

#### **COURSE CONTENT**

| Academic Year      | 2021/2022          | Semester            | 1   |
|--------------------|--------------------|---------------------|-----|
| Course Coordinator | Prof. Chen Wei N   | ling, William       |     |
| Course Code        | CB1131             |                     |     |
| Course Title       | Introduction to Bi | omolecular Engineer | ing |
| Pre-requisites     | Nil                |                     |     |
| No of AUs          | 3                  |                     |     |
| Contact Hours      | 39 hours lecture,  | 6 hours tutorial    |     |
| Proposal Date      | 18 Mar 2020        |                     |     |

#### **Course Aims**

This course is designed for students with an engineering background to learn the fundamentals of molecular and cell biology, biochemistry and biotechnology. The objective of the course is to provide you with a comprehensive and concise overview of biological science with emphases on its relationship with biomedical engineering. Topics to be covered include the relationship between molecular structure & function, dynamic character of cellular organelles, cellular interactions with microenvironment, mechanisms that regulate cellular activities, practical applications of cell & molecular biology.

#### **Intended Learning Outcomes (ILO)**

At the end of the course, you should be able to:

- 1. Explain most of the fundamental concepts of cell & molecular biology, and biochemistry.
- 2. Describe some existing practical techniques & approaches adopted in the field of cell & molecular biology, and biochemistry.
- 3. Suggest how knowledge of cellular & molecular biology, and biochemistry may be applicable to biomedical engineering & medical science.
- 4. Demonstrate analytical skills, resourcefulness and team work in addressing questions relating to cell & molecular biology, and biochemistry in biomedical engineering & medical science.

#### **Course Content**

Biological molecules; Membrane structure, cellular organelles, cytoskeleton, cell-cell & cell-extracellular matrix interactions; Cell division and cell cycle; cell death; DNA replication, transcription and translation; DNA repair and recombination; Control of gene expression; Enzyme properties and kinetics; Metabolism: glycolysis, pentose phosphate pathway, citric acid cycle, oxidative phosophorylation and ATP synthesis; Fatty acid metabolism; Recombinant DNA technology, protein production, and purification.

## Assessment (includes both continuous and summative assessment)

| Component                                      | Course<br>LO<br>Tested | Related<br>Programme<br>LO or<br>Graduate<br>Attributes | Weighting | Team<br>/Individual | Assessment rubrics |
|--|------------------------|---|-----------|---------------------|--------------------|
| 1.Continuous<br>Assessment<br>(40%)            | 1, 2, 3, 4             | b, c, d, e  | 40%       | Individual          | Appendix 1         |
| 2.Final Examination (60%) [2.5hr; Closed Book] | 1, 2, 3, 4             | b, c, d, e  | 60%       | Individual          | Appendix 1         |
| Total  |                        |   | 100%      |                     |                    |

## **Mapping of Course ILOs to EAB Graduate Attributes**

| Course Intended   | Cat    | EAB <sup>3</sup> | EAB's 12 Graduate Attributes* |        |        |        |        |      |     |     |         |        |     |
|---|--------|------------------|-------------------------------|--------|--------|--------|--------|------|-----|-----|---------|--------|-----|
| Learning Outcomes   | Cat    | (a)              | (b)                           | (c)    | (d)    | (e)    | (f)    | (g)  | (h) | (i) | (j)     | (k)    | (I) |
|   | Core   | 0                | •                             | •      | 0      | •      | 0      | 0    | 0   | š   | š       |        | š   |
| Explain most of the ful<br>biology, and biochemi  |        | ntal c           | once                          | ots of | cell 8 | mole   | ecula  | r    |     |     | a, b,   | c, i   |     |
| Describe some existing practical techniques & approaches adopted in the field of cell & molecular biology, and biochemistry  a, b, i  |        |                  |                               |        |        |        |        |      |     |     |         |        |     |
| Suggest how knowledge of cellular & molecular biology, and biochemistry may be applicable to biomedical engineering & medical science |        |                  |                               |        |        |        | a, b,  | d, i |     |     |         |        |     |
| Demonstrate analytic addressing questions biochemistry in biome   | relati | ng to            | cell                          | & m    | nolecu | ılar b | oiolog |      |     |     | a, b, d | , e, i |     |

Legend:

- Fully consistent (contributes to more than 75% of Intended Learning Outcomes)
- Partially consistent (contributes to about 50% of Intended Learning Outcomes)
- Weakly consistent (contributes to about 25% of Intended Learning Outcomes)
  Not related to Student Learning Outcomes š

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#### Formative feedback

Examination results;

