MAJOR IN BIOMEDICAL SCIENCES, MICROBIOLOGY AND INFECTIOUS DISEASE CONCENTRATION

Microbiology is the study of organisms, many of which are too small to be seen with the naked eye, including fungi, protists, and bacteria, as well as acellular agents such as viruses and prions. Microbiology emerged as a distinct science in the late nineteenth century, with the discovery that microorganisms are the cause of many infectious diseases, and that they play essential roles in ecosystems (such as the microbiome) and in industrial processes. Much work in this field is directed toward the cure, control, or eradication of disease in humans and animals, as well as understanding how microbes support health and life. Genetically engineered microorganisms can also be used for the production of improved foods, new drugs and vaccines, and for removing toxic wastes and spills from the environment. Unfortunately, some microbes have received considerable attention as potential agents of bioterrorism and biowarfare, and consequently much work is being done to counter such threats.

Students completing the undergraduate Biomedical Sciences degree program with a concentration in Microbiology and Infectious Diseases acquire knowledge and laboratory skills in the structure, physiology, genetics, pathogenicity, ecology, and taxonomy of microorganisms, as well as immunological techniques. Students engage in authentic hypothesis-driven research problems in inquiry-based laboratory courses. Required courses in biological sciences, chemistry, physics, and mathematics support the major. Ample opportunities exist for undergraduates to obtain laboratory research experience and many student researchers have presented at conferences and have been awarded research grants or fellowships.

A Bachelor of Science degree in Biomedical Sciences with a concentration in Microbiology and Infectious Disease prepares graduates well for continued education in a professional or graduate degree program or for employment in the field.

Learning Outcomes

- **Core Knowledge**: Students will apply and integrate the fundamentals of chemistry, microbial biology, and biochemistry and key principles from the following five core areas of the discipline: immunology, bacteriology, virology, microbial physiology, and microbial genetics.
- **Relevance/Impact**: Students will demonstrate an awareness of issues at the forefront of the discipline and will evaluate the important interaction between microbes and society, from their beneficial use in industrial, biotechnological, and clinical applications to their role as etiologic agents of infectious disease in humans and animals.
- **Communication Skills**: Students will assimilate factual and conceptual information and effectively communicate disciplinary knowledge to both science literate and general audiences through written or verbal presentations.
- **Laboratory Skills**: Students will demonstrate proficiency using microbiological and immunological laboratory techniques employed in clinical, industrial, and research laboratories, and will be able to explain the principles behind the procedures, employ mathematical computations, properly execute the procedures, interpret the results correctly, and analyze the results to draw a conclusion.

Potential Occupations

The curriculum, with the proper selection of departmental electives, meets the requirements for entrance into most professional programs in veterinary and human medicine, and is ideal preparation for students desiring a career as a veterinarian, physician, physician assistant, pharmacist, medical laboratory scientist, optometrist, or dentist. The degree also prepares students for graduate (PhD or MS) studies in various biological sciences, and also provides students with the knowledge and skills to go directly into a career. Career opportunities will continue to grow because microbiology is at the center of complex issues facing our world today, as well as at the forefront of fast-paced innovation and development. Employment opportunities exist in biotechnology (vaccine and therapeutics, pharmaceutical, food, beverage, and medical device industries); government public health agencies (CDC, FDA, and state and municipal health departments); and primary research institutions, such as universities.

For more information about the Microbiology & Infectious Disease concentration under the Biomedical Sciences Major, please visit the College of Veterinary Medicine and Biomedical Sciences (https://vetmedbiosci.colostate.edu/degree-programs/undergraduate/).

Requirements
Effective Summer 2020

Freshman

		AUCC	Credits
CHEM 111	General Chemistry I (GT-SC2)	3A	4
CHEM 112	General Chemistry Lab I (GT-SC1)	3A	1
CHEM 113	General Chemistry II		3
CHEM 114	General Chemistry Lab II		1
CO 150	College Composition (GT-CO2)	1A	3
LIFE 102	Attributes of Living Systems (GT-SC1)	3A	4
MIP 250	Eukaryotic Microbiology		3
MIP 260	The World of Parasites		3
VMBS 100	Introduction to Biomedical Sciences Major		2
Select a minimum of 3 credits from the following:		1B	3-4
MATH 118	College Algebra in Context II (GT-MA1)	1B	

