

UNIVERSITY OF BOLTON

**SCHOOL OF CLINICAL AND BIOMEDICAL
SCIENCES**

**BSc (Hons) MEDICAL BIOLOGY WITH FOUNDATION
and BSc (Hons) BIOMEDICAL SCIENCE WITH
FOUNDATION**

SEMESTER TWO EXAMINATIONS 2023/24

PRINCIPLES OF BIOMOLECULAR SCIENCE

MODULE NO: BIO3025

Date: Wednesday 15 May 2024

Time: 10 - 12

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 and Section B.

WRITE ALL ANSWERS IN ANSWER BOOKLET.

Marks for parts of questions are shown in brackets.

This examination paper carries a total of 80 marks.

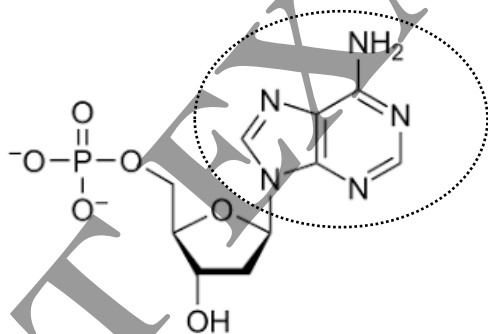
Calculators are permitted, but all working must be shown.

SECTION A: Answer ALL questions in this section; 1 mark per question, 40 marks in total. Students should spend approximately 50 minutes on this section.

1. Which of the following subatomic particles is **NOT** found in the nucleus of an atom?
 - a. Protons
 - b. Electrons
 - c. Neutrons
 - d. All of these particles are found in the nucleus
2. Which of the following correctly describes an isotope?
 - a. An element with a negative charge
 - b. Two or more forms of the same element with different mass numbers
 - c. Two or more forms of the same element with different numbers of protons
 - d. An element with an odd number of electrons
3. Which of the following best describes a covalent bond?
 - a. A positive dipole interacting with a negative dipole
 - b. The donation of electron from one atom to another
 - c. The sharing of electrons between two atoms
 - d. The interaction between a positive and negative ion
4. How many electrons does the element $^{14}_7\text{N}$ have?
 - a. 14
 - b. 7
 - c. 21
 - d. 12
5. Oxygen has the chemical symbol $^{16}_8\text{O}$. Which of the following unknown elements X is likely to be an isotope of oxygen?
 - a. $^{17}_8\text{X}$
 - b. $^{16}_7\text{X}$
 - c. $^{16}_8\text{X}$
 - d. $^{16}_9\text{X}$

Please turn the page

6. If 4 moles of MgCl_2 is dissolved in 500 mL of water, what is the concentration of the resulting solution?
- 0.04 M.
 - 8 M.
 - 20 M.
 - 4 M.
7. Which of the following is **NOT** found in an animal cell?
- Cell wall
 - Cytoplasm
 - Nucleus
 - Mitochondria
8. DNA is made up from a sequence of nucleotides. Which of the following are **NOT** found in DNA?
- Adenosine
 - Thymine
 - Uracil
 - Guanine
9. A DNA nucleotide has the following structure:



What component of a nucleotide has been circled?

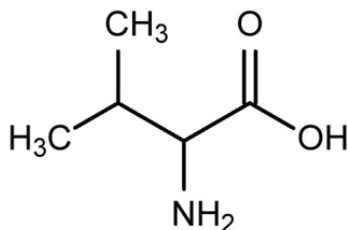
- The phosphate group
- The sugar molecule
- The nucleotide base group
- The amino acid

Please turn the page

10. In which process is mRNA synthesised from a DNA template?
- Transcription
 - Translation
 - Replication
 - Reverse Transcription
11. Which of the following is the correct pairing of the DNA bases?
- AG and CT
 - CG and AT
 - CC, GG, AA, TT
 - None of the above
12. What is the primary function of ribosomes?
- The synthesis of proteins from mRNA
 - The synthesis of mRNA from DNA
 - The splicing of mRNA
 - The repair of damaged DNA
13. Which of the following statements is correct when mutations occur in DNA?
- Mutations only ever occur in protein-coding regions
 - Mutations always cause changes to the shape of proteins
 - Mutations always cause changes to the protein sequence
 - Mutations always cause changes to the DNA sequence
14. Which of the following RNA sequences would be made from the DNA sequence **5'ATGCTCAGGTA CTGA 3'**?
- ATGCTCAGGTA CTGA
 - TCAGTACCTGAGCAT
 - AUGCUCAGGUACUGA
 - UCAGUACCUGAGCAU
15. Alpha helices and beta sheets are examples of which level of protein structure?
- Primary structure
 - Secondary structure
 - Tertiary structure
 - Quaternary structure

Please turn the page

16. The amino acid valine has the following structure:



Which of the following best describes the properties of its side chain?

