UNSW Course Outline

# CHEM3071 The Chemistry of Catalysis, Systems and Biology - 2024

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## General Course Information

**Course Code :** CHEM3071
**Year :** 2024
**Term :** Term 3
**Teaching Period :** T3
**Is a multi-term course? :** No
**Faculty :** Faculty of Science
**Academic Unit :** School of Chemistry
**Delivery Mode :** In Person
**Delivery Format :** Standard
**Delivery Location :** Kensington
**Campus :** Sydney
**Study Level :** Undergraduate
**Units of Credit :** 6

**Useful Links**

Handbook Class Timetable

## Course Details & Outcomes

### Course Description

Building on students' background knowledge in both organic and inorganic chemistry, this course

provides an understanding of the parallels between the function of synthetic and biological molecules. Students will learn about the fundamentals of catalysis by organometallic complexes and enzymes and how weak intermolecular interactions are responsible for complex self-assembled structures in both biology and synthetic chemistry. The fundamental concepts and techniques in organic and organometallic catalysis, self-assembly, supramolecular chemistry and the chemistry of biological assemblies and enzymatic catalysis are presented through a series of lectures, tutorials and laboratory classes.

## Course Aims

The aim of this course is to provide students with an understanding of how weak intermolecular interactions are central to the activity of synthetic chemical systems, and the most fundamental processes in biology.

Practical classes will cover advanced NMR techniques, organometallic catalysis, binding constant measurements, self-assembly, molecular sensing and enzyme catalysis.

# Course Learning Outcomes

| Course Learning Outcomes |
| --- |
| CLO1 : Explain the importance of intermolecular (supramolecular) interactions in chemistry, nanotechnology and biology to describe binding events, self-assembly and solvation and to use this knowledge to predict the stability of different assembled species, including in catalysis applications. |
| CLO2 : Use molecular orbital theory to explain catalytic function and reaction outcomes. |
| CLO3 : Describe the importance of energetics (free energy, enthalpy, entropy, rate constants) and solvation in catalysis, supramolecular chemistry and biology. |
| CLO4 : Explain common catalytic cycles and propose viable mechanisms for important synthetic and biological processes. |
| CLO5 : Design a (supra)molecular system with a specific function, such as catalysis of a specific transformation, molecular sensing or transport. |
| CLO6 : Perform synthetic chemistry and analytical measurements to evaluate catalytic, assembly and kinetic profiles of representative chemical processes in catalysis, supramolecular chemistry and biological chemistry. |

| Course Learning Outcomes | Assessment Item |
| --- | --- |
| CLO1 : Explain the importance of intermolecular (supramolecular) interactions in chemistry, nanotechnology and biology to describe binding events, self-assembly and solvation and to use this knowledge to predict the stability of different assembled species, including in catalysis applications. | • Final Exam<br>• Laboratory work<br>• Tutorial Assessment |
| CLO2 : Use molecular orbital theory to explain catalytic function and reaction outcomes. | • Final Exam<br>• Tutorial Assessment |
| CLO3 : Describe the importance of energetics (free energy, enthalpy, entropy, rate constants) and solvation in catalysis, supramolecular chemistry and biology. | • Laboratory work<br>• Final Exam<br>• Tutorial Assessment |
| CLO4 : Explain common catalytic cycles and propose viable mechanisms for important synthetic and biological processes. | • Final Exam<br>• Tutorial Assessment |
| CLO5 : Design a (supra)molecular system with a specific function, such as catalysis of a specific transformation, molecular sensing or transport. | • Laboratory work<br>• Final Exam<br>• Tutorial Assessment |
| CLO6 : Perform synthetic chemistry and analytical measurements to evaluate catalytic, assembly and kinetic profiles of representative chemical processes in catalysis, supramolecular chemistry and biological chemistry. | • Laboratory work |

# Learning and Teaching Technologies

Moodle - Learning Management System

# Learning and Teaching in this course

Lectures and interactive tutorials will provide the majority of the theoretical material in this course. To prepare for these classes students are expected to engage with material provided online as indicated by the instructors.

