Nanyang Technological University
Division of Chemistry and Biological Chemistry

Academic Year	2022/23	**Semester**	1
Course Coordinator	Roderick Bates		
Course Code	CM2061		
Course Title	Chemistry & Biological Chemistry Laboratory 1		
Pre-requisites	(CM1021 and CM1031) or CM9001/CM5000, or CY1101 or (CM1001 and CM1002) or by permission		
No of AUs	3		
Contact Hours	online pre-lab activities 27 hours laboratory work 30 hours e-labs 30 hours post lab self study 30 hours		
Proposal Date	29 June 2022		

Course Aims

On completing this course, you will be able to carry out laboratory operations in synthetic chemistry associated with the synthesis of organic and inorganic compounds. These may include reactions requiring heating, inert atmosphere, use of bio-reagents and handling reactive intermediates. You will be able to work in a safe and responsible fashion, showing consideration for others in the laboratory. You will be able to evaluate the risks inherent in the procedures and formulate appropriate precautions. You will be able to purify the products of the reactions using techniques that may include recrystallisation, column chromatography and distillation under reduced pressure. You will be able to obtain and interpret characterisation data that may include ^{1}H NMR spectroscopy, infra-red spectroscopy, polarimetry and magnetic susceptibility measurement.

Intended Learning Outcomes (ILO)

By the end of this course, you (as a student) would be able to:

1. evaluate risks in a synthetic procedure and devise appropriate precautions
2. carry out the procedures contained in the course in order to synthesise both organic and inorganic compounds and understand the circumstances in which their use is appropriate
3. carry out the purification procedures contained in the course and understand the circumstances in which their use is appropriate
4. explain the reasons behind the use of the procedures and be able to identify circumstances when they are used improperly
5. characterise synthesised compounds by the methods contained in the course
6. suggest the appropriate technique or techniques to characterise a synthetic compound
7. interpret the data arising from the characterisation techniques contained in the course

Course Content

The synthesis, qualitative and quantitative analysis of organic and inorganic compounds. Techniques for the synthesis of both organic and inorganic compounds. Methods of purification of organic and inorganic reaction products, preparation. Systematic characterisation of synthetic compounds by spectroscopic and other methods, and interpretation of the data obtained. Evaluation of laboratory risks. The content builds upon techniques and concepts from the year 1 courses.

The course will be a combination of conventional in person laboratory experiments and e-labs. In an e-lab, students will follow a LAMS sequence showing videos of different parts of the experiment as well as downloadable data for analysis, interspersed with MCQs for formative assessment.

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team/Individual	Assessment Rubrics
Online quizzes	2, 3, 4	competence	5	individual	Point-based marking (not rubrics based)
Laboratory reports during the semester	1, 2, 3, 4, 5, 7	competence, communication, civic mindedness	30	individual	See Appendix 1
E-labs	1, 4, 6, 7	competence	15	individual	Point-based marking (not rubrics based)
Final examination	1, 2, 3, 4, 6, 7	competence, creativity	50	individual	Point-based marking (not rubrics based)
Total			100%		

Formative feedback

You will be given feedback in three ways:
1. Through marking of the lab reports.
2. By the teaching assistants and faculty members during the laboratory session.
3. In the LAMS activities as part of the e-labs

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Laboratory experience supported by online methods	This is a practical course for you to gain hands on experience. You will carry out experiments yourself to gain experience in handling equipment, chemicals and instruments in a safe, efficient and capable way. Your learning will be supported by pre-lab content, including videos, so that you will be prepared before starting practical work.

Reading and References

The lab manual is provided.

Course Policies and Student Responsibilities

(1) General

You are expected to complete all online activities in good time. You are expected to work safely and efficiently in the laboratory with consideration for other students and the various university staff

who support your laboratory work. This includes leaving a clean working space at the end of the day. You will submit well prepared work in good time. In the lab, you will plan the use of your time carefully so that you complete all laboratory operations in good time.

