

## Term Information

Effective Term Spring 2019

## General Information

Course Bulletin Listing/Subject Area Microbiology  
Fiscal Unit/Academic Org Microbiology - D0350  
College/Academic Group Arts and Sciences  
Level/Career Graduate, Undergraduate  
Course Number/Catalog 5270  
Course Title Antibiotics and Microbial Natural Products  
Transcript Abbreviation Microbial Nat Prod  
Course Description Microorganisms are responsible for producing a vast array of chemically diverse natural product small molecules. The unique biological and chemical properties of many of these small molecules have afforded many valuable applications throughout medicine, agriculture, and biotechnology. Here, we cover the biology behind the chemistry of these molecules and their role in human medicine.  
Semester Credit Hours/Units Fixed: 3

## Offering Information

Length Of Course 14 Week, 12 Week, 8 Week, 7 Week, 6 Week, 4 Week  
Flexibly Scheduled Course Never  
Does any section of this course have a distance education component? No  
Grading Basis Letter Grade  
Repeatable No  
Course Components Lecture  
Grade Roster Component Lecture  
Credit Available by Exam No  
Admission Condition Course No  
Off Campus Never  
Campus of Offering Columbus

## Prerequisites and Exclusions

Prerequisites/Corequisites Successful completion of Microbiology 4120 (Microbial Physiology and Diversity; C- or higher); OR successful completion of Biochemistry 5614 (Metabolism; C- or higher); OR successful completion of Pharmacy 4000 (Integrate Pharmaceutical Sciences I; C- or higher) OR Graduate student standing (with equivalent background); OR consent of the instructor.  
Exclusions None  
Electronically Enforced Yes

## Cross-Listings

Cross-Listings Phr 5270

## Subject/CIP Code

Subject/CIP Code 26.0502  
Subsidy Level Professional Course  
Intended Rank Junior, Senior, Masters, Doctoral, Professional

## Requirement/Elective Designation

The course is an elective (for this or other units) or is a service course for other units

## Course Details

### Course goals or learning objectives/outcomes

- Knowledgeably describe the major types of microbial natural products, their biosynthesis, and function
- Knowledgeably describe the mode of action of major types of antibiotics
- Knowledgeably describe the common mechanisms of antibiotic resistance
- Understand current views on the roles of antibiotics in nature and the origin of resistance genes
- Understand commonly employed methods in natural product discovery
- Understand the impact of genomics on natural product discovery
- Critically evaluate research papers on microbial natural products
- Accurately interpret raw and processed data sets in research papers
- Identify key findings of research papers and explain them clearly to an audience of peers
- Identify strong arguments supported by conclusive data; identify weak arguments supported by inconclusive data
- Argue the merits and/or weaknesses of published work from a knowledgeable perspective

### Content Topic List

- Types of natural products (e.g. Peptides;polyketides; beta-lactams; terpenes)
- Modes of action, resistance, and natural functions
- Assays and analytical methods
- New approaches to natural product discovery

### Sought Concurrence

No

## Attachments

- MICRO-5270-PHR-5270-Syllabus-2018-07-13.pdf: Syllabus  
*(Syllabus. Owner: Kwiek,Jesse John)*
- LG\_Map\_M5270.pdf: Map to Microbiology Program Objectives  
*(Other Supporting Documentation. Owner: Kwiek,Jesse John)*
- Cover\_letter.pdf: Cover Letter  
*(Cover Letter. Owner: Kwiek,Jesse John)*

## Comments

## Workflow Information

| Status           | User(s)   | Date/Time           | Step                   |
|------------------|---|---------------------|------------------------|
| Submitted        | Kwiek,Jesse John  | 07/13/2018 01:10 PM | Submitted for Approval |
| Approved         | Kwiek,Jesse John  | 07/13/2018 01:11 PM | Unit Approval          |
| Approved         | Haddad,Deborah Moore  | 07/13/2018 02:43 PM | College Approval       |
| Pending Approval | Nolen,Dawn<br>Vankeerbergen,Bernadette Chantal<br>Oldroyd,Shelby Quinn<br>Hanlin,Deborah Kay<br>Jenkins,Mary Ellen Bigler | 07/13/2018 02:43 PM | ASCCAO Approval        |





