Course Outline

CHEM3021

Organic Chemistry: Modern Synthetic Strategies

School of Chemistry

Faculty of Science

Term 1, 2021

1. **Staff**

Position	Name	Email	Consultation times and locations	Contact Details
Course Convenor	Prof Naresh Kumar	n.kumar@unsw.edu.au	*By arrangement*	**Office:** Science and Engineering Building Room 733 **Phone:** (02) 9385 4698
Lecturer	A/Prof Jason Harper	j.harper@unsw.edu.au	*By arrangement*	Office: Dalton Building Room 223 Phone: (02) 9385 4692
Lecturer	A/Prof Luke Hunter	l.hunter@unsw.edu.au	*By arrangement*	**Office:** Dalton Building Room 221 **Phone:** (02) 9385 4474
Academic Lab Demonstrators	A/Prof Jonathon Beves	j.beves@unsw.edu.au	*By arrangement*	**Office:** Dalton Building Room 222 **Phone:** (02) 9385 4673
Academic Lab Demonstrators	Dr Vinh Nguyen	t.v.nguyen@unsw.edu.au	*By arrangement*	**Office:** Dalton Building Room 225 **Phone:** (02) 9385 6167
Lab Technicians	Dr Ruth Thomas	Ruth.thomas@unsw.edu.au	*By arrangement*	Lab 262 ChemSci F10
Lab Technicians	Dr Warren Truong	Warren.truong@unsw.edu.au	*By arrangement*	Lab 262 ChemSci F10
Lab Technicians	Dr David Jacyna	d.jacyna@unsw.edu.au	*By arrangement*	Lab 262 ChemSci F10

2. Course information

Units of credit: 6

Pre-requisite(s): CHEM2021 Organic Chemistry: Mechanisms and Biomolecules.

Teaching times and locations: http://timetable.unsw.edu.au/2021/CHEM3021.html

2.1 Course summary

The need for new functional molecules is greater than ever, with ever-growing demand for new therapeutics and materials for the future. The course will focus on developing key skills in making complicated organic molecules from simple building blocks, and transforming one organic molecule to another using the synthetic toolbox. Students will be trained in modern synthetic methodologies and their application in industry to solve real world problems. The concept of retrosynthetic analysis, a logic-based tool that uses pattern recognition and mechanistic understanding for the design of synthetic pathways, will be taught and illustrated with classic case studies, including the synthesis of natural products and bioactive molecules.

2.2 Course aims

CHEM3021 expands the knowledge gained in the first two years by developing skills that are at the core of a practicing organic chemist's arsenal. The course has been designed to integrate skills developed in previous courses across three main areas:

- Synthetically useful and industrially relevant reactions;
- Reactive intermediates and their utilization in organic synthesis;
- The art of making molecules with stereogenic centres (Stereoselective/Asymmetric Synthesis); and
- Retrosynthetic analysis – how an organic chemist goes about designing a practical synthesis of complex molecules.

By the end of this course the students would have gained a sound knowledge of modern synthetic strategies that can be employed for the synthesis of complex organic molecules.

2.3 Course learning outcomes (CLO)

At the successful completion of this course you (the student) should be able to:

1. Learn synthetically useful and industrially relevant chemical reactions (transition metal-catalyzed) and use them to transform one organic molecule to another via the most efficient pathway.
2. Develop an understanding of reactive intermediates (free radicals, nitrenes, carbenes, benzynes), and their utilization in the design and synthesis of organic molecules.
3. Familiarization with the principles of retrosynthetic analysis (disconnection and synthons) and their use in the synthesis of natural products and biologically active molecules.
4. Understand issues of selectivity (chemo-, regio- and stereo-selectivity) and their applications in asymmetric synthesis.

2.4 Relationship between course and program learning outcomes and assessments

Course Learning Outcome (CLO)	LO Statement	Program Learning Outcome (PLO)	Related Tasks & Assessment
CLO 1	Learn synthetically useful and industrially relevant chemical reactions (transition metal-catalyzed) and use them to transform one organic molecule to another via the most efficient pathway.	2.1, 2.2, 3.1, 3.2, 3.3, 3.4, 4.2, 5.2, 5.3	Demonstrated deductive reasoning, Examination, Correct answers to questions.
CLO 2	Develop an understanding of reactive intermediates (free radicals, nitrenes, carbenes, benzynes), and their utilization in the design and synthesis of organic molecules.	2.1, 2.2, 3.1, 3.2, 3.3, 3.4, 4.2, 5.2, 5.3	Lab Work, Ability to use practical laboratory knowledge and skills in preparing target substances, and use chemical information retrieval to find best methods to prepare them. Written reports and assignment.
CLO 3	Familiarization with the principles of retrosynthetic analysis (disconnection and synthons) and their use in the synthesis of natural products and biologically active molecules.	2.1, 2.2, 3.1, 3.2, 3.3, 3.4, 4.2, 5.2, 5.3	Ability to predict products and reaction pathways, suggest appropriate reagents and reaction conditions, explain mechanisms learned in the course. Answer to questions given correctly. Discussi on shows knowledge and understanding of the course. Ability to use lecture concepts in each Topic in problem solving

