



18 November 2020

RE: New Program Proposal: Combined Microbiology BS/MS degree, revision 2

Dear Colleagues,

Thank you for the contingent approval and the helpful comments on the combined Microbiology BS/MS degree. We have addressed the committee's concerns in the revised proposal (highlighted in the track changes version). Just after our signatures (below), we offer a point by point response to the reviewers. We thank you for your consideration.

Regards,

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1. Clarify the distinction between the thesis and non-thesis options. Provide clarification on the final evaluation for each track. For example, it is unclear if all students participate in the exit defense.

Revised as suggested. Clarifying language has been added as follows:

- Executive summary “Both thesis and non-thesis Masters degree candidates will complete a Masters examination comprising both a written document and an oral examination (Department of Microbiology Graduate Program Handbook section 7.3.2). The Masters defense examination committee will be the same committee as the advisory committee,”
 - Assessment plan (MS Learning objectives 2,3)
 - Individual rubrics have been created for the thesis and non-thesis Masters exam.
2. Clarify how the tracks are assessed and mapped to the program goals. Program goal #7 evaluates the master’s defense, and program goal #8 evaluates written communication using the master’s thesis. It is unclear how these goals are measured for non-thesis students. If the master’s defense is used for both tracks, the Panel suggest mapping this to other program goals as well.

Revised as suggested. Assessment 7 (now MS assessment 2) assesses knowledge and assessment 8 (now MS assessment 3) assesses written and oral communication.

- MS Assessment 2: “Both thesis and non-thesis MS students must demonstrate in-depth knowledge in an area of interest. This will be demonstrated for both thesis and non-thesis candidates by an affirmative (passing) vote on both the masters written document and oral defense (see rubric below). The written and oral exam for MS (non-thesis) candidates will cover general knowledge. The written and oral exam for MS-thesis candidates will cover general knowledge and primary data generated by the candidate.”
 - MS Assessment 3: “Effectively communicate science through oral and written presentations to both scientific and general audiences. Performance in M7899 will be used to evaluate effective communication. Written and oral communication for both thesis and non-thesis candidates will be evaluated through the Masters examination (written and oral).”
3. Comment regarding assessment plan: A combined program proposal needs to include the individual assessment plan for both the undergraduate degree and graduate degree. The methods used to assess the program goals for the combined program should be the same for the individual programs. Program goal #6 says “The target goal is for 85% of the BS/MS majors to achieve a B or better in their masters’ core courses and related electives,” which indicates that assessment is not the same for all MS students for this goal. This should be addressed.

Revised as suggested. The BS/MS assessment has been harmonized with the existing BS and the MS assessment plan. The BS/MS assessment plan is now just a combination of the BS + MS assessment.

Proposal for a BS/MS Combination Degree in Microbiology

Program Rationale

The following document presents the rationale and plan for creation of a combined BS/MS degree in Microbiology. Currently, the Microbiology Department offers a BS undergraduate degree and a graduate-level MS or PhD degree. After reviewing the curriculum and the advanced courses being taken by high-performing students in the Microbiology major, it is possible for accelerated students to complete the requirements for their undergraduate degree as well as coursework for a MS degree in microbiology in five years. The plan described below fits the Graduate School's description of the purpose of a combined program as "to give outstanding students an opportunity to pursue simultaneously two degrees in different colleges or schools by reducing the amount of time required to complete both sets of degree requirements."

Executive Summary

The central feature of the proposed combined BS/MS degree program is the ability to double-count advanced Microbiology courses, normally taken by first-year graduate students, as elective credits for the fourth year of the undergraduate major (Appendix A). By double-counting these electives for both the undergraduate and graduate degrees, a student in the combined degree program can fulfill the undergraduate degree requirements in their fourth year and be able to complete the remaining requirements for the Masters degree in an additional year. Thus, this combined degree plan allows students the ability to enhance their undergraduate training with graduate-level coursework and reduce the amount of time necessary for an advanced degree.

The undergraduate BS degree in Microbiology requires completion of 121 credit hours consisting of at least 45 general education credits, prerequisite coursework in Biology, Math, Chemistry, and Physics, and 30 credits specific to the Microbiology major (Appendix B). The Microbiology major requirements include 21 credits of required coursework in Biochemistry and Microbiology and 9 credits of elective courses. Many students come to Ohio State University with Advanced Placement or other college-level credits enabling them to accelerate their progress toward the Microbiology major and many take upper-division (5000-level) courses as early as their third year. The first year of graduate study (either the M.S. or Ph.D. program) in Microbiology includes 11 credit hours of 5000- and 6000-level Microbiology courses (Appendix B). The combined degree program will allow accelerated undergraduate students to take the first year of graduate coursework and apply 9 of these credit hours towards the fulfillment of the 9 undergraduate major elective credits. The remaining requirements for the MS degree include 21 credits of additional coursework which can be completed in an additional (i.e., fifth) year. A sample plan for the combined BS/MS degree is presented in Appendix C and a complete listing of course options and mapping to learning goals is presented in Appendix D. Current and proposed advising sheets are presented in Appendix E.

Students will be made aware of the opportunity to participate in the combined degree program at the point of declaring their major in Microbiology and during appointments with advisors. It is anticipated that most candidates will apply during the Spring semester of the student's third year following consultation with the Microbiology major advisor or honors advisor for admission to the program at the beginning of the student's fourth year. By the time of admission, applicants to the combined degree program must:

1. be in good academic standing (at least 3.5 GPA)
2. have completed the Microbiology major entry classes (MICRO4100 and BIOCHEM4511)
3. have completed at least M4120 in the major core class series (MICRO 4110, 4120, 4130, 4140)

GRE scores will not be required for the combined BS/MS degree. Applications will be reviewed by the Microbiology Department Graduate Studies Committee to determine if the student is ready and capable of accelerated studies. Upon admission, the Chair of the Microbiology Department Graduate Studies Committee, or another Microbiology faculty member designated by the GSC Chair after consultation with the student, will serve as the students BS/MS advisor. A committee consisting of the advisor and two additional Microbiology faculty members will be formed during the student's fourth year and will serve as an advisory body for the selection of remaining coursework for the MS degree (i.e., elective coursework typically in a particular focus area and/or individual study/research credits; Appendix C). Both thesis and non-thesis Masters degree candidates will complete a Masters examination comprising both a written document and an oral examination

(Department of Microbiology Graduate Program Handbook section 7.3.2). The Masters defense examination committee will be the same committee as the advisory committee.

