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UNIVERSITY OF GREATER MANCHESTER

SCHOOL OF HEALTH, SCIENCE AND SOCIETY

BSc (HONS) MEDICAL BIOLOGY
BSc (HONS) BIOMEDICAL SCIENCE

SEMESTER TWO EXAMINATION 2024/2025

MOLECULAR AND CELLULAR BIOLOGY

MODULE NO: BIO4010

Date: Monday 12 May 2025 **Time: 2.00 pm – 4.30 pm**

INSTRUCTIONS TO CANDIDATES:

Candidates are advised that the examiners attach importance to legibility of writing and clarity of expression. YOU ARE STRONGLY ADVISED TO PLAN YOUR ANSWERS

There are TWO sections.

Answer ALL questions from Section A (MCQS: 75 marks) and Section B (Short answer Qs: 50 marks).

Write all answers in answer booklet, including answers to Section A.

Marks for parts of questions are shown in brackets.

This examination paper carries a total of 125 marks.

Calculators are permitted, but all working must be shown.

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SECTION A: Answer ALL questions in this section in the answer booklet, not on the question paper; 1 mark per question, 75 marks in total.

1. What is the smallest unit of matter that retains the properties of an element?
    a. Molecule.
    b. Atom.
    c. Ion.
    d. Compound.

2. What does Avogadro's constant represent?
    a. The number of molecules in one mole of substance.
    b. The weight of one atom.
    c. The mass of water molecules.
    d. The atomic number of elements.

3. What is the molarity of a solution with 2 moles of solute in 1 litre of solvent?
    a. 2 M.
    b. 1 M.
    c. 0.5 M.
    d. 3 M.

4. Which property makes water an excellent solvent for ionic compounds?
    a. Its high pH.
    b. Its dipole nature.
    c. Its neutral charge.
    d. Its low molecular mass.

5. What is the primary difference between prokaryotic and eukaryotic cells?
    a. Presence of a cell membrane.
    b. Presence of a membrane-bound nucleus.
    c. Ability to reproduce.
    d. Presence of ribosomes.

6. What is the function of the plasma membrane?
    a. To provide structural support.
    b. To regulate the entry and exit of materials.
    c. To synthesize proteins.
    d. To store genetic material.

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7. Which term describes the semi-fluid substance in the cytoplasm?
    a. Cytosol.
    b. Plasma.
    c. Matrix.
    d. Solution.

8. What type of cells contain mitochondria?
    a. Only prokaryotic cells.
    b. All eukaryotic cells.
    c. Plant cells only.
    d. Animal cells only.

9. What is the primary function of DNA?
    a. To store energy.
    b. To form the genetic code.
    c. To synthesise amino acids.
    d. To produce ribosomes.

10. Which sugar is found in the backbone of RNA?
    a. Ribose.
    b. Deoxyribose.
    c. Glucose.
    d. Fructose.

11. What is the difference between deoxyribose and ribose?
    a. Ribose has one less oxygen atom.
    b. Deoxyribose has one less oxygen atom.
    c. Ribose has an additional nitrogen atom.
    d. Deoxyribose has an additional nitrogen atom.

12. What is the width of the DNA double helix?
    a. 2 nm.
    b. 3.4 nm.
    c. 10 nm.
    d. 1.4 nm.

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13. Why does base pairing in DNA occur specifically between A-T and C-G?
    a. Hydrogen bonding patterns and molecule size compatibility.
    b. Base proximity to the sugar-phosphate backbone.
    c. Random interactions between nitrogenous bases.
    d. Differences in electronegativity between paired bases.

14. Which model of DNA replication was supported by the Meselson and Stahl experiment?
    a. Conservative model.
    b. Semiconservative model.
    c. Dispersive model.
    d. Fragmentation model.

15. In eukaryotic cells, why are multiple origins of replication necessary?
    a. To maintain the circular nature of the DNA.
    b. To prevent errors in the replication process.
    c. To speed up the replication of large linear chromosomes.
    d. To synthesize RNA primers effectively.

16. What is the function of Okazaki fragments?
    a. They form continuous strands of DNA on the leading strand.
    b. They result from discontinuous synthesis on the lagging strand.
    c. They repair errors in DNA synthesis.
    d. They initiate RNA primer synthesis.

17. Which strand is synthesized continuously during DNA replication?
    a. Template strand.
    b. Leading strand.
    c. Lagging strand.
    d. Okazaki fragment strand.

