Nanyang Technological University
Division of Chemistry and Biological Chemistry

Academic Year	2020/2021	**Semester**	2
Course Coordinator	Mihaiela Corina Stuparu		
Course Code	CM3061		
Course Title	CHEMISTRY & BIOLOGICAL CHEMISTRY LABORATORY 3		
Pre-requisites	CM2061 or by permission		
No of AUs	3		
Contact Hours	online pre-lab activities laboratory work post lab self-study	15 hours 60 hours 15 hours	
Proposal Date	10 March 2020		

Course Aims

This core Chemistry course aims to develop your skills and understanding of fundamentals of synthetic chemistry concepts that are essential for future career chemical industries. This course is also great preparation for a PhD and a career in chemistry research.

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
8. keep an appropriate lab notebook reporting and tracking all the experimental steps
9. communicate the results of scientific work in written and electronic formats to both scientists and the public at large.

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 1-3 courses.

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team/Individual	Assessment Rubrics
Online quizzes	1, 4, 5	competence	20	individual	NA
Proformas and Lab Notebook	1- 9	competence, communication, civic mindedness	20	individual	See Appendix 1
Paper Stile Report	1- 9	competence, communication, civic mindedness	10	individual and team	See Appendix 1
Final exam	1-7, 9	competence, creativity, communication	50	individual	See Appendix 1
Total			100%		

Formative feedback

You will be given feedback in two ways:
1. Through marking of the proformas, lab notebooks, and paper reports.
2. By the teaching assistants and faculty members during the laboratory session.

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, 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
Mihaiela C. Stuparu	CBC04-08	65927765	mstuparu@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	online pre-lab activities	1	reading and quizzes
2-12	laboratory	1-8	reading, online interactive content laboratory experiments, lab notebook recoding, report writing
13	make-up lab when appropriate	1-8	reading, online interactive content laboratory experiments, lab notebook recoding, report writing
The above schedule is for illustrative purposes and is subject to the exigencies of the calendar			

Rubric for the Proforma and Lab Notebook (20%)

For the proforma and lab notebook reports you will be working individually to critically review and communicate experimental data accumulated during the session. It is designed as an opportunity for you to develop your written communication skills and your correct laboratory practice.

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 has 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; descriptive results are as expected; calculations are accurate; data is given correctly	numerical results are out of line; descriptive results are not as expected; calculations are inaccurate and/or data is incorrectly stated	numerical results are far out of line; 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;	comments are not to the point; mechanisms contain errors and/or care unclear; answers to questions are inaccurate and/or verbose;	comments have low relevance; mechanisms are unreasonable and/or poorly drawn; answers are incorrect or illogical; other

	other data presented is clearly given and interpreted	other data presented is unclear and may have errors in interpretation	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

Rubric for paper stile reports (10%)

For the paper stile reports you will be working individual (one report) and in a team (one report), to critically review and communicate experimental data in a paper stile using the appropriate journal formatting and stile. It is designed as an opportunity for you to develop your written communication skills and your team-work spirit, as you can discuss and debate ideas together with your team-mates.

In practice, for the team paper report, everyone in your team will be getting the same score. Your score may vary if there are evidence that you had not contributed to your team.

section	**good**	**average**	**poor**
Abstract and Introduction	• proficient introduction that is interesting and states topic • clearly and accurately provides background information relative to the research question	• basic introduction that states topic but lacks interest • provides reasonable background information	• weak or no introduction of topic • purpose is unclear or missing • Background information is not provided, is irrelevant, or is insufficient
Results and Discussions	• clear and logical order that supports the experimental data • good transitions between and within paragraphs • good summary of topic with clear concluding ideas for future research	• somewhat clear and logical order supports the experimental data • basic transitions between and within paragraphs • basic summary of topic with some final concluding ideas	• lacks development of ideas with weak or no support of the experimental data • no transitions between and within paragraphs. • lack of summary of topic
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
References	• all entries entirely correct and in the correct format	• all entries mostly correct and in minor format errors	• frequent errors and not properly formatted
Style Grammar Text/Paper Format	• style and voice appropriate to the given audience and purpose • uses proper language	• style and voice somewhat appropriate to given audience and purpose	• style and voice inappropriate or do not address given audience, purpose

	• may contain few spelling, punctuation, and grammar errors • follows directions given	• uses proper language • contains several spelling, punctuation, and grammar errors which detract from the paper's readability • frequent errors with	• unclear language • many spelling, punctuation, and grammar errors that the paper cannot be understood • not properly formatted
Supporting Information	• 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

Grading criteria for the Course

The following guideline describes the criteria expected of the different levels of performance in this course.

Standards	**Criteria**
A+ (Exceptional) A (Excellent)	Complete assignment punctually and correctly. Able to apply the knowledge learned very well with referenced to the learning outcomes (LO) 1 to 9 in order to answer the questions in written exams.
A- (Very good) B+ (Good)	Complete assignment punctually and be correct on majority of the questions. Able to apply the knowledge learned with referenced to the LO 1 to 9 to answer most of the questions in written exams.
B (Average) B- (Satisfactory) C+ (Marginally satisfactory)	Complete assignments with average marks. Partially able to apply the knowledge learned with referenced to the LO 1 to 9 to answer some of the questions in written exams.
C (Bordering unsatisfactory) C- (Unsatisfactory)	Not able to complete the assignments on time or achieve average marks. Not able to apply the knowledge learned with referenced to the LO 1 to 9 to answer some of the questions in written exams.
D, F (Deeply unsatisfactory)	Not able to complete assignments. Not able to apply the knowledge learned with referenced to the LO 1 to 9 to answer most of the questions in written exams.

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.