Based on Microbiology Department exit surveys, approximately 25% of graduating Microbiology students are taking a “gap year” following graduation in preparation for professional schools (e.g., medical school, veterinary school, dental school, or PhD programs). Consequently, we anticipate 4-6 students will enroll in the combined degree program each year.

Students in the combined BS/MS degree program who are doing laboratory research as undergraduates (MICRBIOL 4998(H)/4999(H)) can receive research distinction (including honors) with the BS component. Students performing research as undergraduates may continue to do so after admission to the BS/MS degree program. Such students desiring a research focus may elect to complete a thesis MS as part of their combined BS/MS degree and will need to complete 44 credit hours of graduate training (which includes the core and elective course requirements for the non-thesis MS degree) and enrollment in MICRBIOL7999 (Research in Microbiology – MS Thesis). In this situation, the student’s research mentor will become the MS advisor.

A student in the combined degree program can elect to leave the program without penalty. The completed graduate courses will continue to count as elective credits towards the student’s Microbiology BS degree.

Admission to the program results in enrollment of the student as graduate students and credit hours including those that will be double-counted for completion of the undergraduate degree will be charged according to the graduate degree rates of the University. As graduate students, students in the combined BS/MS program may receive financial support through appointment as graduate teaching assistants (GTAs) after completion of the requirements for the BS degree (i.e., after receiving their BS degree). The offering of GTA positions to students in the 5th year of their combined degree depends on the student’s interests and the availability of teaching positions and funding in the Department.

We believe the opportunity to obtain a BS and MS degree will be attractive to ambitious students at Ohio State University preparing for either professional school (e.g., medical school or PhD programs) or employment in Microbiology fields where a MS degree will position them ahead of or open up better career-related positions than those available to BS degree-holding graduates. In addition, the advanced knowledge and training of graduates with an MS degree will enhance the reputation of Ohio State University programs in scientific fields and industries.

APPENDIX A: OVERVIEW OF THE COMBINED BS/MS DEGREE PROGRAM

BS degree

30 credits of Biochemistry and Microbiology coursework
 required courses: 21 credits
 elective courses: at least 9 credits

MS degree

30 credits (at least 18 graded) of Microbiology and related coursework
 required courses: 11 credits (graded) + 1 credit (S/U)
 core courses: 5 credits (graded) + 1 credit (S/U)
 diversity courses (pick two of three options): 6 credits (graded)
 elective courses (> 5000-level): at least 7 credits (graded) – courses determined by area of focus
 recurring courses: 2 credits (S/U) per semester (8 credits in 2 years)

BS degree	UG Core (21 credits)	4 Biochem 4511 5 Micro4100 General Microbiology 3 Micro4110 Pathogenesis & Immunobiology 3 Micro4120 Microbial Physiology & Diversity 3 Micro4130 Microbial Genetics 3 Micro4140 Molecular Microbiology Lab		
	UG Electives = Grad Core (9 of 11 credits)	3 Micro6020 Physiology and Biochemistry 3 Grad Core Diversity 1 3 Grad Core Diversity 2		
MS degree		Micro5161 Intro to Computational Genomics Micro6080 Advanced Microbial Genetics Micro6155 Microbial Ecology & Evolution		
		2 Micro6010 Principles of Microbiology 1 Micro7600 First Year Orientation (S/U)		
	Grad Electives (>7credits in focus area)	Infectious Diseases Micro5122 Immunology Micro5147 Eukaryotic Pathogens Micro5149 Virology Micro7010 Cell & Molec Immunology Micro7724 Molecular Pathogenesis Micro7070 Antibiotics VBS7741 Molecular Virology	Communities & Microbiomes Micro5150 Microbial Ecology Micro5155 Environmental Microbiol Micro5160 Geomicrobiology Micro5161* Intro Comp Genomics Micro5536 Food Microbiology Micro8161 Microbiome Informatics	Molecular Microbiology Micro5129 Mol Biol of Path. Euks Micro8050 The RNA World Micro5149 Virology Micro5270 Microb Nat Products Micro6080* Adv Microb Genetics

* a third core diversity class can be taken as one graduate elective class

APPENDIX B: INDIVIDUAL BACHELOR AND MASTERS DEGREES IN MICROBIOLOGY

Microbiology Major (BS)

121 total credits that includes 30 credits of Microbiology coursework

- General education (not counting pre-requisite coursework): 24-45 credits
- Pre-requisite coursework: 46-48 credits
 - Math & Statistics (8-10 credits)
 - Physics (10 credits)
 - Chemistry & Organic Chem (20 credits)
 - Biology (8 credits) 48 credits
- Required Microbiology courses: 21 credits

Course	Title	Credits	Pre-requisites*
BIOCHEM4511	Biological Chemistry	4 cr (graded)	CHEM2310 (or 2510) one Biological Sciences
MICRBIO4100	General Microbiology & Lab	5 cr (graded)	BIOL1113 CHEM2510
MICRBIO4110	Pathogenesis & Immunobiology	3 cr (graded)	MICRBIO 4100
MICRBIO4120	Microbial Physiology & Diversity	3 cr (graded)	MICRBIO 4100 BIOCHEM 4511
MICRBIO4130	Microbial Genetics	3 cr (graded)	MICRBIO 4100
MICRBIO4140	Molecular Microbiology Lab	3 cr (graded)	MICRBIO 4100 MICRBIO 4130

* or honors equivalent

- Microbiology elective courses: at least 9 credits

Microbiology MS degree (non-thesis)

30 credits (at least 18 graded) of Microbiology coursework

- required courses (MICRBIO6010 double-counted for the BS degree): 5 credits (graded) + 1 credit (S/U)

Course	Title	Credits
MICRBIO6010	Principles of Microbiology	2 cr (graded)
MICRBIO6020	Physiology and Biochemistry	3 cr (graded)
MICRBIO7600	First Year Orientation	1 cr (S/U)

- core diversity (two required, double-counted for the BS degree): 6 credits (graded)

Course	Title	Credits
MICRBIO5161	Intro. to Comp. Genomics	3 cr (graded)
MICRBIO6080	Adv Microbial Genetics	3 cr (graded)
MICRBIO6155	Microbial Ecology & Evolution	3 cr (graded)

