McGill
Faculty of Engineering

Course Outline

CHEE 370

Course Title:	**Elements of Biotechnology**
Credits:	**3**
Contact Hours:	**(3-1-5)**
Course Prerequisite(s):	**N/A**
Course Corequisite(s):	**N/A**
Course Description:	**Biological macromolecules; cell structure and metabolism; industrially significant microbes; enzyme kinetics; introduction to molecular biology and genetic engineering, laboratory exercises.**

Canadian Engineering Accreditation Board (CEAB) Curriculum Content

CEAB curriculum category content	Number of AU's	Description
Math		Mathematics include appropriate elements of linear algebra, differential and integral calculus, differential equations, probability, statistics, numerical analysis, and discrete mathematics.
Natural science	**16**	Natural science includes elements of physics and chemistry, as well as life sciences and earth sciences. The subjects are intended to impart an understanding of natural phenomena and relationships through the use of analytical and/or experimental techniques.
Complementary studies		Complementary studies include the following areas of study to complement the technical content of the curriculum: engineering economics; the impact of technology on society; subject matter that deals with central issues, methodologies, and thought processes of the arts, humanities and social sciences; management; oral and written communications; healthy and safety; professional ethics, equity and law; and sustainable development and environmental stewardship.
Engineering science	**33**	Engineering science involves the application of mathematics and natural science to practical problems. They may involve the development of mathematical or numerical techniques, modeling, simulation, and experimental procedures. Such subjects include, among others, applied aspects of strength of materials, fluid mechanics, thermodynamics, electrical and electronic circuits, soil mechanics, automatic control, aerodynamics, transport phenomena, elements of materials science, geoscience, computer science, and environmental science.
Engineering design		Engineering design integrates mathematics, natural sciences, engineering sciences, and complementary studies in order to develop elements, systems, and processes to meet specific needs. It is a creative, iterative, and open-ended process, subject to constraints which may be governed by standards or legislation to varying degrees depending upon the discipline. These constraints may also relate to economic, health, safety, environmental, societal or other interdisciplinary factors.

Accreditation units (AU's) are defined on an hourly basis for an activity which is granted academic credit and for which the associated number of hours corresponds to the actual contact time: one hour of lecture (corresponding to 50 minutes of activity) = 1 AU; one hour of laboratory or scheduled tutorial = 0.5 AU. Classes of other than the nominal 50-minute duration are treated proportionally. In assessing the time assigned to determine the AU's of various components of the curriculum, the actual instruction time exclusive of final examinations is used.

Graduate Attributes

This course contributes to the acquisition of graduate attributes as follows:

Graduate attribute	KB	PA	IN	DE	ET	IT	CS	PR	IE	EE	EP	LL
Level descriptor	D	D	D									

n/a = Not applicable; I = Introduced; D = Developed; A = Applied

KB *- Knowledge Base for Engineering: Demonstrated competence in university level mathematics, natural sciences, engineering fundamentals, and specialized engineering knowledge appropriate to the program.*

PA *- Problem Analysis: An ability to use appropriate knowledge and skills to identify, formulate, analyze, and solve complex engineering problems in order to reach substantiated conclusions.*

IN *- Investigation: An ability to conduct investigations of complex problems by methods that include appropriate experiments, analysis and interpretation of data, and synthesis of information in order to reach valid conclusions.*

DE *- Design: An ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, economic, environmental, cultural and societal considerations.*

ET *- Use of Engineering Tools: An ability to create, select, adapt, and extend appropriate techniques, resources, and modern engineering tools to a range of engineering activities, from simple to complex, with an understanding of the associated limitations.*

IT *- Individual and Team Work: An ability to work effectively as a member and leader in teams, preferably in a multi-disciplinary setting.*

CS *- Communication Skills: An ability to communicate complex engineering concepts within the profession and with society at large. Such abilities include reading, writing, speaking and listening, and the ability to comprehend and write effective reports and design documentation, and to give and effectively respond to clear instructions.*

PR *- Professionalism: An understanding of the roles and responsibilities of the professional engineer in society, especially the primary role of protection of the public and the public interest.*

IE *- Impact of Engineering on Society and the Environment: An ability to analyse social and environmental aspects of engineering activities. Such abilities include an understanding of the interactions that engineering has with the economic, social, health, safety, legal, and cultural aspects of society; the uncertainties in the prediction of such interactions; and the concepts of sustainable design and development and environmental stewardship.*

EE *- Ethics and Equity: An ability to apply professional ethics, accountability, and equity.*

EP *- Economics and Project Management: An ability to appropriately incorporate economics and business practices including project, risk and change management into the practice of engineering, and to understand their limitations.*

LL *- Life-Long Learning: An ability to identify and to address their own educational needs in a changing world, sufficiently to maintain their competence and contribute to the advancement of knowledge.*

Policies

Academic Integrity

McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures.
(see www.mcgill.ca/students/srr/honest/ for more information).
(approved by Senate on 29 January 2003)

In accord with McGill University's Charter of Students' Rights, students in this course have the right to submit in English or in French any written work that is to be graded.
(approved by Senate on 21 January 2009)

Grading Policy

In the Faculty of Engineering, letter grades are assigned according to the grading scheme adopted by the professor in charge of a particular course. This may not correspond to practices in other Faculty and Schools in the University.

