School of Physical and Chemical Sciences

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

General Course Information | Ngā Whakamārama

CHEM112 / BCHM112
Structure and Reactivity in Chemistry and Biochemistry

0.1250 EFTS 15 Points
Second Semester 2022

Description | Whakamahuki
CHEM/BCHM112 covers aspects of organic and inorganic chemistry and represents half of the general chemistry first year content at UC. Students attempting CHEM/BCHM112 should have at least 14 NCEA level 3 credits in Chemistry, or CHEM114, or a B or better grade in BRDG023, or equivalent preparation approved by the Head of the School of Physical and Chemical Sciences.

Timetable | Wātaka
48 lectures, 6 laboratories (compulsory), 2 drop-in sessions.

Lectures: Mon 11:00 - 11:50 (K1); Tues 9:00 – 9:50 (K1); Thu 16:00 – 16:50 (K1); Fri 9:00-9:50 (A1).
Please check 'My Timetable' and the Web as these can change.

Lectures will be given by:
Dr Jodie Johnston (12 lectures) e-mail: jodie.johnston@canterbury.ac.nz

Dr Chris Fitchett (16 lectures) e-mail: chris.fitchett@canterbury.ac.nz

Prof. Richard Hartshorn (20 lectures) e-mail: richard.hartshorn@canterbury.ac.nz

It is expected, in the Science Faculty, that the average student is responsible for approximately 3 hours of additional study for each hour of lecture at the 100-level.

Course Coordinator | Kairuruku Akoranga
Chris Fitchett, email chris.fitchett@canterbury.ac.nz
Email me anytime if you have any queries about the course.

Laboratory coordinators:
Dr Anthea Lees, anthea.lees@canterbury.ac.nz. Contact Anthea for morning lab session queries
Dr Justine Cottam justine.cottam@canterbury.ac.nz. Contact Justine for afternoon lab session queries.
Email us about any laboratory queries.

Assessment | Aromatawai
Exam: 55% Test: 20% Laboratory: 15% Best Choice 10%

Examination and Formal Tests | Ngā Whakamātautau Ōkawa

Test: Tuesday 16th of August 18:30 – 19:30 (60 Minutes)
Rooms to be confirmed through MyTimetable and the Web. The test will cover the material from the first three weeks of the course (Jodie Johnston's material).

Exam: details to be advised
The final exam will cover the material from the last eight weeks of the course. Material from the first four weeks will not be explicitly re-examined, but you will be assumed to be familiar with it.

The results for the test will be posted as soon as they become available, and your scripts will be returned to you in the first lab after the break. Your **overall grade for CHEM112-BCHM112** will be released at the end of the year, with the other University results.

Textbooks | Tuhinga

Burrows et al.; **Chemistry^3**: introducing inorganic, organic and physical chemistry; Oxford University Press; either the 1st, 2nd or 3rd edition may be used.

Prerequisites

At least 14 NCEA level 3 credits in Chemistry, or CHEM114, or a B or better grade in BRDG023, or equivalent preparation approved by the Head of the School of Physical and Chemical Sciences.

NOTE: Laboratory attendance is COMPULSORY. In order to be ELIGIBLE to pass CHEM112-BCHM112, you must pass the laboratory course and have satisfactory attendance at laboratory sessions.

The Laboratory Classes

The CHEM/BCHM112 laboratory classes commence the **SECOND WEEK** of the semester (i.e. the week beginning 25th July). You must assign yourself to a laboratory (via My Timetable); this is normally indicated on your fees receipt. If you cannot assign yourself to a laboratory class or if you **have a timetable clash** with the class you have been assigned, you should contact Anthea Lees or Justine Cottam during the first week of Semester 2.

The available sessions are:

Lab 01	Wednesday	9:00 – 11:50	Lab 02	Wednesday	13:00 – 15:50
Lab 03	Thursday	09:00 – 11:50	Lab 04	Thursday	13:00 – 15:50
Lab 05	Friday	10:00 – 12:50	Lab 06	Friday	14:00 – 16:50

Laboratory work will be written up on report sheets supplied by the Chemistry Department at the start of each lab class. The report sheets will be retained by laboratory demonstrators at the end of each lab, marked, and returned the following week. Students are advised to retain their sheets for future reference since **laboratory work is examinable**.

