Biomanufacturing (MR)

Degree Requirements

Students may choose from the degree tracks below to complete coursework within a subplan area.

A 150 hour internship or co-op experience is required to complete the degree.

Degrees earned will be distributed as: "Master of Biomanufacturing."

Code	Title	Hours
Core Courses		**14**
BEC 575	Global Regulatory Affairs for Medical Products	
BEC 577	Advanced Biomanufacturing and Biocatalysis	
BEC 590	Industry Practicum in Biomanufacturing	
ST 511	Statistical Methods For Researchers I	
or ST 515	Experimental Statistics for Engineers I	
BEC 515	Biopharmaceutical Product Characterization Techniques	
or BEC 588	Animal Cell Culture Engineering	
Specialization		**6**
Students will select an upstream or downstream specialization.		
Upstream Specialization:		
BEC 563	Fermentation of Recombinant Microorganisms	
BEC 526	Upstream Biomanufacturing Laboratory	
BEC 580	cGMP Fermentation Operations	
OR		
Downstream Specialization:		
BEC 532	Foundations of Downstream Processing and Formulation	
BEC 536	Introduction to Downstream Process Development	
BEC 585	cGMP Downstream Operations	
Subplan		**10-16**
Select a Subplan listed under "Subplan" below		
Total Hours		**30-36**

Subplans

Students must select one subplan option.

Code	Title	Hours
Subplan 1: Professional Science Masters		**16**
BEC 601	Biomanufacturing Seminar (BEC 601 must be taken twice)	
BEC 620	Leadership and Preparation for Industry Internship in Biomanufacturing	
BUS 554	Project Management	
MBA/BUS 5xx Electives (6 Hours)		
Advised Elective (3 Hours)		
Total Hours		**16**

OR

Code	Title	Hours
Subplan 2: Industry Focus		**16**
BEC 601	Biomanufacturing Seminar (BEC 601 must be taken twice)	
BEC 620	Leadership and Preparation for Industry Internship in Biomanufacturing	
BUS 554	Project Management	
COP 501	Co-Op Work Graduate PAR (3 Hours)	
MBA/BUS 5xx Electives (3 Hours)		
Advised Elective (3 Hours)		
Total Hours		**16**

OR

Code	Title	Hours
Subplan 3: Accelerated Bachelors and Masters		**10**
Advised Electives - See your advisor		
Total Hours		**10**

Accelerated Bachelor's/Master's Degree Requirements

The Accelerated Bachelor's/Master's (ABM) degree program allows exceptional undergraduate students at NC State an opportunity to complete the requirements for both the Bachelor's and Master's degrees at an accelerated pace. These undergraduate students may double count up to 12 credits and obtain a non-thesis Master's degree in the same field within 12 months of completing the Bachelor's degree,

This degree program also provides an opportunity for the Directors of Graduate Programs (DGPs) at NC State to recruit rising juniors in their major to their graduate programs. However, permission to pursue an ABM degree program does not guarantee admission to the Graduate School. Admission is contingent on meeting eligibility requirements at the time of entering the graduate program.

Students must complete a total of 30 credit hours to complete the degree. Students who have already taken the 400 level of a course required for the master degree will be required to replace the hours with Advised Electives. Students will choose a specialization area in either upstream or downstream.

A 150 hour internship is required to complete the degree.

Degrees earned will be distributed as: "Master of Biomanufacturing" without a subplan designation.

Code	Title	Hours
Core Courses		**16**
BEC 515	Biopharmaceutical Product Characterization Techniques	
or BEC 588	Animal Cell Culture Engineering	
BEC 575	Global Regulatory Affairs for Medical Products	
BEC 577	Advanced Biomanufacturing and Biocatalysis	
BEC 590	Industry Practicum in Biomanufacturing	
BEC 620	Leadership and Preparation for Industry Internship in Biomanufacturing [1]	
ST 511	Statistical Methods For Researchers I	
or ST 515	Experimental Statistics for Engineers I	

Specialization		**6**
Students must take 6 credits from either the Upstream Specialization or Downstream Specialization below.		
Upstream Specialization:		
BEC 563	Fermentation of Recombinant Microorganisms	
BEC 526	Upstream Biomanufacturing Laboratory	
BEC 580	cGMP Fermentation Operations	
Downstream Specialization:		
BEC 532	Foundations of Downstream Processing and Formulation [2]	
BEC 536	Introduction to Downstream Process Development	
BEC 585	cGMP Downstream Operations	
Advised Electives		**8**
BEC 515	Biopharmaceutical Product Characterization Techniques	
BEC 525	Molecular Biology for Biomanufacturing	
BEC 526	Upstream Biomanufacturing Laboratory	
BEC 532	Foundations of Downstream Processing and Formulation [2]	
BEC 536	Introduction to Downstream Process Development	
BEC 545	Cell Line Development for Biomanufacturing	
BEC 562	Fundamentals of Bio-Nanotechnology	
BEC 563	Fermentation of Recombinant Microorganisms	
BEC 580	cGMP Fermentation Operations	
BEC 585	cGMP Downstream Operations	
BEC 588	Animal Cell Culture Engineering	
BEC 595	Special Topics in Biomanufacturing	
BEC 601	Biomanufacturing Seminar	
BEC 669	Biomanufacturing Research Projects	
BIT 501	Ethical Issues in Biotechnology	
BIT 510	Core Technologies in Molecular and Cellular Biology	
BIT 566	Animal Cell Culture Techniques	
BEC or BIT or Advised (500-700) Elective [3]		As Needed
Minimum Credit Hours:		**30**