18. What is the direction of DNA transcription?
    a. 3' to 5'.
    b. 5' to 3'.
    c. 2' to 4'.
    d. 4' to 2'.

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19. Which sequence is a eukaryotic promoter commonly associated with?
    a. GGGCCC.
    b. TATAAAA.
    c. AAATTT.
    d. CCGGTT.

20. What is the role of mRNA?
    a. Forms the genetic code.
    b. Transports genetic information to ribosomes.
    c. Builds ribosomal subunits.
    d. Replicates DNA strands.

21. What type of RNA is synthesized during transcription?
    a. tRNA.
    b. mRNA.
    c. rRNA.
    d. siRNA.

22. Which amino acid does the codon AUG code for?
    a. Valine.
    b. Methionine.
    c. Leucine.
    d. Glutamic acid.

23. What is the function of the anticodon in tRNA?
    a. Binds to amino acids.
    b. Recognises and binds mRNA codons.
    c. Catalyses peptide bond formation.
    d. Terminates translation.

24. What is the significance of redundancy in the genetic code?
    a. Allows more codons to exist than amino acids.
    b. Prevents nonsense mutations.
    c. Creates overlapping codons.
    d. Stops protein synthesis early.

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25. Where does translation take place in eukaryotic cells?
    a. Nucleus.
    b. Cytoplasm.
    c. Mitochondria.
    d. Smooth endoplasmic reticulum.

26. Which of the following represent a heterozygous genotype?
    a. Aa
    b. aa
    c. AA
    d. None of the above

27. A silent mutation involves:
    a. The creation of a different amino acid.
    b. The creation of a start codon.
    c. The creation of a stop codon.
    d. None of the above

28. Which of the following is a start codon?
    a. UAG
    b. AUG
    c. UAA
    d. UGA

29. Which of the following is an example of a prokaryotic model organism?
    a. *Escherichia coli*
    b. *Saccharomyces cerevisiae*
    c. *Drosophila melanogaster*
    d. None of the above

30. In PCR, which of the following is a cofactor for DNA Polymerase?
    a. dNTPs
    b. Primers
    c. Magnesium
    d. None of the above

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31. Mycotoxins are produced by?
    a. Bacteria
    b. Fungi
    c. Viruses
    d. All of the above

32. In bacteria, peptidoglycan is composed of:
    a. β-(1,4) linked N-acetylglucosamine and N-acetylmuramic acid
    b. β-(1,3) linked N-acetylglucosamine and N-acetylmuramic acid
    c. β-(1,2) linked N-acetylglucosamine and N-acetylmuramic acid
    d. β-(1,6) linked N-acetylglucosamine and N-acetylmuramic acid

33. Which of the following is the target of amphotericin B in the fungal cell wall?
    a. Stigmasterol
    b. Cholesterol
    c. Ergosterol
    d. None of the above

34. Which one of the following is **NOT** associated with bacterial cells?
    a. Lysosomes
    b. Golgi apparatus
    c. Nucleus
    d. All of the above

35. Which of the following describes cholera toxin?
    a. AB2 toxin
    b. AB3 toxin
    c. AB4 toxin
    d. AB5 toxin

36. Which part of bacterial lipopolysaccharide (LPS) has endotoxin activity?
    a. Outer Core
    b. Lipid A
    c. Inner Core
    d. None of the above

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37. The extracellular matrix of a bacterial biofilm can be composed of:
    a. Extracellular DNA
    b. Polysaccharide
    c. Protein
    d. All of the above

38. Which of the following statements is **FALSE** for bacterial plasmids?
    a. Plasmid replication is independent of chromosome replication
    b. Plasmids are double stranded DNA molecules
    c. Plasmids are single stranded DNA molecules
    d. Plasmids are extrachromosomal

39. Which of the following statements about viruses is **TRUE**?
    a. Viruses have membrane-bound organelles.
    b. Viruses replicate independently of the host cell.
    c. Viruses are obligate intracellular pathogens.
    d. Viruses are obligate extracellular pathogens.

40. Which of the following host receptors recognise lipopolysaccharide (LPS) in humans?
    a. Toll-like receptor 4 (TLR4)
    b. Toll-like receptor 5 (TLR5)
    c. Toll-like receptor 8 (TLR8)
    d. Toll-like receptor 9 (TLR9)

41. Which of the following is **NOT** a type of chromosomal aberration?
    a. Inversion
    b. Duplication
    c. Translocation
    d. Conversion

42. Which of the following is **NOT** a key characteristic of a model organism?
    a. Long life cycles
    b. Easy to cross/breed
    c. Characterised genomic sequence
    d. Large numbers of offspring

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43. Point mutations:
    a. Can have no effect on the resulting protein structure
    b. Can have a minor effect on the resulting protein structure.
    c. Can have a major effect on the resulting protein structure.
    d. All of the above are true.