Laboratory exercises have been chosen to align with key learning areas covered in the lectures and tutorials. The tutorials and lab exercises will require students to solve complex problems which will allow students to develop their critical analysis and problem-solving skills.

Lectures: 27 total, online

Tutorial: 9 total, in person

Laboratory: 8 x 4 hour lab experiments, in person

# Additional Course Information

**Expectations of students**

• Attendance/watching online all lectures is expected.

• Attendance at all tutorials and laboratory sessions is mandatory. A minimum level of completion of 7 out of 8 lab experiments is required to pass the course.

• Students are expected to spend an equivalent amount of their own time to the contact hours (68 total) undertaking detailed study of the course materials and completing lab reports.

• Prepare and plan for practical experiments by completing the relevant reading and safety prework prior to the scheduled lab class.

• Adhere to UNSW's Occupational Health and Safety policies including COVID-19 policies

• Keep abreast of all course communications made through UNSW email and Moodle.

• Participate in class discussion and activities.

# Assessments

## Assessment Structure

| Assessment Item | Weight | Relevant Dates |
|---|---|---|
| Final Exam<br>Assessment Format: Individual | 50% | Start Date: Not Applicable<br>Due Date: Exam period |
| Laboratory work<br>Assessment Format: Individual | 40% | Due Date: Online submission due generally by 9:00 am one week from the date of completion of the experiment (except week 10 lab – due Friday week 10 and extra week for flex week) |
| Tutorial Assessment<br>Assessment Format: Individual | 10% | Due Date: Start of lab classes in weeks 4, 8, 10. |

## Assessment Details

### Final Exam

**Assessment Overview**

The final exam is designed to assess your learning and problem-solving skills on all topics delivered across the term, including material from lectures, tutorials and workshops.
The exam is typically 2hrs long with details to be confirmed during the course. The examination will occur during the official university examination period. Feedback is available through inquiry with the course convenor.

**Course Learning Outcomes**

- CLO1 : Explain the importance of intermolecular (supramolecular) interactions in chemistry, nanotechnology and biology to describe binding events, self-assembly and solvation and to use this knowledge to predict the stability of different assembled species, including in catalysis applications.
- CLO2 : Use molecular orbital theory to explain catalytic function and reaction outcomes.
- CLO3 : Describe the importance of energetics (free energy, enthalpy, entropy, rate constants) and solvation in catalysis, supramolecular chemistry and biology.
- CLO4 : Explain common catalytic cycles and propose viable mechanisms for important synthetic and biological processes.
- CLO5 : Design a (supra)molecular system with a specific function, such as catalysis of a specific transformation, molecular sensing or transport.

**Detailed Assessment Description**

Lecturers will provide advice on the assessment expectations in their sections of the course and sample exam-style questions.

The final exam will be administered online via Moodle.  Full details of exam format will be given in due course.

**Assignment submission Turnitin type**

Not Applicable

**Hurdle rules**

Students must get at least 35% of the available marks across the tutorial tests plus final examination (all three modules combined) to pass the course.

Failure to reach this mark will result in an unsatisfactory fail.

There will be no academic supplementary exams if you fail first time – University policy.

**Generative AI Permission Level**

**No Assistance**

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.
For more information on Generative AI and permitted use please see here.

## Laboratory work

**Assessment Overview**

You will attend 8 laboratory sessions across the term to provide an opportunity for you to apply knowledge to practical experiments.

You will submit a written report which is due the week after each class.

Written formal lab reports will be marked within a week of their submission and be returned to students with specific feedback.

