Annexe A: New/Revised Course Content in OBTL+ Format

Course Overview

The sections shown on this interface are based on the templates UG OBTL+ or PG OBTL+
Note that ONLY sections marked "NEW" in the templates are editable in this "OBTL to OBTL+" mode.
If you are revising/duplicating an existing course and do not see the pre-filled contents you expect in the subsequent sections e.g. Course Aims, Intended Learning Outcomes etc. please refer to Data Transformation Status for more information.

Expected Implementation in Academic Year	
Semester/Trimester/Others (specify approx. Start/End date)	
Course Author * Faculty proposing/revising the course	Chen Wei Ning, William
Course Author Email	wnchen@ntu.edu.sg
Course Title	Introduction to Biomolecular Engineering
Course Code	CB1131
Academic Units	0
Contact Hours	45
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	
Co-requisites	
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

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.

Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

ILO 1	Explain most of the fundamental concepts of cell & molecular biology, and biochemistry.
ILO 2	describe some existing practical techniques & approaches adopted in the field of cell & molecular biology, and biochemistry.
ILO 3	Suggest how knowledge of cellular & molecular biology, and biochemistry may be applicable to biomedical engineering & medical science.
ILO 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.

Reading and References (if applicable)

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. 4th ed. International Student Version, 2012: Wiley. 5) Glick, B.R. and C.L. Patten, Molecular Biotechnology: Principles and Applications of Recombinant DNA. 5th ed. 2017: ASM Press/Wiley.

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Biological Molecules	1-4	Lecture notes, tutorial notes, Relevant Chapters in Reference text (Gerald Karp; Essential Cell Biology by Alberts)	In-person	
2	Membrane Structure/ Organelles	1-4	Lecture notes, tutorial notes, Relevant Chapters in Reference text (Gerald Karp; Essential Cell Biology by Alberts)	In-person	
3	Organelles/ Cytoskeleton	1-4	Lecture notes, tutorial notes, Relevant Chapters in Reference text (Gerald Karp; Essential Cell Biology by Alberts)	In-person	
4	Cell-Cell; Cell-extracellular matrix interactions	1-4	Lecture notes, tutorial notes, Relevant Chapters in Reference text (Gerald Karp; Essential Cell Biology by Alberts)	In-person	
5	Cell Division and Cell Cycle; Cell Death	1-4	Lecture notes, tutorial notes, Relevant Chapters in Reference text (Gerald Karp; Essential Cell Biology by Alberts)	In-person	
6	DNA Replication, transcription and translation; DNA repair and recombination	1-4	Lecture notes, tutorial notes, Relevant Chapters in Reference text (Gerald Karp; Essential Cell Biology by Alberts)	In-person	
7	Mid-term Quiz; Control of Gene expression		Lecture notes, tutorial notes, Relevant Chapters in Reference text (Gerald Karp; Essential Cell Biology by Alberts)	In-person	
8	Introduction to Chemical Energy, and Enzyme properties and kinetics	1-4	Lecture notes, tutorial notes, Relevant Chapters in Reference text (Voet & Voet)	In-person	
9	Regulation of Glucose Metabolism	1-4	Lecture notes, tutorial notes, Relevant Chapters in Reference text (Voet & Voet)	In-person	

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
10	Pentose Phosphate Pathway & Gluconeogenesis	1-4	Lecture notes, tutorial notes, Relevant Chapters in Reference text (Voet & Voet)	In-person	
11	Citric Acid Cycle, Oxidative Phosphorylation and ATP Synthesis	1-4	Lecture notes, tutorial notes, Relevant Chapters in Reference text (Voet & Voet)	In-person	
12	Fatty Acid Metabolism	1-4	Lecture notes, tutorial notes, Relevant Chapters in Reference text (Voet & Voet)	In-person	
13	Biological Engineering; Recombinant DNA Technology, Protein Production & Purification	1-4	Lecture notes, tutorial notes, Relevant Chapters in Reference text (Voet & Voet; Glick & Patten)	In-person	

Learning and Teaching Approach

Approach	How does this approach support you 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

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Test/Quiz()	1, 2, 3, 4	b, c, d, e	40	Individual	Analytic	Relational
2	Summative Assessment (EXAM): Final exam()	1, 2, 3, 4	b, c, d, e	60	Individual	Analytic	Relational

Description of Assessment Components (if applicable)

Formative Feedback

Quiz answers will be discussed in class

NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

Attributes/Competency	Level

Course Policy

Policy (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. On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Policy (General)

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.

Policy (Absenteeism)

0

Policy (Others, if applicable)

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 no make-up exam. Mark weighting will be transferred to the final exam.