MATH 124	Logarithmic and Exponential Functions (GT-MA1)	1B	
MATH 125	Numerical Trigonometry (GT-MA1)	1B	
MATH 126	Analytic Trigonometry (GT-MA1)	1B	
MATH 155	Calculus for Biological Scientists I (GT-MA1)	1B	
MATH 160	Calculus for Physical Scientists I (GT-MA1)	1B	
Elective			3
	Total Credits		**30-31**

Sophomore

BC 351	Principles of Biochemistry		4
MIP 300	General Microbiology		3
MIP 302	General Microbiology Laboratory		2
MIP 342	Immunology		4
Select one group from the following:			8
Group A			
CHEM 245	Fundamentals of Organic Chemistry		
CHEM 246	Fundamentals of Organic Chemistry Laboratory		
Concentration Elective (see list below)			
Group B			
CHEM 341	Modern Organic Chemistry I		
CHEM 343[1]	Modern Organic Chemistry II		
CHEM 344	Modern Organic Chemistry Laboratory		
Historical Perspectives (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives)		3D	3
Social and Behavioral Sciences (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#social-behavioral-sciences)		3C	3
Elective			3
	Total Credits		**30**

Junior

Select one course from the following:			5
PH 121	General Physics I (GT-SC1)	3A	
PH 141	Physics for Scientists and Engineers I (GT-SC1)	3A	
Select one course from the following:			3-4
MIP 443	Microbial Physiology		
MIP 450	Microbial Genetics		
Select one course from the following:			4
BMS 300	Principles of Human Physiology		
BMS 360	Fundamentals of Physiology		
Concentration Electives (See list below)			8
Advanced Writing (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#advanced-writing)		2	3
Arts and Humanities (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities)		3B	3
Diversity and Global Awareness (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#diversity-global-awareness)		3E	3
	Total Credits		**29-30**

Senior

MIP 351	Medical Bacteriology	4B	3
MIP 420	Medical and Molecular Virology	4A	4
Select one course from the following:			2-3
MIP 400A	Capstone in Microbiology: Medical Microbiology	4C	

MIP 400B	Capstone in Microbiology: Biotechnology	4C	
MIP 400C	Capstone in Microbiology: Immunology	4C	
MIP 400D	Capstone in Microbiology: Microbial Diversity/Ecology	4C	
MIP 400E	Capstone in Microbiology: Microbial Genetics	4C	
MIP 400F	Capstone in Microbiology: Virology	4C	
MIP 400G	Capstone in Microbiology: Service Learning	4C	
MIP 400H	Capstone in Microbiology: Prion Biology	4C	
MIP 400I	Capstone in Microbiology: Mycobacterial Biology	4C	
MIP 400J	Capstone in Microbiology: Big Data Sets in Microbiology	4C	
MIP 400K	Capstone in Microbiology: Parasitology	4C	
MIP 400L	Capstone in Microbiology: Microbiome Biology	4C	
MIP 400M	Capstone in Microbiology: Vector Biology	4C	
MIP 400N	Capstone in Microbiology: Environmental Sustainability Health Science	4C	
MIP 400O	Capstone in Microbiology: Pathology of Infectious Disease	4C	
MIP 400P	Capstone in Microbiology: Veterinary Microbiology	4C	
MIP 400Q	Capstone in Microbiology: One Health	4C	
MIP 400R	Capstone in Microbiology: Food Microbiology	4C	
MIP 400S	Capstone in Microbiology: Biofilm Biology	4C	
MIP 498	Research	4C	
Select one course from the following:			3
STAT 301	Introduction to Applied Statistical Methods		
STAT 307	Introduction to Biostatistics		
Arts and Humanities (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities)		3B	3
Concentration Electives (See list below)			7
Electives[2]			6-9
	Total Credits		**29-31**
	Program Total Credits:		**120**

