

Course Outline
ChE 3BK3: Bio-Reaction Engineering
September - December, 2020

Instructor: Dr. Kim Jones

Non-useful contact info (this term): JHE-374; Ext. 26333

Useful contact info: kjones@mcmaster.ca; Bioreaction Engineering Team

Teaching Assistant: Varsha Singh; Email: singhv31@mcmaster.ca

Schedule: 3 lecture-hours per week (Monday and Wednesday: 2:30-3:20, Friday 4:30-5:20)

Learning Objectives: Understand the basics of -

- 1) Kinetics of cellular processes, microbial processes and enzyme reactions including those of immobilized cells and enzymes.
- 2) Cell culture. bioreactor design, operation, scale-up and control.
- 3) Bioprocess development including downstream processing.
- 4) Expression systems.

Objective: To provide students with an understanding of the fundamentals of biological processes, including biological reaction kinetics, and bioprocess design, scale-up and operation.

Course Text: M.L. Shuler, F. Kargi And M. DeLisa
Bioprocess Engineering: Basic Concepts
Third Edition, Prentice Hall, 2017

Web Page for Course: Avenue to Learn; MS Teams Bioreaction Engineering

Assessment: Problem Sets (10 @ 5% each) – 50%
Participation – 10%
Summary of Research Paper – 15%
Powerpoint presentation of research paper equations – 15%
Oral exam (open book) – 10%

Format for the Summary of Research Paper:

The objective of this activity is for you to get into the habit of reading, understanding, evaluating and simplifying cutting-edge research publications. A series of papers, from journals such as Science, Nature, Nature Biotechnology, will be made available to each student in the class. The student will then prepare a two page summary of the paper, where the main concepts of the work are explained and the significance of the work is highlighted. This is an individual project and not a group project. I feel that this is a very rich exercise in terms of being able to distill information from a high level publication and to communicate this efficiently to others, a critical set of skills in highly dynamic industries. Students may also choose their own papers from the field of biotechnology. These papers must have been cited at least 100 times and approved by me by the end of September.

Format for the Powerpoint Presentation of Research Paper Equations:

The objective of this activity is for you to be able to interpret and explain equations that you find in a peer-reviewed, recent bioprocessing research paper, making reference to this course. You

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will select a recent research paper that models cell behaviour (e.g. growth in bioreactors, synthetic biology etc.) and create a short “lesson” that is comprehensible by your classmates by the end of the term. You will record a ten minute voice-over Powerpoint presentation. You must have the paper approved by me by the end of October.

Participation:

In this virtual environment, I want to be sure you are really engaged. We will be working on problems in class (in Channels) and I’ll be looking for questions and responses in the Chat. If you cannot attend a class in real time, you must submit a three-line summary of the previous class, due before the start of the next class.

Oral exam:

Since it doesn’t really make sense to have written exams, we will plan for individual 30 minute oral exams during the exam period. I will ask conceptual questions (e.g. “How would you approach this problem? What equation(s) would you use? What other considerations are there?”).

Tentative Course Outline:

LECTURE PERIODS	ACTIVITIES	CHAPTERS IN SHULER AND F. KARGI
1	Introduction	
2-3	Applied microbiology (cell growth, nutrition, the “cell factory”)	Ch. 2
4-7	Enzymes (structure/function, kinetics, industrial enzymes)	Ch. 3
8-9	Gene expression, metabolic regulation	Ch.4
10-12	Cell growth (metabolism)	Ch. 5
13-15	Growth kinetics (batch & continuous growth kinetics, structured and unstructured models)	Ch. 6
16	Stoichiometry (microbial growth and product formation)	Ch. 7
17-22	Bioreactor design and operation (suspended and immobilized cultures)	Ch. 9
23-27	Scale-up and control of bioreactors (transport phenomena, instrumentation, sterilization, examples of large-scale bioprocesses)	Ch. 10
28	Overview of downstream processes (recovery and purification)	Ch. 11
29	Choice of expression system (microbial, mammalian, transgenic)	Ch. 12
30-34	Presentations	
35	Review	

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ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. **It is your responsibility to understand what constitutes academic dishonesty.**

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at <https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/>

The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

AUTHENTICITY/PLAGIARISM DETECTION

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. **All submitted work is subject to normal verification that standards of academic integrity have been upheld** (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

COURSES WITH AN ON-LINE ELEMENT

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

ONLINE PROCTORING

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/ software during tests or exams. This software may be required to be installed before the test/exam begins.

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CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the Code of Student Rights & Responsibilities (the “Code”). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online**.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students’ access to these platforms.

ACADEMIC ACCOMMODATION OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University’s Academic Accommodation of Students with Disabilities policy.

REQUESTS FOR RELIEF FOR MISSED ACADEMIC TERM WORK

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar “Requests for Relief for Missed Academic Term Work”.

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office **normally within 10 working days** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors. The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email

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The P.R.O.C.E.S.S.

As some of you may already be aware, the department of Chemical Engineering has a storied history of education. In addition to teaching and learning, the department is proud of our graduates not only for their academic success, but their more intrinsic traits that make them respected members of the engineering community.

Recently, several high-ranking graduates from the McMaster Chemical Engineering Program employed in various industries (oil/gas, financials, *etc.*) were interviewed to ask what traits they look for when hiring for engineering positions. Using this information, the department would like to present to you the **PROCESS**: a code of conduct that we hope will guide our students throughout this program and their careers to come.

- **P**rofessionalism
- **R**esponsibility
- **O**wnership
- **C**uriosity
- **E**mpathy (and Equity)
- **S**elflessness
- **S**ervice

It is up to YOU to interpret these traits and apply them to your time at McMaster and your career as you see fit. These traits will not be assessed for grades but will be strongly encouraged throughout your time at McMaster. We hope that you identify with these character traits and what they mean to you, and that you **trust the process**.