- electives (at least 7 hours, typically within an area of focus): > 7 credits (graded)
- recurring courses (2 credits per semester)

Course	Title	Credits
MICRBIO7899	Microbiology Colloquium	1 cr (S/U)
MICRBIO8899	Seminars in Microbiology	1 cr (S/U)

Microbiology MS degree (thesis)

44 credits (at least 18 graded) of Microbiology coursework

- required courses (MICRBIO6010 double-counted for the BS degree): 5 credits (graded) + 1 credit (S/U)

Course	Title	Credits
MICRBIO6010	Principles of Microbiology	2 cr (graded)
MICRBIO6020	Physiology and Biochemistry	3 cr (graded)
MICRBIO7600	First Year Orientation	1 cr (S/U)

- core diversity (two required, double-counted for the BS degree): 6 credits (graded)

Course	Title	Credits
MICRBIO5161	Intro. to Comp. Genomics	3 cr (graded)
MICRBIO6080	Adv Microbial Genetics	3 cr (graded)
MICRBIO6155	Microbial Ecology & Evolution	3 cr (graded)

- electives (at least 7 hours, typically within an area of focus): > 7 credits (graded)
- recurring courses (2 credits per semester)

Course	Title	Credits
MICRBIO7899	Microbiology Colloquium	1 cr (S/U)
MICRBIO8899	Seminars in Microbiology	1 cr (S/U)

- research credits (variable)

Course	Title	Credits
MICRBIO7999	Research in Microbiology (MS)	variable (S/U)

APPENDIX C: SAMPLE COMBINED BS/MS CURRICULUM

Year	Credits	Course (title)	GE/ open	BS prereq.	BS core	BS elective	MS core	MS elective	MS S/U
1-AU	15	CHEM1210 (Gen Chem I)		5					
		MATH1151 (Calc I)		5					
		BIO1113 (Biology I)		4					
		ASC1100.07 (Survey)	1						
1-SP	15	CHEM1220 (Gen Chem II)		5					
		STATS1450 (Intro)		3					
		BIO1114 (Biology II)		4					
		GE Course	3						
2-AU	16	CHEM2510 (Org Chem I)		4					
		PHYSICS1200 (Physics I)		5					
		GE Courses	7						
2-SP	15	CHEM2520 (Org Chem II)		4					
		CHEM2540 (Org Chem Lab I)		2					
		PHYSICS1201 (Physics II)		5					
		GE Course	4						
3-AU	16	BIOCHEM4511 (BioChem)			4				
		MICRBIO4100 (General/Lab)			5				
		GE course	4						
		GE course	3						
3-SP	15	MICRBIO4110 (Path & Immuno)			3				
		MICRBIO4120 (Microbial Physiology)			3				
		GE or Open Elective(s)	9						
4-AU	16	MICRBIO4130 (Microbial Genetics)			3				
		MICRBIO4140 (Molec Micro. Lab)			3				
		MICRBIO6020 (Micro Phys & Biochem)				3	3		
		MICRBIO7600 (First-year Orientation)							1
		GE course(s)	6						
4-SP	16	MICRBIO5161 (Intro. Comp. Genomics)				3	3		
		MICRBIO6080 (Adv Microbial Genetics)				3	3		
		MICRBIO7899 (Micro Colloquium)							1
		MICRBIO8899 (Seminars)							1
		GE or Open Elective(s)	8						
5-AU	12	MS elective						3	
		MS elective						3	
		MICRBIO6010 (Principles)					2		
		MICRBIO7899 (Colloquium)							1
		MICRBIO8899 (Seminars)							1
		MICRBIO7193 (Research) or MICRBIO7999							2
5-SP	10	MS elective						3	
		MS elective						3	
		MICRBIO7899 (Colloquium)							1
		MICRBIO8899 (Seminars)							1
		(optional) MICRBIO7193 (Research) or MICRBIO7999							2
Total GE/open credits			45						
Total BS prerequisite credits				46					
Total BS core credits					21				
Total BS elective credits						9			
Total BS degree credits = 121									
Total MS degree required credits							11		
Total MS degree elective credits								12	
Total MS degree S/U credits									11
Total MS degree credits = 34									

APPENDIX D: MAPPING OF COURSES TO PROGRAMMATIC LEARNING GOALS

Required Prerequisites for the Major				U/G Learning Goals					Grad Learning Goals			
Semester Course Number	Course Title	Semester hrs.	1	2	3	4	5	1	2	3	4	
BIOL 1113	Biological Sciences: Energy Transfer and Development	4	B			B						
BIOL 1114	Biological Sciences: Form, Function, Diversity, and Ecology	4	B			B						
MATH Req. #1	MATH 1151	5	B									
	or											
	MATH 1156											
MATH Req. #2	MATH 1152	3 - 5	B									
	or											
	MATH 1157											
	or											
	STATS 1450											
	or											
	STATS 2480											
CHEM 1210	General Chemistry 1	5	B									
CHEM 1220	General Chemistry 2	5	B									
CHEM 2510	Organic Chemistry 1	4	B	B								
CHEM 2520	Organic Chemistry 2	4	B	B								
CHEM 2540	Organic Chemistry Lab 1	2	B	B		B						
PHYS 1200	Mechanics, Thermal Physics, Waves	5	B			B						
PHYS 1201	E&M, Optics, Modern Physics	5	B			B						
Total Hrs.		46 - 48										
Required Core for the Major				U/G Learning Goals					Grad Learning Goals			
Semester Course Number	Course Title	Semester hrs.	1	2	3	4	5	1	2	3	4	
MICRBIOL 4100	General Microbiology	5	I	I	I	I	I					
MICRBIOL 4110	Pathogenesis and Immunobiology	3	A	A	A							
MICRBIOL 4120	Microbial Physiology and Diversity	3	A	A	A							
MICRBIOL 4130	Microbial Genetics	3	A	A	I							
MICRBIOL 4140	Molecular Microbiology Laboratory	3	I	I	I	A	A					
BIOCHEM 4511	Biochemistry	4	I	A			I					
Total Hrs.		21										

