Chemical Engineering (BS): Biomanufacturing Sciences Concentration

To see more about what you will learn in this program, visit the Learning Outcomes website (https://apps.oirp.ncsu.edu/pgas/)!

The Biomanufacturing Sciences Concentration provides students with the knowledge base and hands-on skills that prepare them to quickly contribute to a biomanufacturing operation. Pharmaceuticals, vaccines, enzymes, and bio-fuels are example products. Students completing this concentration also fulfill the requirements for a Minor in Biomanufacturing.

Plan Requirements

First Year		
Fall Semester		**Hours**
CH 101 or CH 103	Chemistry - A Molecular Science [1] or General Chemistry I for Students in Chemical Sciences	3
CH 102 or CH 104	General Chemistry Laboratory [1] or General Chemistry Laboratory I for Students in Chemical Sciences	1
E 101	Introduction to Engineering & Problem Solving [2]	1
E 115	Introduction to Computing Environments	1
MA 141	Calculus I [1]	4
ENG 101	Academic Writing and Research [2]	4
	Hours	**14**
Spring Semester		
CH 201 or CH 203	Chemistry - A Quantitative Science [2] or General Chemistry II for Students in Chemical Sciences	3
CH 202 or CH 204	Quantitative Chemistry Laboratory [2] or General Chemistry Laboratory II for Students in Chemical Sciences	1
MA 241	Calculus II	4
PY 205 & PY 206	Physics for Engineers and Scientists I and Physics for Engineers and Scientists I Laboratory [1]	4
Select one of the following Economics Courses:		3
ARE 201	Introduction to Agricultural & Resource Economics	
ARE 201A	Introduction to Agricultural & Resource Economics	
EC 201	Principles of Microeconomics	
EC 205	Fundamentals of Economics	
E 102	Engineering in the 21st Century	2
	Hours	**17**
Second Year		
Fall Semester		
CH 221 or CH 225	Organic Chemistry I [2] or Organic Chemistry I for Students in Chemical Sciences	3
CH 222 or CH 226	Organic Chemistry I Lab [2] or Organic Chemistry Laboratory I for Students in Chemical Sciences	1
CHE 205	Chemical Process Principles [2]	4
MA 242	Calculus III [2]	4
PY 208 & PY 209	Physics for Engineers and Scientists II and Physics for Engineers and Scientists II Laboratory	4
BEC 220	Introduction to Drug Development and Careers in Biomanufacturing	1
	Hours	**17**
Spring Semester		
CH 223 or CH 227	Organic Chemistry II or Organic Chemistry II for Students in Chemical Sciences	3
CH 224 or CH 228	Organic Chemistry II Lab or Organic Chemistry Laboratory II for Students in Chemical Sciences	1
CHE 225	Introduction to Chemical Engineering Analysis [2]	3
MA 341	Applied Differential Equations I [2]	3
BIO 183	Introductory Biology: Cellular and Molecular Biology	4
	Hours	**14**
Third Year		
Fall Semester		
CHE 311	Transport Processes I [2]	3
CHE 315	Chemical Process Thermodynamics [2]	3
BCH 451	Principles of Biochemistry	4
BEC 425	Molecular Biology for Biomanufacturing	2
BEC 463	Fermentation of Recombinant Microorganisms	2
	Hours	**14**
Spring Semester		
CHE 312	Transport Processes II	3
CHE 316	Thermodynamics of Chemical and Phase Equilibria	3
BBS 426	Upstream Biomanufacturing Laboratory	2
BEC 330	Principles and Applications of Bioseparations	2
	Hours	**10**
Fourth Year		
Fall Semester		
CHE 395	Professional Development Seminar	1
CHE 446	Design and Analysis of Chemical Reactors	3
CHE 450	Chemical Engineering Design I	3
BEC 436	Introduction to Downstream Process Development	2
BEC 480 or BEC 485	cGMP Fermentation Operations or cGMP Downstream Operations	2
	Hours	**11**
Spring Semester		
CHE 448	Bioreactor Design	2
CHE 435	Process Systems Analysis and Control	3

CHE 451	Chemical Engineering Design II	3
Biomanufacturing Elective (p. 2)		2
Bioethics Elective (p. 2)		3
	Hours	**13**
	Total Hours	**110**

[1] A grade of C or higher is required.
[2] A grade of C- or higher is required.

Code	Title	Hours	Counts towards
GEP Courses			
GEP Humanities (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-humanities/)		6	
GEP Social Sciences (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-social-sciences/)		3	
GEP Health and Exercise Studies (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/)		2	
GEP US Diversity, Equity, and Inclusion (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-usdei/)		3	
GEP Global Knowledge (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-global-knowledge/) (verify requirement)			
Foreign Language Proficiency (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/foreign-language-proficiency/) (verify requirement)			
Free Electives			
Free Electives (12 Hr S/U Lmt) [1]		3	
Total Hours		**17**	

[1] Students should consult their academic advisors to determine which courses fill this requirement.

