



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

FINAL EXAMINATION
OCTOBER 2025 SEMESTER

COURSE CODE : CLB11103
COURSE TITLE : BIOLOGY OF CELLS
PROGRAMME NAME : BACHELOR OF CHEMICAL ENGINEERING TECHNOLOGY
(BIOPROCESS) WITH HONOURS
DATE : 27 JANUARY 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 19 PAGES OF QUESTIONS INCLUDING THIS PAGE

SECTION A (Total: 40 marks)

Answer ALL questions.

Please use the answer booklet provided.

1. A mutation causes DNA ligase to become non-functional during replication. Predict the most likely outcome of this mutation.
 - A. Okazaki fragments remain unjoined.
 - B. New nucleotides cannot be added to DNA strands.
 - C. RNA primers cannot be synthesized.
 - D. The DNA double helix cannot unwind.

2. Determine the number of DNA molecules produced after one complete cycle of DNA replication starting from one double-stranded DNA molecule.
 - A. Four
 - B. One
 - C. Eight
 - D. Two

3. The term 'true breeding' refers to _____.
 - A. Organisms that have a high rate of reproduction.
 - B. Organisms that will produce identical copies of themselves upon reproduction.
 - C. Genetically pure lines.
 - D. Organisms that are heterozygous for a given trait.

4. A mutation occurs in a gene, but the amino acid sequence of the protein remains unchanged. Identify the type of mutation described.
 - A. Missense mutation
 - B. Frameshift mutation
 - C. Silent mutation
 - D. Nonsense mutation

5. Select the mutation most likely to have the greatest impact on protein structure and function.
 - A. Substitution of one base in a non-coding region
 - B. Substitution of one base that does not change the amino acid
 - C. Substitution of one base that changes one amino acid
 - D. Deletion of one nucleotide near the beginning of the coding sequence

6. Determine which statement correctly differentiates mitosis from meiosis.
 - A. Mitosis produces four genetically different haploid cells, whereas meiosis produces two identical diploid cells.
 - B. Mitosis results in genetic variation, whereas meiosis maintains chromosome number.
 - C. Mitosis occurs only in reproductive cells, whereas meiosis occurs in somatic cells.
 - D. Mitosis involves one cell division, whereas meiosis involves two successive cell divisions.

7. Choose the correct statement that differentiates a somatic cell from a gamete cell.
- A. Somatic cells contain half the number of chromosomes compared to gamete cells.
 - B. Somatic cells divide by meiosis, while gamete cells divide by mitosis.
 - C. Somatic cells are diploid and form body tissues, while gamete cells are haploid and involved in sexual reproduction.
 - D. Somatic cells are haploid and involved in sexual reproduction, while gamete cells are diploid and form body tissues.
8. Determine the effect of inserting one nucleotide into the coding region of a gene.
- A. Only one amino acid is changed.
 - B. All downstream amino acids may be altered.
 - C. The reading frame remains unchanged.
 - D. The mutation does not affect the protein.
9. Choose from the following which pairs is correct.
- A. TT - heterozygous
 - B. Tt – homozygous dominant
 - C. tt – homozygous recessive
 - D. tt – dominant phenotype

10. Select the option that correctly defines a local regulator in cell communication and identifies the correct sequence of events in cell signalling.
- A. A local regulator is a signalling molecule that travels through the bloodstream to distant target cells; the steps are reception → transmission → response.
 - B. A local regulator is a signalling molecule that affects nearby target cells by diffusion; the steps are reception → signal transduction → response.
 - C. A local regulator is a membrane-bound receptor that activates DNA transcription; the steps are signal transduction → reception → response.
 - D. A local regulator is a signalling molecule released only by nerve cells; the steps are response → reception → signal transduction.
11. Select the option that correctly distinguishes a nucleoside from a nucleotide.
- A. A nucleoside consists of a pentose sugar only, whereas a nucleotide consists of a nitrogenous base and a pentose sugar.
 - B. A nucleoside consists of a nitrogenous base, a pentose sugar, and a phosphate group, whereas a nucleotide consists of a nitrogenous base only.
 - C. A nucleoside consists of a nitrogenous base and a pentose sugar, whereas a nucleotide consists of a nitrogenous base, a pentose sugar, and a phosphate group.
 - D. A nucleoside consists of a nitrogenous base and a phosphate group, whereas a nucleotide consists of a pentose sugar and a phosphate group.
12. Identify the compound that is not shared as a common metabolic intermediate during the aerobic breakdown of both glucose and fatty acids.
- A. Pyruvate
 - B. Citrate
 - C. Glyceraldehyde-3-phosphate
 - D. Acetyl-CoA