Concentration Electives

Code	Title	Credits
Select a minimum of 18 credits from the following not taken elsewhere in the program. CHEM 343 may count as a Concentration Elective for students who select organic chemistry Group B in the Sophomore year.		
A minimum of two laboratory courses MUST be selected from the following:		
MIP 150	Introduction to Research Methods	
MIP 335	Food Microbiology Laboratory	
MIP 343	Immunology Laboratory	
MIP 352	Medical Bacteriology Laboratory	
MIP 425	Virology and Cell Culture Laboratory	
MIP 433/ESS 433	Microbial Ecology Laboratory	
MIP 462/ BSPM 462/BZ 462	Parasitology and Vector Biology	
MIP 550	Microbial and Molecular Genetics Laboratory	
Two unique courses (for a maximum of 6 credits) may be selected from the following:		
MIP 298	Introductory Research	
MIP 384	Supervised College Teaching	
MIP 495	Independent Study	
MIP 498	Research	
ANEQ 460	Meat Safety	2
BC 404	Comprehensive Biochemistry Laboratory	2
BC 463	Molecular Genetics	3
BMS 301	Human Gross Anatomy	5
BMS 305	Domestic Animal Gross Anatomy	4
BMS 325	Cellular Neurobiology	3
BMS 401	Laboratory Research in Biomedical Sciences	4
BMS 450	Pharmacology	3
BSPM 302	Applied and General Entomology	2
BZ 220	Introduction to Evolution	3
BZ 310	Cell Biology	4
BZ 333	Introductory Mycology	4
BZ 346	Population and Evolutionary Genetics	3
BZ 350	Molecular and General Genetics	4
BZ 360	Bioinformatics and Genomics	3
BZ 418	Ecology of Infectious Diseases	4
BZ 577/MIP 577	Computer Analysis in Population Genetics	2
BZ 578/MIP 578	Genetics of Natural Populations	4
CHEM 334	Quantitative Analysis Laboratory	1
CHEM 335	Introduction to Analytical Chemistry	3
CHEM 343	Modern Organic Chemistry II [1]	3
ERHS 210		2
ERHS 320	Environmental Health--Water Quality	3

ERHS 332	Principles of Epidemiology	3
ERHS 430	Human Disease and the Environment	3
ERHS 502	Fundamentals of Toxicology	3
ERHS 567	Cell and Molecular Toxicology Techniques	3
FTEC 360	Brewing Processes	4
FTEC 460	Brewing Science II	4
FTEC 574	Current Issues in Food Safety	2
LIFE 103	Biology of Organisms-Animals and Plants (GT-SC1)	4
LIFE 201B	Introductory Genetics: Molecular/ Immunological/Developmental (GT-SC2)	3
LIFE 203	Introductory Genetics Laboratory	2
LIFE 210	Introductory Eukaryotic Cell Biology	3
LIFE 211	Introductory Cell Biology Honors Recitation	1
LIFE 212	Introductory Cell Biology Laboratory	2
LIFE 320	Ecology	3
MATH 155	Calculus for Biological Scientists I (GT-MA1)	4
MATH 160	Calculus for Physical Scientists I (GT-MA1)	4
MIP 192	Microbiology First-Year Seminar	2
MIP 275	Microcomputing Applications in Microbiology	2
MIP 303	General Microbiology--Honors Recitation	1
MIP 315	Pathology of Human and Animal Disease	3
MIP 334	Food Microbiology	3
MIP 400A	Capstone in Microbiology: Medical Microbiology	2
MIP 400B	Capstone in Microbiology: Biotechnology	2
MIP 400C	Capstone in Microbiology: Immunology	2
MIP 400D	Capstone in Microbiology: Microbial Diversity/Ecology	2
MIP 400E	Capstone in Microbiology: Microbial Genetics	2
MIP 400F	Capstone in Microbiology: Virology	2
MIP 400G	Capstone in Microbiology: Service Learning	2
MIP 400H	Capstone in Microbiology: Prion Biology	2
MIP 400I	Capstone in Microbiology: Mycobacterial Biology	2
MIP 400J	Capstone in Microbiology: Big Data Sets in Microbiology	2
MIP 400K	Capstone in Microbiology: Parasitology	2
MIP 400L	Capstone in Microbiology: Microbiome Biology	2
MIP 400M	Capstone in Microbiology: Vector Biology	2
MIP 400N	Capstone in Microbiology: Environmental Sustainability & Health Science	2
MIP 400O	Capstone in Microbiology: Pathology of Infectious Disease	2
MIP 400P	Capstone in Microbiology: Veterinary Microbiology	2
MIP 400Q	Capstone in Microbiology: One Health	2
MIP 400R	Capstone in Microbiology: Food Microbiology	2
MIP 400S	Capstone in Microbiology: Biofilm Biology	2
MIP 401	Laboratory Research Methods in Microbiology	4
MIP 432/ESS 432	Microbial Ecology	3
MIP 443	Microbial Physiology	4
MIP 450	Microbial Genetics	3
MIP 496	Group Study	1-3
MIP 530	Advanced Molecular Virology	4
MIP 540	Biosafety in Research Laboratories	2
MIP 555	Principles and Mechanisms of Disease	3
MIP 563	Biology of Disease Vectors	3
MIP 570	Functional Genomics	3
PH 122	General Physics II (GT-SC1)	5
SOCR 330	Principles of Genetics	3
SOCR 455	Soil Microbiology	3
SOCR 456	Soil Microbiology Laboratory	1
VS 331	Histology	4
VS 333	Domestic Animal Anatomy	4

