

# Microbiology (BS): Microbial Research Concentration

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

Microbiology is concerned with the growth and development, physiology, classification, ecology, genetics, and other aspects of the life process of an array of microscopic, generally single-celled, organisms and viruses. These organisms frequently serve as model systems for elucidation of fundamental processes that are common to all living cells. Most of the major discoveries that have produced spectacular advances in biology and genomic science during the past decade have resulted from studies of microbial systems. Future developments in biotechnology, production of food and fuel, and human and animal health will rely heavily on understanding microbial processes.

There are 4 avenues to earning a B.S. in Microbiology. Students can opt for a general curriculum (MBO) or can choose to focus in a particular area by selecting one of three areas of concentration: Microbial Biotechnology (MBO-MT) or Microbial Research (MBO-MR) or Microbial Health Sciences (MBO-HS). These concentrations mirror the three most common career paths of Microbiology majors: work in research laboratories and production facilities, further study in graduate school (at the Masters or Doctoral level), and further study in professional schools such as medical and dental schools.

## Plan Requirements

**Microbiology (BS): Microbial Research Concentration:** 120 Total Units

Code	Title	Hours
<b>Orientation</b>		
LSC 103 or MB 103	Exploring Opportunities in the Life Sciences Introductory Topics in Microbiology	1
<b>Communication</b>		
ENG 333	Communication for Science and Research <sup>1</sup>	3
<b>Mathematical Sciences</b>		
MA 131 or MA 141	Calculus for Life and Management Sciences A <sup>1</sup> Calculus I	3
ST 311 or ST 371	Introduction to Statistics <sup>1</sup> Introduction to Probability and Distribution Theory	3
<b>Natural and Physical Sciences</b>		
CH 101	Chemistry - A Molecular Science <sup>1</sup>	3
CH 102	General Chemistry Laboratory <sup>1</sup>	1
CH 201	Chemistry - A Quantitative Science <sup>1</sup>	3
CH 202	Quantitative Chemistry Laboratory <sup>1</sup>	1
CH 221	Organic Chemistry I <sup>1</sup>	3
CH 222	Organic Chemistry I Lab <sup>1</sup>	1
CH 223	Organic Chemistry II <sup>1</sup>	3
CH 224	Organic Chemistry II Lab <sup>1</sup>	1
BIO 181	Introductory Biology: Ecology, Evolution, and Biodiversity <sup>1</sup>	4

BIO 183	Introductory Biology: Cellular and Molecular Biology <sup>1</sup>	4
Select one of the following: <sup>1</sup>		4
PY 201	University Physics I	
PY 205 & PY 206	Physics for Engineers and Scientists I and Physics for Engineers and Scientists I Laboratory	
PY 211	College Physics I	
Select one of the following: <sup>1</sup>		4
PY 202	University Physics II	
PY 208 & PY 209	Physics for Engineers and Scientists II and Physics for Engineers and Scientists II Laboratory	
PY 212	College Physics II	