13 July 2018

Dear Colleagues,

The Department of Microbiology would like to add a new course to our program, Microbiology 5270: **Antibiotics and Microbial Natural Products** (cross-listed as Pharmacy 5270). Microbial natural products represent the largest source of antibiotics in use today, and this new, multidisciplinary class covers the science of these molecules and their role in human medicine. This course will serve as an elective for undergraduates in the Microbiology and Pharmaceutical Science BS programs, and owing to its multiple prerequisite options, we expect course enrollees will come from a wide range of undergraduate and graduate programs. We note that this course was delivered as a one-time offering in Spring 2018 (i.e., Microbiology 5194), and the class was well-received. Feedback from the 5194 offering was incorporated into the revised syllabus that we submit with this proposal. Specific changes to the syllabus (compared to 5194) include the following:

- Successful completion of Pharmacy 4000 has been added as an alternative prerequisite to encourage BSPS undergraduate students (from College of Pharmacy) to enroll in the course.
- The Final Exam has been reduced from 40% to 30% of the students' course grade, and Class Participation has been added (10%).
- Text has been added under "Format" that states students will be assigned as weekly discussion leaders and they will present the papers to the class — this was added to formally define what was done in MICRO 5194.

We thank you for your consideration.

Sincerely,

Jesse J. Kwiek  
Associate Professor  
Vice Chair for Teaching & Undergraduate Affairs  
Department of Microbiology  
476 Biological Sciences Building  
484 West 12th Avenue, Columbus, OH 43210  
[kwiek.2@osu.edu](mailto:kwiek.2@osu.edu); Phone: 614-292-3256; Fax: 614-292-8120

**Microbiology 5270 – Pharmacy 5270**  
**Antibiotics and Microbial Natural Products**  
Spring 2019

**Instructor:**           **Dr. Kou-San Ju**  
Department of Microbiology and the  
Division of Medicinal Chemistry & Pharmacognosy  
290 Aronoff Laboratory  
Email: ju.109 -at- osu.edu  
Office hours: TBA

**Lecture:**               3 Units  
TBD  
TBD

**Description**

Microorganisms represent the largest trove of genetic and metabolic diversity in the world. They are responsible for producing a vast array of chemically diverse natural product small molecules. The unique biological and chemical properties of many of these compounds have afforded many valuable applications throughout medicine, agriculture, and biotechnology. Most critically, microbial natural products represent the largest source of antibiotics in use today. Here, we cover the biology behind the chemistry of these molecules and their role in human medicine.

This course is organized into four distinct modules. First, we examine the different classes of natural products through the lens of biosynthesis -- how the molecules are constructed and diversify. Second, we focus on their function -- not only as antibiotics against human pathogens (mode of action and resistance) but also their proposed functions for the producing organisms. Third, we explore the methods and challenges in natural product discovery and how genomics is revolutionizing the field. The most recent and significant developments in microbial natural products are presented in the final section of the class through student research presentations on select topics.

**Enrollment Requires:**

Successful completion of

Microbiology 4120 (Microbial Physiology and Diversity; C- or higher); **or**  
Biochemistry 5614 (Metabolism; C- or higher); **or**  
Pharmacy 4000 (Integrated Pharmaceutical Sciences I; C- or higher); **or**  
Graduate student standing (with equivalent background); **or**  
Consent of the instructor

**Format**

The first three modules of the course are in the form of faculty led lectures and discussions. The last module is composed of student presentations of the topic of their research paper assignment.

Research papers for in-class discussions will be announced at the beginning of each week. Students will be assigned as discussion leaders and present these papers to the class. All students are expected to study the readings in preparation for lecture and actively participate in discussions.