Laboratory organization: Each laboratory is under the direct control of a senior supervisor, who will give an introductory talk at the start of each class and highlight the details of the pre-lab video which you will have already watched. Your work in the lab will be supervised and your weekly reports will be graded by one of

the demonstrating team. If you encounter difficulties during the lab, you are free to consult any demonstrator, senior supervisor or academic staff member.

Dress for the Laboratory:
Safety glasses: are not supplied. You must wear approved eye protection in the laboratory **AT ALL TIMES**. If you normally wear prescription glasses you must either wear clear plastic safety glasses over them or they must have lenses of plastic or toughened glass and be fitted with side-protectors. They must be purchased before attending your first laboratory class.

Laboratory coats: must be worn, done up, at all times in the laboratory. Coats approved for use in all Science Faculty laboratories are available for purchase from the Department of Chemistry prior to your first laboratory class.

PURCHASING SAFETY GLASSES AND LABORATORY COATS

Safety glasses ($10) and laboratory coats ($37.50) These may be purchased on-line from the University at:

https://www.canterbury.ac.nz/science/current-students/shop/

Laboratory coats & glasses can be collected before the start of term on the following dates, please ensure you bring your Student ID with you, and your receipt number:

Thursday 14th July and Friday 15th July between the hours of 9.00 – 10.00am

First two weeks of semester two: 18th July to 22nd July and 25th July to 29th July, Mon - Fri between the hours of 9.00 – 10.00am or 1:00 – 2:00pm

Coats and glasses can be collected inside the southern entry to the Ernest Rutherford Building

From 2nd August, pickup will be on Tuesday and Thursday, 1.30 – 2.00pm Ernest Rutherford, Chemistry Stores, 130A.

Note: covered shoes must be worn in the stores area.

Suitable footwear: must be worn at all times in the laboratory. For safety reasons this means footwear **that covers all of your feet**. No open-topped or open-toed or backless footwear and absolutely no Jandals.

Laboratory manuals: are provided. A coloured electronic copy is on the Learn website and manuals will be available to collect outside Ernest Rutherford (ER 421) before the first laboratory. Pre- lab videos should be watched on Learn prior to each lab.

Safety Quiz: This will be on the Learn site and must be completed before you come to **your first lab class (week 2).** More information will be given in lectures. This quiz will be marked and will count towards your lab score.

Attendance at Laboratory Classes: You are expected to attend **every** laboratory session. A satisfactory record of attendance and performance at laboratory classes is a condition for obtaining a pass in the course. Students who are unable to attend their lab in a particular week because of an unavoidable commitment should contact: Dr Anthea Lees (anthea.lees@canterbury.ac.nz) or Dr Justine Cottam (justine.cottam@canterbury.ac.nz) and attempt to arrange attendance at one of the other times that same week. (Please note that you cannot make up the missing lab the following week).

Absences due to illness: will be excused, provided a medical certificate from a registered medical practitioner, registered dental surgeon, registered midwife or a student counsellor is presented at the next lab attended.

Unexcused absences: may constitute an unsatisfactory record and result in you failing the laboratory requirement and hence CHEM112-BCHM112. They will be assigned a mark of zero for that experiment and will degrade your final mark. If you miss a lab (or are going to miss a lab) you must contact Dr Anthea Lees or Dr Justine Cottam. Under certain circumstances they can grant an exemption.

Exemption from the laboratory Course: Students who are repeating the course may, on the basis of their level of performance in the laboratory in a previous year, be exempted from attending laboratories. Students who wish to apply (and you must apply) for an exemption should contact Dr Chris Fitchett (Room 858 or, preferably, e-mail chris.fitchett@canterbury.ac.nz by the end of the second week of the Semester.

