# School of Physical and Chemical Sciences

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

General Course Information

**CHEM 338/BCHM 338**
**Chemical Biology and Protein Chemistry**

0.1250 EFTS 15 Points
First Semester 2022

## Description

In this course we explore concepts in chemical biology and protein chemistry. We focus on the molecular determinants and complexity of life, and how this molecular complexity can be unravelled by integrating and using chemical and biochemical principles, tools, techniques and approaches.

In outline, the topics covered include:

- nucleic acids (DNA and RNA), nucleic acid modulating enzymes and their applications
- small molecules and proteins as tools in chemical biology research
- biochemical and chemical strategies for the production and modification of proteins
- the proteome, protein post-translational modifications, and implications for the central dogma
- mass spectrometry, how it works, and as an important tool to investigate and analyse the proteome

This course is preferably taken in conjunction with other 300-level biochemistry courses.

## Timetable

***Lectures & Workshops:*** 3 hours of lectures/problem-solving per week. Details to be confirmed on 'My Timetable' and the web.

Students should note that in the Science Faculty that the average student is responsible for approximately 4.5 hours of additional study for each hour of lecture/workshop contact time at the 300-level.

## Course Co-ordinator

Dr Jodie Johnston, School of Physical and Chemical Sciences.
Room 325 Beatrice Tinsley Building, ext 93044, jodie.johnston@canterbury.ac.nz

## Assessment

The course assessment will include the following elements:

- Test (BLOCK 1) **30**%
- Test/Tut Assignment (BLOCK 2) **25**%
- Final Examination (BLOCKS 3-4) **45**%

## Examination and Formal Tests

Tests: 2 x 1.5 hr test, details to be advised and will be available on the CIS and 'My timetable'.
Exam: 3 hr exam**,** details to be advised.

## Textbooks

There is no one definitive text for this course but there are a series of useful texts detailed below.
*Recommended texts:*

1. Introduction to Bioorganic Chemistry and Chemical Biology, David Van Vranken, Gregory Weiss, ISBN10 0815342144.
   Useful for some concepts covered in Blocks 2 and 3. A copy is available on short-term loan at the library.

2. Lehninger Biochemistry by D L Nelson & M M Cox.
   This book is available to purchase from UBS and there is also a copy available on short-term loan at the library.
3. Foundations of Chemical Biology, C. M. Dobson, J. A. Gerrard, and A. J. Pratt, 2002 ISBN: 9780199248995.
   Useful for basic background information. A copy is available on short-term loan at the library.

**Prerequisites (P)/ Recommended preparation (RP)/ Restrictions (R)**
P: BCHM212 or CHEM212 RP: BCHM202 or BIOL231

**Web-based resources:** Various learning resources for this course are available via the University of Canterbury's *Learn* web site - http://learn.canterbury.ac.nz/. This site will also be used regularly as a means of communication and information distribution for all of your Canterbury courses.

**Goal of the Course**
To explain of the role chemistry and biochemistry play in understanding and manipulating biological systems, building on fundamental chemical and biological principles. This course will provide a firm foundation for students wishing to continue study in the fields of biochemistry, biological chemistry, medicinal chemistry and chemical biology.

**General Learning Objectives (see also detailed Learning Objectives after Course Content, below)**
- Develop an in-depth knowledge of chemical biology and protein chemistry
- Improve ability to apply scientific principles and concepts to understand, evaluate, access and critically review new chemical biology, biochemical, and protein chemistry information
- Develop problem-solving and numeracy skills; the ability to effectively access and use information relevant to chemical biology and use this information to solve associated problems

**Summary of the Course Content**

36 lectures/problem-solving sessions in total, split into 4 blocks (detailed below).