**Readings**

Material for this course will derive from recent literature. Primary sources (including papers) will be provided as PDF documents through Carmen. Abbreviated class notes will also be provided via

Carmen. You are expected to access this site and review these materials in order to prepare for class.

There is no required textbook, but the following is recommended for those who wish to have additional background:

Antibiotics: Actions, Origins, Resistance  
By Christopher Walsh, 2003  
Washington DC: ASM Press

### **Grading and Assignments**

Students will be evaluated on three exams, a research presentation, a written research report, and in-class participation.

|     |                    |
|-----|--------------------|
| 20% | Exam I (in-class)  |
| 20% | Exam II (in-class) |
| 10% | Presentation       |
| 10% | Research Paper     |
| 30% | Final Exam         |
| 10% | Participation      |

### **Exams**

All examinations are as scheduled -- missed exams will be scored zero. Make-up exams will only be allowed for students with medical emergencies or for those whom have obtained prior approval from the instructor. To be eligible to take a make-up exam you must:

1. Email the instructor ***prior*** to the scheduled time of the exam **AND**
2. Provide a valid excuse with written, original documentation for your absence ***prior*** to taking the make-up exam. You may be requested to e-mail a digital copy of your excuse, but valid, original documentation is still required.

If you qualify, you must take the re-scheduled exam within the 24-hour period following the time of the exam or the end of your excused leave. The make-up exam will be different from the regular exam. If you fail to follow these instructions, you will automatically receive a zero as the score for the missed exam. *Documentation that is suspected to be fraudulent will be reported to the Committee on Academic Misconduct (see below).*

### **Presentation**

Students will select, from a pre-approved list, a topic in microbial natural products. After meeting with the instructor (during office hours) to discuss the topic and research the most current and significant developments on the subject. Students will share their findings during an in-class presentation (25 minutes plus 10 minutes for discussion and questions). These time limits will be adjusted depending on the number of students enrolled in the class.

Presentations will be evaluated based on organization, subject knowledge, visual appeal, and preparation. Rubric (with expectations) and the list of topics will be handed out separately no later than the sixth week of class.

### **Research Paper**

Each student is required to write and submit a 10 to 12-page research paper (double-spaced) on his or her assigned topic. The paper should be conceived and written individually. *Each student must write their paper in their own words.*

Figures and references do not count towards the page limit. Papers will be evaluated based on the analysis of the subject material (both depth and completeness of cited sources), thesis presentation, clarity of organization, and the quality of writing. Rubric, with expectations of content and formatting, will be provided no later than the sixth week of class. Information for both presentations and reports should derive from the primary literature (research articles and reviews).

Proper citations are expected to prevent plagiarism (academic misconduct) -- examples will be provided in the rubric. Students are encouraged to speak with the instructor if there are questions regarding the use of citations. Reports will be scanned through Turnitin Feedback Studio to detect academic plagiarism. *Research reports with plagiarism will be scored zero points and referred to the Committee on Academic Misconduct (see below).*

### Submission and Due Dates

A digital copy of the presentation is due two days prior to the presentation date. These will be converted into handouts for the class. Research reports (submitted both electronically **and** in printed form) are due at the start of class on **Monday, April 1<sup>th</sup>**, the first day of student presentations. Files of the presentations and reports are to be submitted via Carmen. No exceptions will be made for late or non-submissions – they will be scored as zero points.

### Participation

Students are expected to arrive on time fully prepared at every class section, play an active role in discussions on lecture topics, and contribute positively to the class through comments that advance the level and depth of dialog. This includes preparation, presentation, and discussion of assigned research papers in class.

Contributing effective comments, asking thoughtful questions, and listening, supporting, and engaging your peers will positively affect your participation grade.

Skipping class (unexcused absences), arriving late, using electronic devices for personal non-class related reasons, dominating class discussions (thereby restricting participation of other students), or making disrespectful / disruptive / offensive comments will negatively affect your participation grade.