			and analytical thinking. Marks for problem solving as presented. Marks in assignments.
CLO 4	Understand issues of selectivity (chemo-, regio- and stereoselectivity) and their application in asymmetric synthesis.	2.1, 2.2, 3.1, 3.2, 3.3, 3.4, 4.2, 5.2, 5.3	

3. Strategies and approaches to learning

3.1 Learning and teaching activities

The course will engage students in learning, at an advanced level, the language of organic chemistry in the lectures and tutorials. This will be achieved by expanding their repertoire of chemical reactions and knowledge of chemical scaffolds. Furthermore, they will be trained in modern synthetic methodologies and their application in industry from the laboratory settings. They will be introduced to the key concepts of reactive intermediates, stereoselectivity and retrosynthesis, which will allow the design and synthesize biologically active molecules and natural products. Application of these concepts will be illustrated using a series of case studies. The course will provide a range of individual practical experience in the execution of multistep synthetic sequences, while at the same time expose students to laboratory techniques, including record keeping, methods of physicochemical characterisation and spectroscopic analysis. Students in the practical classes work at their own pace but are restricted in their hours of work so that they develop skills in time management.

At this stage in their development, students have an understanding of organic chemistry as a field in which the transformations of carbon-based materials from reactant to product are achieved through reactions that are promoted by use of reagents. They have some experience in the techniques used to characterise molecules or their reactions. However, they have limited knowledge of the diverse arsenal of reactions and reagents that are available, and practical experience of these processes. The purpose of this course is to widen the knowledge and experience of the students (Engaging, Designing and Contextualising), to introduce the concepts of modern synthetic strategies, reactive intermediates and retrosynthesis, and to engage the students in learning through practical experience (Engaging and Contextualising), both on paper and in the laboratory.

Teaching Strategies
Examples from chemical practice allow "Contextualising"
Students become more engaged in the learning process if they can see the relevance of their studies to professional, disciplinary and/or personal contexts.

We also have undertaken "Designing" to
Clearly articulated expectations, goals, learning outcomes, and course requirements increase student motivation and improve learning, and

Graduate attributes - the qualities and skills the university hopes its students will develop as a result of their university studies — are most effectively acquired in a disciplinary context.

"Teaching" in the use of laboratory groups supports
Learning cooperatively with peers — rather than in an individualistic or competitive way — may help students to develop interpersonal, professional, and cognitive skills to a higher level.

3.2 Expectations of students

Attendance at Laboratory Classes is compulsory and a roll is kept. The reasons for any absences should be conveyed to the Laboratory Supervisor. If these were due to health problems they should be documented with a medical certificate. In such genuine instances no additional laboratory time will be allowed, but the laboratory marks obtained during session may be scaled accordingly so that you are not disadvantaged.

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

Participate in class discussions and activities.

Pre-laboratory work is expected to take 30-60 minutes per experiment (including safety matters) and post-laboratory write-up is expected to take 1-2 hours per experiment.

Seek assistance from demonstrators and lecturers in advance or assignment due dates.

Adhere to UNSW's Occupational Health and Safety policies.

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4. Course schedule and structure

This course consists of 36 hours of lectures/workshops (4 hours/week) and a laboratory component which is a mixture of online and face-to-face activities (see laboratory manuals, available on Moodle for details). Lectures are delivered using a combination of Powerpoint and blackboard/whiteboard presentations and they include numerous worked examples. The major out-of-class workload is associated with assignments and independent study, which is expected to take 3-4 hours per week.

