

SPECIAL TOPICS: BIOCATALYSIS

ChBE 8803C/4803B

Fall 2003

LECTURES: Tuesday/Thursday, 1:30-3:00 pm; ES & T 1105

INSTRUCTOR: Dr. Andreas Bommarius, IBB 3310, x5-1334,
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TEACHING ASSISTANT: Tracey Thaler, IBB 3412, x5-3089
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WEBSITE: <http://swiki.che.gatech.edu/biocatalysis>

COURSE DESCRIPTION: This course for graduate and advanced undergraduate students provides an in-depth coverage of various topics in biocatalysis. Prior knowledge in organic chemistry and/or biochemistry as well as kinetics and/or reactor design is recommended but not required. Goals of this course are the development of an understanding of proteins as catalysts, knowledge of applications of biological catalysis in various industries, and recognition of the potential of biological catalysis for addressing future challenges in science and engineering.

REQUIRED TEXT: *Biotransformations in Organic Chemistry*, Kurt Faber
Springer, 4th edition, 2000, ISBN 3-540-66334-7

RECOMMENDED TEXTS: *Biocatalysis – Fundamentals and Applications*, A.S. Bommarius and B.R. Riebel, Wiley-VCH, 2003 (avail. November), ISBN: 3-527303-448

Structure and Mechanism in Protein Science, Alan Fersht
Freeman, New York, 1999, ISBN 0-7167-3268-8

Mechanisms in Chemistry and Enzymology, William P. Jencks
Dover, New York, 1975, ISBN 0-486-65460-5

Chemical Reaction Engineering
Octave Levenspiel; John Wiley, 3rd edition, 1999

OR

Elements of Chemical Reaction Engineering
H. Scott Fogler; Prentice Hall, 1999

COURSE GRADING:	Homework 25%	Midterm exam 25%
	Term paper 25%	Final exam 25%

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HOMEWORK ASSIGNMENTS:

25% of total grade, 25 points per problem set; no late homework accepted except in emergencies

Problem set topic	Hand-out date	due date
Basics in enzyme catalysis	08/26	09/02
Enzymes as products and catalysts	09/02	09/09
Protein folding and enzyme stability	09/09	09/16
Enzyme reactions and mechanisms	09/16	09/23
Fermentation and purification	10/21	10/28
Enzyme models, multiple-enzyme systems	10/28	11/04
Evolution and improvement of enzyme activity	11/04	11/11
Enzymes in pharma processes	11/06	11/25

TERM PAPER:

Critique of a biocatalysis-based original paper agreed upon between student and instructor; requirements: short written paper, corresponding Powerpoint presentation, and oral presentation in class.

Purpose:

- critical review of original paper with Biocatalysis topic
- creation of excitement within the student's mind
- honing of oral presentation skills

Requirements:

- paper must contain original experimental data or model; no Review, Minireview, or Perspective allowed (no extraneous pet topics, please!)
- paper must be 4-8 pages long
- paper must not have been presented before or deal with thesis topic

Deliverables:

- due 11/20: ≤ 3 pages of critique, single-sided, 12pt font, 1 in margins
- due 11/20: Powerpoint slides, in "handout, 2 slides per page" format
- presentation with overheads of ii) to class, 15 min, incl. Q & A

Timeline:

suggestions for papers due:	10/21
agreement on papers by:	11/02
3-page critique and Powerpoint presentations due:	11/20
presentations to class:	11/25

FINAL EXAM:

Friday, 12/12, 11:30 - 2:20, ES&T 1105: 25% of total grade; comprehensive; open book, open notes

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Course Outline

- 1 08/19 Purpose and perspective of biocatalysis; comparison with other kinds of catalysis
- 2 08/21 Basics of enzyme catalysis: why and how do enzymes work?
- 3 08/26 Enzymes as products in detergents, textiles, and pulp and paper
- 4 08/28 Enzymes as catalysts in basic, fine, and specialty chemicals, food, and agriculture
- 5 09/2 Protein folding, enzyme deactivation
- 6 09/4 Methods to study proteins I: chromatography, kinetics, isotopes, CD, DSC
- 7 09/9 Selected examples of enzyme reactions and mechanisms
- 8 09/11 Methods to study proteins II: use of databases
- 9 09/16 Activity: advanced enzyme kinetics
- 10 09/18 Selectivity: chemo- & regiospecificity, enantioselectivity (E-value)
- 11 09/23 Stability: enzyme denaturation, aggregation, instability factors
- 09/25 **Midterm exam**
- 12 09/30 Generation of a biocatalyst: fermentation
- 13 10/2 Isolation, preparation and purification of biocatalysts
- 14 10/7 Protein engineering: site-directed mutagenesis, random mutagenesis, recombination
- 15 10/9 Medium engineering: enzymology in non-aqueous media
- 10/14 **Mid-term recess: no class**
- 16 10/17 Examples of enzyme improvement through protein engineering
- 17 10/21 Artificial enzymes: status and perspectives
- 18 10/23 Multiple-enzyme systems: from cofactor regeneration to metabolic engineering
- 19 10/28 Creation of novel function in nature: con-/divergent evolution, gene transfer
- 20 10/30 Examples of evolution: enzyme superfamilies, α/β -barrel enzymes
- 21,22 11/4,6 Enzymes in the synthesis of pharmaceutical intermediates
- 23-25 reschedule Biocatalytic process design: HFCS, aspartame, penicillins
- 26-27 11/25 (2x!) **Presentations of term papers**
- 11/27 **Thanksgiving: no class**
- 28 12/2 Unsolved problems and challenges in biocatalysis
- 29 12/4 Review
- 12/12 **Final** (11:30 a.m. – 2:20 p.m.)