Course Syllabus – CHEM 520

Course Information

Course Number: CHEM 520 WI21
Course Name: Natural Product Biosynthesis and Engineering
Term: WI 2021
Start Date: 01/04/2021
End Date: 03/26/2021
Credits: 3.0

Meeting Days / Times

Mondays and Wednesdays from 11:15am-12:45pm PT / 2:15-3:45pm ET
[Fridays from 11:15am-12:45pm PT / 2:15-3:45pm ET only if make-up time is needed when Monday or Wednesday lecture has a conflict]
(See Calendar in Canvas for the most up-to-date schedule.)

Location

Online via Zoom

Course Managers

Role	Last Name	First Name	Email Address
Instructor	Renata	Hans	hrenata@scripps.edu
Instructor	Shen	Ben	shenb@scripps.edu
TA	Steele	Andrew	asteele@scripps.edu

Course Description

This course will focus on the biosynthesis of natural products and genetic engineering of natural product biosynthetic pathways for structural diversity and production. The following topics will be discussed: (1) natural products in drug discovery and development; (2) methodologies for establishing biosynthetic pathways; (3) the principal biogenetic and biosynthesis theories, and basic bioorganic chemistry and enzymology for natural products biosynthesis; (4) unified biosynthetic pathways for the major classes of natural products; (5) emerging technologies in engineering natural product biosynthetic pathways for structural diversity and production. The following classes of natural products will be covered: polyketides, peptides and β-lactams, metabolites of shikimate origin, terpenoids, steroids, alkaloids, and carbohydrates.

Program Learning Outcomes

By the end of the program, students will have accomplished these objectives:
PLO1: Original Research – graduate students are expected to develop the skills critical for generating high-quality research output. This would include absorbing, recalling, and contextualizing scientific knowledge, evaluating scientific information and data, creating testable hypotheses and investigating hypotheses, mastering scientific tools and techniques, displaying ethical behavior, and receiving and giving feedback.
PLO2: Communication – graduate students are expected to demonstrate the oral, written, and media skills to effectively communicate the impact of a study or a body of work to the greater scientific community and to the public at large using a number of methods.
PLO3: Critical Thinking – graduate students are expected to develop a self-directed process to analyze information, form opinions or judgments, and use this process to improve the quality of their scientific thoughts, navigate problems, and make informed decisions.
PLO4: Intellectual Curiosity – graduate students are expected to acquire the capacity to build their intellectual curiosity and demonstrate problem solving approaches that serve their professional growth and ability to impact a field.
PLO5: Career and Professional Development – graduate students are expected to develop a variety of transferable skillsets throughout their graduate experience, including management and leadership, inclusiveness, resilience, scientific rigor, collaboration, accountability, time management, teamwork, networking, and career planning.

Course Learning Outcomes

Upon completion of this course students will be able to:
CLO1: Recognize biogenetic units and biogenetic classes of natural products
CLO2: Propose chemical and biochemical pathways for major classes of natural products
CLO3: Recognize key biosynthetic questions and experiments to answer these questions
CLO4: Recognize the potential of metabolic pathway engineering for natural product structural diversity and production
CLO5: Understand the chemistry and biochemistry of biosynthesis of the major classes of natural products
CLO6: Understand the principle and the practice of metabolic pathway engineering for natural product structural diversity and production
CLO7: Understand the principle of application of enzymes in natural product synthesis and structural diversity

Background Preparation (Prerequisites)

Satisfactory completion of undergraduate courses in organic chemistry and biochemistry is required, working knowledge of molecular biology and microbiology will be helpful, but prior exposure to natural product biosynthesis and engineering is not necessary.

Required Course Materials

Useful to Consult: Walsh & Tang (2017). Natural Product Biosynthesis: Chemical Logic and Enzymatic Machinery. ISBN: 978-1788010764.
Useful to Consult: Walsh & Wencewicz (2016). Antibiotics: Challenges, Mechanisms, Opportunities. ISBN: 978-1555819309.
Useful to Consult: Cragg, Kingston & Newman (2011). Antitumor Agents from Natural Products. ISBN: 9780429130854.
Useful to Consult: Hopwood (2009). Complex Enzymes in Microbial Natural Product Biosynthesis, Part A and Part B. ISBN: 978-0080923369.
Useful to Consult: Hopwood (2012). Natural Product Biosynthesis by Microorganisms and Plants, Part A, B, and C. ISBN: 978-0124046177.

Attendance Statement

Students are expected to attend all classes. Students who are unable to attend class must seek permission for an excused absence from the course director or teaching assistant. Unapproved absences or late attendance for three or more classes may result in a lower grade or an "incomplete" for the course. If a student has to miss a class, he or she should arrange to get notes from a fellow student and is strongly encouraged to meet with the teaching assistant to obtain the missed material. Missed extra-credit quizzes will not be available for re-taking.