### Major Requirements

LSC 101	Critical and Creative Thinking in the Life Sciences <sup>1</sup>	2
MB 351	General Microbiology <sup>1</sup>	3
MB 354	Inquiry-Guided Microbiology Lab <sup>1</sup>	1
MB 360	Scientific Inquiry in Microbiology: At the Bench	3
MB 411	Medical Microbiology <sup>1</sup>	3
MB 412	Medical Microbiology Laboratory <sup>1</sup>	1
MB 414	Microbial Metabolic Regulation <sup>1</sup>	3
MB 451	Microbial Diversity <sup>1</sup>	3
MB 452	Microbial Diversity Lab <sup>1</sup>	2
MB 480	Current Issues in Microbiology <sup>1</sup>	1
GN 311	Principles of Genetics <sup>1</sup>	4
BCH 351	General Biochemistry <sup>1</sup>	4
	or BCH 451 Principles of Biochemistry	
Select one of the following: <sup>1</sup>		3
BCH 453	Biochemistry of Gene Expression	
BCH 553	Biochemistry of Gene Expression	
GN 421	Molecular Genetics	
GN 521	Molecular Genetics	
Select one of the following: <sup>1</sup>		3
BIO 240	Principles of Human Anatomy & Physiology (A): Nervous, Skeletal, Muscular, & Digestive Systems	
BIO 245	Principles of Human Anatomy & Physiology (B): Endocrine, Cardiovascular, Respiratory & Renal Systems	
BIO 414	Cell Biology	
PB 421	Plant Physiology	
Laboratory Elective (p. 2) <sup>1</sup>		3
Microbial Research Electives:		12
BSC 492	Professional Experience	
BSC 493	Research Experience	
<b>GEP Courses</b>		
ENG 101	Academic Writing and Research <sup>1</sup>	4
GEP Humanities ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-humanities/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-humanities/</a> )		6
GEP Social Sciences ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-social-sciences/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-social-sciences/</a> )		6

GEP Health and Exercise Studies ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/</a> )	2
GEP Additional Breadth ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/</a> ) (Humanities/Social Sciences/Visual and Performing Arts)	3
GEP Interdisciplinary Perspectives ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-interdisciplinary-perspectives/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-interdisciplinary-perspectives/</a> )	3
GEP U.S. Diversity ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-us-diversity/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-us-diversity/</a> ) (verify requirement)	
GEP Global Knowledge ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-global-knowledge/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-global-knowledge/</a> ) (verify requirement)	
Foreign Language Proficiency ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/foreign-language-proficiency/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/foreign-language-proficiency/</a> ) (verify requirement)	
<b>Free Electives</b>	
Free Electives (12 Hr S/U Lmt) <sup>2</sup>	3
<b>Total Hours</b>	<b>120</b>

<sup>1</sup> A grade of C- or higher is required.

<sup>2</sup> Students should consult their academic advisors to determine which courses fill this requirement.

## Laboratory Elective

Code	Title	Hours
BBS 426	Upstream Biomanufacturing Laboratory	2
BBS 526	Upstream Biomanufacturing Laboratory	2
BCH 452	Introductory Biochemistry Laboratory	2
BEC 426	Upstream Biomanufacturing Laboratory	2
BEC 436	Introduction to Downstream Process Development	2
BEC 440	Expression Systems in Biomanufacturing I	3
BEC 441	Expression Systems in Biomanufacturing II	3
BEC 462	Fundamentals of Bio-Nanotechnology	3
BEC 463	Fermentation of Recombinant Microorganisms	2
BEC 475	Global Regulatory Affairs for Medical Products	3
BEC 480	cGMP Fermentation Operations	2
BEC 483	Tissue Engineering Technologies	2
BEC 485	cGMP Downstream Operations	2
BEC 488	Animal Cell Culture Engineering	2
BEC 495	Special Topics in Biomanufacturing	1-4
BEC 497	Biomanufacturing Research Projects	1-3
BEC 526	Upstream Biomanufacturing Laboratory	2
BEC 536	Introduction to Downstream Process Development	2
BEC 540	Expression Systems in Biomanufacturing I	3
BEC 541	Expression Systems in Biomanufacturing II	3
BEC 562	Fundamentals of Bio-Nanotechnology	3
BEC 563	Fermentation of Recombinant Microorganisms	2
BEC 575	Global Regulatory Affairs for Medical Products	3
BEC 580	cGMP Fermentation Operations	2
BEC 583	Tissue Engineering Technologies	2
BEC 585	cGMP Downstream Operations	2
BIT 402	Biotechnology Networking and Professional Development	1