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Last Updated By: Lai Ru Ying

Appendix 1: Assessment Criteria

Criteria	Unsatisfactory	Borderline	Satisfactory	Very good	Exemplary
Explain most of the fundamental concepts of cell & molecular biology, and biochemistry (CMB&B)	Shows limited or no understandings on fundamental concepts of CMB&B	Shows some understandings on fundamental concepts of CMB&B; answers to questions are verbatim from lecture notes	Shows good understandings on fundamental concepts of CMB&B with limited synthesis of the concepts described in lecture notes	Shows good understandings on fundamental concepts of CMB&B with good synthesis of the concepts described in lecture notes	Shows excellent understandings on fundamental concepts of CMB&B with good synthesis of the concepts described in lecture notes
Describe some existing practical techniques & approaches adopted in the field of cell & molecular biology, and biochemistry	Unable to describe existing practical techniques or approaches in CMB&B	Limited ability in describing existing practical techniques or approaches in CMB&B; answers to questions are verbatim from lecture notes	Able to describe existing practical techniques or approaches in CMB&B; with limited synthesis of the concepts described in lecture notes	Good ability in describing existing practical techniques or approaches in CMB&B; with some synthesis of the concepts described in lecture notes	Excellent ability to describe existing practical techniques or approaches in CMB&B; with good synthesis of the concepts described in lecture notes
Suggest how knowledge of cellular & molecular biology, and biochemistry may be applicable to biomedical engineering & medical science	Unable to apply the basic knowledge/ concepts of CMB&B in practical biomedical engineering & medical science problems.	Limited ability in applying the basic knowledge/ concepts of CMB&B in standard practical biomedical engineering & medical science problems.	Able to apply the basic knowledge/ concepts of CMB&B in standard practical biomedical engineering & medical science problems.	Good ability in applying the basic knowledge/ concepts of CMB&B in standard and new practical biomedical engineering & medical science problems.	Excellent ability in applying the basic knowledge/ concepts of CMB&B in standard and new practical biomedical engineering & medical science problems.
Demonstrate analytical skills, resourcefulness and team work in addressing questions relating to cell & molecular biology, and biochemistry in biomedical engineering & medical science	Lack analytical skills, resourcefulness , and teamwork in addressing questions relating to CMB&B in biomedical engineering & medical science	Limited analytical skills, resourcefulness , and teamwork in addressing standard questions relating to CMB&B in biomedical engineering & medical science	Some analytical skills, resourcefulness , and teamwork in addressing standard questions relating to CMB&B in biomedical engineering & medical science	Good analytical skills, resourcefulness , and teamwork in addressing standard and new questions relating to CMB&B in biomedical engineering & medical science	Excellent analytical skills with out-of-the-box thinking, resourcefulness , and teamwork in addressing standard and new questions relating to CMB&B in biomedical engineering & medical science

Mapping of Course ILOs to EAB Graduate Attributes

Course Code & Title	CB1131 Introduction to Biomolecular Engineering
Course Type	Core

Overview											
(a)	○	(b)	●	(c)	●	(d)	◐	(e)	◐	(f)	◐
(g)	◐	(h)	●	(i)	○	(j)	○	(k)	○		

Legend:

●	Fully consistent (contributes to more than 75% of Student Learning Outcome)
◐	Partially consistent (contributes to about 50% of Student Learning Outcome)
○	Weakly consistent (contributes to about 25% of Student Learning Outcome)
Blank	Not related to Student Learning Outcome

Course ILOs		**EAB Graduate Attributes**
1)	Explain most of the fundamental concepts of cell & molecular biology, and biochemistry.	b, c, d, e, h
2)	Describe some existing practical techniques & approaches adopted in the field of cell & molecular biology, and biochemistry.	b, c, d, e, h
3)	Suggest how knowledge of cellular & molecular biology, and biochemistry may be applicable to biomedical engineering & medical science.	b, c, f, g, h, k
4)	Demonstrate analytical skills, resourcefulness and team work in addressing questions relating to cell & molecular biology, and biochemistry in biomedical engineering & medical science.	b, c, d, f, g, i
5)		
6)		
7)		
8)		
9)		
10)		

EAB Graduate Attributes

a) **Engineering Knowledge**: Apply the knowledge of mathematics, natural science, computing and engineering fundamentals, and an engineering specialisation as specified in WK1 to WK4 respectively 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 with holistic considerations for sustainable development. (WK1 to WK4)

c) **Design / Development of Solutions**: Design creative solutions for complex engineering problems and design systems, components or processes that meet identified needs with appropriate consideration for public health and safety, whole-life cost, net zero carbon as well as resource, cultural, societal, and environmental considerations as required. (WK5)

d) **Investigation**: Conduct investigations of complex problems using research-based knowledge (WK8) 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 problems, with an understanding of the limitations. (WK2 and WK6)

f) **The Engineer and the World**: When solving complex engineering problems, analyse and evaluate sustainable development impacts to: society, the economy, sustainability, health and safety, legal frameworks and the environment (WK1, WK5, and WK7).

g) **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice and adhere to relevant national and international laws. Demonstrate an understanding of the need for diversity and inclusion (WK9).

h) **Individual and Collaborative Team Work**: Function effectively as an individual, and as a member or leader in diverse and inclusive teams and in multidisciplinary, face-to-face, remote and distributed settings (WK9).

i) **Communication**: Communicate effectively and inclusively 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, taking into account cultural, language, and learning differences.

j) **Project Management and Finance**: Demonstrate knowledge and understanding of engineering 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.

k) **Life-long Learning**: Recognise the need for, and have the preparation and ability to (i) engage in independent and life-long learning, and (ii) adapt to new and emerging technologies, and (iii) think critically, in the broadest context of technological change (WK8).

No	Knowledge Profile
WK1	A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences
WK2	Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline
WK3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline
WK4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline
WK5	Knowledge including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts that supports engineering design and operations in a practice area
WK6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline
WK7	Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline such as the professional responsibility of an engineer to public safety and sustainable development.
WK8	Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues
WK9	Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc with mutual understanding and respect, and of inclusive attitudes

Reference: EAB Accreditation Manual