13. Determine the correct statement that best explains the fate of pyruvic acid during cellular respiration under different oxygen conditions.
- A. Pyruvic acid is converted into a four-carbon molecule that directly enters the Krebs cycle.
 - B. Pyruvic acid is the final product of glycolysis.
 - C. Pyruvic acid accumulates as a three-carbon molecule when oxygen levels decrease.
 - D. Pyruvic acid is a three-carbon molecule that loses one carbon when oxygen is sufficient before entering the Krebs cycle.
14. Choose the force that holds the two polynucleotide strands together in a DNA molecule.
- A. Covalent bonds between sugar-phosphate backbones.
 - B. Ionic bonds between phosphate groups
 - C. Hydrogen bonds between complementary nitrogenous bases.
 - D. Peptide bonds between nucleotides
15. Choose from the following the immediate result of fertilization in sexual reproduction.
- A. Formation of gametes
 - B. Formation of haploid cells
 - C. Restoration of diploid chromosome number
 - D. Reduction of chromosome number

16. Choose which of the following statements regarding the structure and characteristics of chloroplasts are **NOT** correct.
- I. Chloroplasts are absent in prokaryotic cells.
 - II. Chloroplasts possess their own genetic material.
 - III. Chloroplasts are surrounded by a single membrane.
 - IV. Chloroplasts contain cristae similar to mitochondria.
- A. III and IV
 - B. I and II
 - C. II and III
 - D. I and III
17. An increase in temperature causes excessive membrane fluidity. Identify the membrane component that helps stabilise the membrane in animal cells.
- A. Peripheral proteins
 - B. Carbohydrates
 - C. Phospholipids
 - D. Cholesterol
18. Identify the process used by Amoeba to engulf solid food particles into the cell.
- A. Facilitated diffusion
 - B. Exocytosis
 - C. Phagocytosis
 - D. Pinocytosis

19. Describe the correct sequence of events that occurs when a nerve cell signals a muscle cell to contract.
- A. The signal molecule diffuses freely through the cytoplasm.
 - B. The signal molecule binds to a receptor on the muscle cell membrane and triggers changes in internal cellular reactions.
 - C. The signal molecule enters the muscle cell and binds directly to DNA.
 - D. The signal molecule breaks down membrane proteins.
20. Choose the mechanism that most contributes to new gene combinations in offspring.
- A. Chromosome duplication.
 - B. DNA replication.
 - C. Crossing over.
 - D. Cytokinesis.
21. Determine how Mendel's Law of Segregation is demonstrated in a monohybrid cross.
- A. Alleles on different chromosomes assort together.
 - B. Two alleles for a gene pair randomly combine during fertilization.
 - C. Each allele for a trait is packaged into a separate gamete during meiosis.
 - D. Traits blend to form intermediate phenotypes.
22. A muscle cell contracts due to interaction between actin and myosin. Identify which cytoskeletal component is directly responsible for this function.
- A. Intermediate filaments
 - B. Microfilaments
 - C. Centrioles
 - D. Microtubules

23. A mutation disrupts the function of microtubules in a cell. Determine which cellular process would be most directly affected.
- A. Chromosome separation during cell division
 - B. Lipid metabolism
 - C. Protein synthesis
 - D. Detoxification of harmful substances
24. Choose the correct definition of an ecosystem.
- A. All biotic and abiotic components in a given area.
 - B. The total number of species in the biosphere.
 - C. Only the plant life in a biome.
 - D. A group of the same species living together.
25. Choose the correct statement about how a peptide bond is formed during polypeptide synthesis.
- A. From the side chain of one amino acid to the side chain of another amino acid.
 - B. From the carboxyl end of the first amino acid to the amino end of the second amino acid.
 - C. From the side chain of one amino acid to the amino end of another amino acid.
 - D. From the amino end of the first amino acid to the carboxyl end of the second amino acid.

26. Choose which of the following is the correct amino acid sequence generated from the following mRNA codon sequence.

5' AUGUCUUCGUUAUCCUUG 3'

Refer Below - Figure1 : Genetic Code Table .

