CHEM3081: CHEMICAL BIOLOGY OF DNA AND RNA

Effective Term
Semester A 2024/25

Part I Course Overview

Course Title
Chemical Biology of DNA and RNA

Subject Code
CHEM - Chemistry
Course Number
3081

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

Prerequisites
Nil

Precursors
CHEM2071/BCH2071 Biological Chemistry or
CHEM2003/BCH2003 Biochemistry or
CHEM2007/BCH2007 Principles of Organic Chemistry

Equivalent Courses
BCH3081 Chemical Biology of DNA and RNA

Exclusive Courses
Nil

Part II Course Details

Abstract

In this course, students will be able to:

i) develop an understanding of a wide range of advanced chemical biology techniques, and their application to the study of nucleic acid structure and function studies

ii) devise appropriate chemical biology experiments to address specific basic and applied bioscience problems related to nucleic acids

iii) explore the relationship between nucleic acids and their chemical and biochemical properties

iv) identify the major differences between deoxyribonucleic acids (DNA) and ribonucleic acids (RNA), and the diverse targeting strategies

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Explain the key importance and roles of nucleic acids in chemistry and biology (e.g. chemical bonding, structure, dynamics, function)		x	x	
2	Apply the principles of chemical biology to understand the structure and functions of nucleic acids, and facilitate the discovery/design of novel chemicals for targeting purposes		x	x	
3	Critically evaluate the methods and results section of original papers published in high impact peer-review journals such as nature chemical biology, JACS, angewandte chemie		x	x	x
4	Discover and understand the background of several Nobel Prize Winners' work related to nucleic acids		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	Lecture and in-class discussion	Student will learn in lecture and in-class discussion about the theory and practise of chemical biology techniques to address questions regarding nucleic acid research. Along with the lecture, there will be a "weekly quiz", "what have you learnt" slide, and "Recap of the last lecture" slide to reinforce their understandings and summary the lecture materials	1, 2	
2	Tutorial and group activities	Students will be asked to evaluate relevant papers (chosen by course leader) in small groups, and present their findings to the class. Also, tutorial assignment will be discussed when necessary.	1, 2, 3, 4	
3	Oral presentations	Students will be asked to divide into groups and present the key experiments/findings that lead to Nobel Prize (related to nucleic acids). The course leader will assign the name of the Nobel Laureates to each group.	3, 4	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Weekly short quiz	1, 2	10	
2	Tutorial assignment	1, 2	30	
3	Presentation	3, 4	10	

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Additional Information for ATs

Starting from Semester A, 2015-16, students must satisfy the following minimum passing requirement for courses offered by CHEM: "A minimum of 40% in both coursework and examination components."

Assessment Rubrics (AR)

Assessment Task

1. Weekly short quiz

Criterion

Ability to explain and discuss the principle of nucleic acids, and their relevance to chemistry and biology

Excellent (A+, A, A-)

The student presents excellent understanding of the biology and chemistry of nucleic acids.

Good (B+, B, B-)

The student presents significant understanding of the biology and chemistry of nucleic acids.

Fair (C+, C, C-)

The student presents moderate understanding of the biology and chemistry of nucleic acids.

Marginal (D)

The student presents basic understanding of the biology and chemistry of nucleic acids.

Failure (F)

The student fails to presents basic understanding of the biology and chemistry of nucleic acids.

Assessment Task

2. Tutorial assignment

Criterion

Ability to articulate knowledge learnt in class to address real-life research questions

Excellent (A+, A, A-)

The student presents excellent understanding of the biology and chemistry of nucleic acids.

Good (B+, B, B-)

The student presents significant understanding of the biology and chemistry of nucleic acids.

Fair (C+, C, C-)

The student presents moderate understanding of the biology and chemistry of nucleic acids.

Marginal (D)

The student presents basic understanding of the biology and chemistry of nucleic acids.

Failure (F)

The student fails to presents basic understanding of the biology and chemistry of nucleic acids.

Assessment Task

3. Presentation

Criterion

Ability to integrate and explain the methodology and results published in research papers in related field

Excellent (A+, A, A-)

The student is able to create and deliver a well-structured, fluent and well prepared presentation on the topic of nucleic acid where he/she will share the knowledge on the specific topic with others.

Good (B+, B, B-)

The student is able to create and deliver a fluent and with evidence of significant preparation presentation on the topic of nucleic acid where he/she will share the knowledge on the specific topic with others.

Fair (C+, C, C-)

The student is able to create and deliver a fluent and with evidence of moderate preparation presentation on the topic of nucleic acid where he/she will share the knowledge on the specific topic with others.

Marginal (D)

The student is able to create and deliver a fluent and with evidence of basic preparation presentation on the topic of nucleic acid where he/she will share the knowledge on the specific topic with others.

Failure (F)

The student fails to present a relevant presentation on the topic of chemistry and biology of nucleic acids.

Assessment Task

4. Examination

Criterion

Ability to articulate and apply the methodologies and approaches introduced in this course to tackle real-life research problems

Excellent (A+, A, A-)

The student presents excellent understanding of the biology and chemistry of nucleic acids.

Good (B+, B, B-)

The student presents significant understanding of the biology and chemistry of nucleic acids.

Fair (C+, C, C-)

The student presents moderate understanding of the biology and chemistry of nucleic acids.

Marginal (D)

The student presents basic understanding of the biology and chemistry of nucleic acids.

Failure (F)

The student fails to presents basic understanding of the biology and chemistry of nucleic acids.

Part III Other Information

Keyword Syllabus

- Introduction to Nucleic Acids
- Solid phase chemical synthesis of nucleic acids
- Principles of antisense oligonucleotides for therapeutics
- Recognition of DNA by synthetic chemical molecules

- Protein recognition of DNA and RNA
- RNA secondary and tertiary structure
- Chemical and enzymatic cleavage of nucleic acids
- RNA enzymes and ribosome
- Aptamer and SELEX
- Chemistry of DNA sequencing
- DNA and RNA modification
- Epigenetics
- Genome editing

Reading List

Compulsory Readings

	Title
1	Nil

Additional Readings

	Title
1	Blackburn, M. G., Egli, M., Gait, M. J., & Watts, J. K. (2022). Nucleic Acids in Chemistry and Biology (4th ed.). Royal Society of Chemistry. ISBN 978-1-78801-904-0
2	Neidle, S., & Sanderson, M. (2021). Principles of Nucleic Acid Structure (2nd ed.). Academic Press. ISBN 9780128196779
3	Sugimoto, N. (2021). Chemistry and Biology of Non-canonical Nucleic Acids. Wiley. ISBN 978-3-527-34521-2