**Course Learning Outcomes**

- CLO1 : Explain the importance of intermolecular (supramolecular) interactions in chemistry, nanotechnology and biology to describe binding events, self-assembly and solvation and to use this knowledge to predict the stability of different assembled species, including in catalysis applications.
- CLO3 : Describe the importance of energetics (free energy, enthalpy, entropy, rate constants) and solvation in catalysis, supramolecular chemistry and biology.
- CLO5 : Design a (supra)molecular system with a specific function, such as catalysis of a

specific transformation, molecular sensing or transport.
- CLO6 : Perform synthetic chemistry and analytical measurements to evaluate catalytic, assembly and kinetic profiles of representative chemical processes in catalysis, supramolecular chemistry and biological chemistry.

Assessment information

If you need to miss a laboratory class due to a commitment in another course (e.g. a field trip), this must be notified, with documentation, to the lab supervisor well in advance so that alternative arrangements can be made if possible.

Absence due to illness or misadventure must be documented using the University special consideration procedures or by production of a medical certificate (see https://student.unsw.edu.au/special-consideration).

Students arriving more than 15 minutes after the class start time are too late to commence and will be deemed to have been absent from that laboratory session.

Submissions of lab reports will be online via Moodle.

Reports are generally due by 9:00 am on the day one week from the date of completion of the experiment. (ie immediately before the start of the next lab class).

• All laboratory reports are required to be submitted online using the assignment link on Moodle.

**• Any report submitted after the due date will incur a 10% / day penalty up to 7 days, after which a mark of 0 will be awarded for that report, though feedback will still be provided if a report is submitted.**

Assignment submission Turnitin type

Not Applicable

Hurdle rules

**Satisfactory performance (>50%) in the laboratory course is required to pass the course.**

There are 8 lab experiments/workshops, each is worth 5% of the total course mark.

**A minimum 80% attendance (when rostered to attend) and submission of laboratory work is also required. (This means you can miss no more than one lab session).**

Generative AI Permission Level

**No Assistance**

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.
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## Tutorial Assessment

### Assessment Overview

You will complete one assessment task for each of the three section of the course, which will be either an assignment or an in-tutorial assessment task, such as a written quiz.

In either case you will have to demonstrate your ability to apply the methods covered in the tutorial to solve a task or a problem. Examples include outlining a catalytic pathway, calculate a binding constants or rate constants from experimental data or designing a (bio)chemical system to solve a particular problem such as sensing an analyte.

Individual feedback on each activity will be provided by the lecturer of that section of the course in the form of a marked assessment task.

### Course Learning Outcomes

- CLO1 : Explain the importance of intermolecular (supramolecular) interactions in chemistry, nanotechnology and biology to describe binding events, self-assembly and solvation and to use this knowledge to predict the stability of different assembled species, including in catalysis applications.
- CLO2 : Use molecular orbital theory to explain catalytic function and reaction outcomes.
- CLO3 : Describe the importance of energetics (free energy, enthalpy, entropy, rate constants) and solvation in catalysis, supramolecular chemistry and biology.
- CLO4 : Explain common catalytic cycles and propose viable mechanisms for important synthetic and biological processes.
- CLO5 : Design a (supra)molecular system with a specific function, such as catalysis of a specific transformation, molecular sensing or transport.

### Detailed Assessment Description

Three tests up to 30 mins each in tutorial classes in weeks 4, 8, 10.

Tests will be in person but online via Moodle.

### Assignment submission Turnitin type

Not Applicable

Hurdle rules

Students must get at least 35% of the available marks across the tutorial tests plus final examination (all three modules combined) to pass the course.

Failure to reach this mark will result in an unsatisfactory fail.

There will be no academic supplementary exams if you fail first time – University policy.

Generative AI Permission Level

**No Assistance**

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.
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# General Assessment Information

Grading Basis

Standard

Requirements to pass course

**Students must get at least 35% of the available marks across the tutorial tests plus final examination (all three modules combined) to pass the course.**

**Failure to reach this mark will result in an unsatisfactory fail.**

There will be no academic supplementary exams if you fail first time – University policy.

