

UNIVERSITY OF BOLTON

**SCHOOL OF CLINICAL AND BIOMEDICAL
SCIENCES**

**BSc (Hons) MEDICAL BIOLOGY
BSc (Hons) BIOMEDICAL SCIENCE**

SEMESTER TWO EXAMINATIONS 2023/24

MOLECULAR AND CELLULAR BIOLOGY

MODULE NO: BIO4010

Date: Friday 17 May

Time: 10 – 12.30

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. Unlike RNA, DNA does **NOT** contain:
 - a. Adenine
 - b. Uracil
 - c. Phosphate groups
 - d. Thymine

2. The abbreviation mRNA stands for?
 - a. Messenger ribonucleic acid
 - b. Messenger ribosome acid
 - c. Mixed ribonucleic acid
 - d. Mixed ribosome acid

3. DNA strands run _____ in relation to each other?
 - a. Parallel
 - b. Antiparallel
 - c. Perpendicular
 - d. None of the above

4. Between the two strands of a DNA segment the nitrogen bases are held together by?
 - a. Covalent bonds
 - b. Ionic bonds
 - c. Hydrogen bonds
 - d. Metallic bonds

5. In RNA ribose is a _____ sugar?
 - a. Tetrose
 - b. Pentose
 - c. Hexose
 - d. Heptose

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6. If a double stranded DNA molecule is found to be composed of 40% adenine, how much thymine would be expected?

- a. 10%
- b. 20%
- c. 40%
- d. 80%

7. When NaCl is dissolved in water, the NaCl is the _____ and the resulting liquid is the _____.

- a. Solvent; solution.
- b. Solvent; solute
- c. Solute; solution.
- d. Solute; solvent.

8. _____ are purines, _____ are pyrimidines.

- a. Adenine and Guanine, Cytosine and Thymine.
- b. Cytosine and Guanine, Adenine and Thymine.
- c. Cytosine and Thymine, Adenine and Guanine.
- d. Uracil and Adenine, Thymine and Guanine.

9. If 4 moles of NaCl is dissolved in 500 mL of water, what is the concentration of the resulting solution?

- a. 1 M
- b. 2 M
- c. 4 M
- d. 8 M

10. Which of the following is correct?

- a. Moles = mass \div Mr
- b. Moles = Mr \div mass
- c. Moles = mass \times Mr
- d. Mr = mass \times moles

11. The process by which protein is made from RNA is called?

- a. Transcription
- b. Translation
- c. Replication
- d. None of the above

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12. The three-nucleotide sequence of RNA is called a:
- tRNA
 - Gene
 - Codon
 - None of the above
13. Three nucleotides code for:
- One amino acid
 - Three amino acids
 - One peptide
 - Three peptides
14. A codon in DNA or RNA is a:
- Dinucleotide
 - Trinucleotide
 - Tetranucleotide
 - Pentanucleotide
15. What amino acid does the codon AUG encode?
- Glycine
 - Valine
 - Methionine
 - Valine
16. Which of the following temperatures (in °C) would be appropriate in the denaturation step of a PCR cycle?
- 4
 - 55
 - 72
 - 95
17. The enzyme present in a PCR reaction is:
- DNA ligase
 - RNA polymerase
 - DNA polymerase
 - DNA helicase

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18. A nonsense mutation involves:
- The creation of a different amino acid.
 - The creation of a start codon.
 - The creation of a stop codon.
 - None of the above.
19. Which of the following is **NOT** a stop codon?
- UAG
 - AUG
 - UAA
 - UGA
20. Which of the following are a type of chromosomal aberration?
- Inversion.
 - Duplication.
 - Translocation.
 - All of the above
21. The linkage which joins two amino acid units is called a/an:
- Hydrogen bond
 - Ionic bond
 - Peptide Bond
 - hydrophobic interaction
22. Ribosomes are made up of ____ subunits.
- Two
 - Three
 - Four
 - Five
23. Which of the following represent a heterozygous genotype?
- AA
 - aa
 - Aa
 - None of the above

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

25. For the following DNA template strand, which of the options below corresponds to the mRNA that would be formed following transcription, written 5' to 3'?

Template strand: 3'-C C A C T G A T T-5'

- 5'-C C T G A C T A A-3'
 - 5'-G G U G A C U A A-3'
 - 5'-G G A C T G A T T-3'
 - 5'-G G A C U G A U U-3'
26. The 20 standard amino acids incorporated in protein synthesis are encoded by?
- 3 codons
 - 20 codons
 - 64 codons
 - An infinite number.
27. What does the atomic mass number represent?
- number of protons + number of neutrons
 - number of protons + number of electrons
 - number of neutrons + number of electrons
 - None of the above
28. From its atomic number of 15, it is possible to predict that a phosphorus atom has:
- 15 neutrons
 - 15 protons
 - 15 electrons
 - Only b and c are correct.