### Learning Outcomes

Students that successfully complete this course will:

- Knowledgeably describe the major types of microbial natural products, their biosynthesis, and function
- Knowledgeably describe the mode of action of major types of antibiotics
- Knowledgeably describe the common mechanisms of antibiotic resistance
- Understand current views on the roles of antibiotics in nature and the origin of resistance genes
- Understand commonly employed methods in natural product discovery
- Understand the impact of genomics on natural product discovery
- Critically evaluate research papers on microbial natural products
- Accurately interpret raw and processed data sets in research papers
- Identify key findings of research papers and explain them clearly to an audience of peers

- Identify strong arguments supported by conclusive data; identify weak arguments supported by inconclusive data
- Argue the merits and/or weaknesses of published work from a knowledgeable perspective

### **Course Announcements**

Students are responsible for all announcements made in class, posted on the course website (via Carmen), or communicated by email.

### **Attendance policy**

Students are expected to attend lectures. Exams will be based on material covered in class. Because class slides posted in Carmen do not contain much text, *you should attend every lecture and supplement them with your own notes.*

### **Classroom etiquette**

Electronic devices should be silenced during lectures and exams. Computers and tablets can be used during lectures as long as they do not distract other students. The use of electronic devices during exams is prohibited and will be reported to the Committee on Academic Misconduct (see below).

### **E-mail policy**

Microbial natural products cannot be explained via e-mail. Questions about class material should *not* be submitted via e-mail and they will not be answered. Instead, please ask questions during class or come to office hours and I will be happy to answer them. At the beginning of every class, I will take requests for questions you may have about the previous lecture.

### **Academic misconduct**

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term “academic misconduct” includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487).

The Code of Student Conduct <http://studentlife.osu.edu/csc/>

### **Disability services**

Students with disabilities (including mental health, chronic or temporary medical conditions) that have been certified by the Office of Student Life Disability Services will be appropriately accommodated and should inform the instructor as soon as possible of their needs. The Office of Student Life Disability Services is located in 098 Baker Hall, 113 W. 12th Avenue; telephone 614- 292-3307, [slds@osu.edu](mailto:slds@osu.edu); [slds.osu.edu](http://slds.osu.edu)

### **Diversity statement**

The Department of Microbiology promotes a welcoming and inclusive environment for all students and staff, regardless of race, gender, ethnicity, national origin, disability or sexual orientation. There is no tolerance for hateful speech or actions. All violations of this policy should be reported to the OSU Bias Assessment and Response Team (BART, <http://studentaffairs.osu.edu/bias/>).



### **Student wellness and counseling services**

OSU offers a range of services to assist students experiencing elevated stress levels. **Counseling and Consultation Service** (CCS; [ccs.osu.edu](https://ccs.osu.edu)) provides a range of confidential mental health services to students. 24-hour emergency help is also available through the National **24/7 Prevention Hotline** at 1-800-273-TALK or at [suicidepreventionlifeline.org](https://suicidepreventionlifeline.org). **Wellness Coaching** ([go.osu.edu/wellnesscoaching](https://go.osu.edu/wellnesscoaching)) is a free service provided by the Office of Student Life that takes an empowering, strength-based approach to building your capacity to face challenges and navigate transitions in order to create the life you want to live. In addition, the “**Student Advocacy Center** is committed to helping students navigate Ohio State's structure and to resolving issues. that they encounter at the university” (<http://advocacy.osu.edu/>).