Further information:

- UNSW grading system: https://student.unsw.edu.au/grades
- UNSW assessment policy: https://student.unsw.edu.au/assessment

# Course Schedule

| Teaching Week/Module | Activity Type | Content |
|---|---|---|
| Week 1 : 9 September - 15 September | Lecture | Catalysis: General Introduction.<br>Fundamentals: Energetics, mechanism and orbital interactions in catalysis. |
| | Tutorial | |
| Week 2 : 16 September - 22 September | Lecture | Catalysis: Introduction to organometallic catalysis and examples. |
| | Tutorial | |
| Week 3 : 23 September - 29 September | Lecture | Catalysis: Organometallic catalysis and beyond (including organocatalysis and heterogeneous catalysis) |
| | Tutorial | |
| | Laboratory | Intro to 2D NMR problems – Structural determination of potential reaction products, isomers, mixtures. |
| Week 4 : 30 September - 6 October | Lecture | Supramolecular Chemistry: Intermolecular forces and binding equilibria |
| | Laboratory | Synthesis and characterisation of an organometallic catalyst. |
| | Assessment | Quiz in lab class |
| Week 5 : 7 October - 13 October | Lecture | Supramolecular Chemistry: Host guest chemistry and sensing |
| | Tutorial | |
| | Laboratory | Catalysis using an organometallic catalyst |
| Week 6 : 14 October - 20 October | Other | Flexibility week - no classes |
| Week 7 : 21 October - 27 October | Lecture | Supramolecular Chemistry: Self-assembly and molecular machines |
| | Tutorial | |
| | Laboratory | Supramolecular self-assembly of well-defined structures |
| Week 8 : 28 October - 3 November | Lecture | Biological Chemistry: Protein structure and assembly. Enzymatic Catalysis. |
| | Tutorial | |
| | Laboratory | Molecular sensing through supramolecular binding studies |
| | Assessment | Quiz in lab class |
| Week 9 : 4 November - 10 November | Lecture | Biological Chemistry: Enzyme Catalysis. Photosynthesis. Bioconjugation chemistry – modifying biological activity through chemistry |
| | Tutorial | |
| | Laboratory | Enzyme catalysis / Enzyme kinetics |
| Week 10 : 11 November - 17 November | Lecture | Biological Chemistry: DNA structure, replication and protein synthesis. Recognition, sensing and transport in nature: ion channels, haemoglobin and molecular motors. |
| | Tutorial | |
| | Laboratory | Bio-conjugation chemistry |
| | Assessment | Quiz in lab class |

## Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

## General Schedule Information

[This course consists of 68 hours of class contact hours. You are expected to take an additional 68 hours of out of class contact hours to complete assessments, readings and exam preparation.]

# Course Resources

## Prescribed Resources

There is no set textbook for this course. Nevertheless, there are several texts which may support your learning. This list is intended to give you a starting point for your study.

*Catalysis:*

Inorganic Chemistry, Chapter 25. Catherine E. Housecroft and Alan G. Sharpe. 4th ed. (2012) ISBN 978-0-273-74275-3 or 5th ed (2018) ISBN-13: 978-1292134147, Pearson Education.

A good general introduction to the topic.

*Supramolecular chemistry:*

Supramolecular Chemistry, Jonathan W. Steed and Jerry L. Atwood. 3rd ed. (2021) ISBN 9781119582519

## Recommended Resources

**The notes provided by the lecturers will define the examinable material.** Resources for other topics will be given by the lecturers.

# Staff Details

| Position | Name | Email | Location | Phone | Availability | Equitable Learning Services Contact | Primary Contact |
|---|---|---|---|---|---|---|---|
| Convenor | Jon Beves | | | | Consultations can be arranged by e-mailing the lecturing staff. | Yes | Yes |
| Lecturer | Martin Peeks | | | | | No | No |
| | Leslie Field | | | | | No | No |

# Other Useful Information

### Academic Information

Upon your enrolment at UNSW, you share responsibility with us for maintaining a safe, harmonious and tolerant University environment.