Quiz answers will be discussed in class

### Learning and Teaching approach

| Approach | How does this approach support students in achieving the learning outcomes?   |
|----------|---|
| Lecture  | Demonstrate how to carry out a procedure such as working through a problem by using incomplete handouts which enable students in-class participation. Use of TurningPoint which enables students to answer questions and participate in class |
| Tutorial | TBL classroom discussion sessions on tutorial questions and related topics  |

## Reading and References

- 1) H. Lodish, A. Berk, etc al., Molecular Cell Biology, 5th Ed. W. H. Freeman & Co., 2003.
- 2) Essential Cell Biology: *An introduction to the molecular biology of the cell* by Bruce Alberts et al. (2004, Second Edition and 2009 Third Edition, Garland Publishing Co.).
- 3) Cell and Molecular Biology/ Cell Biology, 6th Edition, Gerald Karp, John Wiley & Sons, Inc.
- 4) Voet, D.J., J.G. Voet, and C.W. Pratt, *Principles of Biochemistry*. 4<sup>th</sup> ed. International Student Version, 2012: Wiley.
- 5) Glick, B.R. and C.L. Patten, *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. 5<sup>th</sup> ed. 2017: ASM Press/Wiley.

#### **Course Policies and Student Responsibilities**

General: You are expected to complete all online activities and take all scheduled assignments and tests by due dates. You are expected to take responsibility to follow up with course notes, assignments and course related announcements. You are expected to participate in all tutorial discussions and activities.

Continuous assessments: You are required to attend all continuous assessments. Absenteeism: Continuous assessments make up a significant portion of your course grade. Absence from continuous assessments without officially approved leave will result in no marks and affect your overall course grade.

Attendance of the mid-term exam by all students is expected. Only students proven medically unfit may be excused from the mid-term exam. In this case, there will be <u>no</u> make-up exam. Mark weighting will be transferred to the final exam.

## **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 <u>academic integrity website</u> 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             |
|----------------|-----------------|----------|-------------------|
| Chen Wei Ning, | N1.2-B1-07      | 63162870 | wnchen@ntu.edu.sg |
| William        |                 |          |                   |

# Planned Weekly Schedule

| Week | Topic  | Course LO | Readings/ Activities  |
|------|--|-----------|---|
| 1 1  | Biological Molecules   | 1-4       |   |
| I    | Biological Molecules   | 1-4       | Lecture notes, tutorial notes,<br>Relevant Chapters in<br>Reference text (Gerald Karp;<br>Essential Cell Biology by<br>Alberts) |
| 2    | Membrane Structure/ Organelles   | 1-4       | Lecture notes, tutorial notes,<br>Relevant Chapters in<br>Reference text (Gerald Karp;<br>Essential Cell Biology by<br>Alberts) |
| 3    | Organelles/ Cytoskeleton   | 1-4       | Lecture notes, tutorial notes,<br>Relevant Chapters in<br>Reference text (Gerald Karp;<br>Essential Cell Biology by<br>Alberts) |
| 4    | Cell-Cell; Cell-extracellular matrix interactions                            | 1-4       | Lecture notes, tutorial notes,<br>Relevant Chapters in<br>Reference text (Gerald Karp;<br>Essential Cell Biology by<br>Alberts) |
| 5    | Cell Division and Cell Cycle; Cell Death                                     | 1-4       | Lecture notes, tutorial notes,<br>Relevant Chapters in<br>Reference text (Gerald Karp;<br>Essential Cell Biology by<br>Alberts) |
| 6    | DNA Replication, transcription and translation; DNA repair and recombination | 1-4       | Lecture notes, tutorial notes,<br>Relevant Chapters in<br>Reference text (Gerald Karp;<br>Essential Cell Biology by<br>Alberts) |
| 7    | Mid-term Quiz; Control of Gene expression                                    |           | Lecture notes, tutorial notes,<br>Relevant Chapters in<br>Reference text (Gerald Karp;<br>Essential Cell Biology by<br>Alberts) |
| 8    | Introduction to Chemical Energy,<br>and Enzyme properties and<br>kinetics    | 1-4       | Lecture notes, tutorial notes,<br>Relevant Chapters in<br>Reference text (Voet & Voet)  |
| 9    | Regulation of Glucose Metabolism   | 1-4       | Lecture notes, tutorial notes,<br>Relevant Chapters in<br>Reference text (Voet & Voet)  |
| 10   | Pentose Phosphate Pathway & Gluconeogenesis                                  | 1-4       | Lecture notes, tutorial notes,<br>Relevant Chapters in<br>Reference text (Voet & Voet)  |