## SYLLABUS

This is a tentative syllabus and is subject to change. The time allotted for student presentations and the schedule of lecture topics will be adjusted depending on the number of students enrolled in the class.

| Date        | Day      | Week | Topic  | Module                           |
|-------------|----------|------|--|----------------------------------|
| 1/7         | M        | 1    | Introduction   | Molecules and Their Biosynthesis |
| 1/9         | W        |      | Peptides   |                                  |
| 1/11        | F        |      | Peptides   |                                  |
| 1/14        | M        | 2    | Polyketides  |                                  |
| 1/16        | W        |      |  |                                  |
| 1/18        | F        |      |  |                                  |
| 1/21        | M        | 3    | <b>Martin Luther King Day – No Class</b>                 |                                  |
| 1/23        | W        |      | B-lactams  |                                  |
| 1/25        | F        |      | Aminoglycosides  |                                  |
| 1/28        | M        | 4    | Terpenes   |                                  |
| 1/30        | W        |      | Unusual Compounds  |                                  |
| <b>2/1</b>  | <b>F</b> |      | <b>Exam 1</b>  |                                  |
| 2/4         | M        | 5    | Mode of Action   | Activity and Resistance          |
| 2/6         | W        |      |  |                                  |
| 2/8         | F        |      |  |                                  |
| 2/11        | M        | 6    | Resistance   |                                  |
| 2/13        | W        |      |  |                                  |
| 2/15        | F        |      |  |                                  |
| 2/18        | M        | 7    | Natural Functions  |                                  |
| 2/20        | W        |      |  |                                  |
| <b>2/22</b> | <b>F</b> |      |  | <b>Exam 2</b>                    |
| 2/25        | M        | 8    | Assays and Analytical Methods                            | Discovery                        |
| 2/27        | W        |      |  |                                  |
| 3/1         | F        |      |  |                                  |
| 3/4         | M        | 9    | New Approaches to Natural Product Discovery              |                                  |
| 3/6         | W        |      |  |                                  |
| 3/8         | F        |      |  |                                  |
| 3/11-15     | MWF      | 10   | <b>Spring Break – No Class</b>                           |                                  |
| 3/18        | M        | 11   | New Approaches to Natural Product Discovery              |                                  |
| 3/20        | W        |      |  |                                  |
| 3/22        | F        |      |  |                                  |
| 3/25        | M        | 12   | New Approaches to Natural Product Discovery              |                                  |
| 3/27        | W        |      |  |                                  |
| 3/29        | F        |      |  |                                  |
| <b>4/1</b>  | <b>M</b> | 13   | <b>Reports Due (Monday 4/1)</b><br>Student Presentations | Special Topics                   |
| 4/3         | W        |      |  |                                  |
| 4/5         | F        |      |  |                                  |
| 4/8         | M        | 14   | Student Presentations                                    |                                  |
| 4/10        | W        |      |  |                                  |
| 4/12        | F        |      |  |                                  |
| 4/15        | M        | 15   | Student Presentations                                    |                                  |

|      |   |    |                    |  |
|------|---|----|--------------------|--|
| 4/17 | W |    |                    |  |
| 4/19 | F |    |                    |  |
| 4/22 | M | 16 | Summary and Review |  |

|            |            |  |                   |  |
|------------|------------|--|-------------------|--|
| <b>TBD</b> | <b>TBD</b> |  | <b>Final Exam</b> |  |
|------------|------------|--|-------------------|--|

## Mapping Microbiology 5270 Learning Goals to BS and Ph.D. Degree Program Learning Goals

### Microbiology BS Degree 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.

### Microbiology 5270 Learning Goals (Mapped to BS Degree Program Learning Goals)

1. Knowledgeably describe the major types of microbial natural products, their biosynthesis, and function (**PLG2 Advanced**)
2. Knowledgeably describe the mode of action of major types of antibiotics (**PLG2 Advanced**)
3. Knowledgeably describe the common mechanisms of antibiotic resistance (**PLG3 Advanced**)
4. Understand current views on the roles of antibiotics in nature and the origin of resistance genes (**PLG3 Advanced**)
5. Understand commonly employed methods in natural product discovery (**PLG2 Advanced**)
6. Understand the impact of genomics on natural product discovery (**PLG3 Advanced**)
7. Critically evaluate research papers on microbial natural products (**PLG4 Advanced**)
8. Accurately interpret raw and processed data sets in research papers (**PLG4 Advanced**)
9. Identify key findings of research papers and explain them clearly to an audience of peers (**PLG4 Advanced**)
10. Identify strong arguments supported by conclusive data; identify weak arguments supported by inconclusive data (**PLG4 Advanced**)
11. Argue the merits and/or weaknesses of published work from a knowledgeable perspective (**PLG5 Advanced**)

