CHEM 455 Enzymology

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Catalog Course Description
This course has been designed to teach the student majoring in science all the major aspects of the study of enzymes. The course focuses on the theories of enzyme kinetics, the mechanisms of enzyme catalysis, and the mechanisms of enzyme regulation in the cell.

Expanded Course Description
Chemical reactions within the cell rarely occur without the presence of a catalyst, known as an enzyme. The focus of this course is enzyme kinetics, the mechanisms of enzyme catalysis, and enzymatic regulation. The course starts with a review of the basic enzymatic concepts. Then, it moves to enzyme kinetics of single substrate reactions, enzyme inhibition and multi-substrate enzyme systems. The course continues with mechanisms of enzyme catalysis, active site studies, and the description of specific well-characterized enzymes. Because many enzymes play key regulatory roles in metabolism, the course concludes with mechanisms of enzyme regulation.

Prerequisite
CHEM 341 or CHEM 351 with a minimum grade of C (2.0) or consent of instructor.

Required Text
No single textbook is sufficient for the material but the best overall reference text is:
"Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding", 2nd ed. (1999), Alan Fersht, W.H. Freeman & Co. New York, NY. A copy of this text will be placed on reserve for reference purposes. Also, the following related texts will be placed on reserve as resources and to provide background information on the various topics discussed in the course: "Fundamentals of Enzymology", 2nd ed. (1995), Nicolas Price & Lewis Stevens, Oxford Univ. Press, New York, NY. "Understanding Enzymes", 2nd ed. (1985) Trevor Palmer, J. Wiley & Sons, N.Y. A copy of the lecture notes, including illustrations, will be made available to you for each lecture topic.

Student Learning Outcomes
The major learning objective of the course is to understand the theories of enzyme kinetics, the mechanisms of enzyme catalysis, and the mechanisms of enzyme regulation in the cell. At the conclusion of the course students should be able to:

- Describe and use the equations of enzyme kinetics.
- Describe the methods used in enzyme kinetics.
- Describe the principles of enzyme inhibition.
- Describe the mechanisms of enzyme catalysis.
- Describe the catalytic mechanisms employed by the most well-characterized

enzymes.

- Describe the mechanisms of enzyme regulation

Course Requirements
There will be four partial exams, a comprehensive final exam and a written report.

Grading Criteria
Your grade will be based on points accumulated on the various course requirements as described below. The final exam will not be returned. However, upon request, students will be allowed to review it.

	Points	%	Date
Exam # 1	35 points	17.5 %	TBA
Exam # 2	35 "	17.5 %	TBA
Exam # 3	35 "	17.5 %	TBA
Exam # 4	35 "	17.5 %	TBA
Report	10 "	5 %	
Final Exam	50 points	25 %	TBA
Total	200 points	100 %	

The course grades will be assigned according to the following scheme:

Percentage	**Grade**	**Percentage**	**Grade**
90 or more	A	70.0-72.4	C-
87.5-89.9	B+	67.5-69.9	D+
82.5-87.4	B	62.5-67.4	D
80.0-82.4	B -	60.0-62.4	D-
77.5-79.9	C+	59.9 or less	F
72.5-77.4	C		

Policy on Late Work and/or Missed Exams
Students who miss any exam will be given 24 hours to contact me otherwise they will be assigned a grade of zero on that exam. Make-up tests will only be given if the student has a valid excuse (severe illness, death in the family, etc.). No late reports will be accepted after the deadline. No exceptions will be made.

Writing Requirement
The university writing requirement will be satisfied in the course with the submission of a double-spaced four pages report. This will consist of a brief summary, but more importantly a critique of a peer-review article on an enzymatic topic that will be assigned by the instructor. The report will be graded based on readability (i.e. clarity, organization & grammar) and content. The deadline for its submission is TBA.

Academic Honesty Policy
As required by the Student Academic Honesty Policy students will be expected to adhere to standards of academic honesty and integrity, as outlined in the Student Academic Honesty Policy. All written work and oral presentation assignments must be original work. All ideas/material that

are borrowed from other sources must have appropriate references to the original sources. Any quoted material should give credit to the source and be punctuated with quotation marks. Students are responsible for honest completion of their work including examinations. There will be no tolerance for infractions. If you believe there has been an infraction by someone in the class, please bring it to the instructor's attention. The instructor reserves the right to discipline any student for academic dishonesty, in accordance with the general rules and regulations of the university. Disciplinary action may include the lowering of grades and/or the assignment of a failing grade for an exam, assignment, or the class as a whole. Incidents of Academic Dishonesty will be reported to the Dean of Students. Sanctions at the University level may include suspension or expulsion from the University

Disabled Students Policy
Students with disabilities who require reasonable accommodations must be approved for services by providing appropriate and recent documentation to the Office of Disabled Student Services (DSS). This office is located in Craven Hall 4200, and can be contacted by phone at (760) 750-4940. Students authorized by DSS to receive reasonable accommodations should meet with me during my office hours in order to ensure confidentiality.

Course Subject Outline

I. ENZYMES AS CATALYSTS (Fersht, Ch. 2; Price, Ch. 1 & 2 & Palmer, Ch. 1 & 16)
A. Overview--proteins as catalysts
B. Enzyme characteristics and properties
C. Enzyme nomenclature/classification
D. Enzyme Purification and Assay
(1) activity measurements
(2) enzyme units
(3) turnover number and properties
(4) purification and purity
(5) initial velocity measurements
(6) assay conditions
(7) methods for measurement
(8) choice of assay method
(9) practical considerations

II. ENZYME KINETICS (Fersht, Ch. 2-4, 6; Price, Ch. 4 & Palmer, Ch. 6-8)
A. Kinetics of single substrate reactions
(1) kinetic concepts
(2) enzyme kinetics
(a) Briggs-Haldane steady-state treatment
(b) Michaelis constant (K_m)
(c) specificity constant
(3) single enzyme kinetics
(4) graphical analysis
B. Enzyme inhibition

(1) Classification
(a) competitive
(b) noncompetitive
(c) uncompetitive
(d) substrate

C. Multi-substrate reactions

(1) convention
(2) mechanisms

D. Substrate binding analysis

(1) derivation
(2) methodology

III. MECHANISMS OF ENZYME CATALYSIS (Fersht, Ch. 2,9; Price, Ch.5 & Palmer, Ch. 10, 11)

A. Reaction Mechanisms and Catalysis

(1) proximity effect
(2) acid-base catalysts
(3) electrostatic
(4) functional groups
(5) structural flexibility

B. Active Site Investigations

(1) kinetic studies
(2) detection of intermediates
(3) x-ray crystallographic studies
(4) chemical modification of amino acid side chains
(5) site-directed mutagenesis studies
(6) enzyme engineering

C. Specific enzymes

(1) alcohol dehydrogenase
(2) ribonuclease A
(3) triose phosphate isomerase
(4) amino acyl tRNA synthetases
(5) carbonic anhydrase

IV. ENZYME REGULATION (Price, Ch. 6)

A. Partial Proteolysis

B. Phosphorylation, adenylylation, disulphide reduction

C. Allosteric regulation

(1) sigmoidal kinetics
(2) symmetry model
(3) concerted model
(4) kinetics and functions of allosteric enzymes
(a) phosphofructokinase

(b) glycogen phosphorylase