McGill
Faculty of Engineering

CHEE 651 Advanced Biochemical Engineering

Winter 2016

Class Schedule

Monday and Wednesday 10:05 – 11:25 AM, ENGMC 12

Instructor

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Office hours: Monday 11:30 - 13:00 or by appointment

Teaching Assistants (TAs)

Scott Cooper, Mr (scott.cooper@mail.mcgill.ca)

Communication

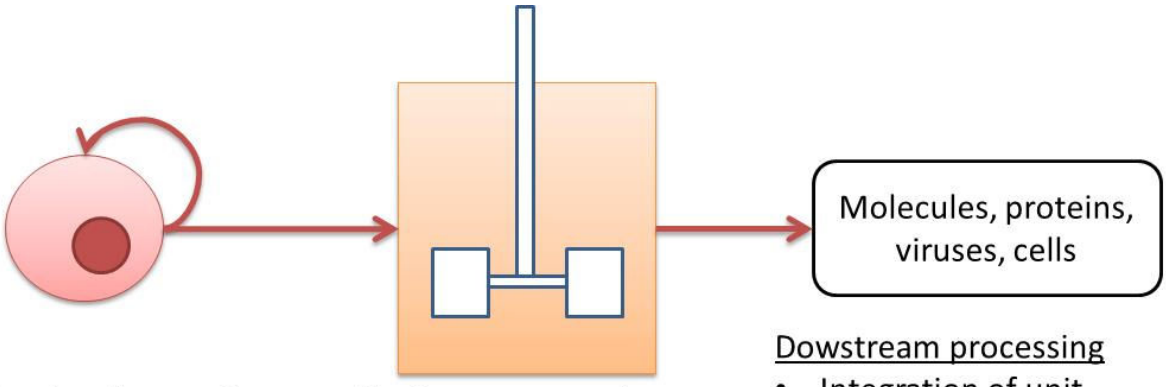
myCourses (accessible via www.mcgill.ca/lms) will be used to distribute course materials, including lecture slides, assignments, and instructions for the laboratory exercise.

For questions about the course material or assignments, please use the myCourses discussion forums as much as possible for the benefit of other students in the class. If you have specific questions that are not of general interest or for urgent matters, please send an email to corinne.hoesli@mcgill.ca.

Learning Outcomes

- Understand, at the molecular level, how biotechnology products such as small molecules, recombinant proteins, viruses and cell-based therapies are produced
- Integrate knowledge of biochemical engineering unit operations to design a recombinant protein production process
- Learn advanced protein and cell line engineering concepts
- Apply fundamental biochemical engineering principles to model advanced bioreactor configurations

COURSE ORGANIZATION



Cell line development
- Bioinformatics
- Protein engineering
- Molecular cloning and expression vectors
- Advanced cell growth kinetics models
- Metabolic modeling

Upstream processing
- Bioreactor design: mass transfer, mixing, cooling
- Advanced bioreactor configurations
- Enzyme and cell immobilization

Dowstream processing
- Integration of unit operations
- Design heuristics

Quality control and regulatory considerations
- Recombinant protein quality control
- Regulatory approval of novel protein therapeutics

COURSE MATERIALS

There is a required textbook that is available at the McGill Bookstore:

Bioprocess Engineering: Basic Concepts, 2nd edition, by Shuler and Kargi. Prentice Hall International Series. ISBN: 0-13-081908-5.

Additional mandatory and suggested reading materials will be posted regularly on myCourses.

LABORATORY SAFETY

WHMIS

Workplace Hazardous Materials Information System (WHMIS) training/exam is mandatory for all students registered in CHEE370 (or 314). If you haven't completed this training yet (i.e. CHEE 291), you must inform me.