Electives: Total Required 9 hrs. Group 1: 3-9 hrs.				U/G Learning Goals					Grad Learning Goals			
Semester Course Number		Course Title	Semester hrs.	1	2	3	4	5	1	2	3	4
MICRBIOL 2000		Introduction to Microbiology Research	1.5				B	B				
MICRBIOL 3704		HIV: From Microbiology to Macrohistory	3			I	I	I				
MICRBIOL 4150		Immunobiology Laboratory	3	I	I	A	A	A				
MICRBIOL 4193		Individual Studies	1-3									
MICRBIOL 4194		Group Studies	1-3									
MICRBIOL 4591S		DNA Finger Printing Workshops in Columbus PS	1				A	A				
MICRBIOL 4797		Study at a Foreign Institution	1-19									
MICRBIOL 4798		Study Tour Domestic	1-19									
MICRBIOL 4998		Undergrad Research in Microbiology	1-5				A	A				
MICRBIOL 4998H		Honors Research	1-5				A	A				
MICRBIOL 4999		Undergrad Research in Microbiology-Thesis	1-5				A	A				
MICRBIOL 4999H		Honors Research-Thesis	1-5				A	A				
MICRBIOL 5122		Immunology	3			A			I			
MICRBIOL 5129		Cellular and Molecular Biology of Pathogenic Eukaryotes	3		A	A			I	I		B
MICRBIOL 5147		Eukaryotic Pathogens	3		A	A	A		I	I		B
MICRBIOL 5149		Introductory Virology	3		A	A			I	I		B
MICRBIOL 5150		Microbial Ecology	3	A	A	A			I			
MICRBIOL 5155		Environmental Microbiology	3	A	A	A			I			B
MICRBIOL 5161		Intro. to Comp. Genomics	3	A	A	A		A	I	I		
MICRBIOL 5170		Microbes and Evolution	3			A			I			
MICRBIOL 5270		Antibiotics and Microbial Natural Products	3		A	A	A	A	I			
MICRBIOL 5536		Food Microbiology Lecture	3		A	I		A	I			
MICRBIOL 5546		Food Microbiology Laboratory	3		A	I	A	A	I	I		
MICRBIOL 6020*		Microbial Physiology and Biochemistry	3	A	A	A	A		A			I
MICRBIOL 6080*		Advanced Microbial Genetics	3		A		A		A	A		
MICRBIOL 6155*		Microbial Ecology & Evolution	3			A	A	A	A			
MICRBIOL 6790*		Scientific Writing	2									A
MICRBIOL 7010*		Cellular and Molecular Immunology	3			A	A		A			
MICRBIOL 7020*		Physiology Meets Pathogenesis	2	A	A	A	A		A			
MICRBIOL 7023*		Molecular Immunology: Lecture	3			A	A		A			
MICRBIOL 7050*		Fermentation Biotechnology	3	A			A	A	A			
MICRBIOL 7060*		Advanced Topics in Molecular Microbiology	2		A		A		A	A		I
MICRBIOL 7193*		Individual Studies	1-5							A	I	
MICRBIOL 7536*		Advanced Food Microbiology	3		A	I	A	A	A			
MICRBIOL 7724*		Molecular Pathogenesis	3		A	A	A		A			
MICRBIOL 7889*		Host-Pathogen Interactions: Research Seminar	1			A	A		A			A
MICRBIOL 7899*		Microbiology Colloquium	1						A	A		

MICRBIOL 7999*	Research in Microbiology	1-8								A	A		
MICRBIOL 8161*	Microbiome Informatics	3	A*	A*	A*					A			
MICRBIOL 8899*	Seminars in Microbiology	1								A			A
Total Hrs.		3-9											
*Indicated graduate-level course. Undergraduates require special permission to enroll.													
Electives: Total Required 9 hrs. Group 2: 0-6 hrs.				U/G Learning Goals					Grad Learning Goals				
Semester Course Number	Course Title	Semester Hrs.	1	2	3	4	5	1	2	3	4		
MICRBIOL 3798.05	Impact of HIV: Tanzania (study abroad)	4			I	B	I						
BIOCHEM 5621	Intro Biological Chemistry Laboratory	4	I			I		I					
MOLGEN 4500	General Genetics	3		I									
MOLGEN 4606	Molecular Genetics I	4		I									
MVIMG 5000	Evolution of Emerging Viruses	2			A			I					
PLPATH 5010	Phytobacteriology	2		I	A			I					
PLPATH 5020	Introduction to Plant Virology	2		I	A			I					
PLPATH 5040	Science of Fungi: Mycology Lecture	3	I	I	A			I					
ANSCI 6090*	Anaerobic Microbiology	3		A				A					
ENR 5263	Biology of Soil Ecosystems	3	I	A				I					
ENR 5266	Field Soil Investigations	3	I			A		I					
Total Hrs.		0-6											
Total Hrs. for the U/G Major		30											
*Indicated graduate-level course. Requires special permission to enroll.													

Undergraduate Program Learning Goals : (B, beginning; I, Intermediate; A, Advanced)

1. Students acquire the ability to interrelate and apply the fundamental concepts of chemistry, physics and mathematics to the functions of living cells.
2. Students understand the chemical properties of biological molecules and how these molecules function in the molecular mechanisms underlying physiological processes in microbial cells.
3. Students understand evolutionary processes, the diversity of microorganisms, and how microorganisms impact their environment, including their roles in human health and disease.
4. Students acquire the ability to design experiments to test hypotheses, perform analyses, interpret and analyze data, and present scientific information in written and oral formats.
5. Students acquire the ability to appraise scientific data presented in the popular press for accuracy and scientific merit and understand issues and ethical conflicts associated with applications of biotechnology.

PhD Graduate Program Learning Goals (Masters PLG are the same less goal #3):

1. Demonstrate a broad base of knowledge in several areas, including microbial physiology, genetics, biochemistry, and pathogenesis.
2. Demonstrate in-depth knowledge in an area of interest.
3. Make an original and substantial contribution to the field, as indicated by at least one first-author publication.
4. Effectively communicate science through oral and written presentations to both scientific and general audiences

APPENDIX E1: CURRENT BS ADVISING SHEET

Microbiology BS

Student ID #: _____

Expected Graduation Term: _____ Student Name.#: _____

Second Major: _____ Minor: _____

Part A: General Education not fulfilled by Part B

GE Category	Course Number	Credit Hours	Grade	Term Taken
Writing		3		
		3		
Literature		3		
VPA		3		
Soc. Sci. 1:		3		
Soc. Sci. 2:		3		
Historical Study		3		
Cultures & Ideas		3		
Foreign Language		4		
		4		
		4		
Social Diversity*		3		
Global Studies*		3		
		3		