Week [Date/Session]	**Topic [Module]**	**Activity [Learning opportunity]**	**Related CLO**
Week 1	Modern synthetic methods in organic chemistry	Lecture/workshop and Lab activity	1
Week 2	Modern synthetic methods in organic chemistry	Lecture/workshop and Lab activity	*1*
Week 3	Modern synthetic methods in organic chemistry	Lecture/workshop and Lab activity	1
Week 4	Reactive intermediates in organic transformations	Lecture/workshop and Lab activity	1, 2
Week 5	Reactive intermediates in organic transformations	Lecture/workshop and Lab activity	1, 2
Week 6	***Flexibility week***	***Flexibility week***	
Week 7	Reactive intermediates in organic transformations	Lecture/workshop and Lab activity	1, 2
Week 8	Target oriented synthesis	Lecture/workshop and Lab activity	1, 3, 4
Week 9	Target oriented synthesis	Lecture/workshop and Lab activity	1, 3, 4
Week 10	Target oriented synthesis	Lecture/workshop and Lab activity	1, 3, 4

5. Assessment

5.1 Assessment tasks

Assessment task	Length	Weight	Mark	Due date (normally midnight on due date)
Assessment 1: Laboratory work: lab book, individual practical reports, Literature search assignment	4 hours per week	30%	30 No marks, however a satisfactory grade is required	See Moodle for precise deadlines. Literature search assignment Week 3 – Fri 05 Mar
Assessment 2: Course Assignments: **i)** Modern synthetic methods, **ii)** Reactive intermediates, **iii)** Target oriented synthesis	3 hours	10%	10	The assignments will be given to you by your lecturer, and submitted via Moodle. **i)** Week 4 – Fri 12 Mar **ii)** Week 8 – Fri 09 Apr **iii)** Week 11 – Fri 30 April See Moodle for precise deadlines.
Assessment 3: **Mid-term examination** on Topic 1 Modern synthetic methods	1 hour	20%	20	Tentatively scheduled to take place during Week 5. Precise dates and times will be posted on Moodle closer to the test.
Assessment 4: **Final examination** on Topics 2 & 3 Reactive intermediates, and Target oriented synthesis	2 hours	40%	40	Exam period. Precise dates and times will be posted on Moodle closer to the exam.

Important note: To be awarded a pass in this subject, in addition to achieving (≥ 50%) for the weighted average of all assessment tasks, students must satisfy three conditions:

(i) An overall pass (≥ 50%) in the laboratory component, and

(ii) Satisfactory overall performance (≥ 35%) in the final and mid-term examinations (all 3 modules combined)
(iii) A minimum attendance of 4/5 laboratories is required.

Failure to satisfy both criteria could result in either a FL or UF (Unsatisfactory Fail) grade being awarded.

Further information

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

UNSW assessment policy: https://student.unsw.edu.au/assessment

5.2 Assessment criteria and standards

Task	**Assessment Criteria**	**Knowledge & abilities assessed**
Laboratory work: Individual practical reports.	Marks for quality of product and yield, lab book and experimental report, and discussion / answers to questions where required.	Ability to use practical laboratory knowledge and skills in preparing target substances
Literature assignment	Marks for problem solving as presented.	Ability to use Chemical Information training in problem solving
Modern synthetic methods assignment	Marks for problem solving as presented.	Ability to use Lecture concepts in problem solving and analytical thinking
Reactive intermediates assignment	Marks for problem solving as presented.	Ability to use Lecture concepts in problem solving and analytical thinking
Target oriented synthesis assignment	Marks for problem solving as presented.	Ability to use Lecture concepts in problem solving and analytical thinking
Mid-term examination only on Topic 1 Modern synthetic methods	Answers to questions given correctly. Discussion shows knowledge and understanding of the course.	Overall level of attainment of knowledge and problem-solving skills in the Topic
Final examination only on Topics 2 and 3 - Reactive intermediates, and Target oriented synthesis	Answers to questions given correctly. Discussion shows knowledge and understanding of the course.	Overall level of attainment of knowledge and problem-solving skills in the Course

5.3 Submission of assessment tasks

All assessments (assignments and lab reports) are required to be submitted online using the

assignment link on Moodle. This will be the only accepted method of submission. A School Assignment/Report Cover Sheet must be attached (available on the Moodle website and in the School Office).

- Reports are due at 23.55 on their due date.
- 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.
- In extenuating circumstances, special consideration provisions may be arranged. Students are encouraged to seek advice from the course conveyer before the due date if they anticipate a situation where they will be prevented from meeting the deadline. Students are also advised to visit the special consideration web page (https://student.unsw.edu.au/special-consideration) and acquaint themselves with UNSW procedures.

