CHEM8012: NATURAL PRODUCT CHEMISTRY AND BIOSYNTHESIS

Effective Term
Semester A 2025/26

Part I Course Overview

Course Title
Natural Product Chemistry and Biosynthesis

Subject Code
CHEM - Chemistry
Course Number
8012

Academic Unit
Chemistry (CHEM)

College/School
College of Science (SI)

Course Duration
One Semester

Credit Units
3

Level
R8 - Research Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

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.

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	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.).		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 have yet to be elucidated.			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 the 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	Presentation	Students will pick up or be given a natural product and provide a group or individual presentation 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	15	-	Yes
2	Presentation	5	15	-	Yes
3	Examination	1, 2, 3, 4, 5	0	-	No

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 (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

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

Excellent
(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Notevenreaching marginal levels

Assessment Task
Presentation (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

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

Excellent
(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Notevenreaching marginal levels

Assessment Task
Examination (for students admitted before Semester A 2022/23 and in Semester A 2024/25 & thereafter)

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-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Notevenreaching marginal levels

Assessment Task
Assignment (for students admitted from Semester A 2022/23 to Summer Term 2024)

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

Excellent
(A+, A, A-) High

Good
(B+, B) Significant

Marginal
(B-, C+, C) Basic

Failure
(F) Notevenreaching marginal levels

Assessment Task
Presentation (for students admitted from Semester A 2022/23 to Summer Term 2024)

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

Excellent
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(B-, C+, C) Basic

Failure

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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, ligases

Reading List

Compulsory Readings

	Title
1	Nil

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