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29. Which of the following are examples of model organisms?
- Escherichia coli*
 - Saccharomyces cerevisiae*
 - Drosophila melanogaster*
 - All of the above
30. Which of the following is **NOT** a domain of life?
- Plantae
 - Bacteria
 - Archaea
 - Eukarya
31. Which of the following organelles has membrane-bound ribosomes?
- Smooth endoplasmic reticulum
 - Rough endoplasmic reticulum
 - Golgi apparatus
 - Nucleus
32. In bacteria, peptidoglycan is composed of:
- β -(1,4) linked N-acetylglucosamine and N-acetylmuramic acid
 - β -(1,6) linked N-acetylglucosamine and N-acetylmuramic acid
 - β -(1,2) linked N-acetylglucosamine and N-acetylmuramic acid
 - β -(1,3) linked N-acetylglucosamine and N-acetylmuramic acid
33. Which antibiotic can be used to target ergosterol in the fungal cell wall?
- Penicillin
 - Amphotericin B
 - Methicillin
 - Ampicillin
34. Which one of the following is associated with bacterial cells?
- Lysosomes
 - Ribosomes
 - Nucleus
 - Golgi apparatus
35. The morphology (shape) of bacteria can be:
- Spherical (cocci)
 - Rod (bacilli)
 - Spiral (spirilla)
 - All of the above

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36. Which of the following terms refers to bacteria that have a single flagellum?
- Monotrichous
 - Amphitrichous
 - Lophotrichous
 - Peritrichous
37. A bacterial biofilm can be composed of:
- Protein
 - Polysaccharide
 - Extracellular DNA
 - All of the above
38. Which of the following statements is false for plasmids found in bacteria?
- Plasmid replication is independent of chromosome replication
 - Plasmid replication is dependent on chromosome replication
 - Plasmids are extrachromosomal
 - Plasmids are double stranded DNA molecules
39. Which of the following statements about viruses is false?
- Viruses do not have organelles
 - Viruses cannot replicate independently of the host cell.
 - Viruses are obligate intracellular pathogens
 - Viruses are obligate extracellular pathogens
40. Bacteria that colonise the human host can be classed as:
- Commensals
 - Pathogens
 - Opportunistic pathogens
 - All of the above
41. Which of the following stages in the cell cycle does **NOT** occur during mitosis?
- Interphase
 - Metaphase
 - Anaphase
 - Telophase
42. What part of the cell cytoskeleton is involved in the mitotic spindle?
- Intermediate filaments
 - Microfilaments
 - Microtubules
 - All of the above

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43. How many cell divisions occur in mitosis?
- One
 - Two
 - Three
 - Four
44. A cell that has half the usual number of chromosomes is called what?
- Haploid
 - Diploid
 - Homozygous
 - Heterozygous
45. What is the first stage of mitosis?
- Telophase
 - Anaphase
 - Metaphase
 - Prophase
46. The cells produced by mitosis are called?
- Sister cells
 - Daughter cells
 - Haploid cells
 - Zygotes
47. At the end of Meiosis, how many gamete cells are produced?
- One
 - Two
 - Four
 - Eight
48. Which two processes are involved in mitotic cell division?
- Nuclear duplication and cytoplasmic division
 - Nuclear duplication and cytoplasmic duplication
 - Spermatogenesis and cytoplasmic duplication
 - Oogenesis and cytoplasmic division
49. What is the term used for when a cell physically divides?
- Cytolysis
 - Cytodivision
 - Cytokinesis
 - Cytotransfer

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50. Which of the following is **NOT** a phagocytic cell?
- Macrophage
 - Neutrophil
 - Monocyte
 - Erythrocyte
51. Which of the following are **NOT** part of innate immunity?
- Complement
 - Antibodies
 - Epithelial barriers
 - Phagocytes
52. Which of the following statements about innate immunity is false?
- Innate immunity is non-specific
 - Innate immunity is specific
 - Innate immunity is heritable
 - Innate immunity is memory based
53. Which of the following factors can influence adaptive immunity?
- Hormones
 - Nutrition
 - Age
 - All of the above
54. The role of complement is to:
- Bind covalently to pathogens
 - Act as a chemoattractant for immune cells
 - Creates pores in bacterial membranes
 - All of the above
55. Antibodies are made by which of the following cells?
- B Lymphocytes
 - T Lymphocytes
 - Basophils
 - Neutrophils
56. Which of the following best describes stem cells?
- Cells found only in plant tissues
 - Specialized cells with limited functions
 - Cells capable of self-renewal and differentiation into various cell types
 - Cells exclusively present in bone marrow

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57. What is the primary characteristic that distinguishes embryonic stem cells from adult stem cells?
- Embryonic stem cells have a limited capacity for self-renewal.
 - Adult stem cells are pluripotent, while embryonic stem cells are totipotent.
 - Adult stem cells are derived from the inner cell mass of blastocysts.
 - Embryonic stem cells can differentiate into any cell type in the body.
58. What is the process by which stem cells differentiate into specialized cell types?
- Apoptosis
 - Mitosis
 - Dedifferentiation
 - Cell fate determination
59. What is the primary function of the cytoskeleton in eukaryotic cells?
- Storage of cellular energy
 - Providing structural support and maintaining cell shape
 - Regulating gene expression
 - Facilitating cellular communication
60. Which of the following structures is **NOT** a component of the cytoskeleton?
- Microtubules
 - Actin filaments
 - Ribosomes
 - Intermediate filaments
61. Which of the following involved in electron transport would likely be found in the inner membrane space of mitochondria?
- Cytochrome c
 - Complex II (Succinate dehydrogenase)
 - Complex III (Cytochrome bc1 complex)
 - Complex IV (Cytochrome c oxidase)
62. Which molecule serves as the final electron acceptor in the electron transport chain?
- NAD⁺
 - FAD
 - Oxygen (O₂)
 - Cytochrome c

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63. Which of the following molecules is responsible for co-translational targeting of a polypeptide to the endoplasmic reticulum (ER)?