Scientific and Professional Ethics

The work you do in this course must be your own. Feel free to build on, react to, criticize, and analyze the ideas of others but, when you do, make it known whose ideas you are working with. You must explicitly acknowledge when your work builds on someone else's ideas, including ideas of classmates, professors, and authors you read. If you ever have questions about drawing the line between others' work and your own, ask the course professor who will give you clear guidance. Exams must be completed independently. Any collaboration on answers to exams, unless expressly permitted, may result in an automatic failing grade and possible expulsion from the Graduate Program.

Technology Requirements and Support

For issues related to Canvas, please contact the Graduate Office by email at: gradprgm@scripps.edu or by phone at: 858-784-8469.

Course Grading

Grading is in accordance with the academic policies of the Skaggs Graduate School. The breakdown of grading is as follows:

- Mid-term Exam: 30%
- Final Exam: 30%
- Term Paper: 30%

- Participation: 10%

Grade Point	Letter Grade	
4.00	A	Outstanding achievement. Student performance demonstrates full command of the course subject matter and evinces a high level of originality and/or creativity that far surpasses course expectations.
3.67	A-	Excellent achievement. Student performance demonstrates thorough knowledge of the course subject matter and exceeds course expectations by completing all requirements in a superior manner.
3.33	B+	Very good work. Student performance demonstrates above-average comprehension of the course subject matter and exceeds course expectations on all tasks as defined in the course syllabus. There is notable insight and originality.
3.00	B	Satisfactory work. Student performance meets designated course expectations and demonstrates understanding of the course subject matter at an acceptable level.
2.67	B-	Marginal work. Student performance demonstrates incomplete understanding of course subject matter. There is limited perception and originality.
2.33	C+	Unsatisfactory work. Student performance demonstrates incomplete and inadequate understanding of course subject matter. There is severely limited or no perception or originality. Course will not count toward degree.
2.00	C	Unsatisfactory work. Student performance demonstrates incomplete and inadequate understanding of course subject matter. There is severely limited or no perception or originality. Course will not count toward degree.
0.00	I	Incomplete is assigned when work is of passing quality but is incomplete for a pre-approved reason. Once an incomplete grade is assigned, it remains on student's permanent record until a grade is awarded.
0.00	P	Satisfactory work. Student performance demonstrated complete and adequate understanding of course subject matter. Course will count toward degree.
0.00	F	Unacceptable work/Failure. Student performance is unacceptably low level of knowledge and understanding of course subject matter. Course will not count toward degree. Student may continue in program only with permission of the Dean.

0.00	W	Withdrew from the course with Dean's permission beyond the second week of the term.

- All courses will be recorded and maintained in the student's permanent academic record; only courses that apply towards the degree will appear on the academic transcript. Non-credit or audited courses will not appear on the transcript.
- 4 core courses taken for a letter grade (pass = B- or higher for a core course)
- 2 elective courses taken pass/fail (pass = A, B, C for an elective)

Course Schedule:

Date	Details
Wed Jan 6, 2021	Introduction (Shen)
Mon Jan 11, 2021	Methods of Natural Product Biosynthesis and Engineering (Shen)
Wed Jan 13, 2021	Fatty Acids (Shen)
Mon Jan 18, 2021	No Class (Martin Luther King Jr. Day)
Wed Jan 20, 2021	Polyketides I (Shen)
Fri Jan 22, 2021	Polyketides II (Shen)
Mon Jan 25, 2021	Beta-Lactam (Shen)
Wed Jan 27, 2021	Nonribosomal Peptides I (Shen)
Mon Feb 1, 2021	Nonribosomal Peptides II (Shen)
Wed Feb 3, 2021	Ribosomally Synthesized and Post-translationally Modified Peptides (RiPPs) (Shen)
Mon Feb 8, 2021	Shikimate Metabolites I (Shen)
Wed Feb 10, 2021	Assignment Mid Term Exam
Mon Feb 15, 2021	No Class (President's Day)
Wed Feb 17, 2021	Shikimate Metabolites II (Shen)
Fri Feb 19, 2021	Terpenoids I (Shen)
Mon Feb 22, 2021	Terpenoids II (Shen)
Wed Feb 24, 2021	Steroids (Shen)
Mon Mar 1, 2021	Alkaloids I (Renata)
Wed Mar 3, 2021	Alkaloids II (Renata)
Mon Mar 8, 2021	Carbohydrates I (Renata)
Wed Mar 10, 2021	Carbohydrates II (Renata)
Mon Mar 15, 2021	Emerging Technologies for Natural Products I (Shen)
Wed Mar 17, 2021	Emerging Technologies for Natural Products II (Shen)
Mon Mar 22, 2021	Final Exam