In the event of extraordinary circumstances beyond the University's control, the content and/or evaluation scheme in this course is subject to change.

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CLASS SCHEDULE

Monday (lecture)	02:35 – 3:55 PM, SADB 1/12
Monday (tutorial)	4:05 – 4:55 PM, SADB 1/12
Wednesday (lecture)	02:35 – 3:55 PM, SADB 1/12

INSTRUCTOR

Professor Corinne A. Hoesli
Office: Wong 4230
Phone: 514-398-4275
Email: corinne.hoesli@mcgill.ca
Office hours: Wednesday 4:00 - 5:00 PM or by appointment

TEACHING ASSISTANTS (TAS)

Stephanie Fernandez (stephanie.fernandez@mail.mcgill.ca). OfficeWong7080. Lead contact for quizzes/bioinformatics.
Meghan Marshall (meghan.marshall2@mail.mcgill.ca). Office: Wong 7200. Lead contact for Lab 1.
Evelyne Kasparek (evelyne.kasparek@mail.mcgill.ca). Office: Wong 5160. Lead contact for Lab 2.

COMMUNICATION

myCourses (accessible via www.mcgill.ca/lms) will be used to distribute all course materials.

To ask any questions, please come to my office hours, make an appointment with me, drop by my office, or contact the TAs. For questions that may interest the whole class, please post a discussion thread on myCourses.

COURSE LEARNING OUTCOMES

- Comprehend the structure and function of basic biological compounds.
- Comprehend the reactions and processes involved in cell growth and gene expression.
- Comprehend genetic engineering strategies used to produce foreign proteins in cells.
- Develop enzyme kinetics models from first principles and apply the models obtained.
- Design, conduct and analyze molecular biotechnology experiments.
- Participate in teamwork during laboratories and presentations.
- Communicate experimental results and biotechnology concepts in written and oral reports.
- Understand the societal and economic impact of certain advances in biotechnology.
- Understand fundamental bioreactor design criteria for cell survival and growth.
- Locate external sources of information on biotechnology and engage in self-direction.

Course Organization

This course first introduces fundamental molecules involved in cell structure and function. The course then discusses methods to manipulate cells for applications in biotechnology. Finally, the course introduces fundamental notions in biochemical engineering, including enzyme kinetics, medium formulation and cell growth stoichiometry.

Cellular biology	Genetic engineering	Industrial biotechnology
Module 2. Biomolecules and cell structure	Module 5. Molecular cell biology • Central Dogma: replication, transcription, translation • Control of gene expression	Module 1. What is biotechnology?
Module 4. Metabolism and Bioenergetics • Bioenergetics • Glycolysis, fermentation, aerobic respiration	Module 6. Molecular biotechnology • Manipulation of DNA • DNA delivery vectors • Analytical techniques • Bioinformatics	Module 3. Enzyme kinetics • Michaelis-Menten kinetics • Modulation of enzyme activity Module 7. Introduction to biochemical engineering • Medium formulation • Cell growth stoichiometry • Sterilisation

Course Materials

Required reading consists of course handouts that will be provided at least two days prior to each class via myCourses. ©Instructor generated course materials (e.g., handouts, notes, summaries, exam questions, etc.) are protected by law and may not be copied or distributed in any form or in any medium without explicit permission from the instructor. Note that infringements of copyright can be subject to follow up by McGill University under the Code of Student Conduct and Disciplinary Procedures.

Laboratory Safety

WHMIS

Workplace Hazardous Materials Information System (WHMIS) training/exam is mandatory for all students registered in CHEE370. If you haven't completed this training yet (i.e. in CHEE291), 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 the 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)

Please consult myCourses regularly for an updated detailed schedule and exact due dates.