*Courses in these areas can overlap with another GE category when applicable

Part B: Major Prerequisites

Course	Credit Hours	Grade	Term Taken	Course	Credit Hours	Grade	Term Taken
Math 1151	5			Chem 1210	5		
OR Math 1156	5			Chem 1220	5		
Math 1152	5			Chem 2510	4		
OR Math 1157	5			Chem 2520	4		
OR Stat 1450	3			Chem 2540	2		
OR Stat 2450	3			Physics 1200	5		
OR Stat 2480	3			OR Physics 1250	5		
Bio 1113	4			Physics 1201	5		
Bio 1114	4			OR Physics 1251**	5		

Honors courses can substitute where available

Additional courses may be required or suggested for pre-professional students

**Math 1152 is a prerequisite/co-requisite for Physics 1251

Microbiology BS

Part C: Microbiology BS Core

Course	Title	Major Credit Hours	Grade	Term Taken
BIOCHEM 4511	Intro to Biological Chemistry	4		
MICRBIO 4100	General Microbiology & Lab	5		
MICRBIO 4110	Pathogenesis & Immunobiology	3		
MICRBIO 4120	Microbial Physiology & Diversity	3		
MICRBIO 4130	Microbial Genetics	3		
MICRBIO 4140	Molecular Microbiology Lab	3		

Part D: Microbiology BS Electives

Course	Title	Major Credit Hours	Grade	Term Taken	Group 1 or 2	Mark if S/U***

At least 3 credits must be from Group 1

***At most 3 credits graded S/U may be counted toward the major

BS Degree

Major Core Credits (21): _____

Major Elective Credits (≥ 9): _____

Major Credits not graded S/U (≥ 27): _____

Total BS Major Credits (≥ 30): _____

Upper Division Credits (≥ 39): _____

Total BS Credits (≥ 121): _____

APPENDIX E2: CURRENT MS (NON-THESIS) ADVISING SHEET

Microbiology MS (non-thesis)

Student ID #: _____

Expected Graduation Term: _____

Student Name.#: _____

Part A: Required Courses

Course	Title	Credit Hours	Grade	Term Taken	Mark if S/U
MICRBIO 6010	Principles of Microbiology	2			
MICRBIO 6020	Physiology and Biochemistry	3			
MICRBIO 7600	First-Year Orientation	1			X
SUB-TOTAL (6)					

Part B: Core Diversity [Select 2]

Course	Title	Credit Hours	Grade	Term Taken	Mark if S/U
MICRBIO 5161	Intro. to Comp. Genomics	3			
MICRBIO 6080	Adv. Microbial Genetics	3			
MICRBIO 6155	Microbial Ecology & Evolution	3			
SUB-TOTAL (6)					

Part C: Electives

Course	Title	Credit Hours	Grade	Term Taken	Mark if S/U
MICRBIO	Elective:				
MICRBIO	Elective:				
MICRBIO	Elective:				
MICRBIO	Elective:				
MICRBIO	Elective:				
SUB-TOTAL (≥ 7)					

Part D: Recurring Courses

Course	Title	Credit Hours	Grade	Term(s) Taken	Mark if S/U
MICRBIO 7899	Microbiology Colloquium	1 each semester			X
MICRBIO 8899	Seminars in Microbiology	1 each semester			X
SUB-TOTAL					

MS Degree

Required Credits (12): _____

Elective Credits (≥ 7): _____

Credits not graded S/U (≥ 18): _____

Total MS Degree Credits (≥ 30): _____

APPENDIX E3: CURRENT MS (THESIS) ADVISING SHEET

Microbiology MS (thesis)

Student ID #: _____

Expected Graduation Term: _____

Student Name.#: _____

Part A: Required Courses

Course	Title	Credit Hours	Grade	Term Taken	Mark if S/U
MICRBIO 6010	Principles of Microbiology	2			
MICRBIO 6020	Physiology and Biochemistry	3			
MICRBIO 7600	First-Year Orientation	1			X
SUB-TOTAL (6)					

Part B: Core Diversity [Select 2]

Course	Title	Credit Hours	Grade	Term Taken	Mark if S/U
MICRBIO 5161	Intro. to Comp. Genomics	3			
MICRBIO 6080	Adv. Microbial Genetics	3			
MICRBIO 6155	Microbial Ecology & Evolution	3			
SUB-TOTAL (6)					

Part C: Electives

Course	Title	Credit Hours	Grade	Term Taken	Mark if S/U
MICRBIO	Elective:				
MICRBIO	Elective:				
MICRBIO	Elective:				
SUB-TOTAL (≥ 7)					

Part D: Recurring Courses

Course	Title	Credit Hours	Grade	Term(s) Taken	Mark if S/U
MICRBIO 7899	Microbiology Colloquium	1 each semester			X
MICRBIO 7999	Research in Microbiology (MS)	Variable			X
MICRBIO 8899	Seminars in Microbiology	1 each semester			X
SUB-TOTAL					

MS Degree

Required Credits (12): _____

Elective Credits (≥ 7): _____

Credits not graded S/U (≥ 25): _____

Total MS Degree Credits (≥ 44): _____

APPENDIX E4: PROPOSED BS/MS ADVISING SHEET

Microbiology BS/MS

Student ID #: _____

Expected Graduation Term: _____

Student Name.#: _____

Second Major: _____

Minor: _____

Part A: General Education not fulfilled by Part B

Should complete majority prior to starting MS courses

GE Category	Course Number	Credit Hours	Grade	Term Taken
Writing		3		
		3		
Literature		3		
VPA		3		
Soc. Sci. 1:		3		
Soc. Sci. 2:		3		
Historical Study		3		
Cultures & Ideas		3		
Foreign Language		4		
		4		
		4		
Social Diversity*		3		
Global Studies*		3		
		3		

*Courses in these areas can overlap with another GE category when applicable

Part B: Major Prerequisites

Should be completed prior to starting MS courses

Course	Credit Hours	Grade	Term Taken	Course	Credit Hours	Grade	Term Taken
Math 1151	5			Chem 1210	5		
OR Math 1156	5			Chem 1220	5		
Math 1152	5			Chem 2510	4		
OR Math 1157	5			Chem 2520	4		
OR Stat 1450	3			Chem 2540	2		
OR Stat 2450	3			Physics 1200	5		
OR Stat 2480	3			OR Physics 1250	5		
Bio 1113	4			Physics 1201	5		
Bio 1114	4			OR Physics 1251**	5		

