42-321 Cellular and Molecular Biotechnology - Fall 2006

GENERAL INFORMATION

Rapid Navigation Aids:

Top

PEOPLE/PLACES/TIMES/TEXTS

Instructor: Todd M. Przybycien, DH 2100, x8-3857, todd@andrew.cmu.edu

Office Hours: Tue 3:30-4:30 + Fri 11:30-12:30 + *Open Door Policy*

N.B.: Office hours may change from time to time; notification of changes will be sent by email.

Open Door Policy: If my office door is open, and I'm not meeting with someone or on the phone, then I'm available for a quick question or two. If my door is closed or only ajar, then I'm either in some seemingly terribly important meeting or frantically trying to meet some sort of deadline and

would not like to be disturbed. Please try to make preferential use of my office hours or those of the TAs if possible.

TAs:

N.B.: Please try to make use of TA's scheduled office hours whenever possible; at non-office hour times, please don't expect TA to drop everything to work with you if they're busy doing something else. Also, office hours may change from time to time; notification of changes will be sent by email.

Sam Hund, x8-8382, shund

Office hours: Wed 2:30-3:30 + Thu 5:30-6:30, default location Doherty Hall 2100

Class Hours:

MWF 3:30 - 4:20 pm in Porter Hall A22

Exams:

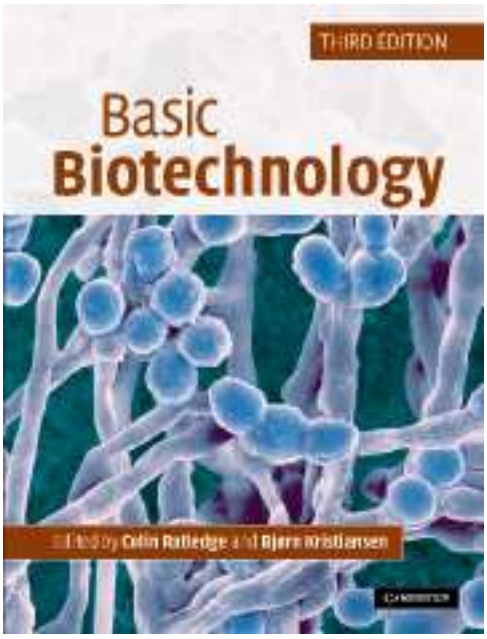
Midterm #1: TBA
Midterm #2: TBA

Final Exam: TBA

Course Texts:

Basic Biotechnology, 3rd Ed., Ratledge and Kristiansen, 2006

A very recently revised (Jan 2006) text from a collection of top European biotech researchers.



Top

OBJECTIVES

By the end of the course you should be able to:

1. understand the function and organization of the major metabolic networkse,

2. develop and use stoichiometric descriptions of cell growth, substrate usage and product formation,

3. understand and explain basic genetic engineering tool and approaches as applied to microbial and fungal systems,

4. develop and use mathematical models for cellular growth, substrate utilization and product formation,

5. develop and use mathematical models for biological reactors, with due consideration given to transport phenomena,

6. understand the principles of and develop and use mathematical models for downstream processing operations,

7. understand the factors governing bioprocess economics,

8. be conversant about the structure, aims and products of the North American biotechnology industry,

9. be conversant about the current social/political/economic ramifications of biotechnology,

10. use a symbolic mathematics program (such as MATLAB) and a spreadsheet program (such as Excel) for basic calculations and numerical analysis,

11. work successfully in a team environment, both as a team member and team leader, and

12. make succinct, informative oral presentations of technical information and lead sustained discussions of the interplay between technical and social/polical/economic issues.

Top

ORGANIZATION

Each week will consist of three 50 minute lectures. During the lectures, I will ask questions of the class and encourage questions and discussion as learning is more effective when it is both active and interactive. On Fridays, we will hold discussion sessions on both the social/economic/politcal dimensions of biotechnology and on the North American biotechnology industry. I will lead the initial discussion session; class members will lead the subsequent discussion sessions.

PROBLEM SETS

Top

There will be roughly ten problem sets which you will complete in self-selected groups of two. Each problem set will consist of several graded problems. The assignments are available for viewing and printing at the Problem Sets site and will be due in class as listed on the Syllabus. Each group will turn in one copy of their completed problem set; I suggest that each student in each group keep a copy of each completed problem set for their own records as well. Solutions will be posted on the class Web site (see Solutions and Grading site). *Problem sets must be turned in by the due date and time. Late problem sets will be corrected, but will receive a grade of zero.* More information on the structure of the group work activities is given in the Teamwork Guidelines section.

EXAMS

Top

Mid-term exams will be given during the semester in accord with the schedule listed on the Syllabus. All exams will be open notes and open homework. Exam problems will synthesize and extend ideas presented in the lectures and problem sets. Exam solutions and grade distributions will be posted on the Solutions and Grading site. For anyone excused from one of the mid-semester exams for a valid reason, see the Attendance section below, a single cumulative make-up exam will be given on Wednesday, 6 December 2005 from 3:30-5:20. This make-up exam will be comprehensive, as it must include material from both regular mid-term exams.