1 CHEM 343 may count as a Concentration Elective for students who select organic chemistry Group B in the Sophomore year.

2 Select enough elective credits to bring the program total to a minimum of 120 credits, of which at least 42 must be upper-division (300- to 400-level).

Major Completion Map

Distinctive Requirements for Degree Program:
To Declare Major: competitive entry controls required and capped enrollment in place. Please contact Director of Student Success in the CVMBS Student Success Center for more information.

To prepare for first semester: The curriculum for the microbiology and infectious disease concentration assumes students enter college prepared to take MATH 124. Entering students who are not prepared to take MATH 124 will need to prerequisite requirements in the first semester. Those requirements are listed as benchmark courses in Freshman Semester 1 below. LIFE 102 requires high school chemistry as a prerequisite; CHEM 111 requires Algebra II as a prerequisite (this prerequisite is met by having Algebra II by test credit, transfer credit, or placement out of MATH 117 and MATH 118 on Math Placement Exam).

Freshman

Semester 1		**Critical**	**Recommended**	**AUCC**	**Credits**
CHEM 111	General Chemistry I (GT-SC2)	X		3A	4
CHEM 112	General Chemistry Lab I (GT-SC1)	X		3A	1
CO 150	College Composition (GT-CO2)			1A	3
LIFE 102	Attributes of Living Systems (GT-SC1)	X		3A	4
VMBS 100	Introduction to Biomedical Sciences Major				2

Select 0-1 credits from the following:					0-1
MATH 118	College Algebra in Context II (GT-MA1)			1B	
MATH 124	Logarithmic and Exponential Functions (GT-MA1)		X	1B	
MATH 125	Numerical Trigonometry (GT-MA1)			1B	
MATH 126	Analytic Trigonometry (GT-MA1)			1B	
MATH 124 must be completed by the end of Semester 1, if necessary.		X			
	Total Credits				**14-15**
Semester 2		**Critical**	**Recommended**	**AUCC**	**Credits**
CHEM 113	General Chemistry II	X			3
CHEM 114	General Chemistry Lab II	X			1
MIP 250	Eukaryotic Microbiology				3
MIP 260	The World of Parasites	X			3
Select 2-4 credits from the following:					2-4
MATH 124	Logarithmic and Exponential Functions (GT-MA1)			1B	
MATH 125	Numerical Trigonometry (GT-MA1)			1B	
MATH 126	Analytic Trigonometry (GT-MA1)			1B	
MATH 155	Calculus for Biological Scientists I (GT-MA1)			1B	
MATH 160	Calculus for Physical Scientists I (GT-MA1)			1B	
Elective					3
CO 150 must be completed by the end of semester 2.		X			
3-4 credits of MATH must be completed by the end of semester 2.		X			
MATH 125 must be completed by the end of semester 2.		X			
	Total Credits				**15-17**
Sophomore					
Semester 3		**Critical**	**Recommended**	**AUCC**	**Credits**
MIP 300	General Microbiology	X			3
MIP 302	General Microbiology Laboratory	X			2
Select one group from the following:					3-5
Group A: (5 credits)					
CHEM 245	Fundamentals of Organic Chemistry	X			
CHEM 246	Fundamentals of Organic Chemistry Laboratory	X			
Group B: (3 credits)					
CHEM 341	Modern Organic Chemistry I				
Social and Behavioral Sciences (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#social-behavioral-sciences)				3C	3
Elective					3
	Total Credits				**14-16**
Semester 4		**Critical**	**Recommended**	**AUCC**	**Credits**
BC 351	Principles of Biochemistry		X		4
MIP 342	Immunology	X			4
Select the same Group (A or B) as selected Semester 3:					3-5
Group A: (3 credits)					
Concentration Elective (See list on Requirements Tab)					
Group B: (5 credits)					
CHEM 343	Modern Organic Chemistry II				
CHEM 344	Modern Organic Chemistry Laboratory				
Historical Perspectives (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#historical-perspectives)				3D	3
	Total Credits				**14-16**
Junior					
Semester 5		**Critical**	**Recommended**	**AUCC**	**Credits**
Select MIP 450 Semester 5 if MIP 443 will not be taken Semester 6:					0-3