Pre-lab timelines: Prior to each experimental laboratory session (except the first one), you are expected to complete a timeline plan for the session. This will require you to watch the pre-lab video on the Learn site and read and understand the introduction, theory and experimental sections for that experiment in the lab manual. These timelines are **compulsory** and are part of your lab mark. There are also pre-lab questions to complete.

Laboratory Assessment: During the course you will be expected to become proficient at common laboratory techniques such as distillation, heating under reflux, purification of products, accurately recording observations, recording data, making calculations and interpreting results. Your supervisor and demonstrators will assess your performance in these areas, and your general attitude, application and organisation in the laboratory; i.e. your weekly mark will not purely be on the basis of what is written in your report sheet.

Each week you will be supplied with a report sheet for the week's experiment. This is completed during the lab, and handed in to your demonstrator before leaving. Your demonstrator will grade it and return it to you at the next laboratory period. It is **strongly recommended** that you retain your report sheets after marking because: (a) they represent proof that you attended the Lab that week and; (b) more importantly perhaps, some test/exam questions are based on Laboratory experiments.

If your overall attendance at laboratories is judged unsatisfactory you will not be given a pass in the laboratory course and will thus fail CHEM112-BCHM112. If your attendance is satisfactory but your performance is not, you may be required to take a practical examination at the end of the course.

"BestChoice" On-line Problems and Quizzes

"BestChoice" is a computer-based service provided by the University of Auckland. All students enrolled in CHEM112-BCHM112 will be given free access to the BestChoice website. This contains a comprehensive selection of computer-based practice exercises ("problems") which cover nearly all aspects of the CHEM112-BCHM112 course material. You are expected to use this as complementary learning material and your participation in BestChoice is worth **10% of the marks** for CHEM112-BCHM112. To achieve this mark, you must complete a certain percentage of the activities available. You will be notified of this on the Learn site.

Details of how to log-in will be posted on Learn and will not start until Week 2

Computer equipment: The University provides several student computer facilities. All available computer facilities can be found at: http://www.canterbury.ac.nz/its/computer-workrooms/

CHEM/BCHM112 course content outline:

Structure, Isomerism, Stereochemistry and Synthesis

Weeks 1-3, taught by Jodie Johnston

- Representations of organic molecules
- Functional groups
- Resonance
- Types of Isomerism
- Stereochemical descriptors
- Optical rotation
- Stereochemistry in amino acids and introduction to peptides
- Stereochemistry in carbohydrates
- Molecular characterisation using Mass spectrometry and NMR

Reaction Mechanisms

Weeks 4-7, taught by Chris Fitchett

- Types of Organic Reactions
- Introduction to reaction mechanisms
- Conventions used for drawing mechanisms
- Introduction to nucleophilic addition and substitution
- Nucleophilic substitutions of alkyl halides
- Electrophilic additions to alkenes
- Electrophilic substitutions of benzene

Transition Metal Chemistry

Weeks 8-12, taught by Richard Hartshorn

- Electron configurations and oxidation states
- Redox reactions and analyses
- Complexation, equilibria, and the chelate effect
- Ligand exchange mechanisms
- Complexes in medicine and biology
- Isomerism
- Colour and crystal field theory
- Electrochemical cells, reduction potentials, and the Nernst equation

CHEM/BCHM112 Learning Objectives

Structure, Isomerism, Stereochemistry and Synthesis

Weeks 1-3, taught by Jodie Johnston

At the end of this section you should be able to:

- Describe and demonstrate the conventions used for representing organic molecules
- Recognise common functional groups
- Interpret the conventional (IUPAC) nomenclature used for the naming of simple organic molecules
- Describe the concept of resonance, recognise situations where it may occur, and provide examples of it.
- Define and provide examples of the distinction between the terms: structural (constitutional) isomerism and stereoisomerism, conformational and configurational isomerism, enantiomers and diastereoisomers
- Be able to assign: R/S descriptors to enantiomers and E/Z descriptors to alkenes
- Describe and illustrate the isomerism in substituted cycloalkanes
- Define and explain the terms: optical rotation, polarimeter, racemic mixture, meso compound
- Provide examples of the importance of chirality in nature
- Outline the structural and stereochemical features of simple carbohydrates, amino acids and peptides
- Describe how molecules can be characterised using NMR and Mass spectrometry

