CHEN 4930 Biopharmaceutical Process Laboratory

Instructor: Aaron Moment, ajm2293@columbia.edu, Mudd 803

TAs:

Location: ET380 and Carleton Lab. Please go to the Carleton lab for required safety briefing, lab tours, and introductions.

Prerequisites: Organic Chemistry Lab I, Undergraduate Organic Chemistry

Course Description: This laboratory based course is intended for junior and senior undergraduates and graduate students interested in gaining hands-on experience in biopharmaceutical processing. The exercises relate directly to processes and unit operations applied widely in the biopharmaceutical industry, including tableting, dissolution, disintegration, fermentation, chromatography, tangential flow filtration, mixing, and crystallization. The connections between process parameters, chemical and molecular properties, process performance, and product attributes will be illustrated through a combination of discussions in lab, experiments, and report writing.

Course Significance: This course provides students with hands on skills and direct understanding of several important pharmaceutical production techniques from both small molecule and macromolecule biologics perspectives. ABET outcomes 1,2, 5, and 6 are directly addressed by this class, especially 5 and 6.

ABET student outcome 5: An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

ABET student outcome 6: An ability to conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions.

Logistics: The lab activities are scheduled in a 2.5 hr block Tuesdays from 1.10 pm to 3.40 pm. There are **three students** per lab group, and your group will be working in the lab in **six total instances**, alternating with other groups. In other words you will **cycle one week on/ one week off in lab**. Your lab report is due the Friday of the off week, and you group is expected to work on the lab report during the off week.

Location: The primary location of the lab activities will be in ETA380. The module in tableting and compaction will be run in the Carleton Lab utilizing the MTS Universal Testing Instrument.

Office hr: There are no formal office hr. You are welcome to come to the lab sessions in your off week to ask questions, and are encouraged to discuss the material and ask questions during lab time.

Safety: Lab safety is part of this course, and is not optional. You are required to complete the training listed below before starting your lab modules. Wear lab goggles and gloves at all times, and lab coats as necessary. Safety is first and look out for your lab mates.

1. Through Rascal (https://www.rascal.columbia.edu)
   1.1. Carleton Lab Site-Specific Training (TC2600)
   1.2. Machine Shop Safety Training (TC0600)
2. ***In person*** EH&S Laboratory Safety/Chemical Hygiene/Hazardous Waste/Laboratory Fire Safety Training provided on 21 Jan at 1.10 pm in Carleton Lab (https://research.columbia.edu/safety-trainings)
3. ***In person*** first day walkthrough on 21 Jan at 1.10 pm in Carleton, then to ET380.

Access Form: Please fill out after completing your training: https://carleton.columbia.edu/access

TAs: The TAs play a big role in this class and there are multiple. One TA will be stationed in the Carleton Lab and the other in A380. Please talk to them about your lab set ups and the lab work. We also have additional volunteer TAs who may be supporting individual activities such as protein purification or crystallization.

Quizzes: There will be a 10 minute quiz before each lab module to test if you read and understood basic elements of the module before starting.

Modules:

1. Tableting, Mechanical Properties
   1.1. Use of MTS Universal Testing machine to make tablets and measure their mechanical properties on student designed formulations
2. Pharmaceutical Properties of Solid Oral Dosage Forms
   2.1. Measurement of biopharmaceutical properties with dissolution and disintegration
3. Protein Purification with Chromatography
   3.1. Cation Exchange
   3.2. Gradient Elution
4. Tangential Flow Filtration
   4.1. Separation of solutes based on molecular size
   4.2. MWCO and membrane permeability
   4.3. Buffer Exchange and Concentration
5. Bioreactor kLa
   5.1. Measurement of kLa, the gas liquid mass transfer coefficient
6. Crystallization of alpha and beta glutamic acid from monosodium glutamate
   6.1. Measurement of induction time for nucleation vs. supersaturation
   6.2. Determination of crystal from via XRD/ DSC
   6.3. Particle size analysis and Optical Microscopy

Grading:
85%: Group lab reports are due the Friday of your "off week."
10%: Quizzes are ~ 10 minutes and administered in the lab to each student before starting the

session. These are generally multiple choice and involve materials to be covered in the lab that day, as well as safety questions.
5% participation, e.g. asking questions, being present, and engaging with the TA and the instructor.

Required Texts:
Laboratory Manuals and supplementary readings provided via Courseworks.

Schedule:

CHEN 4930 Planning

Group No	1	2	3	4	5	6	7
Date							
21-Jan	SAFETY FOR ALL						
28-Jan	CTS		TFF		PP		kLa
4-Feb		CTS		TFF		PP	
11-Feb	Dis		CTS		TFF		PP
18-Feb	(Siyan PP)	Dis		CTS		TFF	
25-Feb	X		Dis		CTS		TFF
3-Mar		X		Dis		CTS	
10-Mar	ON LINE TRANSITION						
24-Mar							
31-Mar	PP	kLa	kLa	X	X	Dis	CTS
7-Apr							
14-Apr	TFF	PP	PP	kLa	kLa	X	DIS
21-Apr							
28-Apr	kLa	TFF	X	PP	Dis	Kla	X

CTS	Compaction Tensile Strength
Dis	Disso/ Disintegration
X	Crystallization
kLa	Mass Transfer Coefficient
PP	Protien Purification
TFF	Tangential Flow Filtration

Equipment:

1. MTS Universal Testing (Carleton Lab)
2. Keyence Microscope (Carleton Lab)
3. Spinner Bioreactors (ET A380)
4. Dissolved Oxygen Probe (ET A380)
5. Conductivity Probe (ET A380)
6. UV-VIS (ET A380) for concentration determination
7. AKTA Start (ET A380) for protein purification and columns
8. Tangential Flow Filtration Membrane cartridges and pumps (ET A380)

9. Crystallization Vessels (ET A380)
10. Optical Polarizing Microscope (ET A380)
11. DSC/ XRD from shared facilities (Havermeyer 5th floor, samples run by TA)