44. Which of the following factors can influence individual immunity?
    a. Age
    b. Malnutrition
    c. Hormones
    d. All of the above.

45. Which of the following are examples of phagocytic cells?
    a. Macrophages
    b. Neutrophils
    c. Dendritic cells
    d. All of the above.

46. Antibodies are made by which of the following cells?
    a. B Lymphocytes
    b. T Lymphocytes
    c. Macrophages
    d. NK cells

47. How many different codons are possible?
    a. 64
    b. 20
    c. 3
    d. An infinite number

48. Which of the following is **NOT** part of PCR?
    a. Degradation
    b. Denaturation
    c. Annealing
    d. Extension

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49. Which of the following are **NOT** part of innate immunity?
    a. Antibodies
    b. Epithelial barriers
    c. Complement
    d. NK cells

50. Which of the following is **NOT** a granulocyte?
    a. Macrophage
    b. Neutrophil
    c. Eosinophils
    d. Basophil

51. Which of the following is **NOT** a component of the eukaryotic cytoskeleton?
    a. Microtubules
    b. Microfilaments
    c. Intermediate filaments
    d. Ribosomes

52. Kinetochores serve as points of attachment for:
    a. Microtubules
    b. Microfilaments
    c. Intermediate filaments
    d. All of the above

53. Which of the following components of the cytoskeleton is composed of actin?
    a. Microtubules
    b. Intermediate filaments
    c. Microfilaments
    d. None of the above

54. Which of the following is a key difference between mitosis and meiosis?
    a. Mitosis produces four daughter cells, meiosis produces two
    b. Mitosis involves two rounds of division, meiosis involves one
    c. Mitosis produces genetically identical cells, meiosis produces genetically diverse cells
    d. Mitosis occurs in gametes, meiosis occurs in somatic cells

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55. During which phase of mitosis do the chromosomes align at the cell's equator?
    a. Prophase
    b. Metaphase
    c. Anaphase
    d. Telophase

56. What is the result of meiosis?
    a. Two diploid cells
    b. Four haploid cells
    c. Two haploid cells
    d. Four diploid cells

57. In meiosis, what is the significance of the reduction division?
    a. It reduces the chromosome number by half
    b. It doubles the chromosome number
    c. It maintains the chromosome number
    d. It increases genetic diversity

58. Which of the following is a characteristic of stem cells?
    a. They can only divide a limited number of times
    b. They are specialized cells
    c. They have the ability to differentiate into various cell types
    d. They cannot self-renew

59. Which stem cells are created by reprogramming adult stem cells?
    a. Embryonic stem cells
    b. Induced pluripotent stem cells
    c. Unipotent stem cells
    d. Totipotent stem cells

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60. What is the main ethical concern associated with the use of embryonic stem cells?
    a. Their ability to cause tumours
    b. The destruction of embryos
    c. Their limited differentiation potential
    d. Their high cost

61. Which of the following are types of protein receptors?
    a. G-protein coupled receptors
    b. Receptor tyrosine kinases
    c. Ligand-gated ion channels
    d. All of the above

62. Which of the following is **NOT** a source of adult stem cells?
    a. Bone marrow
    b. Embryos
    c. Blood
    d. Adipose tissue

63. Which of the following is the main function of the Rough Endoplasmic Reticulum (RER)?
    a. It provides structural support for the cell
    b. It is the main site for energy production in the cell
    c. It is the site of DNA replication in the cell
    d. It is the main site of folding, modifying and transporting proteins

64. Which enzyme in the ER catalyses the formation of disulfide bonds?
    a. BiP
    b. Calnexin
    c. Protein Disulfide Isomerase (PDI)
    d. Oligosaccharide Transferase (OTC)

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65. Which sequence is found on all resident ER proteins for retrieval?
    a. KDEL sequence
    b. NLS sequence
    c. NES sequence
    d. PTS sequence

66. What happens to proteins that are not properly folded in the ER?
    a. They are sent to the Golgi apparatus
    b. They are degraded by the proteasome or autophagy
    c. They are stored in the peroxisome
    d. They are secreted out of the cell