Honors courses can substitute where available

**Math 1152 is a prerequisite/co-requisite for Physics 1251

Microbiology BS/MS

Part C: Microbiology BS Core

Course	Title	BS Credit Hours	MS Credit Hours	Grade	Term Taken
BIOCHEM 4511	Intro to Biological Chemistry	4			
MICRBIO 4100	General Microbiology & Lab	5			
MICRBIO 4110	Pathogenesis & Immunobiology	3			
MICRBIO 4120	Microbial Physiology & Diversity	3			
MICRBIO 4130	Microbial Genetics	3			
MICRBIO 4140	Molecular Microbiology Lab	3			

Biochem 4511, Micro 4100, and Micro 4120 in Part C MUST be completed prior to starting MS courses
 OSU GPA must be ≥ 3.5 prior to starting MS courses

Part D: Microbiology BS Electives/MS Requirements

Course	Title	BS Credit Hours	MS Credit Hours	Grade	Term(s) Taken	Mark if S/U
MICRBIO 6010	Principles of Microbiology	2	2			
MICRBIO 6020	Microbial Physiology & Biochem	3	3			
MICRBIO	Core Diversity 1:	3	3			
MICRBIO	Core Diversity 2:	3	3			
MICRBIO	Elective:					
MICRBIO	Elective:					
MICRBIO	Elective:					
MICRBIO	Elective:					
MICRBIO 7600	First-Year Orientation		1			X
MICRBIO 7899	Microbiology Colloquium		4 (1 each semester)			X
MICRBIO 7999*	Research in Microbiology		Variable			X
MICRBIO 8899	Seminars in Microbiology		4 (1 each semester)			X
Space for Additional Microbiology Coursework						

* MICRBIO7999 enrollment for students in the thesis-MS program only

BS Degree

Major Core Credits (21): _____
 Major Elective Credits (≥ 9): _____
 Major Credits not graded S/U (≥ 27): _____
 Total BS Major Credits (≥ 30): _____
 Upper Division Credits (≥ 39): _____
 Total BS Degree Credits (≥ 121): _____

MS Degree

Required Credits (12): _____
 Elective Credits (≥ 7): _____
 Credits not graded S/U (≥ 18): _____
 Total MS Degree Credits* (≥ 30): _____

* thesis-MS requires > 44 credits

BS and MS Program Learning Objectives and Methods of Assessment.

BS Graduates of Microbiology should be able to:

1. Students acquire the ability to interrelate and apply the fundamental concepts of chemistry, physics and mathematics to the functions of living cells. (BS)
 - a. **Indirect:** All microbiology majors (BS) are required to complete prerequisite courses in Biology (1113-1114), Chemistry (1210-1220 and 2510-2520 and 2540), Physics (1200-1201) and Mathematics/Statistics (Math1151 or 1156, and one of the following Math1152, Math1157, Stats1450 or Stats2480). Performance of microbiology majors in the prerequisite courses will provide an indirect measure of their preparation. **Criteria:** The initial measure for meeting the goal will be based on student performance in the required classes: M4100, M4110, M4120, M4130, M4140 and Biochem 4511. A final course grade of 70% (C-) is required for the major; however, we desire a mean grade of 75% (C or above) and a mean of =85% (B or above) is ideal.
 - b. **Direct - Embedded testing** Students understanding of these foundation courses will be re-evaluated in a pre-screening test covering biological and chemical concepts specifically related to microbiology. This will provide a direct measure of the student's readiness for the program. The screening test will be administered to students in General Microbiology (M4100), the first required core course in the major. **Criteria:** The initial measure for meeting the goal is a score of >50% in each of the five topic areas: Chem, CellBio, BioChem, Metabolism and Genetics. Students are grouped based on where they took Introductory Biology (B1113 or equivalent).
 - c. **Indirect - Survey (Student)** Student data from the "Curricular Experiences" sections of the Senior Survey, will provide an additional indirect measure of the students general assessment of the program. **Criteria:** A combined response rate of 75% in the two top levels (5-4) in the "curricular experiences" sections of the Senior Survey, covering the major program, is desired.
2. Students understand the chemical properties of biological molecules and how these molecules function in the molecular mechanisms underlying physiological processes in microbial cells. (BS)
 - a. **Direct - Embedded testing** Overall performance in individual core courses, performance on selected assignments, embedded questions and targeted tests in core and elective courses will be used to measure student achievement at the intermediate and advanced levels. **Criteria:** The initial measure for meeting the goal will be based on student performance in the required classes. This goal is highly represented in the core series: M4100, M4110, M4120, M4130 and Biochem 4511. The target goal is for =75% of the majors achieving C or above in the core courses. Similar levels of performance are desired on embedded questions and targeted tests. Advanced material on these topics is presented in Group 1 electives: M5129, M5147, M5149, M5150, M5155 and M5536.
 - b. **Indirect - Survey (Student)** Student data from the "Curricular Experiences" sections of the Senior Survey, will provide an additional indirect measure of the students general assessment of the program. **Criteria:** A combined response rate of 75% in the two top levels (5-4) in the "curricular experiences" sections of the Senior Survey, covering the major program, is desired.
 - c. **Indirect - Grade review** Overall performance in individual core courses and elective courses, will be used to measure achievement at the intermediate and advanced levels. **Criteria:** The initial measure for meeting the goal will be based on student performance in the required classes. This goal is highly represented in the core series: M4100, M4110, M4120, M4130 and Biochem 4511. The target goal is for =75% of the majors achieving C or above in the core

courses. Similar levels of performance are desired on the elective courses M5129, M5147, M5149, M5150, M5155 and M5536.