BIT 410	Manipulation of Recombinant DNA	4
BIT 462	Gene Expression Analysis: Microarrays	2
BIT 463	Fermentation of Recombinant Microorganisms	2
BIT 464	Protein Purification	2
BIT 465	Real-time PCR Techniques	2
BIT 466	Animal Cell Culture Techniques	2
BIT 467	PCR and DNA Fingerprinting	2
BIT 468	Genome Mapping	2
BIT 471	RNA Interference and Model Organisms	2
BIT 473	Protein Interactions	2
BIT 474	Plant Genetic Engineering	2
BIT 476	Applied Bioinformatics	2
BIT 477	Metagenomics	2
BIT 478	Mapping the Brain	2
BIT 479	High-Throughput Discovery	2
BIT 480	Yeast Metabolic Engineering	2
BIT 481	Plant Tissue Culture and Transformation	2
BIT 492	External Learning Experience	1-6
BIT 493	Special Problems in Biotechnology	1-6
BIT 495	Special Topics in Biotechnology	1-3
BIT 502	Biotechnology Networking and Professional Development	1
BIT 562	Gene Expression Analysis: Microarrays	2
BIT 563	Fermentation of Recombinant Microorganisms	2
BIT 564	Protein Purification	2
BIT 565	Real-time PCR Techniques	2
BIT 566	Animal Cell Culture Techniques	2
BIT 567	PCR and DNA Fingerprinting	2
BIT 568	Genome Mapping	2
BIT 571	RNA Interference and Model Organisms	2
BIT 573	Protein Interactions	2
BIT 574	Plant Genetic Engineering	2
BIT 577	Metagenomics	2
BIT 578	Mapping the Brain	2
BIT 579	High-Throughput Discovery	2
BIT 580	Yeast Metabolic Engineering	2
BME 483	Tissue Engineering Technologies	2
BME 583	Tissue Engineering Technologies	2
CHE 462	Fundamentals of Bio-Nanotechnology	3
CHE 463	Fermentation of Recombinant Microorganisms	2
CHE 488	Animal Cell Culture Engineering	2
CHE 562	Fundamentals of Bio-Nanotechnology	3
CHE 563	Fermentation of Recombinant Microorganisms	2
FS 426	Upstream Biomanufacturing Laboratory	2
FS 526	Upstream Biomanufacturing Laboratory	2
GN 312	Elementary Genetics Laboratory	1
MB 360	Scientific Inquiry in Microbiology: At the Bench	3
MB 420	Fundamentals of Microbial Cell Biotransformations	2
MB 520	Fundamentals of Microbial Cell Biotransformations	2
PB 481	Plant Tissue Culture and Transformation	2
PO 466	Animal Cell Culture Techniques	2
PO 566	Animal Cell Culture Techniques	2

## Semester Sequence

This is a sample.

Course	Title	Hours
<b>First Year</b>		
<b>Fall Semester</b>		
BIO 181	Introductory Biology: Ecology, Evolution, and Biodiversity <sup>1</sup>	4
CH 101	Chemistry - A Molecular Science <sup>1</sup>	3
CH 102	General Chemistry Laboratory <sup>1</sup>	1
LSC 101	Critical and Creative Thinking in the Life Sciences <sup>1</sup>	2
MA 131	Calculus for Life and Management Sciences A <sup>1</sup>	3
MB 103	Introductory Topics in Microbiology	1
GEP Health and Exercise Studies ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/</a> )		1
Hours		15
<b>Spring Semester</b>		
BIO 183	Introductory Biology: Cellular and Molecular Biology <sup>1</sup>	4
CH 221	Organic Chemistry I <sup>1</sup>	3
CH 222	Organic Chemistry I Lab <sup>1</sup>	1
ENG 101	Academic Writing and Research	4
GEP Social Sciences ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-social-sciences/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-social-sciences/</a> )		3
Hours		15
<b>Second Year</b>		
<b>Fall Semester</b>		
CH 223	Organic Chemistry II <sup>1</sup>	3
CH 224	Organic Chemistry II Lab <sup>1</sup>	1
PY 211	College Physics I <sup>1</sup>	4
MB 351	General Microbiology <sup>1</sup>	3
GEP Social Sciences ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-social-sciences/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-social-sciences/</a> )		3
MB 354	Inquiry-Guided Microbiology Lab <sup>1</sup>	1
Hours		15
<b>Spring Semester</b>		
CH 201	Chemistry - A Quantitative Science <sup>1</sup>	3
CH 202	Quantitative Chemistry Laboratory <sup>1</sup>	1
PY 212	College Physics II <sup>1</sup>	4
MB 360	Scientific Inquiry in Microbiology: At the Bench <sup>1</sup>	3
MB 411	Medical Microbiology <sup>1</sup>	3
MB 412	Medical Microbiology Laboratory <sup>1</sup>	1
Hours		15
<b>Third Year</b>		
<b>Fall Semester</b>		
ENG 333	Communication for Science and Research	3
GN 311	Principles of Genetics <sup>1</sup>	4
ST 311	Introduction to Statistics	3

