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**ChE 212**  
**Spring 1997**

## Biochemical Separations

Instructor: Joseph A. Shaeiwitz  
Office: 417 ES  
Phone: 293-2111 ext. 410  
Class: 9:30-10:45 TTh 401 ES

Goals: Chemical Engineers are being called upon to solve problems involving separation and purification of bio-molecules such as proteins and antibiotics. In this course we will cover the types of operations needed for separation and purification of these unique molecules.

Text: Belter, P. A., E. L. Cussler and W.-S. Hu, *Bioseparations. Downstream Processing for Biotechnology*, Wiley-Interscience, 1988.

Grading:	Problems	10%
	Project	25%
	Midterm Exam	30%
	Final Exam	35%

Course Policies (exceptions at discretion of instructor):

1. There are no make-up exams.
2. All problem sets are due at the beginning of class or at the stated time.
3. A late assignment = no assignment.
4. Exam grading appeals must be submitted in writing on the day the exam is returned. If you miss that class, you lose the opportunity for regrading.
5. Any classes canceled due to inclement weather (or any other reason) will be rescheduled.
6. You may (and are encouraged to) work in groups on problem sets. However, what you submit must be your own work. Assignments that are obviously copied will receive no credit.
7. Problem sets and exams should be neat and easy to follow. Each problem should start on a new page. Your answer should be boxed, have units as appropriate, and have the correct number of significant figures. No credit will be given for answers without work. Credit will be deducted for missing or incorrect units, sloppy work which is hard to follow, and for the incorrect number of significant figures. You should round-off the final answer to the correct number of significant figures. If you round-off intermediate calculations, thereby making your final answer inaccurate, significant credit will be deducted.

## Project:

The purpose of the project is for each student to become familiar with at least one aspect of biochemical separations in greater depth than is possible in a survey course such as this. The project must begin with a paper from the recent literature, within the last 4 years. A copy of the paper should be appended to your report. You must trace back the development in the chosen paper to produce a comprehensive history and/or analysis leading up to the chosen paper. Most of the references on the reading list are reviews which are more than 4 years old, so you will have to search the literature for a recent paper. The following journals are suggested, but the list is not exhaustive:

*Biotechnology and Bioengineering*  
*Biotechnology Progress*  
*Enzyme and Microbial Technology*

In order that the project not be put off until the end of the semester, the following schedule is required:

1/30/97    turn in topic or potential list of topics for approval  
3/25/97    project due

Bibliography: (\* = on reserve in Evansdale Library - I have all of these books and could lend them out on a short term basis)

- \* 1. Albertsson, P.-Å., *Partition of Cell Particles and Macromolecules (3rd ed.)*, Wiley-Interscience, 1986.
- \* 2. Asenjo, J. A. (ed.), *Separation Processes in Biotechnology*, Dekker, 1990.
- \* 3. Asenjo, J. A. and J. Hong (eds.), *Separation, Recovery and Purification in Biotechnology*, ACS Symposium Series #314, American Chemical Society, 1986.
- \* 4. Atkinson, B. and F. Mavituna, *Biochemical Engineering and Biotechnology Handbook*, Macmillan, 1983. (in reference section)
- \* 5. Bailey, J. E. and D. F. Ollis, *Biochemical Engineering Fundamentals (2nd ed.)*, McGraw-Hill, 1986. BO
- \* 6. Burgess, R. (ed.), *Protein Purification. Micro to Macro*, A. R. Liss, Inc., 1987.
- \* 7. Dechow, F. J., *Separation and Purification Techniques in Biotechnology*, Noyes, 1989.
8. Fiechter, A. (ed.), *Reaction Engineering*, Advances in Biochemical Engineering, Vol 24, Springer-Verlag, 1982.

9. Fiechter, A. (ed.), *Chromatography*, Advances in Biochemical Engineering, Vol 25, Springer-Verlag, 1982.
10. Fiechter, A. (ed.), *Downstream Processing*, Advances in Biochemical Engineering/Biotechnology, Vol 26, Springer-Verlag, 1983.
- \* 11. Hamel, J.-F., J. B. Hunter and S. K. Sikdar (eds.), *Downstream Processing and Bioseparation*, ACS Symposium Series #419, American Chemical Society, 1990.
- \* 12. Harrison, R. (ed.), *Protein Purification Process Engineering*, Marcel Dekker, New York, 1994.
- \* 13. Ladisch, M. R., R. C. Wilson, C. C. Painton and S. E. Builder (eds.), *Protein Purification*, ACS Symposium Series #427, American Chemical Society, 1990.
14. LeRoith, D., J. Shiloach and T. J. Leahy (eds.), *Purification of Fermentation Products*, ACS Symposium Series #271, American Chemical Society, 1985.
- \* 15. McGregor, W. C. (ed.), *Membrane Separations in Biotechnology*, Marcel Dekker, New York, 1986.
- \* 16. Seetharam, R. and S. K. Sharma (eds.), *Purification and Analysis of Recombinant Proteins*, Marcel Dekker, New York, 1991.
- \* 17. Walter, H., D. E. Brooks and D. Fisher (eds.), *Partitioning in Aqueous Two-Phase Systems*, Academic Press, 1985.
- \* 18. Wang, D. I. C., C. L. Cooney, A. L. Demain, P. Dunnill, A. E. Humphrey and M. D. Lilly, *Fermentation and Enzyme Technology*, Wiley-Interscience, 1979.
- \* 19. Wheelwright, S. M., Protein Purification. *Design and Scale up of Downstream Processing*, Hanser, 1991.

## Approximate Syllabus

[Under reading, the format is a(b), where a is the number of the reference in the bibliography on the previous pages, and b is the chapter or page numbers. If only one number is given, it refers to a chapter in the text. *Paper(s)* refers to journal articles which will be handed out.]

<u>Class</u>	<u>Date</u>	<u>Topic</u>	<u>Reading</u>	<u>Assignment Due</u>
1	1/7	Introduction, Biochemistry	1, App A	
2	1/9	Biochemistry, Microbiology Genetic Engineering	5(1,2)	
3	1/14	Industrial Products		
		General Approach to Bioseparations	1	
4	1/16	Discussion, Problems	2(1), 16(1), 19(1,2,3)	
5	1/21	Filtration	2	PS 1
6	1/23	Filtration	12(4)	
7	1/28	Filtration		
8	1/30	Centrifugation	3, 10(1), 8(4)	topic
9	2/4	Centrifugation		PS 2
10	2/6	Cell Lysis	4, paper, 12(3)	
11	2/11	Extraction	5	PS 3
12	2/13	Extraction	2(10), 17(1,6)	
13	2/18	Extraction		PS 4
14	2/20	Adsorption	6	
15	2/25	Fixed Bed Operations		PS 5
16	2/27	<b>MIDTERM EXAM</b>		
17	3/11	Fixed Bed Adsorption	7	
18	3/13	Chromatography		
19	3/18	Chromatography	2(13)	PS 6
20	3/20	Chromatography	12(7,8)	
21	3/25	Chromatography		project
22	3/27	Precipitation	8, 10(1), 12(6)	
23	4/1	Ultrafiltration Carrier Membranes	9, 15(5) 3(6)	PS 7

24	4/3	Electrophoresis	9, 3(12,13), 13(15)	
25	4/8	Other Electrical Separations		PS 8
26	4/9	Crystallization	10	
27	4/15	Crystallization		PS 9
28	4/17	Drying	11	
29	4/22	Industrial Examples	6(pp.457-499),	PS 10
30	4/24	Industrial Examples	16(7,8,11), 19(15)	
	4/29	<b>FINAL EXAM 11AM-1PM</b>		