There will be a final, three-hour exam that all students will take. The final exam will be open notes and open homework. Our final exam will be held during the final exam period. **Make no travel plans until your complete final exam schedule has been established. There will be neither make-up final exam given nor will there be alternate exam times given due to conflicts with travel plans.**

GRADE APPEALS

Top

All problem set and exam grade appeals should be made by the next lecture following the return of the graded problem sets or exams. Problem set grade appeals should be made in person to the TA. Exam grade appeals should be made to the instructor by writing a brief statement listing the specific problems involved and the associated specific concern(s) on either the front cover or back page of the exam papers and returning the exam to the instructor; concerns expressed as "regrade" with no specific comments included will not be considered.

ATTENDANCE

Top

Attendance at lectures is strongly encouraged, although it is the prerogative of the student. Each student is responsible for all materials presented and all announcements made in class regardless of attendance. Poor attendance will not positively influence borderline grade decisions.

Attendance at exams is mandatory. There are two acceptable exceptions: 1) a documented medical excuse from the Infirmary, or 2) an appropriate statement from the Dean of Students presented in advance of the given exam. Students excused from one of the mid-term exams in this manner will take the end-of-semester make-up exam. Failure to take an exam due to over-sleep, under-sleep, scheduling confusion, inability to find exam room etc. will result in failure of the exam. If you are unsure about the schedule or location of an exam, please ask the instructor or one of the TAs in advance of the exam!

GRADING

Top

A final numerical average will be computed for each student using the weighting criteria presented below:

category	weighting
Group Work	
problem sets (~10 @ 4%)	40%
discussion leadership (~4 @ 4%)	16%
cover memos, team organization, interim & final evaluations	4%
Individual Work	
mid-term exams (2 @ 15%)	30%
final exam	20%

Final grades will be based on your numerical average:

overall numerical average	final letter grade
≥ 90%	A
≥ 80%	B

≥ 70%	C
≥ 60%	D
<60%	R

This is an absolute rather than a relative scale. It is theoretically possible for everyone in the class to receive an "A" grade; this would be wonderful. *You are not competing with each other for grades.* You are expanding the limits of your own knowledge and abilities. An excellent way to aid your own virtual expansion process is to help someone else push his or her knowledge limits back! You may come to the instructor for an informal assessment of your current average at any time. Should an individual exam or assignment prove unexpectedly challenging, I may rescale everyone's grades on that exam or assignment to bring it in line with expected performance levels; note however, that I will never rescale scores downwards from their original values. Borderline individual averages, those within 2.0 points of the cutoffs above, will be examined to determine if some unusual score, i.e. one bad exam day, is greatly affecting the overall course grade or if there is a trend of consistent improvement and strong group performance. These situations will positively influence borderline grade decisions. Poor records of attendance, completed assignments or group performance will not positively influence borderline grade decisions. Note that there is no "extra credit" or "makeup" work available to improve your numerical average.

ACADEMIC INTEGRITY

Top

The university policies regarding academic integrity are listed on the CMU Website at http://www.cmu.edu/policies/StudentPolicy.html and in the CMU Student Handbook. These policies address in detail the expectations of student-instructor and student-student interactions. Some major points pertaining to our class specifically:

1. Problem sets. Each group member is expected to contribute their fair share to the groups' efforts. This means neither racing far ahead of the rest of the group so as not to give others an opportunity to contribute, nor coasting so that you contribute little or nothing to the group's progress. The covering memo for each problem set and the interim and final team member evaluations for each block of problem sets are expected to be consistent: if you can't tell someone to their face during the completion of assignments that their performance is not meeting expectations, you have no right to hide behind the anonymity of an evaluation form to give them a

poor rating. This of course is difficult, but it is a means of looking out for your own best interests. Each group is expected to turn in its own work for grading; you may discuss approaches to problems with other groups.

3.

2. Exams. Exams must reflect individual efforts exclusively. Permitted resources for the exams will be announced in class and will be explicitly stated on each exam.

If you are unsure about how to apply these guidelines, ask the instructor for clarification. Noncompliance with these guidelines will be addressed promptly via the mechanisms outlined by the university policies.

SUGGESTED STRATEGY

Top

Recipe for success:

1. Read the text and assigned materials; hit the WWW. Try to read the assigned material before the corresponding lecture(s).

2. Go to class. The instructor will explain concepts in several different ways to help you "see" the underlying concepts and work through problems.

3. Contribute to your homework groups. Try to outline the solution to each problem on an assignment on your own, before meeting as a group. Use the group as a way to discuss alternative approaches, to correct errors in logic or concepts, and to divide up the final number-crunching. For additional preparation for exams, allot a fixed amount of time, say 15 min per problem, to develop an outline for problem solutions and then move on to the next problem. After you have visited each problem, then go back and flesh out the details.

I hear and I forget. I see and I remember. I do and I understand. - Confucius

4. Ask questions in class, after class and at office hours. Talk with the instructor. Talk with the TA. Take an active role in your education.

