

# CHBE 481

## Bioprocess Engineering II

### Class Times

Lectures:		8:00 to 9:20 am	T, Th
Tutorials:	Weekly	2:00 to 4:00 pm	Mondays
(Starting Monday, Sept. 19)			

### Rooms

Lectures:	CHBE 1.03
Tutorials:	CHBE 1.03

### Instructor

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Office hours: 4 - 6"ish" pm, every Monday via Zoom

## COURSE RESOURCES

### Textbook

**Bioprocess Engineering: Basic Concepts**, 3<sup>rd</sup> Ed., M. Shuler, F. Kargi, M. DeLisa  
Note: If you own the 2<sup>nd</sup> edition of this book, that is fine and may be used. The course notes and modules (see below) will be your primary learning resource for the course, with the text providing useful supplementary content as needed.

### Additional Reference Texts (Available on-line via UBC Libraries)

- Turton, R., Shaeiwitz, J.A., Chemical Process Equipment Design, Prentice Hall, 2017. Ray Sinnott, Gavin Towler: "Chemical Engineering Design: SI Edition", 6th Edition, Elsevier Science & Technology (2020), ISBN: 978-0-08-102599-4.
- Joseph A. Shaeiwitz, Richard Turton, Wallace B. Whiting, Debangsu Bhattacharyya, "Analysis, Synthesis and Design of Chemical Processes", Prentice Hall (2018) ISBN: 0-13-417750-9, 978-0-13-417750-2.
- Hall. S.M. "Rules of Thumb for Chemical Engineers", 6th Edition, Elsevier, 2018.

### Course Notes (Reading Modules) and Lectures

The primary learning materials for the course are provided in a series of reading modules that will be made available to you via the course website on Canvas. The main content of each lecture will likewise be posted in PDF format on the course website for your use.

## WELCOME STATEMENT

Welcome back – I do hope you all are looking forward to this new academic year and the learning we will achieve together!

We acknowledge that UBC's Vancouver Point Grey campus is situated on the traditional, ancestral, unceded territory of the x'məθk'əy'əm (Musqueam) people.

## **COURSE GOALS, CONTENT, EXPECTATIONS, AND SCHEDULE**

### Course Abstract

Bioprocessing encompasses the many steps required to synthesize, isolate and formulate biological products. As with processing of chemical products, there is a great deal of diversity in bioprocessing methods, including the equipment and facilities required. However, several basic processing steps and types of equipment are utilized in the production of many biotech products, and together they can serve as a basis for understanding the engineering requirements for a safe and successful manufacturing process. This course will introduce you to typical process flow diagrams and associated unit operations for the production and downstream processing of biological products. The function and range of operability of common bioprocessing equipment will be examined to provide a sound basis for equipment selection. Finally, you will learn the engineering fundamentals and methods for describing, designing and scaling up major bioprocessing unit operations, including batch and fed-batch aerated fermentors, perfusion bioreactors (and their associated heat exchange, pumping and instrumentation systems), centrifuges and membrane-based separation systems, and solid-phase-extraction and chromatography columns.

### Key Learning Outcomes

- Learn the basic theory and operational steps of DNA cloning using plasmid vectors
- Understand the key unit operations and the underpinning theoretical concepts used to produce and purify biological products
- Learn how to design a process for manufacturing a biological product
- Develop general knowledge of the biotech industry
- Further develop skills in solving complex open-ended engineering problems

### Performance Assessment

2 Group Presentations	10%
1 Group Assignment and Design Report	20%
4 Individual Assignments	20%
Mid-Term Examination	20%
Final Examination	30%

All elements of the course will be graded on a numeric (percentage) basis, including individual homework assignments, the group presentations and group design assignment and report, and both examinations.

Both the mid-term examination and the final examination are written tests. Each exam is open book and open note, and you may use the course textbook, lecture notes and modules, as well as completed assignments in solving either exam.

Students are expected to complete and then submit each group and individual assignment at the start of class on the specified submission date. Late assignments will not be accepted unless a prior arrangement with the instructor has been made and agreed upon prior to that submission date.

