Academic Year	AY19/20	**Semester**	2
Course Coordinator	Curtis Alexander Davey (Assoc Prof)		
Course Code	CM1051		
Course Title	Basic Biology and Biochemistry		
Pre-requisites	None		
Mutually Exclusive	**BS1005 Biochemistry I**		
No of AUs	3		
Contact Hours	Lectures: 26, Tutorials: 13		

Course Aims

This course aims to introduce the structural, biophysical and chemical principles of key biological macromolecules found in living organisms. You will use your understanding of the underlying molecular bases and functions of the macromolecules involved in various biochemical reactions to solve problems related to nucleic acids, proteins, carbohydrates, lipids and vitamins.

Intended Learning Outcomes (ILO)

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

1. Calculate dissociation constant (e.g. pKA and pH) and isoelectric point (pI)
2. Determine the types and numbers of stereoisomers in nuclecic acids, proteins and carbhydrates
3. Calculate torsion angles for macromolecules
4. Design new primers for DNA sequencing and gene amplification
5. Interpret the functional bases of major macromolecules towards the evolution of new activities
6. Design experiments to purify nucleic acids and proteins
7. Design new macromolecules (e.g. peptides/proteins) via structural biology approaches
8. Translate three-dimensional structures of proteins to aid in designing novel drug molecules
9. Translate molecular bases of major lipid molecules to the development of diseases based on disregulated lipid metabolism
10. Translate molecular bases of vitamin structure to diseases caused by vitamin deficiency

Course Content

Building blocks of macromolecules (covalent and non-covalent bonding, free energy, acids, bases, buffers)

Primary, secondary and tertiary structures of nucleic acids (DNA, RNA), proteins, polymers (carbohydrates, lipids)

Modifications of nucleic acid and proteins (e.g. spontaneous, chemical, genetic, post-translational)

Folding of proteins, quaternary structure of proteins (myoglobin, hemoglobin)

Carbohydrates (tautomers, stereochemistry, ring structures, saccharides)

Lipids (triglycerides, phospholipids, membrane transfer) Vitamins (solubility, deficiency and disease, dietary issues) How to use Pymol molecular visualization software

Accessing biological databases such as Protein Data Bank (PDB)

Assessment (includes both continuous and summative assessment)

Component	Course ILO Tested	Related Programme LO or Graduate Attributes	Weighting	Team/Individual	Assessment rubrics
1. Midterm Test 1	1, 2, 3, 4, 5, 6, 7	Competence, Creativity	25%	Individual	Point-based marking (not rubrics based)
2. Midterm Test 2	1, 2, 3, 4, 5, 6, 7, 8, 9	Competence, Creativity	25%	Individual	Point-based marking (not rubrics based)
3. Examination (Multiple Choice Questions)	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	Competence, Creativity	50%	Individual	
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 and design. Furthermore, you will be given opportunities to express your ideas and discuss them with lecturers and TAs as course progresses. This will help you to achieve intended learning outcomes 1, 2, 3, 4, 5, 6, 7, 8 and 9.

Summative Feedback: Summative feedback on reports will be given. For written reports, an examiner report will be provided with comments on mistakes, areas of improvement and examples of good practice in scientific writing etc. at the end of semester. This will help you to achieve intended learning outcomes 2, 3, 7, 8 and 9.

Learning and Teaching approach

Lectures (26 hours)	You will be spending time to learn detailed biochemical principles of biological small molecules and macromolecules (water molecules, DNA/RNA, proteins, carbohydrates, lipids, vitamins) and related research skills and technological advances, which will help you to engage in molecular design initiatives (such as for biotechnology or drug development) and to conceive of ideas for designing new experiments and contemplating modern problems in biochemistry. To better engage you in class, we will make use of macromolecular graphics display and a mixture of modern and old school humour. In addition, you will be encouraged to ask questions or have discussions after the lecture.
Tutorials (13 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.

Reading and References

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

1. You are expected to read the lecture/tutorial materials prior to the lecture/tutorial session in question. This will help you to learn much more efficiently as you will already have an impression on the topics to be covered. You should also read through both two 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
Curtis Alexander Davey (Assoc Prof)	04s-44	6592 1549	Davey@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course ILO	Readings/Activities
1	Chemical Principles of Biochemistry	1, 2	MVAA Ch 1, 2, 3 Lehninger Ch 1, 2
2	DNA-1 •Structures and properties of nucleotides •Nucleic acid chemistry •Primary structures of nucleic acids •DNA as genetic substance •Secondary and tertiary structures of nucleic acids •Watson-Crick DNA model •Modifications of the double-stranded DNA model	2, 3, 4, 6	MVAA Ch 4 Lehninger Ch 8
3	DNA-2 •Unusual secondary structures of DNA •Circular DNA and Supercoiling •Stability of secondary and tertiary structure of DNA	2, 3, 4, 5, 6	MVAA Ch 4 Lehninger Ch 8, 9
4	RNA •Primary structure of RNA •Secondary structure of RNA •Tertiary structure of RNA •Prediction and determination of RNA structure •RNA as self-catalytic enzyme	2, 5, 6, 8	MVAA Ch 4 Lehninger Ch 8, 26
5	Protein-I •Amino acids as building blocks of polypeptides •Chemistry and properties of amino acids	1, 2, 3, 5, 6	MVAA Ch 5 Lehninger Ch 3
6	Protein-II •Primary structure of proteins •Peptide backbone torsion angles •Cleavage of peptides	1, 2, 3, 5	MVAA Ch 5 Lehninger Ch 3
7	Protein-III •Folding of proteins •Secondary structures of proteins •Tertiary structures of proteins	5, 8, 9	MVAA Ch 6 Lehninger Ch 4
8	Protein-IV •Quaternary structure of proteins •Proteins in motions •Structure and functional relationship: hemoglobin and myoglobin	5, 8, 9	MVAA Ch 7, 8 Lehninger Ch 5

9	Carbohydrates •Tautomers •Stereoisomers •Ring structures •Monosaccharides and their derivatives •Oligosaccharides •Polysaccharides	5, 7	MVAA Ch 9 Lehninger Ch 7
10	Lipids I •Chemical properties of lipids •Fatty acids •Triglycerols •phospholipids •sterols •other lipids	5, 10	MVAA Ch 10 Lehninger Ch 11
11	Lipids-II •Lipid constituent of biological membranes •Structure of membrane-bilayer •Membrane transport	5, 10	MVAA Ch 10 Lehninger Ch 11
12	Vitamins •Vitamins: a special class of biomolecules •Fat-soluble and water-soluble vitamins •Structure and chemical properties •Vitamin deficiency and disease •Dietary and other sources; unanswered questions.	5, 11	MVAA Ch 19 Lehninger Ch 11

Appendix 1: Intended Affective Outcomes

As a result of this course, it is expected you will develop the following "big picture" attributes:

Appreciate the roles of biological macromolecules (DNA, RNA, proteins, vitamins) in the life sciences

Appreciate the role of scientific discovery in transforming people's lives

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.