GEP Health and Exercise Studies ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-health-exercise-studies/</a> )	1	
Micro Research Elective <sup>1</sup>	3	
Hours		14

<b>Spring Semester</b>		
Cell/Physiology Elective <sup>1</sup>	3	
Biochemistry Elective <sup>1</sup>	4	
Laboratory Elective (p. 2) <sup>1</sup>	3	
GEP Additional Breadth ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/</a> )	3	
Microbial Research Elective <sup>1</sup>	3	
Hours		16

<b>Fourth Year</b>		
<b>Fall Semester</b>		
MB 414	Microbial Metabolic Regulation <sup>1</sup>	3
Microbial Research Elective <sup>1</sup>	3	
MB 480	Current Issues in Microbiology <sup>1</sup>	1
GEP Humanities ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-humanities/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-humanities/</a> )	3	
MB 451	Microbial Diversity <sup>1</sup>	3
MB 452	Microbial Diversity Lab <sup>1</sup>	2
Hours		15

<b>Spring Semester</b>		
Gene Expression Elective <sup>1</sup>	3	
Microbial Research Elective <sup>1</sup>	3	
GEP Interdisciplinary Perspectives ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-interdisciplinary-perspectives/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-interdisciplinary-perspectives/</a> )	3	
Free Elective	3	
GEP Humanities ( <a href="http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-humanities/">http://catalog.ncsu.edu/undergraduate/gep-category-requirements/gep-humanities/</a> )	3	
Hours		15
Total Hours		120

<sup>1</sup> A grade of C- or higher is required.

## Career Opportunities

Many students majoring in the Department of Biological Sciences take advantage of scholarship and honors programs available at NC State, including the University Honors Program and the University Scholars Program. In addition, we offer a discipline-based Undergraduate Honors Program in Biological Sciences (DBS Honors Program). The DBS Honors Program requires students to design a challenging program of advanced study, including eight credits of honors coursework in biology and at least two semesters of research or teaching scholarship.

Participants write an honors thesis and are required to present their scholarly work at a local, regional, or national meeting. Invitations to join the DBS Honors Program are sent in the first three weeks of the Fall and Spring semesters. Students in any major in the Department of Biological Sciences who have earned an overall GPA of 3.60 after completing 30-65 credit hours at NC State will receive an invitation to join the DBS Honors Program; transfer students in any of our majors who have earned an overall GPA of 3.60 in 15 credit hours at NC State also will receive an invitation.

Students who graduate from the Department of Biological Sciences are well prepared for employment in various government agencies and private industries. Graduates may continue their education with studies leading to advanced degrees in many areas of the biological sciences, including cell biology, ecology, microbiology, genetics, zoology, neurobiology, and biomedical disciplines. Many choose to seek advanced degrees in medicine, dentistry, optometry, veterinary medicine, public health, and other health-related fields. Students who plan to seek certification for pre-college teaching may want to pursue a second major in the Department of Science, Technology, Engineering & Mathematics Education.