### Academic Integrity

The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the breakdown of the academic enterprise, and therefore serious consequences arise and harsh sanctions are imposed. For example, incidences of plagiarism or cheating may result in a mark of zero on the assignment or exam and more serious consequences may apply if the matter is referred to the President's Advisory Committee on Student Discipline. Careful records are kept in order to monitor and prevent recurrences.

A more detailed description of academic integrity, including the University's policies and procedures, may be found in the Academic Calendar at <http://calendar.ubc.ca/vancouver/index.cfm?tree=3,54,111,0>.

### Course Delivery and Academic Concession Information

Over the past two years of the global pandemic, we've had to adapt our education approaches to follow BC Provincial Health Officer orders and reduce transmission of COVID, especially before vaccines were available to provide some protection.

Due to these Provincial orders, we used a number of strategies to adapt to conditions and requirements at the time. However, it has been the experience within CHBE and across UBC that when recorded classes were consistently available, in-person class attendance dropped markedly. This lower engagement in the classroom experience adversely affected student learning and performance.

Consequently, and in line with the rest of the university, the mode of instruction for this course will be in-person attendance and in-person instruction for all lectures, tutorials and exams. There may be some limited use of online elements to enhance student learning outcomes, but please be aware that in-person attendance is expected and will generally be required to perform well in this course.

It is therefore important for all to understand that lectures and tutorials will not be recorded for the course excepting special circumstances and agreements between the instructor and the affected student(s).

More specifically, an academic concession may be granted for a student when an unexpected situation or circumstance prevents them from attending class, completing graded work or exams.

Academic concessions may include:

- Later deadline for an assignment
- Make-up test or quiz
- [Deferred standing](#) for coursework and exams
- Late [withdrawal](#) from a course

For complete details on academic concessions, please visit the [UBC Academic Calendar](#).

# Course Outline

<b>Date</b>	<b>Type</b>	<b>Topic</b>
08/09	Lecture	Introductions and Brief Course Overview
13/09	Lecture	Recombinant DNA Technology
15/09	Lecture	Recombinant DNA Technology - HW Assignment 1 Posted
19/09	<b>Tutorial 1</b>	<b>Basics of Recombinant Gene Expression</b>
20/09	Lecture	Recombinant DNA Technology
22/09	Lecture	Recombinant DNA Technology
26/09	<b>Tutorial 2</b>	<b>Cloning and Bioprocess Flow Diagrams</b>
27/09	Lecture	Gene Cloning and Bioprocess Flow Diagrams - HW Assignment 1 Due at start of Class
29/09	Lecture	Design of Bioreactors - Bioreactor Design Project Posted (Group Project)
03/10	<b>Tutorial 3</b>	<b>381 Refresher - M&amp;E Balances in Bioreactors</b>
04/10	Lecture	Design of Bioreactors
06/10	Lecture	Design of Bioreactors
10/10	<b>Tutorial 4</b>	<b>No Tutorial - Thanksgiving</b>
11/10	Lecture	Design of Bioreactors
13/10	Lecture	Design of Bioreactors
17/10	<b>Tutorial 5</b>	<b>Bioreactor Design</b>
18/10	Lecture	Cell Harvesting Technology Basics
20/10	Lecture	Centrifugation
24/10	<b>Tutorial 6</b>	<b>No Tutorial - CCEC Conference (Vancouver)</b>
25/10	Lecture	Centrifugation (recorded lecture posted on Canvas)
27/10	Lecture	Filtration Technology - Basic Concepts - Bioreactor Design Reports Due @ Start of Class
31/10	<b>Tutorial 7</b>	<b>Bioreactor Design Presentations &amp; Mid-Term Review</b>
01/11	Lecture	Microfiltration Theory and Unit Operations
03/11	Lecture	Microfiltration Theory and Unit Operations
07/11	<b>Tutorial 8</b>	<b>Mid-Term Examination</b>
08/11	Lecture	Ultrafiltration Theory and Operations
10/11	Lecture	No Lecture Mid-Term Break
14/11	<b>Tutorial 9</b>	<b>Biomass Harvesting Operations Design</b>
15/11	Lecture	Ultrafiltration Theory and Operations
17/11	Lecture	Fundamentals of Chromatography
21/11	<b>Tutorial 10</b>	<b>Product Concentration Operations Design</b>
22/11	Lecture	Fundamentals of Chromatography
24/11	Lecture	Isocratic Elution Chromatography - SEC
28/11	<b>Tutorial 11</b>	<b>Chromatography Theory</b>
29/11	Lecture	Frontal Chromatography Theory and Modes
01/12	Lecture	Adsorptive Chromatography
05/12	<b>Tutorial 12</b>	<b>Chromatography Operations and Column Design</b>
06/12	Lecture	Adsorptive Chromatography and Course Wrap-up

