Academic Year	AY22/23	**Semester**	2
Course Coordinator	Zhao Yanli		
Course Code	CM1002		
Course Title	Foundations of Chemistry II		
Pre-requisites	None		
Mutually Exclusive	CY1101 Molecule, BS1013 Foundations of Chemistry II, BS1033 Laboratory for Foundations of Chemistry II		
No of AUs	4		
Contact Hours	Lectures: 39, Tutorials: 5, Laboratory: 18		

Course Aims

The course covers fundamental concepts and organizing principles of chemistry that provide the foundation for many aspects of chemical science and related fields. It aims to bring Freshmen students in science and engineering to the same level of command of basic chemistry that is essential to progress to advanced courses. The concepts espoused in the course will be illustrated and connected with real world applications whenever relevant. Practical work is at the heart of chemistry. The laboratory component of this course aims to expose you to chosen experiments which will help you gain familiarity with a variety of skills, laboratory techniques and equipment and instill in you the ability to work independently as well as part of a team.

Intended Learning Outcomes (ILO)

Upon successfully completing this course, you should be able to:

1.<u>Organic chemistry</u>

(a) Draw correct molecular structures with stereochemistry and assign stereochemical descriptors to organic molecules.

(b) Explain synthesis, properties of organic compounds, such as alkanes, alkenes, benzene and other related aromatic compounds, halides, aldehydes, ketones, as well as carboxylic acids and their derivatives.

(c) Identify representative organic reactions of the aforementioned class of compounds, predict, and design some simple molecular transformations involving these compounds.

2. <u>Carbohydrates</u>

(a) Determine the types and numbers of stereoisomers in carbohydrates.
(b) Recognize the nucleophilic addition to carbonyl compounds to obtain hemiacetal or hemiketal.
(c) Explain the interconversion between cyclic alpha and beta-anomers and open-chain carbonyl.
(d) Recognize the difference in retaining glycosidase and inverting glycosidases.

<u>3.Proteins</u>

(a) Interpret and apply the amino acid properties as building blocks for proteins.
(b) Design new macromolecules (e.g. peptides/proteins) via structural biology approaches
(c) Translate three-dimensional structures of proteins to aid in designing novel drug molecules
(d) Calculate torsion angles for macromolecules

4.Enzyme kinetics

(a) Explain the terms Vmax, Kcat and Ki in Michaelis-Menten Kinetics

(b) Explain the difference between competitive inhibitor and non-competitive inhibitor

(c) Perform Lineweaver-Burk Plot.

5. Lipids

(a) Translate the molecular bases of major lipid molecules to the development of diseases based on dysregulated lipid metabolism

(b) Recognize and explain the lipid molecule compositions of lipid bilayer membrane in cells.

6.Laboratory

(i) Employ in an actual laboratory setting the various analytical and experimental techniques, methods and equipment commonly used in chemical science. Perform basic chemistry lab experiments, analyze, interpret, and present experimental data.

Course Content

1. Stereochemistry of sp3 hybridized carbons.
2. Structure, Synthesis and reactivity of Alkenes, Alkyl halides, Benzene (and related aromatic compounds), Carbonyl compounds and their respective derivatives.
3. Carbohydrates
4. Proteins
5. Enzyme Kinetics
6. Lipids
7. Basic Laboratory Techniques for the Chemistry Laboratory

Assessment (includes both continuous and summative assessment)

Component	Course ILO Tested	Related Programme LO or Graduate Attributes	Weighting	Team/Individual	Assessment rubrics
Midterm Test 1	1,2	Competence, Creativity	10%	Individual	Appendix 1
Midterm Test 2	3,4,5	Competence, Creativity	10%	Individual	Appendix 1
Laboratory	7	Competence, Creativity, Communicati	30%	Individual	Appendix 2

		on and Character			
Final Examination	1, 2, 3, 4,5,6	Competence, Creativity	50%	Individual	Appendix 1
Total			*100%*		

Formative feedback

Formative feedback: Lecturers and TAs will be closely working with you to monitor your learning progress. They will provide you with timely feedback to improve your understanding of concepts. Furthermore, you will be given opportunities to express your ideas and discuss them with lecturers and TAs.

Summative Feedback: Summative feedback on laboratory reports and mid-term tests will be given. For laboratory reports, you will be provided with comments on mistakes, areas of improvement and examples of good practice in scientific writing etc.
This will help you to achieve the intended learning outcomes above.

Learning and Teaching approach

Lectures (39 hours)	The lectures will convey key concepts in organic chemistry and biochemistry/chemical biology thus providing critical information and background on how the concepts come about, with relevant theories and illustrative examples. The concepts will also be further illustrated with worked examples and with real world applications to show the relevance and importance of learning chemistry and its links to other disciplines.
Tutorials (5 hours)	TAs will provide materials containing concepts taught in classes and cover related applications derived from corresponding lectures. You will be assigned to a small group for interactive discussions, which will help you to develop your own critical thinking capability and problem solving skills in a team-based learning environment.
Laboratory (18 hours)	Laboratory session will consist of three main parts. Pre-laboratory exercises will involve online pre-lab quiz to be attempted prior to a lab session and consists of risk assessment and questions based on the lab manual to ensure that students have read and understood the respective experimental description before starting the actual lab session. During the actual lab session students will typically work in pairs and conduct the assigned experiment under the supervision of laboratory TAs following the instructions provided in the lab manual. This will train students in applying concepts learned to real life situations. Subsequent to the lab session you are to submit a individual post-lab report in the prescribed format which will help to develop your critical thinking ability, ability to assimilate, evaluate and present the data gathered during a lab experiment.