**BLOCK 1:** ***10 lectures/problem-solving sessions***
**Nucleic Acids and Nucleic Acid Modulating Enzymes**

These lectures will give an introduction to the chemistry and biological chemistry of nucleic acids (DNA and RNA) and the enzymes that manipulate them covering topics such as; the chemical structure of nucleic acids, roles of nucleic acids in the cell, natural and synthetic approaches to making nucleic acids, modification of nucleic acids, applications of nucleic acid chemistry and nucleic acid manipulating enzymes.
**Lecturer: Dr Jodie Johnston, Room 325 Beatrice Tinsley Building, ext. 93044, jodie.johnston@canterbury.ac.nz**

**BLOCK 2:** ***9 lectures/problem-solving sessions***
**The Wider World of Proteins**

This part of the course will introduce the world of proteins beyond what is imagined by the central dogma, and the breadth of protein modification in nature. We will then focus on glycosylation of proteins, mass spectrometry and proteomics, and peptides and their synthesis.
**Lecturer: Dr Tim Allison, Room 328 Beatrice Tinsley Building, ext. 93034, timothy.allison@canterbury.ac.nz**

**BLOCK 3:** ***9 lectures/problem-solving sessions***
**How Chemical and Biological Tools Are Used to Create Diverse and Complex Proteins**

We will explore the biosynthesis of both natural and 'unnatural' proteins, and how these can be used to uncover new knowledge of the biological function and behaviour of these biomolecules. We will cover recombinant protein expression, mutagenesis, incorporation of unnatural amino acids, ligation technologies for building proteins, site-specific chemical modification of proteins, and antibody-drug conjugates.

**Lecturer: Dr Tim Allison, Room 328 Beatrice Tinsley Building, ext. 93034,**
**timothy.allison@canterbury.ac.nz**

**BLOCK 4:** ***8 lectures/problem-solving sessions***
**Small Molecules and Proteins as Tools in Chemical Biology**

These lectures will explore how a range of proteins (including antibodies and biotin binding proteins), aptamers and small molecule protein modulators are adapted to be used as tools in biological chemistry and chemical biology research. Case studies, including from recent scientific publications in the chemical biology research area will be discussed to highlight key points.

**Lecturer: Dr Jodie Johnston, Room 325 Beatrice Tinsley Building, ext. 93044,**
**jodie.johnston@canterbury.ac.nz**

## LEARNING OBJECTIVES

**BLOCK 1 and 4:**
At the end of these blocks you should be able to:

- Understand the fundamental concepts of nucleic acid chemistry, structure and function and describe how these concepts have affected their use in research and biotechnology
- Describe ways in which nucleic acids are made and manipulated biologically and synthesised chemically, and give examples of how this has affected the advancement of in biomedicine, research and biotechnology
- Describe what a chemical probe is, and how it is used in chemical biology/chemical genetics research
- Explain the differences between forward and reverse chemical genetics experiments and discuss their advantages and limitations over traditional genetics approaches
- Describe, with examples, how proteins such as antibodies and biotin binding proteins have been adapted to be used as tools in research
- Describe, what an aptamer is, how they are generated and what applications they have

**BLOCK 2 and 3:**
At the end of these blocks you should be able to:

- Describe and understand how peptides and proteins are made biologically, chemically, and how chemistry can be used to harness nature's own tools
- Describe the different ways in which the proteome is extended through protein modification, and understand the importance and effect on proteome diversity
- Describe how peptides and proteins can be crafted and modified using chemical approaches
- Describe and understand the utility of mass spectrometry and proteomics for identifying proteoforms and analysing proteins

## GENERAL INFORMATION 2022

**Chemistry Department Policy on 'Dishonest Practice'**
The University has strict guidelines regarding 'dishonest practice' and 'breach of instructions' in relation to the completion and submission of examinable material. In cases where dishonest practice is involved in tests or other work submitted for credit a department may choose to not mark such work ('Academic Integrity and Breach of Instruction Regulations').

The Department of Chemistry upholds this policy. It considers plagiarism, collusion, copying, and ghost writing to be unacceptable and dishonest practices:

- ***Plagiarism*** is the presentation of any material (text, data or figures, on any medium including computer files) from any other source without clear and adequate acknowledgement of the source.
- ***Collusion*** is the presentation of work performed in whole, or in part, in conjunction with another person or persons, but submitted as if it has been completed by the named author alone. This interpretation is not intended to discourage students from having discussions about how to approach an assigned task and incorporating general ideas that come from those discussions into their own individual submissions, but acknowledgement is necessary.
- ***Copying*** is the use of material (in any medium, including computer files) produced by another person or persons with or without their knowledge and approval. **This includes copying of the lab reports (raw data may be shared within the group if permitted or required by the experiment) - data analysis and interpretation of obtained results MUST be performed individually.**
- ***Ghost writing*** is the use of other person(s) (with, or without payment) to prepare all or part of an item of work submitted for assessment.