67. What triggers the unfolded protein response (UPR) in the ER?
    a. Accumulation of properly folded proteins
    b. Accumulation of misfolded proteins
    c. Increase in lipid synthesis
    d. Decrease in calcium levels

68. What is the function of ubiquitin in the ERAD pathway?
    a. Synthesizes proteins
    b. Tags misfolded proteins for degradation
    c. Transports lipids
    d. Stores calcium

69. What process involves vesicles fusing with the plasma membrane to release their contents?
    a. Endocytosis
    b. Exocytosis
    c. Autophagy
    d. Retrotranslocation

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70. Which of the following is the primary molecule used for energy storage in cells?
    a. ATP
    b. NADH
    c. FADH2
    d. Glucose

71. What is the main purpose of the citric acid cycle?
    a. To produce glucose
    b. To generate high-energy electron carriers
    c. To store energy as glycogen
    d. To synthesize proteins

72. What is the primary role of the electron transport chain in cellular respiration?
    a. To produce glucose
    b. To generate a proton gradient
    c. To synthesize proteins
    d. To store energy as glycogen

73. Which molecule serves as the final electron acceptor in the electron transport chain?
    a. NAD+
    b. FAD
    c. Oxygen (O2)
    d. Cytochrome c

74. Which protein family plays a crucial role in facilitating vesicle fusion with the plasma membrane during the process of exocytosis?
    a. GTPases
    b. ATPases
    c. SNAREs (Soluble N-ethylmaleimide-sensitive factor Attachment Protein Receptors)
    d. Integrins

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75. What is the net gain of ATP molecules produced directly from glycolysis per molecule of glucose?
    a. 2 ATP
    b. 4 ATP
    c. 6 ATP
    d. 8 ATP

[Total for Section A: 75 marks]

SECTION B: Answer ALL questions in this section in the answer booklet, not on the question paper; 5 marks per question, 50 marks in total.

76. You are working as a technician in a medical laboratory.

    a) Describe how you would make 2 litres of a 0.5 M solution of NaCl. (Molar Mass Na = 22.99; Molar Mass Cl = 35.45).

    (3 marks)

    b) How would you dilute the solution described in part (a) to make 0.20 L of a 100 mM solution?

    (2 marks)

    Total 5 marks

77. Describe the key differences between prokaryotic and eukaryotic cells.

    5 marks

78. Explain the role of tRNA in translation.

    5 marks

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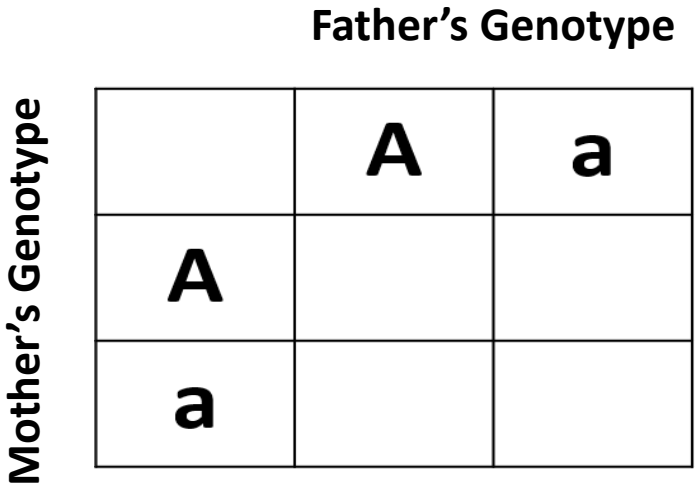
79. a) **In your answer book**, complete the Punnett square shown below.

(3 marks)

b). What percentage offspring are in the heterozygous state?

(2 marks)



Total 5 marks

80. With the aid of a clearly labelled diagram, outline the key structural differences between Gram-positive and Gram-negative bacteria.

5 marks

81. Define the role of complement in innate immunity.

5 marks

82. Outline the steps in a polymerase chain reaction (PCR).

5 marks

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83. Define the common characteristics of signal peptides used in protein targeting.

5 marks

84. Describe the 3 typical modes of endocytosis in eukaryotic cells.

5 marks

85. Describe the difference between an embryonic stem cell and an adult stem cell.

5 marks

[Total for Section B: 50 marks]

END OF QUESTIONS

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FORMULAE SHEET

Molarity and dilution

$$\text{Moles} = \frac{\text{Mass}}{M_r}$$

$$\frac{\text{Moles}}{\text{Solvent volume (L)}} = \text{Molarity (M)}$$

$$\mathbf{M_1V_1 = M_2V_2}$$