- a. Mitochondria
- b. Signal recognition particle (SRP)
- c. Protein disulphide-isomerase (PDI)
- d. Actin

64. Which cellular organelle is primarily responsible for coordinating co-translational transport and post-translational modifications of proteins?

- a. Lysosome
- b. Endoplasmic reticulum (ER)
- c. Peroxisome
- d. Golgi apparatus

65. Which of the following best describes the function of tyrosine kinases?

- a. Enzymes that catalyze the dephosphorylation of tyrosine residues in proteins
- b. Enzymes that catalyze the phosphorylation of tyrosine residues in proteins
- c. Enzymes that catalyze the formation of disulfide bonds in proteins
- d. Enzymes that catalyze the phosphorylation of serine and threonine residues in proteins

66. Which of the following is a characteristic feature of receptor tyrosine kinases?

- a. They are exclusively found in the cytoplasm of cells.
- b. They are activated by binding to intracellular signalling molecules.
- c. They primarily function as enzymes involved in lipid metabolism.
- d. They typically possess an extracellular ligand-binding domain and an intracellular kinase domain.

67. Electrical signalling is a method most commonly used by which of the following cell types?

- a. Nerve cells
- b. Epithelial cells
- c. Pancreatic cells
- d. Muscle cells

68. 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

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69. Which of the following two molecules from glycolysis feed directly into the citric acid (TCA) cycle?
- Glucose and fructose
 - Water and oxygen
 - Pyruvate and Acetyl-CoA
 - Glycerol and Pyruvate
70. What is the main role of the Golgi complex in eukaryotic cells?
- To synthesise proteins
 - To generate energy for the cell
 - To process and sort proteins and lipids for transport to their final destination
 - To store DNA
71. Which protein family is responsible for mediating cell-cell adhesion primarily in epithelial tissues?
- Integrins
 - Cadherins
 - Collagens
 - Fibronectins
72. Which of the following is a mechanism of cellular secretion utilized by exocrine glands to release substances such as enzymes and hormones?
- Exocytosis
 - Endocytosis
 - Pinocytosis
 - Phagocytosis
73. Which protein family plays a crucial role in facilitating vesicle fusion with the plasma membrane during the process of exocytosis?
- GTPases
 - ATPases
 - SNAREs (Soluble N-ethylmaleimide-sensitive factor Attachment Protein receptors)
 - Integrins
74. Which of the following is a characteristic feature of SNARE proteins?
- They are primarily located in the nucleus.
 - They are involved in the breakdown of cellular waste.
 - They form a complex that facilitates the fusion of vesicles with target membranes.
 - They are exclusively found in prokaryotic cells.

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75. Which of the following SNARE proteins is typically located on the vesicle membrane

during membrane fusion events?

- a. VAMP (Synaptobrevin)
- b. Syntaxin
- c. SNAP-25
- d. Rab

[Total for Section A: 75 marks]

SECTION B: Answer ALL questions in this section; 5 marks per question, 50 marks in total.

1. Describe using a clearly labelled diagram, the structure of a nucleotide.

[5 marks]

2. Identify the differences between a bacterial cell and an animal cell.

[5 marks]

3. Using a clearly labelled diagram, distinguish between the Gram-positive and Gram-negative bacterial cell envelopes.

[5 marks]

4. Outline the stages of mitosis.

[5 marks]

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

- a) Describe how you would make 500 mL of a 0.4 M solution of CaCl_2 .
(Molar Mass Ca = 40.08; Molar Mass Cl = 35.45).

[3 marks]

- b) How would you dilute the solution described in part (a) to make 0.25 L of a 200 mM solution?

[2 marks]

[Total 5 marks]

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6. Explain with reference to Table 1, the consequences of point mutations in a codon sequence can have on the amino acid that is produced.

[Total 5 marks]

Table 1: The Genetic Code

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

7. Define the common characteristics of a signal peptides used in protein targeting?

[5 marks]

8. Describe how stem cells differ from other cells and explain what the term cell potency means?

[5 marks]

9. Name one protein that is integral to the cytoskeleton in eukaryotic cells, highlighting its significance in cellular structure, organization and movement?

[5 marks]

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10. Cellular respiration is the process by which the cell generates energy in the form of ATP. Name the 3 major pathways involved in cellular respiration and explain which generates the most energy for the cell.

[5 marks]

[Total for Section B: 50 marks]

END OF QUESTIONS

PAST EXAMINATION