		Second letter				
		U	C	A	G	
First letter	U	UUU } Phe UUC } UUA } Leu UUG }	UCU } Ser UCC } UCA } UCG }	UAU } Tyr UAC } UAA } Stop UAG } Stop	UGU } Cys UGC } UGA } Stop UGG } Trp	Third letter U C A G
	C	CUU } Leu CUC } CUA } CUG }	CCU } Pro CCC } CCA } CCG }	CAU } His CAC } CAA } Gln CAG }	CGU } Arg CGC } CGA } CGG }	
	A	AUU } Ile AUC } AUA } AUG } Met or start	ACU } Thr ACC } ACA } ACG }	AAU } Asn AAC } AAA } Lys AAG }	AGU } Ser AGC } AGA } Arg AGG }	
	G	GUU } Val GUC } GUA } GUG }	GCU } Ala GCC } GCA } GCG }	GAU } Asp GAC } GAA } Glu GAG }	GGU } Gly GGC } GGA } GGG }	

Figure 1: Genetic Code Table

- A. met-arg-glu-arg-glu-arg
- B. met-ser-ser-leu-ser-leu
- C. met-ser-leu-ser-leu-ser
- D. met-glu-arg-arg-gln-leu
27. Select the macromolecule that provides quick energy and structural support in plants.
- A. Lipids
- B. Carbohydrates
- C. Proteins
- D. Nucleic acids

28. A researcher observes vesicles carrying proteins from the endoplasmic reticulum to another organelle for modification and sorting. Determine which organelle receives these vesicles.
- A. Peroxisome
 - B. Golgi apparatus
 - C. Lysosome
 - D. Nucleus
29. Identify the conclusion Mendel drew from his monohybrid cross involving pea seed shape.
- A. Offspring always resemble one parent.
 - B. Traits blend permanently in offspring.
 - C. Each trait is controlled by a pair of factors that segregate during gamete formation.
 - D. Dominant traits appear only in the F_2 generation.
30. Explain the main purpose of chromosome duplication before cell division.
- A. To initiate cytokinesis
 - B. To increase cell size
 - C. To allow protein synthesis
 - D. To ensure each daughter cell receives a complete set of DNA
31. During DNA replication, the lagging strand is synthesised discontinuously. Identify the reason this occurs.
- A. RNA primers cannot bind to the leading strand.
 - B. Helicase works only on one strand.
 - C. DNA polymerase can only add nucleotides in the 3' to 5' direction.
 - D. DNA polymerase can only add nucleotides in the 5' to 3' direction.

32. A replication fork is actively synthesizing DNA. Determine which enzyme is directly responsible for separating the two parental DNA strands to allow replication to proceed.
- A. DNA polymerase
 - B. Helicase
 - C. Primase
 - D. DNA ligase
33. Determine how the structure of the phospholipid bilayer supports selective permeability in biological membranes.
- A. Only large nonpolar molecules can freely diffuse through the lipid bilayer.
 - B. The hydrophobic interior prevents water from entering the cell entirely.
 - C. Phospholipids allow certain substances to pass through based on their size and polarity.
 - D. The phospholipid tails bind selectively to proteins to regulate entry.
34. A student identifies a cell that lacks membrane-bound organelles but is capable of metabolism and reproduction. Based on the cell theory, this cell should be classified as:
- A. Plant cell
 - B. Eukaryotic cell
 - C. Multicellular organism
 - D. Prokaryotic cell

35. Determine which genetic principle is demonstrated by the appearance of new combinations of traits in the F_2 generation of Mendel's dihybrid cross.
- A. Law of independent assortment.
 - B. Law of incomplete dominance.
 - C. Law of segregation.
 - D. Law of dominance.
36. Identify the membrane function demonstrated when ions such as Na^+ and K^+ move across the membrane to support nerve impulses.
- A. Cell adhesion
 - B. Enzymatic activity
 - C. Transport of molecules and ions
 - D. Cell recognition
37. Identify the following properties of water that are important for the temperature regulation of an exothermic animal.
- I. High surface tension
 - II. Low viscosity
 - III. Highest density at 4°C
 - IV. High heat capacity
- A. II and IV
 - B. I and IV
 - C. I and III
 - D. I and II

38. A membrane contains a high proportion of unsaturated fatty acids. Explain how this composition affects membrane properties.
- A. Decreases membrane fluidity
 - B. Increases membrane rigidity
 - C. Increases membrane fluidity
 - D. Prevents protein movement
39. A DNA sequence undergoes a mutation that introduces a premature stop codon. Identify the type of mutation involved.
- A. Nonsense mutation
 - B. Missense mutation
 - C. Frameshift mutation
 - D. Silent mutation
40. Determine the correct response of a cell when insulin binds to its membrane receptor.
- A. Inhibition of glucose transport
 - B. Breakdown of glycogen into glucose
 - C. Uptake of glucose and formation of glycogen
 - D. Release of glucose into the blood

SECTION B (Total: 60 marks)

Answer THREE (3) questions only.

Please use the answer booklet provided.

Question 1

Cells depend on water and biological macromolecules to maintain structure, support metabolic reactions, and carry out essential cellular functions.

- (a) Describe the molecular structure of water and explain how hydrogen bonding occurs between water molecules.

