NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

COURSE CONTENT

Academic Year	2022/2023	**Semester**	2
Course Coordinator	Assoc. Prof. Tan Meng How / Dr Mukta Bansal		
Course Code	CH3104		
Course Title	Biochemical Engineering		
Pre-requisites	Pre-Req: CH1104 & CH1131/CB1131 Co-Req: CH2104/CH2114 & CH3102/CH2112		
No of AUs	3		
Contact Hours	26 hours lecture, 13 hours tutorial		
Proposal Date	5 November 2019		

Course Aims

Engineers working in the process industries are making increased use of biological systems for production and environmental management. To set up and optimise these processes, chemical engineers need to understand the fundamentals of biological processes and their applications. This course is designed to teach you (as future chemical engineers) key aspects associated with biochemical processes, fundamental biology (such as the basic structure and function of cells, enzyme structure and function, and basic molecular biology), and important principles of cell, genetic, and protein engineering.

Intended Learning Outcomes (ILO)

At the end of this course, you (as a student) should be able to:

1) Describe the basic structure and function of cells, their metabolism, and their growth behaviour.
2) Describe different real-life applications of biochemical engineering.
3) Explain and interpret DNA mutations.
4) Explain and apply recombinant DNA technology that is used in academia and industry.
5) Explain and apply the principles of cell, genetic, and protein engineering.
6) Describe different host chassis that can be used for biochemical engineering.
7) Use different mathematical modelling tools to find out KM, Vmax of the native enzyme and immobilized enzyme.
8) Model cell growth and product formation.
9) Explain the basic features of bioreactors and their operation. Apply chemical engineering principles to design basic biological products and processes.

Course Content

Introduction to biochemical engineering
Basics of molecular and cell biology
Metabolism
Medical applications
Alteration of cellular information
Recombinant DNA technology
Genome engineering
Genetically engineered organisms
Enzymes and enzyme kinetics
Cell growth and product formation in batch culture and continuous culture
Bioreactors

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team /Individual	Assess-ment rubrics
Quiz 1 (20%)	1, 2, 3, 4	a, b, c, d, e, f, g, h, l	20%	Individual	See Appendix 1
Quiz 2 (20%)	5, 6, 7, 8	a, b, c, d, e, l	20%	Individual	See Appendix 1
Final Examination (60%) (2hrs, closed book, exam paper not allowed to be removed from exam hall)	1, 3, 4, 5, 6, 7, 8, 9	a, b, c, d, e, l	60%	Individual	See 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	◐	◐	◐	●	○	○	○	○				○
Describe the basic structure and function of cells, their metabolism, and their growth behaviour.													b, c, d
Describe different real-life applications of biochemical engineering.													f, g, h
Explain and interpret DNA mutations.													b, d
Explain and apply recombinant DNA technology that is used in academia and industry.													a, b, c, d, e, l
Explain and apply the principles of cell, genetic, and protein engineering.													a, b, c, d, e, l
Describe different host chassis that can be used for biochemical engineering.													a, b, c, d, l
Use different mathematical modelling tools to find out KM, Vmax of the native enzyme and immobilized enzyme.													a, b, c, d, e
Model cell growth and product formation.													a, b, c, d, e
Explain the basic features of bioreactors and their operation. Apply chemical engineering principles to design basic biological products and processes.													a, b, c, d, e

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)

Blank Not related to Student Learning Outcomes

Formative feedback

Quiz and examination results;
Marker's report on overall examination performance will be uploaded to NTULearn;
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, use incomplete handouts which enable you to participate in class.
Tutorial	Classroom discussion sessions on tutorial questions and related topics

Reading and References

1) "Bioprocess Engineering: Basic Concepts", Michael L. Shuler, Fikret Kargi, P Hall.

2) "Brock Biology of Microorganisms", 12th Edition, Madigan, Martinko, Dunlap, Clark, *Pearson International Edition*.

3) "Biochemical Engineering", H. W. Blanch, D. S. Clark, *Taylor & Francis*.

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.

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
Tan Meng How	N1.2-B2-33	6513 8063	mh.tan@ntu.edu.sg
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Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Introduction to biochemical engineering Basics of molecular and cell biology	1, 2	Chapter 1 Chapters 2 and 4
2	Metabolism	1	Chapter 5
3	Medical applications	2, 9	Chapter 15
4	Alteration of cellular information	3	Chapter 8
5	Recombinant DNA technology	4, 5	Lecture Notes
6	Genome Engineering	5	Lecture Notes
7	Genetically engineered organisms	6	Chapters 12 and 14
8	Introduction to Enzymes and Enzyme Kinetics	7	Chapter 3
9	Significance & Determination of Rate Parameters Enzyme Inhibition Enzyme Immobilization	7	Lecture Notes
10	Cell Growth and Product Formation	8	Chapter 6
11	Cell Growth and Product Formation	8	Chapter 7
12	Bioreactors	9	Chapter 9
13	Bioreactors	9	Chapter 10

Appendix 1: Assessment Criteria

Criteria	Unsatisfactory: <40%	Borderline: 40% to 49%	Satisfactory: 50% to 69%	Very good: 70% to 89%	Exemplary: > 90%
Knowledge & Comprehension Understanding the fundamentals of biochemical engineering	Poor understanding of the fundamentals.	Fair understanding of the fundamentals.	Satisfactory understanding of the fundamentals.	Good understanding of the fundamentals.	Very good and comprehensive understanding of the fundamentals.
Problem Solving Able to analyze biochemical engineering problems using appropriate methods.	Unable to utilize appropriate methods to solve any problems.	Can solve only a few problems. Logic may be shaky.	Able to solve some problems, but no ability to think outside the box.	Able to solve all problems, but is restricted only to textbook knowledge. Limited ability to think outside the box.	Able to solve all problems correctly. Can further identify potential caveats and suggest reasonable alternatives accordingly.

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