3. Students understand evolutionary processes, the diversity of microorganisms, and how microorganisms impact their environment, including their roles in human health and disease. (BS)
 - a. **Direct - Embedded testing** Overall performance in individual core courses, and performance on selected assignments, embedded questions and targeted tests in core and elective courses, will be used to measure intermediate and advanced levels. **Criteria:** The initial measure for meeting the goal will be based on student performance in the required classes. This goal is highly represented in the core series: M4100, M4110, M4120, M4130 and Biochem 4511. The target goal is for =75% of the majors achieving C or above in the core courses. Similar levels of performance are desired on embedded questions and targeted tests. Advanced material on these topics is presented in Group 1 electives: M2200, M3704, M5122, M5129, M5147, M5149, M5155, M5160 and M5536.
 - b. **Indirect - Grade review** Overall performance in individual core courses, and performance on selected assignments, embedded questions and targeted tests in core and elective courses, will be used to measure intermediate and advanced levels. **Criteria:** The initial measure for meeting the goal will be based on student performance in the required classes. This goal is highly represented in the core series: M4100, M4110, M4120, M4130 and Biochem 4511. The target goal is for =75% of the majors achieving C or above in the core courses. Similar levels of performance are desired on embedded questions and targeted tests. Advanced material on these topics is presented in Group 1 electives: M2200, M3704, M5122, M5129, M5147, M5149, M5155, M5160 and M5536.
 - c. **Indirect - Survey (Student)** Student interviews or focus groups, and data from the “curricular experiences” sections of the Senior Survey, will provide an additional indirect measure of the students general assessment of the program. **Criteria:** A combined response rate of 75% in the two top levels (5-4) in the “curricular experiences” sections of the Senior Survey, covering the major program, is desired.
4. Students acquire the ability to design experiments to test hypotheses, perform analyses, interpret and analyze data, and present scientific information in written and oral formats. (BS)
 - a. **Direct - Embedded testing** Overall performance in individual core courses, and performance on selected assignments, embedded questions and targeted tests in core and elective courses, will be used to measure intermediate and advanced levels. **Criteria:** The initial measure for meeting the goal will be based on student performance in the core and elective classes with laboratory components, M4100, M4140, and M5546, electives with data analyses and presentations requirements, M2200, M3704, M5147, and independent research, M4998(H) and M4999(H). The target goal is for =75% of the majors achieving C or above in the core courses and related electives. Similar levels of performance are desired on embedded questions and targeted tests. In addition to performance in these courses, presentation at local (NMS and Denman) or national meetings and research publications are a measure of high achievement.
 - b. **Indirect - Grade review** Outcomes will be measured using indirect and direct means. Overall performance in individual core courses, and performance on selected assignments, embedded questions and targeted tests in core and elective courses, will be used to measure intermediate and advanced levels. **Criteria:** The initial measure for meeting the goal will be based on student performance in the core and elective classes with laboratory components, M4100, M4140, and M5546, electives with data analyses and presentations requirements, M2200, M3704, M5147, and independent research, M4998(H) and M4999(H). The target goal is for =75% of the majors achieving C or above in the core courses and related electives.

Similar levels of performance are desired on embedded questions and targeted tests. In addition to performance in these courses, presentation at local (Spring Expo and Denman) or national meetings and research publications are a measure of high achievement.

- c. **Direct - Student Research** Student participation in independent research (M4998[H] and 4999[H]) and presentation at local (Spring Expo and Denman) or national meetings and research publications will also be monitored. **Criteria:** Participation in independent research (M4998[H] and 4999[H]), presentation at local (Spring Expo and Denman) or national meetings and research publications are a measure of high achievement.
 - d. **Indirect - Survey (Student)** Student interviews or focus groups, and data from the “curricular experiences” sections of the Senior Survey, will provide an additional indirect measure of the students general assessment of the program. **Criteria:** A combined response rate of 75% in the two top levels in Section 4 of the Senior Survey, covering the major program, is desired.
5. Students acquire the ability to appraise scientific data presented in the popular press for accuracy and scientific merit and understand issues and ethical conflicts associated with applications of biotechnology. (BS)

MS Program Learning Objectives and Methods of Assessment.

1. Demonstrate a broad base of knowledge in several areas, including microbial physiology, genetics, biochemistry, and pathogenesis.
 - a. **Direct** – Satisfactory performance in Microbiology Colloquium (M7899), demonstrated both in presenting a research paper and by asking questions when other students present.
 - b. **Indirect** - Performance in individual core courses 5000 level and above will be used to measure intermediate and advanced levels. **Criteria:** Achievement of this goal will be based on student performance in the core graduate classes (M6101, M6020, and two of these three courses: M5161, M6080, M6155) and electives (M5122, M5147, M5149, M7010, M7724, M7070, VBS7741, M5150, M5155, M5160, M5536, M8161, M5129, M8050, M5270, M6080). The target goal is for 80% of the MS majors to achieve a B or better in their masters’ core courses and related electives. In addition to performance in these courses, presentation at local or national meetings and research publications are a measure of high achievement.
2. Both thesis and non-thesis MS students must demonstrate in-depth knowledge in an area of interest. This will be demonstrated for both thesis and non-thesis candidates by an affirmative (passing) vote on both the masters written document and oral defense (see rubric below). The written and oral exam for MS (non-thesis) candidates will cover general knowledge. The written and oral exam for MS-thesis candidates will cover general knowledge and primary data generated by the candidate.
3. Effectively communicate science through oral and written presentations to both scientific and general audiences. Performance in M7899 will be used to evaluate effective communication. Written and oral communication for both thesis and non-thesis candidates will be evaluated through the Masters examination (written and oral).

BS/MS assessment includes both the BS and MS assessments listed above.

EVALUATION RUBRIC: Masters (M.S.) DEFENSE EXAM - Thesis

Candidate Name: _____

Date: _____

Title of Thesis: _____

Evaluation/Guidance	Does not meet Expectations	Meets Expectations	Exemplary Performance
1. Problem Definition: Has stated the research problem clearly and provides motivation for the research			
2. Literature and Previous Work: Demonstrated sound knowledge of literature in the area, and of prior work on the specific research problem			
3. Results: Analyzed and interpreted research results/data effectively			
4. Quality of Written Communication: Communicates research results clearly and professionally			
5. Quality of Oral Communication: Communicates research results clearly and professionally			
6. Critical Thinking: Has demonstrated capability for independent research in the area of study and expertise in the area			
7. Broader Impact: Demonstrated awareness of broader implications of the concluded research.			

Overall Assessment: The assessment of the overall performance of the candidate based on the evidence provided in items 1 – 9 above.