[1] BEC 620 is required while pursing the bachelors degree and needs to be taken the spring semester before starting the graduate degree.

[2] Students who took BEC 330 cannot take BEC 532. They will replace the course with a 2 hour Advised Elective.

[3] Advised Electives can include 500-700 level courses from the student's undergraduate major.

Degree Requirements

Students must complete a total of 36 credit hours to complete the degree. Students will choose a specialization area in either upstream or downstream.

A 150 hour internship is required to complete the degree.

Degrees earned will be distributed as: "Master of Biomanufacturing" without a subplan designation.

Code	Title	Hours
Core Courses		**18**
BEC 515	Biopharmaceutical Product Characterization Techniques	2
or BEC 588	Animal Cell Culture Engineering	
BEC 575	Global Regulatory Affairs for Medical Products	3
BEC 577	Advanced Biomanufacturing and Biocatalysis	3
BEC 590	Industry Practicum in Biomanufacturing	3
BEC 601	Biomanufacturing Seminar [1]	1
BEC 601	Biomanufacturing Seminar	1
BEC 620	Leadership and Preparation for Industry Internship in Biomanufacturing	2
ST 511	Statistical Methods For Researchers I	3
or ST 515	Experimental Statistics for Engineers I	
Specialization		**6**
Students will select an upstream or downstream specialization.		
Upstream Specialization:		
BEC 563	Fermentation of Recombinant Microorganisms	2
BEC 526	Upstream Biomanufacturing Laboratory	2
BEC 580	cGMP Fermentation Operations	2
OR		
Downstream Specialization:		
BEC 532	Foundations of Downstream Processing and Formulation [2]	2
BEC 536	Introduction to Downstream Process Development	2
BEC 585	cGMP Downstream Operations	2
Professional Courses		**9**
BUS 554	Project Management	3
Select 6 credit hours from the following choices:		
MBA 585	Current Topics in BioSciences Management	3
MBA 586	Legal, Regulatory and Ethical Issues in Life Science Industries	3
MIE 501	Strategic Management Foundations	3
MBA or BUS or COM 5xx Elective		
Advised Electives		**3**
BEC 515	Biopharmaceutical Product Characterization Techniques	2
BEC 525	Molecular Biology for Biomanufacturing	2
BEC 526	Upstream Biomanufacturing Laboratory	2
BEC 532	Foundations of Downstream Processing and Formulation [2]	2
BEC 536	Introduction to Downstream Process Development	2
BEC 545	Cell Line Development for Biomanufacturing	2
BEC 562	Fundamentals of Bio-Nanotechnology	3
BEC 563	Fermentation of Recombinant Microorganisms	2
BEC 580	cGMP Fermentation Operations	2
BEC 585	cGMP Downstream Operations	2
BEC 588	Animal Cell Culture Engineering	2
BEC 595	Special Topics in Biomanufacturing	1-6
BEC 669	Biomanufacturing Research Projects	1-4
BIT 501	Ethical Issues in Biotechnology	1
BIT 510	Core Technologies in Molecular and Cellular Biology	4

BIT 566	Animal Cell Culture Techniques	2
BEC or BIT or Advised (500-700) Elective		As Needed
Minimum Credit Hours:		**36**

[1] BEC 601 must be taken twice.

[2] Students who took BEC 330 cannot take BEC 532. They will replace the course with a 2 hour Advised Elective.

Faculty

Full Professors

Ruben G. Carbonell

Amy Michele Grunden

Harold Henry Lamb

Paul Edward Mozdziak

Balaji M. Rao

Heike Inge Ada Sederoff

John Douglas Sheppard

Associate Professors

Paul T. Hamilton

Gavin John Williams

Assistant Professor

Stefano Menegatti

Practice/Research/Teaching Professors

Kirill Efimenko

Gary Louis Gilleskie

Imara Yasmin Perera

John H. van Zanten

Emeritus Faculty

Michael Carl Flickinger

Instructors

Gregory Kale Buhrman

Hayley Flores

Sara Siegel