City University of Hong Kong
Course Syllabus

offered by Department of Chemistry
with effect from Semester A 2024/25

Part I Course Overview

Course Title:	Natural Product Chemistry and Biosynthesis
Course Code:	CHEM8012
Course Duration:	1 semester
Credit Units:	3 credits
Level:	R8
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	Nil
Precursors: *(Course Code and Title)*	Nil
Equivalent Courses: *(Course Code and Title)*	Nil
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. Abstract

This course aims to give students a comprehensive overview of (i) different classes of naturally occurring organic molecules (termed as natural products) produced by microorganisms and plants, (ii) organic reactions utilized in the 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 to provide plausible biosynthetic schemes for given compounds as well as genes/enzymes required for their biosynthesis. This course will also help students to understand chemical reactions occurring in other biological systems (e.g., in human) or to design biosynthetic pathways to afford compounds of interest.

2. Course Intended Learning Outcomes (CILOs)

No.	CILOs[#]	Weighting (if applicable)	Discovery-enriched curriculum related learning outcomes		
			A1	*A2*	*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.		✓		
2.	Understand and 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.).		✓	✓	
3.	Describe the reaction schemes to construct the core structures of natural products.		✓	✓	✓
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).		✓	✓	
5.	Provide and elaborate plausible biosynthetic pathways of given natural products whose biosynthesis have yet to be elucidated.			✓	✓
		100%			

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 self-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.

3. Learning and Teaching Activities (LTAs)

LTA	Brief Description	CILO No.					Hours/week (if applicable)
		1	2	3	4	5	
Lectures and exercises	Students will be given a general introduction to natural product chemistry, classification of natural products, and biosynthetic units of natural products.	✓					
Lectures and exercises	Students will learn several important organic reactions used in the natural product biosynthesis.		✓				
Lectures and exercises	Students will learn the reaction mechanisms to provide the core structures of natural products.			✓			
Lectures and exercises	Students will learn several important enzymes involved in natural product biosynthesis and how they facilitate a variety of biosynthetic reactions.				✓		
Presentation	Students will pick up or be given a natural product and provide a group or individual presentation on the compound.					✓	

4. Assessment Tasks/Activities (ATs)

Assessment Tasks/Activities	CILO No.					Weighting	Remarks
	1	2	3	4	5		
Continuous Assessment: 30%							
Assignments	✓	✓	✓	✓		15%	
Presentation					✓	15%	
Examination: 70% (duration: 3 hours)							
Examination	✓	✓	✓	✓	✓	70%	
						100%	

Starting from Semester A, 2015-16, students must satisfy the following minimum passing requirement for CHEM courses:

"A minimum of 40% in both coursework and examination components."

5. Assessment Rubrics

Applicable to students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)	Failure (F)
1. Assignment	Ability to explain organic reactions in the natural product biosynthesis as well as the enzymes involved therein.	High	Significant	Moderate	Basic	Not even reaching marginal levels
2. Presentation	Ability to summarize and present properties, biosynthesis, and potential application of a given natural product.	High	Significant	Moderate	Basic	Not even reaching marginal levels
3. Examination	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.	High	Significant	Moderate	Basic	Not even reaching marginal levels

Applicable to students admitted from Semester A 2022/23 to Summer Term 2024

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B)	Marginal (B-, C+, C)	Failure (F)
1. Assignment	Ability to explain organic reactions in the natural product biosynthesis as well as the enzymes involved therein.	High	Significant	Basic	Not even reaching marginal levels
2. Presentation	Ability to summarize and present properties, biosynthesis, and potential application of a given natural product.	High	Significant	Basic	Not even reaching marginal levels
3. Examination	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.	High	Significant	Basic	Not even reaching marginal levels

Part III Other Information

1. 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, ligases

2. Reading List

2.1 Compulsory Readings

1.	
2.	
3.	
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2.2 Additional Readings

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.	
3.	
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