

Microbiology 5194

Microbial Natural Products: Discovery, Biosynthesis, and Antibiotic Activity

Spring 2018

Instructor: **Dr. Kou-San Ju**
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Office hours: TBD

Lecture: 3 Units
MWF, 3:00-3:55 pm
609 Biological Sciences Building

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. This will include the impact of microbial natural products in industrial biotechnology. The final section of the class is dedicated to covering the most recent and significant developments in the field through student research presentations on select topics.

Prerequisites

Enrollment requires: Successful completion of Microbiology 4120 (Microbial Physiology and Diversity; C- or higher); **or** successful completion of Biochemistry 5614 (Metabolism; 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 lectures and discussions. The last module is composed of student presentations. All students are expected to study the assigned readings in preparation for lecture and discussion.

Readings

Material for this course will derive from recent literature. Primary sources (including papers) will be provided as PDF documents through Carmen. 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, and a research report.

20% Exam I (in-class)
20% Exam II (in-class)
10% Presentation
10% Research Paper
40% Final Exam

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, each pair will divide

and research the most current and significant developments on the subject. Students will share their findings during an in-class presentation (20 minutes plus 5 minutes for discussion and questions). Depending on the number of students enrolled in the class, presentations may be allocated extra time. Pairs of students will be equally responsible for the presentation and are expected to become experts in the subject material.

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 separated no later than the sixth week of class.

Research Paper

Each student is required to write and submit a six to seven research paper (double-spaced) on his or her portion of the assigned topic. The paper should be conceived and written individually. Collaboration between student pairs should only lead to verbal discussions and preparation of the oral presentation. *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 2nd**, 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.

Learning Outcomes

Students that successfully complete this course will:

- Knowledgably describe the major types of microbial natural products, their biosynthesis, and function
- Knowledgably describe the mode of action of major types of antibiotics
- Knowledgably 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; 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) 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. **Wellness Coaching** (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
1/8	M	1	Introduction	Molecules and Their Biosynthesis
1/10	W		Peptides	
1/12	F			
1/15	M	2	Martin Luther King Day – No Class	
1/17	W		Peptides	
1/19	F		Polyketides	
1/22	M	3	B-lactams	
1/24	W		Aminoglycosides	
1/26	F		Terpenes	
1/29	M	4	Unusual Compounds	
1/31	W			
2/2	F		Exam 1	
2/5	M	5	Mode of Action	Activity and Resistance
2/7	W			
2/9	F			
2/12	M	6	Resistance	
2/14	W			
2/16	F			
2/19	M	7	Natural Functions	
2/21	W			
2/23	F		Exam 2	
2/26	M	8	Assays and Analytical Methods	Discovery
2/28	W			
3/2	F			
3/5	M	9	New Approaches to Natural Product Discovery	
3/7	W			
3/9	F			
3/12-16	MWF	10	Spring Break – No Class	
3/19	M	11	New Approaches to Natural Product Discovery	
3/21	W			
3/23	F			
3/26	M	12	Translating resistance	Industrial Biotechnology
3/28	W		Combinatorial Biosynthesis	
3/30	F		Synthetic Biology	
4/2	M	13	Reports Due (Monday 4/2)	Special Topics
4/4	W		Student Presentations	
4/6	F			

4/9	M	14	Student Presentations	
4/11	W			
4/13	F			
4/16	M	15	Student Presentations	
4/18	W			
4/20	F			
4/23	M	16	Summary and Review	

TBD	TBD		Final Exam	
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