Biomanufacturing Electives

Code	Title	Hours	Counts towards
BEC 445	Cell Line Development for Biomanufacturing	2	
or BEC 545	Cell Line Development for Biomanufacturing		
BEC 462	Fundamentals of Bio-Nanotechnology	3	
BEC 475	Global Regulatory Affairs for Medical Products	3	
or BEC 575	Global Regulatory Affairs for Medical Products		
BEC 480	cGMP Fermentation Operations	2	
or BEC 580	cGMP Fermentation Operations		
BEC 483	Tissue Engineering Technologies	2	
or BME 483	Tissue Engineering Technologies		
BEC 485	cGMP Downstream Operations	2	
or BEC 585	cGMP Downstream Operations		
BEC 488	Animal Cell Culture Engineering	2	
BEC 497	Biomanufacturing Research Projects	1-3	

Bioethics Electives

Code	Title	Hours	Counts towards
IDS 201	Environmental Ethics	3	
IDS 303	Humans and the Environment	3	
NR 303	Humans and the Environment	3	
PHI 325	Bio-Medical Ethics	3	
STS 302	Contemporary Science, Technology and Human Values	3	
STS 304	Ethical Dimensions of Progress	3	
STS 325	Bio-Medical Ethics	3	

Semester Sequence

This is a sample.

First Year		
Fall Semester		**Hours**
CH 101	Chemistry - A Molecular Science [1]	3
or CH 103	or General Chemistry I for Students in Chemical Sciences	
CH 102	General Chemistry Laboratory [1]	1
or CH 104	or General Chemistry Laboratory I for Students in Chemical Sciences	

E 101	Introduction to Engineering & Problem Solving [1]	1
E 115	Introduction to Computing Environments	1
ENG 101	Academic Writing and Research [1]	4
MA 141	Calculus I	4
GEP Health and Exercise Studies (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/)		1
	Hours	**15**
Spring Semester		
CH 201 or CH 203	Chemistry - A Quantitative Science [2] or General Chemistry II for Students in Chemical Sciences	3
CH 202 or CH 204	Quantitative Chemistry Laboratory or General Chemistry Laboratory II for Students in Chemical Sciences	1
MA 241	Calculus II [1]	4
PY 205	Physics for Engineers and Scientists I [1]	3
PY 206	Physics for Engineers and Scientists I Laboratory [1]	1
E 102	Engineering in the 21st Century	2
GEP Health and Exercise Studies (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/)		1
	Hours	**15**
Second Year		
Fall Semester		
BEC 220	Introduction to Drug Development and Careers in Biomanufacturing	1
CH 221 or CH 225	Organic Chemistry I [2] or Organic Chemistry I for Students in Chemical Sciences	3
CH 222 or CH 226	Organic Chemistry I Lab or Organic Chemistry Laboratory I for Students in Chemical Sciences	1
CHE 205	Chemical Process Principles	4
MA 242	Calculus III	4
PY 208	Physics for Engineers and Scientists II	3
PY 209	Physics for Engineers and Scientists II Laboratory	1
	Hours	**17**
Spring Semester		
BIO 183	Introductory Biology: Cellular and Molecular Biology	4
CH 223 or CH 227	Organic Chemistry II or Organic Chemistry II for Students in Chemical Sciences	3
CH 224 or CH 228	Organic Chemistry II Lab or Organic Chemistry Laboratory II for Students in Chemical Sciences	1
CHE 225	Introduction to Chemical Engineering Analysis [2]	3
MA 341	Applied Differential Equations I [2]	3
Select one of the following:		3
EC 205	Fundamentals of Economics	
EC 201	Principles of Microeconomics	
ARE 201	Introduction to Agricultural & Resource Economics	
	Hours	**17**
Third Year		
Fall Semester		
BCH 451	Principles of Biochemistry	4
BEC 425	Molecular Biology for Biomanufacturing	2
BEC 463	Fermentation of Recombinant Microorganisms	2
CHE 311	Transport Processes I [1]	3
CHE 315	Chemical Process Thermodynamics [1]	3
GEP Requirement (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/)		3
	Hours	**17**
Spring Semester		
BEC 426	Upstream Biomanufacturing Laboratory	2
BEC 330	Principles and Applications of Bioseparations	2
CHE 312	Transport Processes II	3
CHE 316	Thermodynamics of Chemical and Phase Equilibria	3
Free Elective		3
GEP Requirement (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/)		3
	Hours	**16**
Fourth Year		
Fall Semester		
BEC 436	Introduction to Downstream Process Development	2
BEC 480 or BEC 485	cGMP Fermentation Operations or cGMP Downstream Operations	2
CHE 395	Professional Development Seminar	1
CHE 446	Design and Analysis of Chemical Reactors	3
CHE 450	Chemical Engineering Design I	3
GEP Requirement (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/)		3
	Hours	**14**
Spring Semester		
Biomanufacturing Elective (p. 2)		2
CHE 448	Bioreactor Design	2
CHE 435	Process Systems Analysis and Control	3
CHE 451	Chemical Engineering Design II	3
Bioethics Elective (p. 2)		3
GEP Requirement (http://catalog.ncsu.edu/undergraduate/gep-category-requirements/)		3
	Hours	**16**
	Total Hours	**127**

[1] A grade of C or higher is required.
[2] A grade of C- or higher is required.

Career Opportunities

Careers in chemical engineering are sometimes exciting, always demanding, and ultimately provide a sense of accomplishment and achievement. Graduates find employment in sub-disciplines such as production, technical service, sales, management and administration; research and development; and consulting and teaching. Students desiring careers in teaching, research, or consulting are encouraged to continue their education and pursue a graduate degree (consult the Graduate Catalog). The undergraduate curriculum also provides strong preparation for graduate study in a wide range of professional specialties, and chemical engineering graduates often pursue careers in the medical sciences, business management, and law.