



**University of Nebraska – Lincoln**  
**Department of Biological Systems Engineering**  
**BSEN 446/846 – Unit Operations of Biological Processing**

Lecture: M 12:30 – 14:20 • Discussion: W 13:00 – 14:20  
Room 110, Chase Hall, UNL East Campus

**INSTRUCTOR:** Dr. Mary-Grace C. Danao  
**OFFICE:** 244 Food Innovation Center on Nebraska Innovation Campus  
**OFFICE HOURS:** By appointment  
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### Course Description and Objectives

Application of heat, mass, and moment transport in analysis and design of unit operations for biological and agricultural materials. Evaporation, drying, distillation, extraction, leaching, thermal processing, membrane separation, centrifugation, and filtration. At the end of the course, students will be knowledgeable of the...

- variety of unit operations used in processing agricultural and food products,
- importance of properties of biological materials, and
- utility of principles of transport phenomena in guiding process of design.

**Pre-requisites:** AGEN/BSEN 225 – Engineering Properties of Biological Materials (3 credit hours)  
AGEN/BSEN 344 – Biological and Environmental Transport Processes (3 credit hours)

### Course Resources and Required Materials

**Course website:** <http://canvas.unl.edu>  
**Required textbook:** Geankoplis, C.J. (2003). *Transport Processes and Separation Process Principles*. 4<sup>th</sup> Edition. Upper Saddle River, NJ: Pearson Education, Inc.  
Available online through [UNL Libraries](#).

**References:** Geankoplis CJ, Lepek D, Hersel A (2018). *Transport Processes and Separation Process Principles* (5<sup>th</sup> edition). Upper Saddle River, NJ: Pearson Education, Inc.  
Toledo RT. (2006). *Fundamentals of Food Engineering* (3<sup>rd</sup> edition). New York, NY: Springer Science + Business Media, LLC.  
McCabe WL, Smith JC, Harriott P (2014). *Unit Operations of Chemical Engineering* (7<sup>th</sup> edition). New York, NY: McGraw-Hill.

**Required materials:** Binder, engineering paper and scientific calculator. All class notes (slides) and handouts are available on Canvas course webpage.

### Course Policies and Grading

**Attendance.** All lecture materials and handouts will be available on Canvas. Students are expected to stay on top of reading and lecture materials to prepare for weekly discussion sessions. In the event that a student finds it necessary to be absent from class, it is the student's responsibility to inform the instructor and to make up resulting deficiencies.

**Academic Honesty.** Academic honesty is essential to the existence and integrity of an academic institution. The responsibility for maintaining that integrity is shared by all members of the academic community. The [University's Student Code of Conduct](#) addresses academic dishonesty. Students who commit acts of academic dishonesty are subject to disciplinary action and are granted due process and the right to appeal any decision.

**Course grade.** The grade favors those who consistently keep up with the assigned reading material and homework and actively participates in class discussions. Course grade will be based on the following percentages:

Evaluation	Portion of the Grade		Grading Scale		
	BSEN 446	BSEN 846			
Worksheets	40%	20%	A- = 90 – 93%	A = 94 – 97%	A+ = 98 – 100%
Exam 1	30%	30%	B- = 80 – 83%	B = 84 – 86%	B+ = 87 – 89%
Exam 2	30%	30%	C- = 70 – 73%	C = 74 – 76%	C+ = 77 – 79%
Project	---	20%	D- = 60 – 63%	D = 64 – 66%	D+ = 67 – 69%
			F = 59% and below		

**Assignments.** All work must be done on engineering paper and legible. Illegible work will be returned to the student and will not be graded.

**Worksheets** are due at the beginning of the following in-person discussion session. Solutions will be posted on the course website one week after the due date. Late work will be accepted only until the solutions are posted.

**Two exams (both take-home)** are scheduled for this course. Exam 1 will cover material from Chapters 8, 9 and 10 and is due on Monday, March 6<sup>th</sup>. Exam 2 will cover material from Chapters 12, 13, and 14 and will be due on Wednesday, May 10<sup>th</sup>. *No late exams will be accepted.*

**Project.** Graduate students are required to design a food, agricultural, or biologics production facility for a small startup company or business using SuperPro Designer software for their course project. The software is available in the computers in Chase Hall Room 110. Use the software to develop a process flow diagram, incorporating all the unit operations needed to use for production, and generate a full report and 20-30 minute presentation to the class.

**Wellness Day (March 8<sup>th</sup>).** The University encourages instructors to temporarily reduce or redistribute, at their own discretion, the academic workload for their courses to allow for periods of less intense course requirements during the semester. Students may use these days to catch up on other assignments or simply have a “break” from the intense, condensed nature of the semester.

**Instructional Continuity Plan.** If/when in-person classes are canceled (e.g., due to inclement weather), students will be notified of the instructional continuity plan for this class via an announcement on the course website (<http://canvas.unl.edu>) and their @huskers.unl.edu email. This class has been designed so that students can proceed with viewing course materials and completing assignments independently.

### Services for Students with Disabilities

The University strives to make all learning experiences as accessible as possible. If a student anticipates or experiences barriers based on their disability (including mental health, chronic or temporary medical conditions), please let the instructor know immediately so that options to complete assessments can be discussed privately. To establish reasonable accommodations, the instructor may request that the student

register with [Services for Students with Disabilities \(SSD\)](#). If a student is eligible for services and register with SSD, the student should let the instructor know about the arrangements with SSD as soon as possible so that accommodations can be implemented in a timely manner. For more information on SSD services, please call 402-472-3787 or e-mail [ssddocumentation@unl.edu](mailto:ssddocumentation@unl.edu).