Reading and References

Recommended textbooks:

Recommended textbook: Organic Chemistry: 9th Ed, John McMurry; ISBN-13: 978-1305080485, ISBN-10: 1305080483

Recommended textbook: Biochemistry, 4th Ed (2013), Mathews / Van Holde / Appling /Anthony-Cahill; ISBN-13: 978-0138004644

Recommended reference textbook: Lehninger Principles of Biochemistry, 5th Ed (2008), Nelson / Cox; ISBN: 9780716771081, W. H. Freeman, 2008

Course Policies and Student Responsibilities

You are expected to read the lecture/tutorial/laboratory materials prior to the respective lecture/tutorial/laboratory session. This will help you to learn much more efficiently as you will already have an impression on the topics to be covered. For laboratory sessions, besides reading the laboratory manual and understanding the experimental procedure, you should also complete the risk assessment component of the lab report in which you should list possible hazards and their prevention steps. You should also read through the recommended textbooks as outlined in the Weekly Schedule.

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
Zhao Yanli	SPMS CBC 06-18	6316 8792	zhaoyanli@ntu.edu.sg
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Planned Weekly Schedule

Week	Topic	Course ILO	Readings/Activities
1,2,3	Stereochemistry of sp3 hybridized carbons	1	Lecture, pre-recorde lectures, recommended text

4,5,6,7	Structure, Synthesis and reactivity of Alkenes, Alkyl halides, Benzene (and related aromatic compounds), Carbonyl compounds and their respective derivatives.	1	Lecture, pre-recorded lectures, recommended text (see readings and references), other relevant materials and exercises posted on NTULearn
8	Carbohydrate	2	MVAA Ch 9 Lehninger Ch 7
9,10	Proteins	3	MVAA Ch 5, 6 Lehninger Ch 3, 4, 5
11,12	Enzyme Kinetics	4	MVAA Ch 5, 6 Lehninger Ch 3, 4, 5
13	Lipids	5	MVAA Ch 10 Lehninger Ch 11

Note: Lecture schedule,Midterm test dates and topics tested may vary based on course progress. Please always refer to announcements made via NTULearn which will supersede the above information.

Appendix 1: Assessment Criteria for mid-term test and final exam

Rubric for Midterm and Final Examination

For the questions in the midterm and final exam, you will be expected to show your competency to understand basic general chemistry principles and having critical thinking and practical skills to solve scientific problems. Questions posed will be mix of short answer, calculation based and Multi-choice questions.

0-3 marks	4-7 marks	8-10 marks
Shows little to no understanding of the theoretical and practical principles covered in the lectures	Shows moderate to good understanding of the theoretical and practical principles covered in the lectures	Shows a comprehensive or near comprehensive understanding of the theoretical and practical principles covered in the lectures

Appendix 2: Assessment Rubric for Laboratory

	Exceptional (10-8)	Admirable (6-7)	Acceptable (4-5)	Poor (1-3)
Overall presentation	Appropriate as a piece of scientific writing. Words were chosen carefully and appropriately. Sentence structure was clear and easy to follow. The report is free of spelling, punctuation, calculation and grammatical errors.	Minimal awkward phrasing or word choices. Minimal mistakes in calculations and explanations	Many passages are phrased poorly, contained awkward word choices, or many long sentences. Narrative is disorganized in many places. Multiple grammatical and/or spelling errors.	Poorly organized report with frequent awkward phrases, poor word choices and wrong inferences/calculations. Lacks cohesion, style and fluidity.
Answers to Proforma questions	Relevant experimental data/calculation steps are presented which are used for answering proforma questions. Demonstrates a logical, coherent working knowledge and understanding of important experimental concepts, forms appropriate conclusions based on interpretations of results, includes applications of and improvements in the experiment, collected data and analysis and demonstrates accountability by providing justification for any errors. Address all specific questions posed in the proforma.	All data and associated figures, calculations etc. are presented. Demonstrates an understanding of most important experimental concepts, forms conclusions based on results and/or analysis but either lacks proper interpretation, suggests inappropriate improvements in the experiment or lacks overall justification of error. Address most of the specific points for questions posed in the proforma.	Most figures, graphs, and tables are included, but some important or required features are missing. Certain data reported are not mentioned in the text or are missing. Captions are not descriptive or incomplete. While some of the results have been correctly interpreted and discussed, partial but incomplete understanding of results is still evident. Student fails to make one or two connections to underlying theory. Address some of the specific points or questions posed in the proforma.	Figures, graphs, and tables are poorly constructed; have missing titles, captions or numbers. Certain data reported are not mentioned in the text. Important data missing. Does not demonstrate an understanding of the important experimental concepts, forms inaccurate conclusions, suggests inappropriate improvements in the experiment and lacks overall justification of error. Address none of the specific points or questions posed in the proforma.

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.