Reaction Mechanisms

Weeks 4-7, taught by Chris Fitchett

At the end of this section you should be able to:

- Understand what is meant by a reaction mechanism, and differentiate different types of reaction.
- Recognise the Nucleophile and Electrophile in chemical reactions.
- Analyse a substitution reaction to determine which of the two types of mechanism are operating.
- Use Curly Arrows to illustrate a mechanism, and predict the structure of any intermediates and transition states.
- Evaluate how changes in reactant structure, leaving group ability and nucleophile can affect the reaction mechanism and energy profile
- Use Curly Arrows to show the mechanism for the electrophilic addition to alkenes of Br_2, HBr/HCl and H_2O and the origin of Markovnikov's rule.
- Evaluate the mechanism of addition reactions of alkenes using structural features of the reactants, and predict the structure of any intermediates and transition states.
- Recognise the different types of carbonyl groups, and predict the outcome of their nucleophilic substitution and addition reactions.
- Understand the reactivity of Grignard reagents and predict the outcome of their reactions with electrophiles (water, carbonyl groups, epoxides, etc).
- Evaluate the mechanism of electrophilic substitution reactions of benzene (halogenation, nitration, alkylation and acylation) using Curly Arrows, and predict the structure of any intermediates and transition states.
- Use the synthetic transformations discussed as part of short reactions schemes (2-4 steps).

TRANSITION METAL CHEMISTRY

Weeks 8-12, taught by Richard Hartshorn

At the end of this section you should be able to:

- define transition metals in terms of their electron configurations, describe complex formation in solution, define and give examples of the terms: co-ordination compound (complex or complex ion), co-ordination number, ligand, denticity, and chelate;
- identify common oxidation states of the first row transition metals, and give examples of their use in quantitative redox titrations;
- explain and give examples of the use of coloured compounds in qualitative and quantitative analysis;
- write equilibrium expressions to describe the stability of complexes, describe complex formation in solution by stepwise substitution reactions, explain the chelate effect, describe the meaning of the terms labile and inert in this context and outline common mechanisms of substitution;
- give examples of isomerism and optical activity in transition metal complexes and be able to recognise cases where they may exist;
- describe the chemistry involved in complexometric titrations, chelation therapy, and cancer treatment using cisplatin (*cis*-diamminedichloridoplatinum(II)).
- give examples of the roles of transition metals in biology;
- use Crystal Field Theory (CFT) to account for some of the observed physical properties of transition metal complexes (colour and magnetism);
- account for the forms in which transition metals are found in nature in terms of Hard-Soft Acid-Base (HSAB) theory and describe how trends in standard electrode potentials for the reduction of M^{2+} and M^{3+} affect the choice of method for the industrial production of the metal;
- describe the different kinds of electrochemical measurements that can be made, explain the connection between redox reactions and electrochemistry, define the terms emf and standard reduction potential, and use them to deduce the relative oxidizing or reducing power of a redox system;
- to write down the conventional cell diagram for an electrochemical cell, based either on a given spontaneous redox reaction or on experimental data for a given cell, and vice versa;
- explain how the experimental reversible electric potential difference (reversible emf), E_{cell}, between a pair of electrodes in a cell is related to the free energy change of the cell reaction under any conditions by $\Delta G = -nFE_{cell}$
  and under standard conditions by $\Delta G^\circ = -nFE^\circ_{cell}$
- to use the Nernst equation to calculate the emf of a cell under non-standard conditionsand to calculate the emf of a concentration cell.

GENERAL INFORMATION 2022

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 School of Physical and Chemical Sciences 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: Late work should be accompanied by a detailed explanation of why the work is late. The work will be marked, and up to 10% of the total marks will be subtracted for *each day* the work is late, at the discretion of the lecturer. Days late include weekends and holidays. If you know in advance that you will be unable to complete an assessment on time, please contact your lecturer, in advance, to discuss.

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**
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