



UNIVERSITI KUALA LUMPUR
MALAYSIAN INSTITUTE OF CHEMICAL AND BIO-ENGINEERING TECHNOLOGY

FINAL EXAMINATION
OCTOBER 2025 SEMESTER

COURSE CODE : CBB20003
COURSE TITLE : PRINCIPLES OF MICROBIOLOGY
PROGRAMME NAME : BACHELOR OF CHEMICAL ENGINEERING TECHNOLOGY
(BIOPROCESS) WITH HONOURS
DATE : 03 FEBRUARY 2026
TIME : 2:00PM - 5:00PM
DURATION : 3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. This question paper consist of TWO sections.
4. Answer ALL questions for Section A.
5. Section B consist of four questions. Answer THREE (3) questions only.
6. Please write your answer on the answer booklet provided.
7. Please answer all questions in English only.
8. Please answer MCQ/EMQ questions using OMR sheet. ☐ *Tick if applicable*
9. Refer to the attached Formula/ Appendices. ☐ *Tick if applicable*

THERE ARE 10 PAGES OF QUESTIONS INCLUDING THIS PAGE

SECTION A (Total: 40 marks)

Answer ALL questions.

Please use the answer booklet provided.

Question 1

The bacterial cell wall is a complex, mesh-like structure that in most bacteria is essential for the maintenance of cell shape and structural integrity. The bacterial cell wall performs several functions as well, in addition to providing overall strength to the cell.

- (a) By using suitable illustrations, distinguish the cell wall structure of Gram-positive and Gram-negative bacteria.

(6 marks)

- (b) Describe the discoveries or contributions made by the following scientists in the history of microbiology.

- i. Louis Pasteur
- ii. Edward Jenner

(4 marks)

Question 2

Bacteria have diverse morphology and cell structures.

- (a) Briefly describe the function of the following structure in the bacteria:

- i. Fimbriae and flagella
- ii. Endospores

(2 marks)

- (b) A spore suspension of *Aspergillus niger* was prepared. The four corner squares of the hemocytometer are counted for a total of 100 spores. Determine the spore concentration.

(2 marks)

- (c) Microorganisms play a vital role in every ecological community. Describe the roles of microorganisms in the nitrogen cycle.

(6 marks)

Question 3

Culture media provide the essential nutrients and environmental conditions required to support the growth and maintenance of microorganisms during laboratory cultivation.

- (a) List TWO (2) chemical and physical requirements that are essential for bacterial growth.

(4 marks)

- (b) Different types of culture media are used in laboratory settings to support the growth of microorganisms. Categorize and compare two culture media with different constituents in the figures provided below.

Refer Below - Figure1 : Culture media A . Figure2 : Culture media B .

(6 marks)

Constituent	Amount
Glucose	5.0 g
Ammonium phosphate, monobasic ($\text{NH}_4\text{H}_2\text{PO}_4$)	1.0 g
Sodium chloride (NaCl)	5.0 g
Magnesium sulfate ($\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$)	0.2 g
Potassium phosphate, dibasic (K_2HPO_4)	1.0 g
Water	1 liter

Figure 1: Culture media A

Constituent	Amount
Peptone (partially digested protein)	5.0 g
Beef extract	3.0 g
Sodium chloride	8.0 g
Agar	15.0 g
Water	1 liter

Figure 2: Culture media B

Question 4

Microbial growth is an increase in the number of cell in a bacterial or fungal population.

- (a) With the aid of a diagram, describe the 4 stages commonly found in the bacteria growth curve in detail.

(8 marks)

- (b) *Staphylococcus aureus* culture (1 mL) was serially diluted with 9 mL of sterile distilled water and repeated 2 times to the dilution factor of 10^{-3} . Then 100 μL of the final diluent was cultured on a nutrient agar plate. The plate was then incubated for 24 hours at 37°C. A total of 118 colonies was observed after incubation.

Using the information given, calculate the amount of colony forming unit (CFU) per mL of the original *S. aureus* culture stock.

(2 marks)

SECTION B (Total: 60 marks)

Answer **THREE (3)** questions only.

