

Course Syllabus

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The Hong Kong University of Science and Technology (Guangzhou)

UG Course Syllabus

Introduction to Biotechnology

UFUG 1403

3 credits

No pre-/co-requisites

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Course Description

Advancement in science has enabled scientists to modify biological systems for specific purposes. Many of these technologies have been used to improve our daily life and this area of study is commonly referred to as biotechnology. This course is designed to introduce some of the major subjects in this field including the history of biotechnology, ethics in genetic modification and use of animals in experimental studies, molecular foundation of biotechnology, animal biotechnology, plant and agricultural biotechnology, and health-care applications. You will learn how different aspects of biotechnology affect our daily life and have impact on the society.

Intended Learning Outcomes (ILOs)

By the end of this course, students should be able to:

1. Understand the basic concepts of biotechnology and how these concepts related to our daily life.
2. Recognize how biotechnology can help to resolve healthcare issues and develop a sustainable society.
3. Evaluate and analyze information relevant to biotechnology issues.
4. Communicate and explain information regarding issues and importance of biotechnology to general public.

5. Use a global perspective to analyze issues related to bioscience and biotechnology.

Course Outline

Week	Topics	Brief outline of the topics	Related Course ILOs	Pedagogies applied	Supportive materials
1	History of Biotechnology	<p>Overview of the evolution of biotechnology, key milestones, and influential figures.</p> <p>Introduction to course structure and assessments.</p> <p>Discussion on smart manufacturing and its intersection with biotechnology.</p>	<p>ILO1, ILO2, ILO4</p>	<p>Lecture, in-class discussion, small group brainstorming on biotechnology's impact on society.</p>	<p>Videos, course syllabus</p>
	Molecular Foundation of Biotechnology	<p>Exploration of DNA structure, gene expression mechanisms, and the processes of DNA damage and repair.</p> <p>Reading assignments may include chapters on molecular biology fundamentals.</p>			
2	DNA Synthesis <i>in vitro</i> and DNA Sequencing	<p>Introduction to DNA detection techniques, including PCR and various DNA sequencing methodologies. Practical applications of these techniques will be discussed.</p>	<p>ILO1, ILO2, ILO4, ILO5</p>	<p>Lecture, in-class discussions, and interactive matchy-matchy games to reinforce learning concepts.</p>	<p>JoVE education online videos</p>

3	Lab 1	PCR and DNA sequencing	ILO1, ILO2, ILO3	Hands-on session	Lab manual
4	Let's Do DNA Cloning!	Introduction to recombinant DNA technology, including the principles and methods of DNA cloning.	ILO1, ILO2, ILO3, ILO4	Problem-based learning, interactive matchy-matchy games and group discussions to solve cloning scenarios.	JoVE education online videos, supplementary handouts for cloning practice
5	RNA-based Technologies	Overview of RNA detection techniques, RNA sequencing, gene silencing mechanisms and strategies, and riboswitches. Discussion on the significance of RNA in biotechnology.	ILO1, ILO2, ILO3, ILO4, ILO5	Role-playing games (RPGs) to simulate knowledge transfer, and group discussions.	JoVE education online videos, experiment and lab manual
6	Protein-based Technologies	Exploration of protein detection methods, proteomics, protein structure prediction, and protein interactions detection methods. Introduction to protein engineering techniques.	ILO1, ILO2, ILO3, ILO4	RPGs and group discussions on protein engineering applications.	JoVE education online videos, experiments and lab manuals, supplementary handouts
7	Lab 2	SDS-PAGE and Western Blotting	ILO1, ILO2, ILO3	Hands-on session	Lab manual

8	BioCRF visit & Mid-term	Assessment covering material from Weeks 1-6, evaluating understanding of key concepts and techniques in biotechnology and the application of biotechnology in solving real-world problems.	ILO1, ILO2, ILO3, ILO4, ILO5	Written examination	
9	Immune Technology	Study of antibodies and antigens, monoclonal antibody production, antibody humanization, and engineering. Discussion on vaccination technologies utilizing antibodies.	ILO1, ILO2, ILO3, ILO4	Role-playing games (RPGs) and group discussion to simulate knowledge transfer	JoVE education online videos
10	Cloning and Stem Cells	Examination of cell differentiation, the role and applications of stem cells, cloning techniques, and ethical considerations surrounding cloning and stem cell research.	ILO1, ILO2, ILO3, ILO4, ILO5	Problem-based learning and group discussion, video watching to have enhanced learning and deeper understanding about ethical issues involved	JoVE education online videos, movie clips, film list for out-of-class viewing.
11	Transgenic Animals and Plants	Overview of transgenic organisms, including knockout/knockin animals and transgenic plants. Discussion on the ethical implications and regulatory	ILO1, ILO2, ILO3, ILO4, ILO5	Video watching, case studies and group discussions on transgenic applications	JoVE education online videos

frameworks governing transgenic research.