MIP 450	Microbial Genetics				
Select one course from the following:					5
PH 121	General Physics I (GT-SC1)	X	X	3A	
PH 141	Physics for Scientists and Engineers I (GT-SC1)	X		3A	
Concentration Electives (See list on Requirements Tab)					5
Diversity and Global Awareness (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#diversity-global-awareness)				3E	3
	Total Credits				**13-16**

Semester 6		**Critical**	**Recommended**	**AUCC**	**Credits**
Select MIP 443 Semester 6 if MIP 450 was not taken Semester 5:					0-4
MIP 443	Microbial Physiology				
Select one course from the following:					4
BMS 300	Principles of Human Physiology				
BMS 360	Fundamentals of Physiology				
Concentration Electives (See list on Requirements Tab)					3
Advanced Writing (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#advanced-writing)				2	3
Arts and Humanities (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities)				3B	3
Select MIP 450 (Fall) or MIP 443 (Spring) by end of semester 6.		X			
	Total Credits				**13-17**

Senior

Semester 7		**Critical**	**Recommended**	**AUCC**	**Credits**
MIP 420	Medical and Molecular Virology	X		4A	4
Select one AUCC 4C course from the following:		X		4C	2-3
MIP 400A	Capstone in Microbiology: Medical Microbiology			4C	
MIP 400B	Capstone in Microbiology: Biotechnology			4C	
MIP 400C	Capstone in Microbiology: Immunology			4C	
MIP 400D	Capstone in Microbiology: Microbial Diversity/Ecology			4C	
MIP 400E	Capstone in Microbiology: Microbial Genetics			4C	
MIP 400F	Capstone in Microbiology: Virology			4C	
MIP 400G	Capstone in Microbiology: Service Learning			4C	
MIP 400H	Capstone in Microbiology: Prion Biology			4C	
MIP 400I	Capstone in Microbiology: Mycobacterial Biology			4C	
MIP 400J	Capstone in Microbiology: Big Data Sets in Microbiology			4C	
MIP 400K	Capstone in Microbiology: Parasitology			4C	
MIP 400L	Capstone in Microbiology: Microbiome Biology			4C	
MIP 400M	Capstone in Microbiology: Vector Biology			4C	
MIP 400N	Capstone in Microbiology: Environmental Sustainability Health Science			4C	
MIP 400O	Capstone in Microbiology: Pathology of Infectious Disease			4C	
MIP 400P	Capstone in Microbiology: Veterinary Microbiology			4C	
MIP 400Q	Capstone in Microbiology: One Health			4C	
MIP 400R	Capstone in Microbiology: Food Microbiology			4C	
MIP 400S	Capstone in Microbiology: Biofilm Biology			4C	
MIP 498	Research			4C	
Select one from the following:					3
STAT 301	Introduction to Applied Statistical Methods				
STAT 307	Introduction to Biostatistics				
Concentration Elective (See list on Requirements Tab)					2
Arts and Humanities (http://catalog.colostate.edu/general-catalog/all-university-core-curriculum/aucc/#arts-humanities)				3B	3
	Total Credits				**14-15**

Semester 8		Critical	Recommended	AUCC	Credits
MIP 351	Medical Bacteriology	X		4B	3
Concentration Electives (See list on Requirements Tab)		X			5
Electives		X			6-9
The benchmark courses for the 8th semester are the remaining courses in the entire program of study.		X			
	Total Credits				**14-17**
	Program Total Credits:				**120**