## Mapping Microbiology 5270 Learning Goals to BS and Ph.D. Degree Program Learning Goals

### Required Prerequisites for the Major Learnin g Goals

| Semester Course Number |            | Course Title  | Semester hrs   | 1 | 2 | 3 | 4 | 5 |
|------------------------|------------|---|----------------|---|---|---|---|---|
| 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  | Calculus 1 (5 Hrs)  | 5              | B |   |   |   |   |
|                        | or         |   |                |   |   |   |   |   |
|                        | MATH 1156  | Calculus for Biol. Sciences (5 Hrs)                         |                |   |   |   |   |   |
| MATH Req. #2           | MATH 1152  | Calculus 2 (5 Hrs)  | 3 - 5          | B |   |   |   |   |
|                        | or         |   |                |   |   |   |   |   |
|                        | MATH 1157  | Math. Modeling for Biol. Sciences (5 Hrs)                   |                |   |   |   |   |   |
|                        | or         |   |                |   |   |   |   |   |
|                        | STATS 1450 | Intro. to the Practice of Statistics (3 Hrs)                |                |   |   |   |   |   |
|                        | or         |   |                |   |   |   |   |   |
|                        | STATS 2480 | Statistics for the Life Sciences (3 Hrs)                    |                |   |   |   |   |   |
| 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 |   |
| <b>Total Hrs.</b>      |            |   | <b>46 - 48</b> |   |   |   |   |   |

Goal: B: Beginning; I, Intermediate; A, Advanced

### Required Core for the Major Learnin g Goals

| Semester Course Number |  | Course Title                       | Semester hrs | 1 | 2 | 3 | 4 | 5 |
|------------------------|--|------------------------------------|--------------|---|---|---|---|---|
| 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 |
| <b>Total Hrs.</b>      |  |                                    | <b>21</b>    |   |   |   |   |   |

Goal: B: Beginning;  
I, Intermediate; A, Advancec

### Electives: Total Required 9 hrs Learnin g Goals

Group 1: 3-9 hrs

| Semester Course Number |  | Course Title                                 | Semester hrs | 1 | 2 | 3 | 4 | 5 |
|------------------------|--|--|--------------|---|---|---|---|---|
| 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 |