12	Biotechnology in Human Health	Exploration of applications such as DNA fingerprinting, gene therapy, and the role of smart manufacturing in biomedicine.	ILO1, ILO2, ILO3, ILO4, ILO5	Case studies on real-world applications, and group discussions on health-related biotechnologies.	JoVE education online videos, health biotechnology articles.
13	The Future of Biotechnology	Discussion on emerging trends such as on-demand medicine production, digital healthcare, precision medicine, bioprinting of organs, ecological engineering, brain-computer interfaces, and new RNA techniques.	ILO1, ILO2, ILO4, ILO5	Group brainstorming on future trends, presentations on emerging technologies, and discussions on implications.	JoVE education online videos, movie clips, recent reports or journal articles on biotechnology trends.
	Group Presentation	Students will present their group projects	ILO1, ILO2, ILO4, ILO5	Group presentations	Presentation guidelines

Assessment and Grading

This course will be assessed using criterion-referencing and grades will not be assigned using a curve. Detailed rubrics for each assignment are provided below, outlining the criteria used for evaluation.

Assessments:

Assessment Task	Contribution to Overall Course grade (%)	Due date
Mid-Term	30%	TBA *
Final examination	30%	TBA *
Lab performance and lab reports	25%	Two weeks after lab 1, lab 2 or BioCRF visit*
Group Project	15%	TBA *

* Assessment marks for individual assessed tasks will be released within two weeks of the due date.

Mapping of Course ILOs to Assessment Tasks

Assessed Task	Mapped ILOs	Explanation
Mid-Term	ILO1, ILO2, ILO3, ILO4, ILO5	This task assesses students' ability to explain and apply fundamental concepts of biotechnology (ILO 1), evaluate how biotechnology can address healthcare issues and contribute to sustainability (ILO 2), critically analyze information related to biotechnology issues (ILO 3), communicate the importance of these concepts to a wider audience (ILO 4), and use a global perspective to assess biotechnological challenges (ILO 5).

Final examination	ILO1, ILO2, ILO3, ILO4, ILO5	<p>This task evaluates students' comprehensive understanding of biotechnology concepts (ILO 1), their ability to assess biotechnology's role in resolving societal challenges (ILO 2), their skills in analyzing complex biological information (ILO 3), their capacity to articulate the significance of biotechnological advancements (ILO 4), and their global perspective on the implications of biotechnology (ILO 5).</p>
Lab performance and lab reports	ILO1, ILO2, ILO3	<p>These hands-on lab sessions provide students with practical experience applying foundational biotechnology concepts in real-world settings (CILO 1), understanding how these techniques can lead to sustainable practices in healthcare and industry (CILO 2), and evaluating experimental results to draw meaningful conclusions (CILO 3).</p>
Group Project	ILO1, ILO2, ILO4, ILO5	<p>This assessment encourages students to collaboratively explore/design and present a biotechnological topic, demonstrating their understanding of key concepts (CILO 1), evaluating the potential</p>

societal benefits of biotechnology (CILO 2), effectively communicating complex information to a general audience (CILO 4), and analyzing the global context of their chosen topic in biotechnology (CILO 5).

Grading Rubrics

1. Mid-Term Examination Rubric (100 total points, and accounting for 30 points in final score)

- Multiple Choice Questions: Correct Answer (2 points each). Full points for correct answer, no points for incorrect or unanswered questions.
- True or False Questions: Correct Answer (2 points each). Full points for correct answer, no points for incorrect or unanswered questions.
- Short Answer Questions: Accuracy (5 points each). Correctness of the answer based on course material. For each question, there will be five scoring points. One point is awarded for each correct scoring point. No points for incorrect or unanswered questions.
- Essay Questions: Accuracy (10 points each). Correctness of the answer based on course material. For each question, there will be at least five scoring points. Two points is awarded for each correct scoring point with good or reasonable arguments. No points for incorrect or unanswered questions.

