CHEM4090: NATURAL PRODUCT CHEMISTRY

Effective Term
Semester B 2025/26

Part I Course Overview

Course Title
Natural Product Chemistry

Subject Code
CHEM - Chemistry
Course Number
4090

Academic Unit
Chemistry (CHEM)

College/School
College of Science (SI)

Course Duration
One Semester

Credit Units
3

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Precursors
CHEM3015 Organic Chemistry

Additional Information
CHEM4031 Advanced Organic Chemistry provides a simplified version of this course along with other contents.

Part II Course Details

Abstract
This course aims to give students a comprehensive overview of (i) different classes of naturally occurring organic molecules (termed "natural products") produced by microorganisms and plants, (ii) organic reactions utilized in natural product biosynthesis, and (iii) genes and enzymes involved therein. Students will also learn how to use bioinformatic tools to link biosynthetic genes to natural products and vice versa. Altogether, students will be able to classify and describe natural products and provide plausible biosynthetic schemes for given compounds as well as genes/enzymes required for their biosynthesis. This course will also help students understand chemical reactions occurring in other biological systems (e.g., in humans) or design biosynthetic pathways to afford compounds of interest.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Classify natural products into several major groups (i.e., polyketides, terpenoids, alkaloids, peptides, phenylpropanoids, etc.) and indicate the biosynthetic units in the chemical structures.		x		
2	Describe the concepts and basic principles of the organic reactions utilized in the biosynthetic processes (e.g., aldol reaction, Claisen reaction, Wagner-Meerwein rearrangement, Mannich reaction, etc.).		x	x	
3	Describe the reaction schemes to construct the core structures of natural products.		x	x	x
4	Explain the reactions by the core synth(et)ases (i.e., polyketide synthases, terpene synthases, and nonribosomal peptide synthetases) and by tailoring enzymes (e.g., oxidoreductases, isomerases, and transferases).		x	x	
5	Provide and elaborate plausible biosynthetic pathways of given natural products whose biosynthesis has yet to be elucidated by utilizing bioinformatic tools (e.g., BLAST, FunBGCeX, 2ndFind, etc.) where necessary.		x	x	x

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures and exercises	Students will be given a general introduction to natural product chemistry, classification of natural products, and biosynthetic units of natural products.	1	
2	Lectures and exercises	Students will learn several important organic reactions used in natural product biosynthesis.	2	

3	Lectures and exercises	Students will learn the reaction mechanisms to provide the core structures of natural products.	3	
4	Lectures and exercises	Students will learn several important enzymes involved in natural product biosynthesis and how they facilitate a variety of biosynthetic reactions.	4	
5	Lectures and exercises	Students will learn how to utilize bioinformatic tools to link biosynthetic genes to natural products and vice versa.	5	
6	Presentation/report	Students will pick up or be given a natural product and provide a group or individual presentation/ report on the compound.	5	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Assignments	1, 2, 3, 4, 5	15	-	Yes
2	Presentation/ report	5	15	-	Yes

Continuous Assessment (%)

30

Examination (%)

70

Examination Duration (Hours)

3

Minimum Continuous Assessment Passing Requirement (%)

40

Minimum Examination Passing Requirement (%)

40

Assessment Rubrics (AR)

Assessment Task

Assignment

Criterion

Ability to explain organic reactions in the natural product biosynthesis as well as the enzymes involved therein.

Excellent (A+, A, A-)

Able to explain the mechanisms of diverse reactions in natural product biosynthesis with high accuracy.

Good (B+, B, B-)
Able to explain the mechanisms of diverse reactions in natural product biosynthesis.

Fair (C+, C, C-)
Able to explain the mechanisms of major reactions in natural product biosynthesis.

Marginal (D)
Able to explain the mechanisms of some reactions in natural product biosynthesis.

Failure (F)
Unable to explain the mechanisms of most reactions in natural product biosynthesis.

Assessment Task
Presentation/report

Criterion
Ability to summarize and present properties, biosynthesis, and potential application of a given natural product.

Excellent (A+, A, A-)
Able to show an in-depth understanding of properties, biosynthesis, and potential application of a given natural product.

Good (B+, B, B-)
Able to show a good understanding of properties, biosynthesis, and potential application of a given natural product.

Fair (C+, C, C-)
Able to show a moderate understanding of properties, biosynthesis, and potential application of a given natural product.

Marginal (D)
Able to show a limited understanding of properties, biosynthesis, and potential application of a given natural product.

Failure (F)
Unable to show an understanding of properties, biosynthesis, and potential application of a given natural product.

Assessment Task
Examination

Criterion
Ability to solve problems related to natural product chemistry/biosynthesis, to propose plausible biosynthetic routes to given natural products, and to discuss the possibility of biosynthetic engineering of given compounds.

Excellent (A+, A, A-)
Able to answer most of the examination questions correctly.

Good (B+, B, B-)
Able to answer a large portion of the examination questions correctly.

Fair (C+, C, C-)
Able to answer around half of the examination questions correctly.

Marginal (D)

Able to answer a limited number of the examination questions correctly.

Failure (F)
Unable to answer most of the examination questions correctly.

Part III Other Information

Keyword Syllabus

Natural products
Fatty acids and polyketides, terpenoids and steroids, meroterpenoids, aromatic amino acids and phenylpropanoids, alkaloids, nonribosomally and ribosomally synthesized peptides, carbohydrates

Natural product biosynthesis
Acetate pathway, mevalonate and methylerythritol phosphate (MEP) pathways, shikimate pathway, peptide biosynthesis

Biosynthetic enzymes
Polyketide synthases (PKSs), terpene synthases/cyclases, nonribosomal peptide synthetases (NRPSs), oxidoreductases, transferases, isomerases, hydrolases, lyase, ligase

Reading List

Additional Readings

	Title
1	Medicinal Natural Products: A Biosynthetic Approach; Paul M. Dewick (John Wiley & Sons, Ltd, 3rd Edition). The electronic version of the textbook is available from the CityU Library: https://onlinelibrary.wiley.com/doi/book/10.1002/9780470742761
2	Natural Product Biosynthesis : Chemical Logic and Enzymatic Machinery; Christopher T. Walsh and Yi Tang (Royal Society of Chemistry, 2nd Edition). The electronic version of the textbook is available from the CityU Library: https://ebookcentral.proquest.com/lib/cityuhk/detail.action?pq-origsite=primo&docID=31227330