**Additional Information**

***Special consideration of assessment*:** If you feel that illness, injury, bereavement or any other critical extenuating circumstance beyond your control has prevented you from completing an item of assessment or affected your performance in that assessment, you may apply for special consideration. Special consideration is not available for items worth less than 10% of the course. Applications for special consideration should be made **within five days** of the due date for the work or examination. In the case of illness or injury, medical consultation should normally have taken place shortly before, or within 24 hours after, the due date for the required work or the date of the test or examination. For details on special consideration, or to make an application, refer to the Examinations Office website http://www.canterbury.ac.nz/exams/. ***You have the right to appeal any decision.***

***Extensions of deadlines:*** Where an extension may be granted for an assessment item, this will be decided by application to the course co-ordinator.

***Late withdrawal from the course***: If you are prevented by extenuating circumstances from completing the course after the final date for withdrawing from the course, you may apply for special consideration for late discontinuation. For details on special consideration, or to make an application, refer to the Examinations Office website http://www.canterbury.ac.nz/exams/. Applications must be submitted ***within five days*** of the end of the main examination period for the semester.

***Missing of tests*:** In rare cases a student will not be able to sit a test. In such cases, the student should consult with the course co-ordinator to arrange alternative procedures. **This must be done well in advance of the set date for the test.**

***Past tests and exams:*** these can be found on our website using the link below:
www.chem.canterbury.ac.nz/for/undergraduate.shtml

***Submission of reports and assignments*: Reports (including lab reports) and assignments should be handed in on time.** Extensions will be granted only in exceptional circumstances (such as illness or bereavement). If an extension is required, as early as possible you should request it from the lecturer concerned.
*Note:* If you do not submit an assignment for assessment, you will be allotted zero marks, which will affect your final result. You should ensure that you pick up marked assignments and keep them until the end of the course as evidence that the work was completed and marked in the case that either is disputed. To guard against accidental loss, it would be prudent to keep photocopies or electronic copies of anything submitted.

***Late Work:*** Acceptance of late work will be at the discretion of the course coordinator. Please contact the coordinator if your assessment is likely to be late.

***Marks and Grades:*** The following numbers should be considered as a guide to the expected grades under normal circumstances. The School reserves the right to adjust mark/grade conversions, if necessary.

***Please note that for all invigilated assessments (tests and exams) worth 33% and above, failure to obtain a mark of at least 40% will result in a final grade no higher than an R at 100 and 200 level, and a C- at 300 level.***

| Grade: | A+ | A | A− | B+ | B | B− | C+ | C | C- | D | E |
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| Minimum mark %: | 90 | 85 | 80 | 75 | 70 | 65 | 60 | 55 | 50 | 40 | 0 |

***Reconsideration of Grades:*** Students should, in the first instance, speak to the course co-ordinator about their marks. If they cannot reach an agreeable solution, or have questions about their grade in a course, students should then speak to the Director of Undergraduate Studies, Assoc Prof Greg Russell (phone 3694228). Students can appeal any decision made on their final grade. You can apply at the Registry for reconsideration of the final grade within four weeks of the date of publication of final results. Be aware that there are time limits for each step of the appeals process.

***Students with Disabilities:*** Students with disabilities should speak with someone at Equity and Disability Service, phone: 369 3334 (or ext. 93334), email: eds@canterbury.ac.nz).

***Academic Advice*:** Assoc Prof Greg Russell is the coordinator of undergraduate chemistry courses. His interest is in the academic performance and well-being of all such students. Anyone experiencing problems with their chemistry courses or requiring guidance about their B.Sc. in Chemistry should get in contact with Greg.

***Staff-Class Rep Liaison*:** Assoc Prof Greg Russell is in charge of liaison with students in chemistry courses. Your class will appoint a student representative to the liaison committee at the start of the semester. Please feel free to talk to the Academic Liaison or the student rep about any problems or concerns that you might have.

Greg Russell (greg.russell@canterbury.ac.nz, tel. 369 5129)
Director of Undergraduate Studies
School of Physical and Chemical Sciences
2022