(4 marks)

- (b) Explain how the properties of water (polarity, cohesion, and high specific heat capacity) contribute to its biological importance in cells.

(6 marks)

- (c) Identify the four (4) major classes of biological macromolecules found in cells.

(4 marks)

- (d) From the macromolecules listed in (c), choose any two (2). For each macromolecule, describe its basic structure and biological function.

(6 marks)

Question 2

Meiosis and the cell cycle are fundamental processes that ensure accurate cell division, genetic continuity, and variation in living organisms, enabling growth, development, and reproduction.

- (a) Describe the main stages of meiosis and state one (1) key event that occurs in each stage.

(8 marks)

- (b) Discuss how meiosis contributes to genetic variation in organisms.

(4 marks)

- (c) Describe the phases of the cell cycle, including interphase and the mitotic phase.

(8 marks)

Question 3

A grassland ecosystem consists of grasses, deer, insects, flowering plants, pollinating insects, and predators. The ecosystem experiences normal rainfall followed by a drought and later recovery of vegetation. Refer to the figures (Figure 1 and Figure 2) provided below.

- (a) Identify and describe one (1) mutualistic interaction and one (1) other symbiotic interaction shown in Figure 1.

Refer Below - Figure2 : Population Interaction Diagram .

(6 marks)

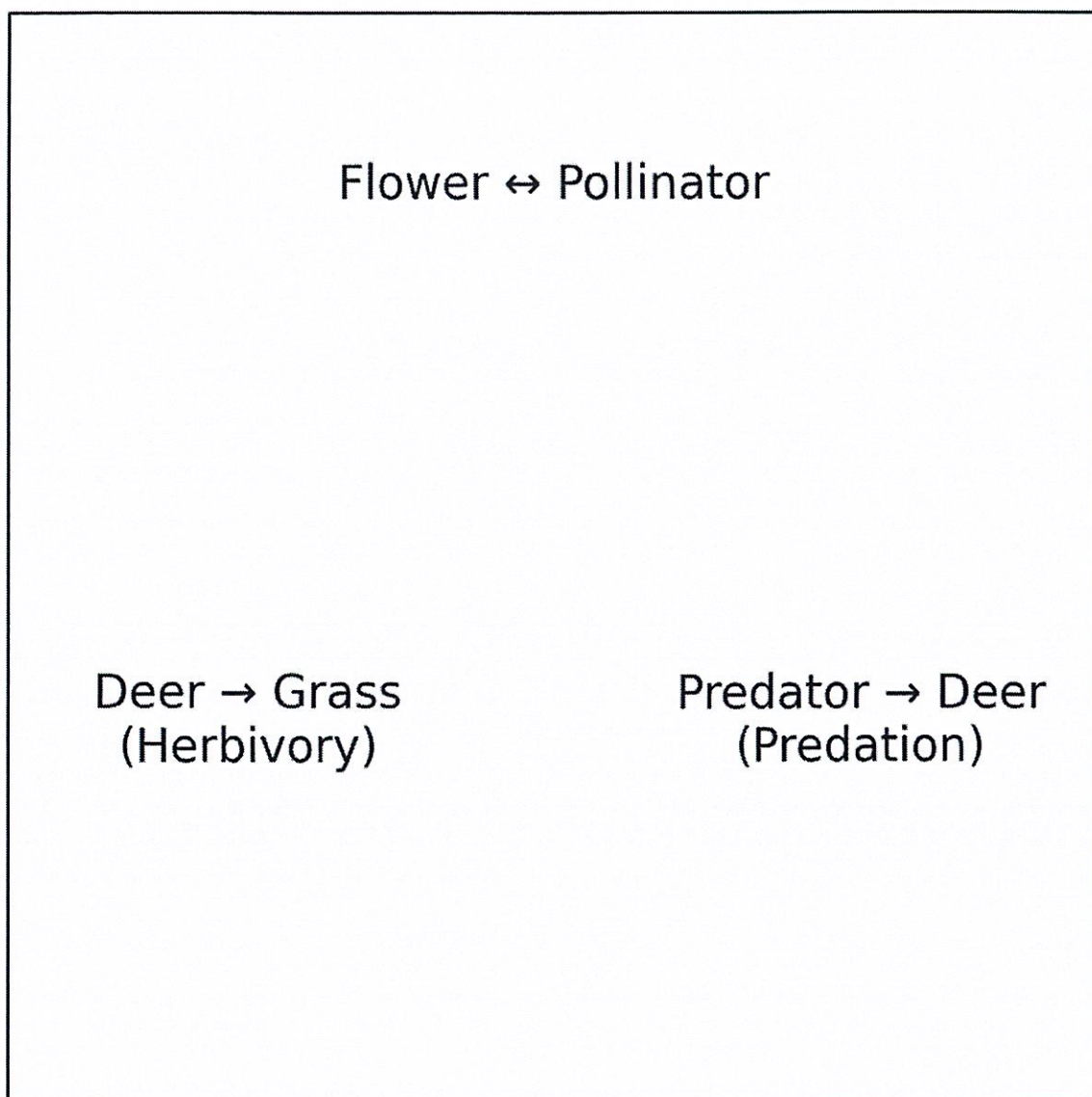


Figure 2: Population Interaction Diagram

- (b) Explain how these interactions influence population size and survival.

(4 marks)

- (c) Explain one (1) density-dependent and one (1) density-independent factor affecting population size shown in Figure 2.

Refer Below - Figure3 : Population Fluctuation in a Grassland Ecosystem .

(6 marks)

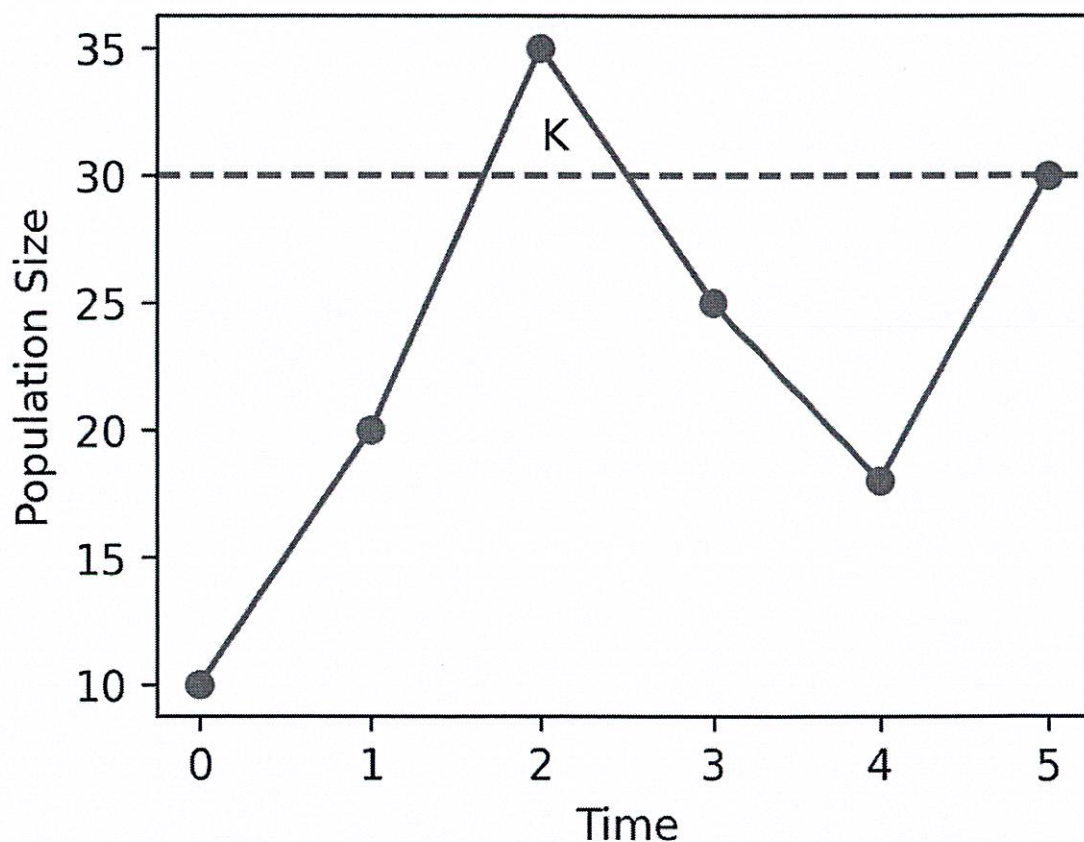


Figure 3: Population Fluctuation in a Grassland Ecosystem

- (d) Discuss how these factors influence population size in relation to carrying capacity (K).

(4 marks)

Question 4

Protein synthesis in eukaryotic cells occurs through translation, which takes place at ribosomes using mRNA and tRNA.

- (a) Explain how mRNA, tRNA, and ribosomes interact during the process of translation to produce a polypeptide chain.

(6 marks)

- (b) Describe the three main stages of translation: initiation, elongation, and termination.

(9 marks)

- (c) Explain how accuracy in amino acid incorporation is ensured during translation.

(5 marks)

END OF EXAMINATION PAPER