2. Final Examination Rubric (100 total points, and accounting for 30 points in final score)

- Multiple Choice Questions (2 points each): Full points for correct answer, no points for incorrect or unanswered questions.
- True or False Questions (2 points each): Full points for correct answer, no points for incorrect or unanswered questions.
- Short Answer Questions (5 points each): Correctness of the answer based on course material. For each question, there will be five scoring points. One point is awarded for each correct scoring point. No points for incorrect or unanswered questions.
- Essay Questions (10 points each): Correctness of the answer based on course material. For each question, there will be at least five scoring points. Two points is awarded for each correct scoring point with good or reasonable arguments. No points for incorrect or unanswered questions.
- Problem-Solving Questions (15 points each): Problem Identification (3 points), Analysis/Reasoning (5 points), Solution/Proposal (5 points) and Conclusion/Implications (2 points). Points will be given depending on the correctness, scientific basis, logical reasoning, solution practicableness of the answer. The competency of applying knowledge to a specific scenario or problem is aimed to be examined.

3. Lab performance and lab reports Rubric

- Lab reports (25 points in final score): There will be 3 lab reports required for each student and the lab reports are worthy 10 points each for lab 1&2, and 5 points for BioCRF visit. Lab Reports 1 & 2 are broken down into the following sections: Introduction and Background (2 points), Materials and Methods (2 points), Results (2 points), Discussion and Analysis (3 points) and Conclusion (1 point). The grading criteria will be depending on the clarity and understanding of the experiments, and standard result representation. Lab report 3 is broken down into the following sections: Visit Overview and Objectives (1 point), Observation and Recording (1.5 points), One instrument introduction (1.5 points), and Reflection and Implications (1 point).
- Lab performance will be taken into account in the final assessment. For any student who is late for or absent from lab sessions, a deduction of 2–100% will be applied to their lab report scores. Please check the "Undergraduate Laboratory Teaching Regulations" for details.

4. Group Project Rubric

- Group presentation (15 points in final score): The project is a presentation-based discussion. The score will be breakdown into Content Knowledge (3 points), Presentation file preparation (3 points), Presentation Skills (3 points), Q&A Session (3 points) and Team Collaboration (3 points). With each category, the scores will be earned as Excellent (3 pts), Good (2 pts), Satisfactory (1 pt) and Needs Improvement (0 pts).

Final Grade Descriptors:

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	Demonstrates a comprehensive grasp of subject matter, expertise in problem-solving, and significant creativity in thinking. Exhibits a high capacity for scholarship and collaboration, going beyond core requirements to achieve learning goals.
B	Good Performance	Shows good knowledge and understanding of the main subject matter, competence in problem-solving, and the ability to analyze and evaluate issues. Displays high motivation to learn and the ability to work effectively with others.
C	Satisfactory Performance	Possesses adequate knowledge of core subject matter, competence in dealing with familiar problems, and some capacity for analysis and critical thinking. Shows

persistence and effort to achieve broadly defined learning goals.

D Marginal Pass Has threshold knowledge of core subject matter, potential to achieve key professional skills, and the ability to make basic judgments. Benefits from the course and has the potential to develop in the discipline.

F Fail Demonstrates insufficient understanding of the subject matter and lacks the necessary problem-solving skills. Shows limited ability to think critically or analytically and exhibits minimal effort towards achieving learning goals. Does not meet the threshold requirements for professional practice or development in the discipline.

Course AI Policy

Lab report and group project can be completed with the aid of AI tools. **AI assistance is strictly prohibited to generate fake lab results.** Students must disclose any AI tools used in their work, including specifying how the tools were used. Please carefully cross-check AI outputs and verify AI-generated contents before using them, as they may be incorrect or misleading.

Communication and Feedback

Assessment marks for individual assessed tasks will be communicated via Canvas within two weeks of submission. Feedback on assignments will include presentation and formatting, accuracy of content, timeliness and adherence to guidelines, creativity and originality, and areas for improvement. Students who have further questions about the feedback including marks should consult the instructor within five working days after the feedback is received.

Resubmission Policy

No resubmission will be accepted. In the event of illness or unforeseen circumstances (e.g., natural disasters, accidents), late submissions will be permitted within one week. Please provide documentary proof along with the late submission.

Required Texts and Materials

Biotechnology, Second Edition (2nd Edition) by David P. Clark and Nanette J. Pazdernik, 2015

Online resource: https://ebookcentral.proquest.com/lib/thehong/detail.action?docID=7263834#goto_toc

Academic Integrity

Students are expected to adhere to the university's academic integrity policy. Students are expected to uphold HKUST(GZ)'s Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct. Please refer to Regulations for Academic Integrity and Student Conduct for the University's definition of plagiarism and ways to avoid cheating and plagiarism.

[Optional] Additional Resources

JoVE: Education Core library Video