You are required to:

- Comply with the University's conditions of enrolment.
- Act responsibly, ethically, safely and with integrity.
- Observe standards of equity and respect in dealing with every member of the UNSW community.
- Engage in lawful behaviour.
- Use and care for University resources in a responsible and appropriate manner.
- Maintain the University's reputation and good standing.

For more information, visit the UNSW Student Code of Conduct Website.

## Academic Honesty and Plagarism

**Referencing** is a way of acknowledging the sources of information that you use to research your assignments. You need to provide a reference whenever you draw on someone else's words, ideas or research. Not referencing other people's work can constitute plagiarism.
Further information about referencing styles can be located at https://student.unsw.edu.au/referencing

**Academic integrity** is fundamental to success at university. Academic integrity can be defined as a commitment to six fundamental values in academic pursuits: honesty, trust, fairness, respect, responsibility and courage. At UNSW, this means that your work must be your own, and others' ideas should be appropriately acknowledged. If you don't follow these rules, plagiarism may be detected in your work.
Further information about academic integrity, plagiarism and the use of AI in assessments can be located at:

- The Current Students site,
- The ELISE training site, and
- The Use of AI for assessments site.

The Student Conduct and Integrity Unit provides further resources to assist you to understand your conduct obligations as a student: https://student.unsw.edu.au/conduct

## Submission of Assessment Tasks

### Penalty for Late Submissions

UNSW has a standard late submission penalty of:

- 5% per day,
- for all assessments where a penalty applies,
- capped at five days (120 hours) from the assessment deadline, after which a student cannot

submit an assessment, and
- no permitted variation.

***Any variations to the above will be explicitly stated in the Course Outline for a given course or assessment task.***

Students are expected to manage their time to meet deadlines and to request extensions as early as possible before the deadline.

**Special Consideration**

If circumstances prevent you from attending/completing an assessment task, you must officially apply for special consideration, usually within 3 days of the sitting date/due date. You can apply by logging onto myUNSW and following the link in the My Student Profile Tab. Medical documentation or other documentation explaining your absence must be submitted with your application. Once your application has been assessed, you will be contacted via your student email address to be advised of the official outcome and any actions that need to be taken from there. For more information about special consideration, please visit: https://student.unsw.edu.au/special-consideration

**Important note**: UNSW has a "fit to sit/submit" rule, which means that if you sit an exam or submit a piece of assessment, you are declaring yourself fit to do so and cannot later apply for Special Consideration. This is to ensure that if you feel unwell or are faced with significant circumstances beyond your control that affect your ability to study, you do not sit an examination or submit an assessment that does not reflect your best performance. Instead, you should apply for Special Consideration as soon as you realise you are not well enough or are otherwise unable to sit or submit an assessment.

## Faculty-specific Information

**Additional support for students**

- The Current Students Gateway
- Student Support
- Academic Skills and Support
- Student Wellbeing, Health and Safety
- Equitable Learning Services
- UNSW IT Service Centre
- Science EDI Student Initiatives, Offerings and Guidelines

## School-specific Information

### UNSW Changes to Special Consideration: Short Extension

The School of Chemistry has carefully reviewed all of its assessments to determine whether they are suitable for automatic short extensions as set out by the UNSW Short Extension Policy. The current deadline structures for all assessment tasks in the School of Chemistry already accommodate the possibility of unexpected circumstances that may lead students to require additional time for submission. **The School of Chemistry has opted out of the UNSW Short Extension provision for all its courses,** and we have already integrated flexibility into our assessment deadlines. This decision is subject to revision in response to the introduction of new course offerings. All students may still apply for Special Consideration for any assessment via the usual procedures.

## School Contact Information

Level 1, Dalton Building (F12)

W: www.chemistry.unsw.edu.au

Also see: ***Contacts and Support*** section of the course Moodle page (where applicable)