Week	Dates	Lecture Topic	Tutorial and/or lab	Due dates and notes
1	Sept 2 & 7	Module 1. Introduction to Biotechnology Module 2. Biomacromolecules and Cell Structure	No tutorial	Read Modules 1 – 2.1 Poster teams of 2 due
2	Sept 12 & 14	Module 2. Biomacromolecules and Cell Structure	Sample problems	Read Modules 2.2 – 2.6
3	Sept 19 & 21	Module 2. Biomacromolecules and Cell Structure September 21st: guest lecture by Nathalie Tufenkji	No tutorial	Read Module 2.7 Poster topic due
4	Sept 26 & 28	Module 3. Enzyme kinetics	Sample problems	Read Modules 3.1 – 3.5 *Sept 28: bring your laptop to class!*
5	Oct 3 & 5	Module 3. Enzyme kinetics Module 4. Metabolism & Bioenergetics	Enzyme kinetics lab	Read Modules 3.6 – 3.7 *Bring your laptop!* Lab 1: draft protocol due
6	Oct 12 (Oct 10 Thanksgiving holiday)	Module 4. Metabolism & Bioenergetics	No tutorial	Read Modules 4.1 – 4.4 Lab 1: final protocol due
7	Oct 17 & 19	Lecture: poster design Module 4. Metabolism & Bioenergetics	Feedback: enzyme kinetics protocol	Read Module 4.5 ***Laboratory 1 (all week)***
8	Oct 24 & 26	**October 24: Midterm Exam** Module 5. Molecular Biology of the Cell	**Midterm exam during tutorial**	Read Modules 4.6 – 4.7 ***Laboratory 1 (all week)***
9	Oct 31 & Nov 2	Module 5. Molecular Biology of the Cell	Bioinformatics exercise	Read Modules 5.1 – 5.2 **Pre-lab 2 quiz Nov. 2** Lab 1 report due
10	Nov 7 & 9	Module 5. Molecular Biology of the Cell	Bioinformatics exercise	Read Modules 5.3 – 5.4 Draft poster due ***Laboratory 2 (all week)***
11	Nov 14 & 16	Module 6. Molecular Biotechnology	No tutorial	Read Module 6 Lab 2 report due
12	Nov 21 & 23	Module 7. Introduction to Biochemical Engineering	Sample problems	Read Module 7 Bonus bioinformatics assignment due (optional)
13	Nov 28 & 30	**Nov 28: Poster Presentations** Module 7. Introduction to Biochemical Engineering	***Poster session***	
14	Dec 5	Review	Review	

EVALUATION AND ASSESSMENT*

Assessment	Weight
Quizzes • There will be 7 quizzes. The 5 best quiz grades will be counted towards the final mark (2% per quiz). If you miss more than 1 quiz for a valid reason (see below), the average quiz grade will be used instead. Quizzes will be in different formats (including quizzes on the reading assignments, pop quizzes, take-home quizzes) and dates will not be announced in advance. Quizzes will be handed out during the lectures.	10%
Laboratories (2) • There will be two laboratories. • Laboratory 1 will be worth 10% of the final mark. Laboratory 2 will be worth 5%. • The labs will take place Monday through Friday in the afternoon. A sign-up sheet will be available on myCourses to choose lab times. • The labs will take place in Wong 1180. • Laboratory 1 will require the submission of a draft lab protocol that will be graded prior to the lab. Laboratory 2 will require the completion of a pre-lab quiz. • Labs will be performed in groups of ~4 students. • Each lab evaluation will include both individually-graded and group-graded elements. • Each final laboratory report must consist of the following sections: objective, background information, methods, results, discussion, conclusions. • The individually-graded component of each laboratory report will consist of sample problems related to the laboratory theory and/or the pre-lab quiz.	15%
Poster presentation (1) • There will be one poster presentation by groups of ~4 students worth 10% of the final mark. • The poster presentation will take place November 28th, from 14h35 – 16h55. • The evaluation of the poster presentation will include peer evaluation (20%), evaluation by a group of experts (30%) and the evaluation of the professor (50%).	10%
Midterm exam • The midterm exam will take place October 24th in SABD 1/12., from 14h35 – 16h05. • The midterm exam will cover Modules 1-3. • The exam will consist of multiple-choice, short-answer and/or long-answer questions. • The exam is closed-book and closed-notes. Please bring a Faculty Standard Calculator.	25%
Final exam • The final exam will be cumulative (i.e. will cover all units). • The exam will consist of multiple-choice, short-answer and/or long-answer questions. • The exam is closed-book and closed-notes. Please bring a Faculty Standard Calculator.	40%
Optional Bioinformatics Assignment (bonus)	+2%

* Updated instructions, reading assignments, course materials and due dates will be posted on myCourses. No paper copies of course materials will be distributed apart from pop quizzes.

Policy for Missed Exams/Lab/Poster presentation: For students who miss an exam/lab/poster presentation for a valid reason (e.g. medical, accompanied by a valid medical note): the weight of the missed exam/lab/presentation will be added to the weight of the final examination.

ACADEMIC INTEGRITY

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LANGUAGE OF SUBMISSION

In accord with McGill University's Charter of Students' Rights, students in this course have the right to submit in English or in French any written work that is to be graded.

SUGGESTED READING/REFERENCES

The course content is based on the 3 textbooks listed below, in particular *Biochemistry* by Judith and Donald Voet. To complete the material covered in handouts posted on myCourses, students are strongly advised to consult these textbooks. Two to three copies of each textbook have been placed on reserve at the Schulich Library.

Alberts, B., A. Johnson, et al. (2008). Molecular Biology of the Cell, Garland Science, Taylor & Francis Group. ISBN: 978-0-8153-4105-5

Madigan, M. T., J. M. Martinko, et al. (2012). Brock Biology of Microorganisms. San Francisco, Pearson Education, Inc. ISBN: 978-0-321-64963-8

Voet, D. and J. G. Voet (2011). Biochemistry, John Wiley & Sons, Inc. ISBN: 978-0470-57095-1