Statement of Safe Laboratory Practice

The Department of Chemical Engineering is committed to providing a safe laboratory environment for its faculty, staff, students and visitors. We must wear appropriate attire and personal protective equipment when present in the lab. We must report accidents, dangerous incidents or suspected occupational illnesses to their immediate supervisor without delay. We must refrain from manipulating any hazardous materials prior to undergoing appropriate safety training and receiving safety instructions. Finally, the use of cell phones is prohibited in the laboratories. The laboratory technicians, teaching assistants and professors have the authority to expel from the lab anybody who does not abide by any of these rules. More information can be found on the Environmental Health and Safety (EHS) website: www.mcgill.ca/ehs/.

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COURSE CONTENT AND SCHEDULE (TENTATIVE – consult myCourses regularly for updates)

Biochemical engineering uses chemical engineering and biological principles to study, design, utilize and create biological based processes and products. The course will cover both fundamentals of biochemical engineering and application of the knowledge through the study of protein design, protein expression and reactor design. This knowledge will then be applied to industrial production of bioproducts by looking at expression systems, reactor design and recovery considerations.

Weeks	Lecture Topic	Assignments*
1 (January 7)	Introduction to biochemical engineering	
2 (January 11)	Molecular cell biology review; protein folding	
3 (January 18)	Enzyme kinetics and allosteric regulation	
4 (January 25)	Cell line engineering and cell growth models	Bioprocess design topics due
5 (February 1)	Upstream processing: bioreactor modes of operation	Assignment 1 due: cell & molecular biology
6 (February 8)	Upstream processing: bioreactor design	
7 (February 15)	Upstream processing: bioreactor design	
8 (February 22)	Downstream processing: centrifugation, filtration, chromatography	Assignment 2 due: upstream processing
Reading week – no classes		
9 (March 7)	Formulation	Lab report due
10 (March 14)	Quality control and regulatory challenges	Draft presentation slides due (optional)
11 (March 21)	Bioprocess design presentations	Presentation slides and quiz due
12 (March 28)	Bioprocess design presentations	
13 (April 4)	Bioprocess design presentations	
14 (April 11)	Research avenues in biochemical engineering	Assignment 3 due: downstream processing

*Remember to consult myCourses regularly for changes in due dates and reading assignments.

EVALUATION AND ASSESSMENT

Item	
Assignments There will be 3 assignments. Assignments and due dates will be posted on MyCourses. Paper copies of the assignment questions will not be distributed. Assignments should be completed individually and submitted via myCourses according to the file format described in the assignment. Assignments submitted one day late: lose 50% of the marks; if more than 24 h late: receive a zero (unless you have a valid reason; e.g. medical note).	20%
Laboratory – The lab will take place at the end of February and will be performed in teams of 3-4 students. The lab protocol will be available on MyCourses 2-3 weeks before the lab. One lab report per group is required (50% marks lost for 24 h late submission; all marks lost >24 hours). The report will consist of a literature review, hypothesis and objective, methods, results and discussion.	10%
Bioprocess design presentation – Teams of 3-4 students will develop a bioprocess for the production of a recombinant protein, vaccine or other biochemical engineering product. Each team will present orally, submit a written overview of their process as well as their presentation slides.	20%
Final exam – The final exam will be cumulative and consist of short and/or long-answer questions. The exam is closed-book and closed-notes. Please bring a Faculty Standard Calculator.	50%

Policy for missed lab/oral presentation with a valid reason: the weight of the missed lab/oral presentation will be added to the weight of the final examination.

SUGGESTED READING/REFERENCES

Students will find the following resources helpful:

Cell and molecular biology fundamentals:

Madigan, M. T. and Martinko, J.M. Brock Biology of Microorganisms, 12th edition, Prentice Hall, 2007.

Donald Voet and Judith G. Voet, Biochemistry, 4th edition, Wiley, 2011. ISBN 978-0-470-57095-1

Biochemical engineering:

Bailey, James E., and David F. Ollis. Biochemical Engineering Fundamentals. New York, NY: McGraw-Hill Education, 1986. ISBN: 9780070666016.