5.4. Feedback on assessment

Task	**WHO**	**WHEN**	**HOW**
Laboratory work: individual practical reports	Demonstrators in lab	Generally, in the same lab. period as submission of the report, or following week	Marks, written & verbal advice
Literature assignment	Prof Naresh Kumar	Within 2 weeks of the assignment due date	Written advice
Modern synthetic methods	Dr Luke Hunter	Within 2 weeks of assignment due date	Marks, & written advice
Reactive intermediates	A/Prof Jason Harper	Within 2 week of assignment due date	Marks, & written advice
Target oriented synthesis	Prof Naresh Kumar	Within 2 week of assignment due date	Marks, & written advice
Mid-term examination only on Topic 1 Modern synthetic methods	Dr Luke Hunter	Within 2 week of the examination	Marks awarded
Final examination only on Topics 2 and 3, Reactive intermediates, and Target oriented synthesis	UNSW Exams Branch		Final mark for the course is awarded

6. Academic integrity, referencing and plagiarism

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.[1] 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 and **plagiarism** can be located at:

- The *Current Students* site https://student.unsw.edu.au/plagiarism, and
- The *ELISE* training site https://subjectguides.library.unsw.edu.au/elise

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

7. Readings and resources

Text Books	Textbook: "Organic Structures from Spectra" 5th Edition, by LD Field, S Sternhell, and JR Kalman, Wiley 2013 (available from UNSW Bookshop) This text is also available as an e-book through the UNSW Library. "Organic Chemistry" by J. Clayden, N. Greeves, S. Warren and P. Wothers, Oxford University Press, (either the first or second edition would suffice)
Course Manual	CHEM3021 course manual will be available online in Moodle
Required Readings	As notified by individual lecturers
Additional Readings	As notified by individual lecturers
Recommended Internet Sites	Moodle website As notified by individual lecturers **Laboratory:** Material Safety Data Sheets (MSDSs) for risk assessment may be obtained from the following site: http://www.chemalert.unsw.edu.au/chemalert/index/index.do Additionally, the UNSW School of Chemistry website **http://www.chem.unsw.edu.au/local** contains direct links to many important chemistry-related websites and databases.
Societies	*UNSW Students of Chemistry Society (SOCS) http://www.chem.unsw.edu.au/schoolinfo/socs.html* *UNSW Chemical Society* *Royal Australian Chemical Institute http://www.raci.org.au/*
Computer Laboratories or Study Spaces	Gibson Computer laboratory – Ground floor, Dalton Building

[1] International Center for Academic Integrity, 'The Fundamental Values of Academic Integrity', T. Fishman (ed), Clemson University, 2013.

8. Administrative matters

Occupational Health and Safety[2]	Information on relevant Occupational Health and Safety policies and expectations at UNSW: https://safety.unsw.edu.au/ School of Chemistry OH&S policy and requirements see laboratory manual. To be admitted to a laboratory, you must wear safety glasses meeting the minimum size requirements as posted outside all teaching laboratories, a lab coat and covered shoes (no thongs, open sandals or clogs). You must also complete all safety pre-lab work, risk assessment or other prescribed preparation relating to carrying out safe laboratory work. Visitors are not allowed to undergraduate laboratories without the permission of the lab supervisor.		
Assessment Procedures	Exemption for practical classes can be given to repeating students providing they have completed the course to a satisfactory level within the past 3 years. Applications for exemption should be made to the Course Coordinator, Prof Naresh Kumar, Science and Engineering Building SEB 733, before the start of session. Any requests based on medical grounds should be addressed to the Course Coordinator, but permission should not be assumed.		
Equity and Diversity	Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course Convenor prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equitable Learning Services (9385 4734 or https://student.unsw.edu.au/els. Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.		
Grievance Policy[3]	**School Contact**	**Faculty Contact**	**University Contact**
	A/Prof John Stride Director of Teaching j.stride@unsw.edu.au Tel: 9385 4672	A/Prof Alison Beavis Deputy Dean (Education) sci.dde@unsw.edu.au Tel: 9385 0752	Student Conduct and Appeals Officer (SCAO) within the Office of the Pro-Vice Chancellor (Students) and Registrar. Tel: 02 9385 8515 studentcomplaints@unsw.edu.au University Counselling and Psychological Services[4] Tel: 9385 5418

[2] UNSW Occupational Health and Safety: https://safety.unsw.edu.au/
[3] UNSW Grievance Policy: http://www.policy.unsw.edu.au/policy/student_grievance_resolution.pdf
[4] University Counselling Service https://student.unsw.edu.au/counselling

9. Additional support for students

- The Current Students Gateway: https://student.unsw.edu.au/
- Academic Skills and Support: https://student.unsw.edu.au/academic-skills
- Student Wellbeing, Health and Safety: https://student.unsw.edu.au/wellbeing
- Disability Support Services: https://student.unsw.edu.au/disability-services
- UNSW IT Service Centre: https://www.myit.unsw.edu.au/