## Counseling and Psychological Services

UNL offers a variety of options to students to aid them in dealing with stress and adversity. [Counseling and Psychological & Services \(CAPS\)](#) is a multidisciplinary team of psychologists and counselors that works collaboratively with Nebraska students to help them explore their feelings and thoughts and learn helpful ways to improve their mental, psychological and emotional well-being when issues arise. CAPS can be reached by calling 402-472-7450.

[Big Red Resilience & Well-Being \(BRRWB\)](#) provides one-on-one well-being coaching to any student who wants to enhance their well-being. Trained well-being coaches help students create and be grateful for positive experiences, practice resilience and self-compassion, and find support as they need it. BRRWB can be reached by calling 402-472-8770.

## Classroom Emergency Preparedness and Response Information

- If the fire alarm is activated, instructors and students should exit the building by the nearest safe exit.
- If it is a weather emergency (e.g., tornado), instructors and students should follow the instructions for Chase Hall.
- For other emergency situations, consider the following:
  - If immediate evacuation seems to be the best option, students should evacuate using the closest exits away from the source of the emergency. Students should hold hands in the air when exiting the building.
  - If immediate evacuation does not appear to be safe or feasible, consider one of these options:
    - If the room has a solid door with a lock, lock the door. If there is a second door in the room, also lock that door.
    - Turn off the lights.
    - Stay low and away from the door.
    - Silence cell phones and stay quiet.
    - If the room is unable to be locked, consider whether a door that opens inward can be blocked.
    - If the room is unable to be locked or the door blocked, consider having personnel hide in locations where appropriate.
  - When the emergency is over and the group is exiting, move slowly and hold their hands in the air.

## Tentative Spring 2023 Course Schedule (updated 1/23/2023)

*This schedule is subject to change. If/when in-person classes are canceled (e.g., due to inclement weather), students will be notified of the instructional continuity plan for this class via an announcement on the course website (<http://canvas.unl.edu>) and their @huskers.unl.edu email.*

	Date	Class Topic and Activity	Reading Assignment	What's Due?
M	23 Jan	Course introduction	Sections 8.1 – 8.4	
W	25 Jan	Chapter 8 – Evaporation	Sections 8.5 – 8.8	
M	30 Jan			Worksheet 1
W	1 Feb	Chapter 9 – Drying of Process Materials	Sections 9.1 – 9.4	
M	6 Feb			Worksheet 2
W	8 Feb		Sections 9.5 – 9.7	
M	13 Feb			Worksheet 3
W	15 Feb		Sections 9.8 – 9.10	
M	20 Feb	Chapter 10 – Stage and Continuous Gas-Liquid Separation Processes		Worksheet 4
W	22 Feb		Sections 10.1 – 10.3	
M	27 Feb	Chapter 10		Worksheet 5
W	1 Mar	Chapter 10	Sections 10.4 – 10.6	
M	6 Mar	<i>No class: Work on Exam 1</i>		Exam 1
W	8 Mar	<i>Wellness Day: No class</i>		
M	13 Mar	<i>Spring Vacation: No class</i>		
W	15 Mar	<i>Spring Vacation: No class</i>		
M	20 Mar	Chapter 12 – Liquid-Liquid and Fluid-Solid Separation Processes		
W	22 Mar		Sections 12.1 – 12.3	
M	27 Mar	Chapter 12		Worksheet 6
W	29 Mar	Chapter 12	Sections 12.4 – 12.5	
M	3 Apr	Chapter 12		Worksheet 7
W	5 Apr	Chapter 12	Sections 12.7 – 12.8	
M	10 Apr	Chapter 13 – Membrane Separation Processes		Worksheet 8
W	12 Apr		Sections 13.1 – 13.4	
M	17 Apr			Worksheet 9
W	19 Apr		Sections 13.9 – 13.11	
M	24 Apr	Field trips		Worksheet 10
W	26 Apr			
M	1 May	Chapter 14 – Mechanical-Physical Separation Systems		
W	3 May		Sections 14.1 – 14.5	
M	8 May	Class project presentation		
W	10 May	<i>No class: Work on Exam 2</i>		Exam 2

## Remaining Spring 2023 Course Schedule (updated 3/22/2023)

This schedule is subject to change. If/when in-person classes are canceled (e.g., due to inclement weather), students will be notified of the instructional continuity plan for this class via an announcement on the course website (<http://canvas.unl.edu>) and their @huskers.unl.edu email.

Date	Class Topic and Activity	Reading Assignment	What's Due?
M 20 Mar	Chapter 10 – Stage and Continuous Gas-Liquid Separation Processes	Section 10.5	
W 22 Mar		Section 10.6	
M 27 Mar	Chapter 12 – Liquid-Liquid and Fluid-Solid Separation Processes		Worksheet 5
W 29 Mar		Sections 12.1 – 12.3	
M 3 Apr		Sections 12.4 – 12.5	Worksheet 6
W 5 Apr			
M 10 Apr		Sections 12.7 – 12.8	Worksheet 7
W 12 Apr	Field trip: ADM Soybean Crush Facility		
M 17 Apr	Field trip: Novozymes		Worksheet 8
W 19 Apr	Chapter 13 – Membrane Separation Processes		
M 24 Apr		Sections 13.1 – 13.4	Worksheet 9
W 26 Apr		Sections 13.9 – 13.11	
M 1 May	Chapter 14 – Mechanical-Physical Separation Systems Narrated slides – Dr. Danao is out of town.		Worksheet 10
W 3 May	Narrated slides – Dr. Danao is out of town.	Sections 14.1 – 14.5	
M 8 May	Class project presentation		
W 10 May	No class: Work on Exam 2		Exam 2