DETAILED SYLLABUS

Top

Day	Date	Topics	Reading Basic Biotechnology by Ratledge and Kristiansen (abbrev as BB) Other Reading (PDF files) Reading Links	Assignments
M	28 Aug	Introductions & Course Organization 1. **Public Perception of Biotech** D. **Discussion:** Commentary on social, political and economic dimensions of biotechnology	BB: Chp 1	
W	30	2. **Cell Growth and Metabolism** 2.a major pathways	BB: Chp 2 Topic 2 notes discussion paper	
F	1 Sep	D. **Discussion:** Concerns about biotechnology at the outset of "modern biotechnology"	paper	
M	4	Labor Day – No Class		
W	6	2. **Cell Growth and Metabolism** (cont'd) 2.b reckoning metabolic energy		
F	8	D. **Discussion:** Amgen Overview		
M	11	2. **Cell Growth and Metabolism** (cont'd) 2.c pathway regulation Add Deadline		
T	12			team organization

				form due
W	13	2. **Cell Growth and Metabolism** (cont'd) 2.d. The Trp and Lac operons	BB: Chp 3	
F	15	D. **Discussion:** GM crops concerns 2. **Cell Growth and Metabolism** (cont'd) 2.d. The Trp and Lac operons (2.e metabolic flux analysis)		problem set 1 due in class
M	18	2. **Cell Growth and Metabolism** (cont'd) 2.d. The Trp and Lac operons		
W	20	3. **The Stoichiometry of Cell Growth** 3.a. Growth stoichiometry 3.b. Yield coefficients		
F	22	D. **Discussion:** Genentech and Biogen/IDEC Overviews 3. **The Stoichiometry of Cell Growth** (cont'd) 3.c. Degree of reduction balances		problem set 2 due in class
M	25	3. **The Stoichiometry of Cell Growth** (cont'd) 3.d. Yield coefficient correlations		
W	27	4. **Genetic Engineering** 4.a. Mutation	BB: Chp 4,5	
F	29	D. **Discussion:** PDL BioPharma		problem set 3 due in class

		Overview 4. **Genetic Engineering** (cont'd) 4.b. Selection/Screening		
M	2 Oct	D. **Discussion:** Genzyme Overview 4. **Genetic Engineering** (cont'd) 4.c. DNA manipulation		
W	4	4. **Genetic Engineering** (cont'd) 4.d. plasmid design considerations		
F	6	D. **Discussion:** Wyeth BioPharma Overview 4. **Genetic Engineering** (cont'd) 4.e. barriers to expression		problem set 4 due in class
M	9	**4. Genetic Engineering** (cont'd) 4.f. expression in procaryotes versus eucaryotes (yeasts and fungi)		
W	11	5. **Microbial Growth Kinetics** (cont'd)	BB: Chp 6	
F	13	6. **Microbial Growth Kinetics** (cont'd)		
M	16	6. **Microbial Growth Kinetics** (cont'd)		problem set 5 due in class
W	18	Midterm Exam No. 1 (note 2 hours)		
F	20	Mid-Semester Break - No Class		
M	23	6. **Ideal Bioreactors**		
W	25	D. **Discussion/Video:** Antibiotics production video NYSTAR		

F	27	6. **Ideal Bioreactors** (cont'd)		
M	31	6. **Ideal Bioreactors** (cont'd)		
W	1 Nov	7. **Real Bioreactors** 7.a. mixing effects	BB: Chp 7,8	
F	3	D. **Discussion**: ZymoGenetics overview 7. **Real Bioreactors** (cont'd) 7.a. mixing effects **Downstream Processing** (cont'd)		
M	6	7. **Real Bioreactors** (cont'd) 7.b mass transport considerations Drop Deadline		problem set 6 due 9 am
W	8	7. **Real Bioreactors** (cont'd) 7.b mass transport considerations		
F	10	D. **Discussion**: MedImmune overview 7. **Real Bioreactors** (cont'd) 7.c heat transport considerations		
M	13	problem set review AIChE/Genentech		problem set 7 due
W	15	Midterm Exam No. 2 (part 1) AIChE/Tec de Monterrey		
F	17	Midterm Exam No. 2 (part 2) Tec de Monterrey		
M	20	**8. Downstream Processing**	BB: Chp 9	

		8.a. Overview 8.b. cell harvest – filtration		
W	22	Thanksgiving Break – No Class		
F	24	Thanksgiving Break – No Class		
M	27	**8. Downstream Processing** 8.b. cell harvest – filtration		
W	29	**8. Downstream Processing** 8.c. cell disruption 8.d. inclusion body processing 8.e. primary isolation		
F	1 Dec	D. **Discussion**: RepliGen overview 8.e. primary isolation 8.f. purification		problem set 8 due
M	4	D. **Discussion**: ImClone overview 9. **Antibiotic Production**	BB: Chp 18	
W	6	10. **Recombinant Protein Production**	BB: Chp 21	
F	8	D. **Discussion**: vaccine production concerns, policy, business 10. **Recombinant Protein Production** (cont'd) Last Day of Class		problem set 9 due
F	15Dec	Final Exam Time: 5:30-8:30 pm Location: PH A18A		

		NO MAKE UP FINAL GIVEN		