CRITERIA	Performance Criteria		
OVERALL Rating Masters exam:	Does NOT PASS Masters Exam	Passes Masters Exam	
	Does not meet Expectations	Meets Expectations	Exemplary Performance

Name of the Examining Committee Member: _____

Signature of the Examining Committee Member: _____

EVALUATION RUBRIC: Masters (M.S.) DEFENSE EXAM (Non-thesis)

Candidate Name: _____

Date: _____

Title: _____

Evaluation/Guidance	Does not meet Expectations	Meets Expectations	Exemplary Performance
1. Problem Definition: Has stated the research problem clearly and provides motivation for the research			
2. Literature and Previous Work: Demonstrated sound knowledge of literature in the area, and of prior work on the specific research problem			
3. Quality of Written Communication: Communicates research results clearly and professionally			
4. Quality of Oral Communication: Communicates research results clearly and professionally			
5. Critical Thinking: Has demonstrated capability for independent research in the area of study and expertise in the area			
6. Broader Impact: Demonstrated awareness of broader implications of the concluded research.			

Overall Assessment: The assessment of the overall performance of the candidate based on the evidence provided in items 1 – 5 above.

CRITERIA	Performance Criteria		
OVERALL Rating Masters exam:	Does NOT PASS Masters Exam	Passes Masters Exam	
	Does not meet Expectations	Meets Expectations	Exemplary Performance

Name of the Examining Committee Member: _____

Signature of the Examining Committee Member: _____

Coursework Changes to the Microbiology PhD and MS Degrees

BACKGROUND

Our last revision of the PhD and MS program was in 2011 during the quarter-to-semester conversion. Since that time, the Department of Microbiology has performed a review of our graduate course offerings, particularly in light of guidelines established by the American Society for Microbiology (ASM) and the evolving interests of graduate student applicants. The field of microbiology is rapidly changing with the development of genome-scale methodologies and analysis of datasets generated by large scale sequencing efforts. Our revised curriculum reflects changes to stay relevant to modern microbiology as well as changes in our program faculty (i.e., faculty hires in areas of genome analysis and computational approaches to build in these growth areas of microbiology). At the same time, our program has a strong reputation in biochemistry and infectious diseases which we maintain.

REVISIONS TO THE PHD PROGRAM COURSEWORK

Current PhD coursework requirements

The current coursework required of both MS and PhD graduate students includes 18 hours of graded courses comprising 10 hours of core courses taken during the first year followed by at least 8 hours of elective credits typically completed in the second year of study. The choice of electives is done in consultation with the dissertation/thesis advisor and the dissertation/thesis committee.

Core Coursework

Year of Study	Course	Course Title	Credit Hrs	Grading
1 (Au)	MICRBIO6010	Principles of Microbiology	2	S/U
	MICRBIO6020	Microbial Physiology and Biochemistry	3	Graded
1 (Sp)	MICRBIO6080	Advanced Microbial Genetics	3	Graded
	MICRBIO7020	Physiology Meets Pathogenesis	2	Graded
		Total Core Courses	10 (8 Graded)	
2 (Au, Sp)	Variable	Elective Courses (5000-level and above):	>8 (8 Graded)	

During the first year, PhD students also complete laboratory rotations (MICRBIO6789) before joining a lab for their dissertation research. Students take their PhD Candidacy examination in the Autumn semester of year 3 in the program. In addition, all graduate students (MS and PhD) take two required seminar courses in the Autumn and Spring semesters throughout their training.

Other Required Courses

Year of Study	Course	Course Title	Credit Hrs	Grading
1 (Au,Sp)	MICRBIO6789	Research Principles and Techniques in Microbiology	5 per semester	S/U
2 (Au,Sp,Su) 3 (Au)	MICRBIO7898	Research in Microbiology (pre-candidacy)	variable	S/U
3 (Sp) and on	MICRBIO8999	Research in Microbiology (post-candidacy)	variable	S/U
every year (Au,Sp)	MICRBIO7899	Microbiology Colloquium	1 per semester	S/U
every year (Au,Sp)	MICRBIO8899	Seminar in Microbiology	1 per semester	S/U

Proposed Changes to MS and PhD coursework requirements

To give MS and PhD students greater flexibility to tailor their foundation in Microbiology, we will allow students to choose two of three “diversity core” course options during the second semester of study to accommodate the broader areas in Microbiology. The third diversity core class can be taken as an elective during the second year of study depending on the student’s interests and approval of the dissertation/thesis committee. We will retain MICRBIO6080 (Advanced Microbial Genetics) as one of the diversity core classes since the principles taught are broadly applicable to many aspects of Microbiology. We will remove MICROBIO7020 (Physiology Meets Pathogenesis) from the core coursework as the material is not applicable to all students and there is an approved elective course (MICRBIO7724: Molecular Pathogenesis) that effectively serves those students interested in infectious microbial diseases. We propose two new courses to give options for students interested in computational approaches (MICRBIO5161: Bioinformatics and Molecular Microbiology) and in evolutionary processes underlying environmental microbiology (MICRBIO6155: Microbial Ecology & Evolution). Each of the new diversity core courses will be 3 credit hours and will be graded. Thus, under the new program, students will complete 5 credits of core coursework plus 6 credit hours of diversity core classes instead of 10 credits of required core coursework. Because of the additional credit hour that results, the elective credits required for the MS and PhD degrees will be reduced from 8 to 7. The other required courses (MICRBIO6789 for PhD students, MICRBIO7898, MICRBIO8899, and MICRBIO7898/8999) will remain unchanged.

Core Coursework

Year of Study	Course	Course Title	Credit Hrs	Grading
1 (Au)	MICRBIO6010	Principles of Microbiology	2	S/U
	MICRBIO6020	Microbial Physiology and Biochemistry	3	Graded
1 (Sp)	One of the Diversity Core	MICRBIO5161: Intro. to Computational Genomics or MICRBIO6080: Advanced Microbial Genetics or MICRBIO6155: Microbial Ecology and Evolution	3	Graded
	One of the Diversity Core	MICRBIO5161: Intro. to Computational Genomics or MICRBIO6080: Advanced Microbial Genetics or MICRBIO6155: Microbial Ecology and Evolution	3	Graded
		Total Core Courses	11 (9 Graded)	
2 (Au,Sp)	Variable	Elective Courses (5000-level and above):	>7 (7 Graded)	

The development of the diversity core courses will provide students with the ability to tailor their education more appropriately for their interests yet also enable the program to maintain a high standard for foundational coursework. These diversity core courses are highly relevant to multiple areas of Microbiology and thus are retained as a more diversified core rather than relegated to true elective courses. The greater options will provide better and more relevant training to our graduate students, keeping the Microbiology PhD degree program competitive.