## STUDENT INCLUSION AND RESOURCES

UBC is committed to a community in which every member is respected, included, and celebrated. Taking care of your health and wellbeing is important. [UBC Health & Wellness \(opens in a new window\)](#) is here to support wellness of mind, body, and spirit, and provides a range of clinical, counselling, and mental health services for students. [The Centre for Accessibility \(opens in a new window\)](#) facilitates educational equity for students with disabilities and chronic medical conditions. If you think you may need academic accommodations to meet the learning outcomes of this course and you have a disability please contact the Centre for Accessibility. If you're not sure that you qualify as having a disability but are concerned, the Centre for Accessibility can help clarify if you are eligible.

**Academic Advising** empowers students to take ownership of their education at UBC by offering personalized advising services in a supportive environment.

For CHBE-specific issues such as CHBE course registration and planning, you can connect with [CHBE Departmental staff \(opens in a new window\)](#). Drop-in meetings with and advising by CHBE staff is available through Zoom. Staff is available Monday to Friday from 9:00 am to 3:30 pm. You may also email your questions or requests for appointments to [undergrad@chbe.ubc.ca](mailto:undergrad@chbe.ubc.ca). Your email should include your student ID and the specific nature of your enquiry.

For issues beyond CHBE, such as academic concession, late withdrawals, SD exams, and letters of permission/completion, you can reach out to [Engineering Academic Services \(opens in a new window\)](#).

[First Nations Longhouse \(opens in a new window\)](#): The First Nations Longhouse serves as a “home away from home,” as well as an academic, social, spiritual, and cultural hub for Indigenous students attending UBC.

[Indigenous Liaison for the Faculty of Applied Science \(opens in a new window\)](#): Catherine McInnis is the designated advisor in Engineering Academic Services for Indigenous students in the Engineering program. faculty member in the position of the Indigenous Liaison for the School of Nursing. You can connect with her through the PD portal or email her directly with three suggested times you are available.  
Email: [catherine.mcinnis@ubc.ca](mailto:catherine.mcinnis@ubc.ca)

[International Student Advising \(opens in a new window\)](#) provides advising and resources to assist International students in navigating immigration, health insurance, and settlement matters.

UBC's Equity & Inclusion Office provides information about [accessible and all-gender washrooms on campus \(opens in new window\)](#). Information about how to update [legal and preferred names \(opens in a new window\)](#) can be found on the Student Services website. [UBC Trans and Non-binary Student Guide \(opens in a new window\)](#) was written

in Summer 2020 and describes resources and support on campus for trans and non-binary students.

[The Office of the Ombudsperson \(opens in a new window\)](#) works with all UBC community members to ensure students are treated fairly and can learn, work, and live in a fair, equitable and respectful environment. If you have concerns about relevant UBC policies and/or processes, an Ombuds Officer can identify and explain policies and guide you in exploring options for directly and effectively dealing with your concerns.

The [Sexual Assault Support Center \(SASC\) \(opens in a new window\)](#) is committed to the education, support, and empowerment of people of all genders who are survivors of sexualized violence, as well as their friends and family.