 27 ATPases