NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

COURSE CONTENT

Academic Year	2024/2025	**Semester**	1
Course Coordinator	Assoc Prof. Chew Sing Yian / Assoc Prof. Sierin Lim		
Course Code	BG1141		
Course Title	Cellular and Molecular Biology for Bioengineers		
Pre-requisites	Nil		
No of AUs	3		
Contact Hours	32 hours lecture, 7 hours tutorial		
Proposal Date	4 Mar 2021		

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 LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team /Individual	Assessment rubrics
1. Continuous Assessment (40%)	1, 2, 3, 4	b, c, d, e	40%	Individual	Appendix 1
2. Final Examination (60%) [2hrs; Restricted open book (One A4 cheat sheet]	1, 2, 3, 4	b, c, d, e	60%	Individual	Appendix 1
Total			100%		

Mapping of Course ILOs to EAB Graduate Attributes

Course Intended Learning Outcomes	Cat	EAB's 12 Graduate Attributes*											
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
	Core	◐	●	●	◐	◐	◐	◐	◐	š	š		š
Explain most of the fundamental concepts of cell & molecular biology, and biochemistry													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 analytical skills, resourcefulness and team work in addressing questions relating to cell & molecular biology, and biochemistry in biomedical engineering & medical science													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)
- š Weakly consistent (contributes to about 25% of Intended Learning Outcomes)
- Blank Not related to Student Learning Outcomes

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*. 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.

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 no 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 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
Chew Sing Yian	N1.2-B2-20	6316 8812	sychew@ntu.edu.sg
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Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Biological Molecules	1-4	Lecture notes, tutorial notes, Relevant Chapters in Reference text (Gerald Karp; Essential Cell Biology by Alberts)
2	Membrane Structure/ Organelles	1-4	Lecture notes, tutorial notes, Relevant Chapters in Reference text (Gerald Karp; Essential Cell Biology by Alberts)
3	Organelles/ Cytoskeleton	1-4	Lecture notes, tutorial notes, Relevant Chapters in Reference text (Gerald Karp; Essential Cell Biology by Alberts)
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)
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)
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)
7	**Mid-term Quiz**; Control of Gene expression		Lecture notes, tutorial notes, Relevant Chapters in Reference text (Gerald Karp; Essential Cell Biology by Alberts)
8	Introduction to Chemical Energy, and Enzyme properties and kinetics	1-4	Lecture notes, tutorial notes, Relevant Chapters in Reference text (Voet & Voet)
9	Regulation of Glucose Metabolism	1-4	Lecture notes, tutorial notes, Relevant Chapters in Reference text (Voet & Voet)

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

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

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.

l) **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