(2) Absenteeism
Students who miss a laboratory session with a valid reason only will be permitted to join the make up session.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email
Roderick Bates	CBC04-08	63168907	roderick@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	online pre-lab activities	1	video, reading and quizzes
2-12	laboratory (in person and e-labs)	1-7	online interactive content laboratory experiments report writing
13	make-up lab when appropriate	1-7	online interactive content laboratory experiments report writing
The above schedule is for illustrative purposes and is subject to the exigencies of the calendar			

Appendix 1: Lab reports CM2061

Risk Assessment

By their choice of risk, students are expected to show that they have selected three of the most significant risks relevant to the experiment and formulate appropriate precautions.

Pre-Lab Calculations and exercises (where relevant)

Calculations should be accurate and results reported to the appropriate number of decimal places. Other questions (if any) should be answered accurately and concisely. Any chemical structures should be drawn clearly and accurately, using appropriate software.

Results

Calculations should be accurate and results reported to the appropriate number of decimal places. Other questions (is any) should be answered accurately and concisely. Spectroscopic data reported (if any) should be chosen appropriately. In particular, "characteristic" data should be chosen so that it is genuinely characteristic of the compound. Any chemical structures should be drawn clearly and accurately, using appropriate software.

Discussion

Any questions should be answered accurately and concisely. Structures (including mechanisms) should be drawn correctly and clearly, using appropriate software.

Attached spectroscopic data

Spectra should be clear. NMR spectra should be free of signals from impurities, such as residual solvents. IR spectra should display the bands of interest and have an appropriate vertical scale.

Experimental

The experimental should be written closely following the model format provided.

section	**good**	**average**	**poor**
risk assessment	the most significant risk have been selected and appropriate precautions have been suggested	the suggested risks are not the most significant or the precautions are poorly thought out	the suggested risks are not the most significant and the precautions are poorly thought out
pre-lab	structures are correctly drawn, calculations are accurate and results are given to the correct number of decimal places	structures contain errors, calculations are inaccurate and/or results are not given to the correct number of decimal places	structures contain serious errors or are illegible, calculations contain serious errors and/or the number of decimal places is excessive
results	numerical results are within expected values;	numerical results are out of line;	numerical results are far out of line;

	descriptive results are as expected; calculations are accurate; data is given correctly	descriptive results are not as expected; calculations are inaccurate and/or data is incorrectly stated	descriptive results indicate serious experimental issues; calculations are highly inaccurate and/or data is incorrectly stated
discussion	comments are pertinent; mechanisms are drawn correctly and clearly; answers to questions are accurate and concise; other data presented is clearly given and interpreted	comments are not to the point; mechanisms contain errors and/or care unclear; answers to questions are inaccurate and/or verbose; other data presented is unclear and may have errors in interpretation	comments have low relevance; mechanisms are unreasonable and/or poorly drawn; answers are incorrect or illogical; other data presented is highly unclear with serious errors in interpretation
data	the data clearly shows that the desired compound has been prepared and is largely free from impurities	the data clearly shows that the desired compound has been prepared but it is contaminated	it is unclear from the data that the desired compound has been prepared or it shows that it is present in only small amounts
experimental	the experimental section is clearly and concisely written in accordance with the model provided	the experimental section is complete but deviates from the model in a number of ways	the experimental section is incomplete and deviates from the model in a large number of ways

CBC Programme Learning Outcome

The Division of Chemistry and Biological Chemistry (CBC) offers an undergraduate degree major in Chemistry that satisfies the American Chemical Society (ACS) curricular guidelines and equips students with knowledge relevant to the industry. Graduates of the Division of Chemistry and Biological Chemistry should have the following key attributes:

1. Competence

Graduates should be well-versed in the foundational and advanced concepts of chemical science, be able to evaluate chemistry-related information critically and independently, and be able to use complex reasoning to solve emergent chemical problems.

2. Creativity

Graduates should be able to synthesize and integrate multiple ideas across the curriculum, and propose innovative solutions to emergent chemistry-related problems based on their training in chemistry.

3. Communication

Graduates should be able to demonstrate clarity of thought, independent thinking, and sound scientific analysis and reasoning through written and oral reports to audiences with varying technical backgrounds. They should also be able to effectively engage other professional chemists in collaborative endeavours.

4. Character

Graduates should be able to act in responsible ways and uphold the high ethical standards that the society expects of professional chemists.

5. Civic-mindedness

Graduates should be aware of the impact of chemistry on society, and how chemistry can be applied to benefit mankind. They should also be aware of and uphold the best chemical safety practices.