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|---|----|-----------------------------------|-----|--------------------------------|
|   | 11 | Citric Acid Cycle, Oxidative      | 1-4 | Lecture notes, tutorial notes, |
|   |    | Phosphorylation and ATP           |     | Relevant Chapters in           |
|   |    | Synthesis                         |     | Reference text (Voet & Voet)   |
|   | 12 | Fatty Acid Metabolism             | 1-4 | Lecture notes, tutorial notes, |
|   |    |                                   |     | Relevant Chapters in           |
|   |    |                                   |     | Reference text (Voet & Voet)   |
|   | 13 | Biological Engineering;           | 1-4 | Lecture notes, tutorial notes, |
|   |    | Recombinant DNA Technology,       |     | Relevant Chapters in           |
|   |    | Protein Production & Purification |     | Reference text (Voet & Voet;   |
|   |    |                                   |     | Glick & Patten)                |

# Appendix 1: Assessment Criteria

| Explain most of the fundamental concepts of cell & molecular biology, and biochemistry (CMB&B)  Describe some existing practical techniques & approaches in adopted in the field of cell & molecular biochemistry  Suggest how knowledge of cellular & concepts of collular & concepts of collular & concepts of comolecular biology, and biochemistry  Suggest how be concepts of collular & concepts of concepts | Explain most of<br>the fundamental<br>concepts of cell<br>& molecular<br>biology, and<br>biochemistry<br>(CMB&B) | Shows limited<br>or no<br>understandings<br>on fundamental<br>concepts of | Shows some understandings on fundamental concepts of CMB&B answers to questions are verbatim from | Shows good<br>understandings<br>on fundamental<br>concepts of<br>CMB&B with<br>limited | Shows good<br>understandings<br>on fundamental<br>concepts of<br>CMB&B with<br>good synthesis | Shows<br>excellent<br>understandings<br>on fundamental<br>concepts of |
|--|--|---|---|--|---|---|
| the fundamental concepts of cell & molecular biology, and biochemistry (CMB&B)  Describe some existing practical techniques & approaches in adopted in the field of cell & molecular biolochemistry  Suggest how knowledge of cellular & molecular biology, and biochemistry  The basic knowledge of cellular & molecular biology, and biochemistry  Demonstrate analytical skills, resourcefulness and teamwork in addressing questions relating to cell & molecular biomedical engineering & medical science  Demonstrate analytical skills, resourcefulness and teamwork in addressing questions relating to cell & molecular endievation and teamwork in addressing questions relating to cell & molecular biomedical engineering & medical arenal manufactured and process of cMB&B in biomedical engineering & medical arenal manufacture and process of cMB&B in biomedical engineering & molecular endievation for fundamental concepts of CMB&B in biomedical engineering & molecular biology and biochemistry  The fundamental concepts of CMB&B with concepts of CMB&B in biomedical engineering & machina to concepts of CMB&B in biomedical engineering & molecular endies of cundamental concepts of CMB&B in biomedical engineering & machina to concepts of CMB&B in biomedical engineering & machina to concepts of CMB&B in biomedical engineering & molecular endiestorate on fundamental concepts of CMB&B with good synthesis of the concepts of concepts of concepts of cMB&B in biomedical engineering & medical science problems.  Demonstrate analytical skills, resourcefulness, and teamwork in addressing questions relating to cMB&B in biomedical biomedical biomedical engineering & molecular endiestorate concepts of cMB&B in biomedical biomedical biomedical engineering & molecular endiestorate analytical skills, resourcefulness and teamwork in addressing questions relating to cMB&B in biomedical  | the fundamental concepts of cell & molecular biology, and biochemistry (CMB&B)                                   | understandings<br>on fundamental<br>concepts of                           | on fundamental<br>concepts of<br>CMB&B<br>answers to<br>questions are<br>verbatim from            | understandings<br>on fundamental<br>concepts of<br>CMB&B with<br>limited               | understandings<br>on fundamental<br>concepts of<br>CMB&B with<br>good synthesis               | understandings<br>on fundamental<br>concepts of                       |
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| biochemistry (CMB&B)    CMB&B    CMB&B  | biochemistry<br>(CMB&B)  | CMB&B   | questions are<br>verbatim from  |  |   | CMDOD   |
| Combability   Compatible   Concepts   Conc   | (CMB&B)  Describe some   |   | verbatim from   | synthesis of the   |   | CIVIDAR WITH  |
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# Appendix 2: The EAB (Engineering Accreditation Board) Accreditation SLOs (Student Learning Outcomes)

- a) **Engineering Knowledge:** Apply the knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems
- b) **Problem Analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- c) **Design/development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
- d) **Investigation:** Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- e) **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations
- f) **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- g) **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for the sustainable development.
- h) **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- i) **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
- j) Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- k) **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and economic decision-making, and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- I) **Life-long Learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change