Please use the answer booklet provided.

Question 1

Understanding the growth patterns of microorganisms and the methods used to control them is fundamental in microbiology.

- (a) You are a production engineer at a company producing recombinant human insulin using *E. coli* as the host. Suggest and elaborate **Two (2)** methods for measuring the *E. coli* growth during the production of the recombinant human insulin.

(6 marks)

- (b) You are a production manager in a food manufacturing company. Suggest **THREE (3)** methods to control microbial growth.

(6 marks)

- (c) Once a virus infected the host cell, two different processes may occur. Elaborate the lytic and lysogenic cycle of the virus infection.

(8 marks)

Question 2

Accurate identification of microbial species is essential in clinical diagnosis, food safety, environmental monitoring, and research. The choice of identification method affects the accuracy, speed, and reliability of results.

- (a) From the soil sample collected in Tabong Naning, Melaka, you have isolated an unknown microbial strain. This unknown microbial strain produces a novel antibiotic compound and has the potential to be developed for industrial use. Propose and elaborate 2 approaches to identify the species of the unknown bacterial isolate.

(10 marks)

- (b) Elaborate the **FIVE (5)** mechanisms of action for antimicrobial drugs (antibiotics) in inhibiting the growth of microorganisms.

(10 marks)

Question 3

Antimicrobial susceptibility testing plays a crucial role in clinical microbiology and pharmaceutical research. It is used to evaluate the effectiveness of antimicrobial agents against specific microorganisms and to guide appropriate therapeutic decisions.

- (a) A study was conducted to determine the antibacterial susceptibility of two antibiotics, X and Y on *E. coli*. Both antibiotic X and Y were prepared in concentration range of 1 to 16 mg/ml.

- i. After incubating at 37 °C for 24 hours, the growth of the bacterial suspension in each of the test tubes was examined by observing the turbidity of the media. Based on the result shown in the tables, determined the MIC and MBC/ MLC of antibiotic X and Y on *E. coli*.

Refer Below - Table1 : The mixture from each test tube was streaked on a nutrient agar and the following result was observe . Table2 : After incubating at 37 °C for 24 hours, the growth of the bacterial suspension in each of the test t .

(8 marks)

Table 1: The mixture from each test tube was streaked on a nutrient agar and the following result was observe

Test Tube	1	2	3	4	5
Final concentration of antibiotic (mg/ml)	16	8	4	2	1
Presence of growth, for antibiotic X	No	No	No	Yes	Yes
Presence of growth, for antibiotic Y	No	Yes	Yes	Yes	Yes

Table 2: After incubating at 37 °C for 24 hours, the growth of the bacterial suspension in each of the test t

Test Tube	1	2	3	4	5
Final concentration of antibiotic (mg/ml)	16	8	4	2	1
Turbidity of the media in test tubes for antibiotic X	Clear	Clear	Clear	Turbid	Turbid
Turbidity of the media in test tubes for antibiotic Y	Clear	Clear	Turbid	Turbid	Turbid

- ii. Based on the results obtained, determine which antibiotic is more effective in inhibiting *E. coli*. Justify your answer

(2 marks)

- (b) The lac operon is an example of control over the system of bacterial gene expression.

- i. Describe the structure of the lac operon and each component in this system.

(6 marks)

- ii. Predict and explain how the presence of lactose will alter the expression of the structural gene of lac operon.

(4 marks)

Question 4

Microorganisms play a significant role in various industries and ecosystems. Beyond their association with diseases, microbes are widely utilized in food production, pharmaceuticals, agriculture, environmental management, and biotechnology.

- (a) Recombinant human insulin is an important development of medical therapeutic for diabetes. You are required to clone the human insulin gene and express it in *Escherichia coli*. Describe the steps taken and materials needed in the procedure.

(10 marks)

- (b) Choose **One (1)** from the industries listed below and describes the application of microorganism in your chosen industry. Explain the role of microorganisms in detail.

- i. Food industry
- ii. Pharmaceutical industry
- iii. Agricultural industry

(10 marks)

END OF EXAMINATION PAPER