## Mapping Microbiology 5270 Learning Goals to BS and Ph.D. Degree Program Learning Goals

|                   |   |            |  |  |   |   |   |
|-------------------|---|------------|--|--|---|---|---|
| MICRBIOL 4999H    | Honors Research-Thesis                                  | 1-5        |  |  |   | A | A |
| MICRBIOL 5122     | Immunology  | 3          |  |  |   | A |   |
| MICRBIOL 5129     | Cellular and Molecular Biology of Pathogenic Eukaryotes | 3          |  |  | A | A |   |
| MICRBIOL 5147     | Eukaryotic Pathogens                                    | 3          |  |  | A | A | A |
| MICRBIOL 5149     | Introductory Virology                                   | 3          |  |  | A | A |   |
| MICRBIOL 5150     | Microbial Ecology                                       | 3          |  |  | A | A | A |
| MICRBIOL 5155     | Environmental Microbiology                              | 3          |  |  | A | A | A |
| MICRBIOL 5161     | Bioinformatics and Molecular Microbiology               | 3          |  |  | A | A | A |
| MICRBIOL 5170     | Microbes and Evolution                                  | 3          |  |  |   | A |   |
| MICRBIOL 5270     | Antibiotics and Microbial Natural Products              | 3          |  |  | A | A | A |
| MICRBIOL 5536     | Food Microbiology Lecture                               | 3          |  |  | A | I | A |
| MICRBIOL 5546     | Food Microbiology Laboratory                            | 3          |  |  | A | I | A |
| MICRBIOL 6020*    | Microbial Physiology and Biochemistry                   | 3          |  |  | A | A | A |
| MICRBIOL 6080*    | Advanced Microbial Genetics                             | 3          |  |  | A |   | A |
| MICRBIOL 7010*    | Cellular and Molecular Immunology                       | 3          |  |  |   | A | A |
| MICRBIOL 7020*    | Physiology Meets Pathogenesis                           | 2          |  |  | A | A | A |
| MICRBIOL 7023*    | Molecular Immunology: Lecture                           | 3          |  |  |   | A | A |
| MICRBIOL 7050*    | Fermentation Biotechnology                              | 3          |  |  | A |   | A |
| MICRBIOL 7060*    | Advanced Topics in Molecular Microbiology               | 2          |  |  | A |   | A |
| MICRBIOL 7536*    | Advanced Food Microbiology                              | 3          |  |  | A | I | A |
| MICRBIOL 7724*    | Molecular Pathogenesis                                  | 3          |  |  | A | A | A |
| MICRBIOL 7889*    | Host-Pathogen Interactions: Research Seminar            | 1          |  |  |   | A | A |
| MICRBIOL 7899*    | Microbiology Colloquium                                 | 1          |  |  |   |   |   |
| <b>Total Hrs.</b> |   | <b>3-9</b> |  |  |   |   |   |

\*Indicated graduate-level course. Requires special permission to enroll. **Goal:** B: Beginning; I, Intermediate; A, Advanced

Electives: Total Required 9 hrs  
Group 2: 0-6 hrs

Learning Goals

| Semester Course Number          | Course Title                          | Semester Hrs. | 1 | 2 | 3 | 4 | 5 |
|---------------------------------|---------------------------------------|---------------|---|---|---|---|---|
| BIOCHEM 5621                    | Intro Biological Chemistry Laboratory | 4             | I |   |   | I |   |
| MOLGEN 4500                     | General Genetics                      | 3             |   | I |   |   |   |
| MOLGEN 4606                     | Molecular Genetics I                  | 4             |   | I |   |   |   |
| MVIMG 5000                      | Evolution of Emerging Viruses         | 2             |   |   | A |   |   |
| PLPATH 5010                     | Phylobacteriology                     | 2             |   | I | A |   |   |
| PLPATH 5020                     | Introduction to Plant Virology        | 2             |   | I | A |   |   |
| PLPATH 5040                     | Science of Fungi: Mycology Lecture    | 3             | I | I | A |   |   |
| ANSCI 6090*                     | Anaerobic Microbiology                | 3             |   | A |   |   |   |
| ENR 5263                        | Biology of Soil Ecosystems            | 3             | I | A |   |   |   |
| ENR 5266                        | Field Soil Investigations             | 3             | I |   |   | A |   |
| <b>Total Hrs.</b>               |                                       | <b>0-6</b>    |   |   |   |   |   |
| <b>Total Hrs. for the Major</b> |                                       | <b>30</b>     |   |   |   |   |   |

\*Indicated graduate-level course. Requires special permission to enroll. **Goal:** B: Beginning; I, Intermediate; A, Advanced

## **Mapping Microbiology 5270 Learning Goals to BS and Ph.D. Degree Program Learning Goals**

### **Microbiology Ph.D. Degree Program Learning Goals**

PhD graduates of Microbiology should be able to:

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.

### **Microbiology 5270 Learning Goals (Mapped to Ph.D. Degree Program Learning Goals)**

Learning goals for Microbiology 5270 align with our graduate degree PLG 1, 2 and 4. Although this is a 5000-level course, the course content represents a specialization and we envision that this course will meet intermediate and advanced level goals for Microbiology graduate students.