- a. Uncharged, non-polar side chain
- b. Positively charged, hydrophilic side chain
- c. Polar, hydrophilic side chain
- d. Uncharged, polar side chain

17. Which of the following bonds connects two monosaccharides to make a disaccharide?

- a. Peptide bond
- b. Double bond
- c. Glycosidic bond
- d. Amide bond

18. Which type of carbohydrate is used as an energy storage molecule in animal cells?

- a. Glycogen
- b. Starch
- c. Cellulose
- d. Chitin

19. Which organ is responsible for producing insulin in response to low blood sugar?

- a. The liver
- b. The kidneys
- c. The brain
- d. The pancreas

20. The plasma membrane is made up primarily of which types of lipids?
- Steroids
 - Triglycerides
 - Phospholipids
 - All of the above
21. Triglycerides are used for the long-term storage of energy in cells. Which of the following properties makes them suitable for this?
- Triglycerides are hydrophilic so they can dissolve easily in cells
 - Triglycerides contain many high-energy carbon-oxygen bonds
 - Triglycerides are hydrophobic so they don't attract water into cells
 - None of the above
22. Which of the following factors can affect enzyme activity?
- Temperature
 - The concentration of enzyme cofactors
 - Substrate concentration
 - All of the above
23. Enzymes speed up reactions by _____.
- Increasing the temperature of reactants
 - Lowering the activation energy of a reaction
 - Providing energy for reactions
 - Being incorporated into the products of a reaction
24. What is the net production of ATP molecules from one molecule of glucose in the process of glycolysis?
- 2 ATP molecules
 - 4 ATP molecules
 - 6 ATP molecules
 - 0 ATP molecules

25. Which type of membrane transport does **NOT** require membrane proteins?

- a. Active transport
- b. Facilitated diffusion
- c. Osmosis
- d. Receptor-mediated endocytosis

26. Penicillin is a competitive enzyme inhibitor used commonly as an antibiotic. Which of the following statements about penicillin is true?

- a. Penicillin binds permanently to the enzyme active site and blocking it
- b. Penicillin has a similar shape to the enzyme's natural substrate
- c. Penicillin interacts with the allosteric site to change the enzyme shape
- d. Penicillin is often used to treat viral infections

27. Which of the following molecules can diffuse freely across cell membranes?

- e. Carbon dioxide
- f. Polypeptides
- g. Sodium ions
- h. Glucose

28. Paracrine signalling describes which of the following scenarios?

- a. Signalling from one cell to another nearby cell via physical contact
- b. Signalling from one cell to another far away via the release of molecules into the blood stream
- c. Signalling from one cell to itself via its own signalling molecules
- d. Signalling from one cell to another nearby cell via local diffusion

29. **Glucose + _____ → Water + ATP + Heat + Carbon dioxide**

The above equation represents the process of cellular respiration. Fill in the missing component:

- a. Energy
- b. Triglycerides
- c. Oxygen
- d. Amylase

30. Which of the following is **NOT** a stage in cellular respiration?
- Glycolysis
 - Gluconeogenesis
 - The electron transport chain
 - Krebs cycle
31. The gene responsible for causing Cystic fibrosis is recessive (c). Which of the following genotypes will result in disease?
- CC
 - Cc
 - cc
 - All of the above
32. Which of the following is a desirable trait in a model organisms?
- They have a long life cycle
 - Their genome is well-characterised
 - Their cells have more than two copies of each gene
 - They produce low numbers of offspring
33. How many molecules of DNA would be expected after 10 rounds of PCR, if a single molecule of DNA was used as an initial template?
- 1
 - 10
 - 20
 - 1024
34. Charles Darwin observed native Finch populations in the Galapagos islands. He noticed that the finches found on different islands were similar, but unable to reproduce with each other. Which of the following best describes the process that took place?
- Natural selection
 - Allopatric speciation
 - Sympatric speciation
 - Artificial selection

39. Finish the following sentence:

Innate immunity...

- Is activated within a few hours of infection
- Requires previous exposure to a disease to be effective
- Depends on the production of antibodies
- Is enhanced upon re-exposure to the same disease

40. Which of the following is NOT an example of a phagocytic cell?

- Macrophage
- Dendritic cell
- Neutrophil
- Red blood cell

[Total for Section A: 40 marks]

SECTION B: Answer ALL questions in this section; 40 marks in total. Students should spend approximately 70 mins on this section.

For Section B Q1, write all answers to 2 decimal places:

- This question is about MgCl_2 (MW: 95)
 - How many grams of MgCl_2 would be required to be added to 1.5 litres of water to make a 1M solution? **[2]**
 - What is the concentration of a solution with a volume of 3 litres containing 130 grams of MgCl_2 ? (Moles = Mass/Mr) **[2]**
 - Using the concentration calculated in question 1b, what would the concentration be if the solution was subjected to heat and 2 litres of water were lost, giving a final volume of 1 litre? **[3]**
 - How much water would you need to add if you were to dilute Solution 1c to final concentration of 0.5M? **[3]**

[Total: 10 marks]

Please turn the page

2. Briefly describe the differences between innate and acquired immunity. In your answer, give clear examples of both.

[5 marks]

3. Gene A has the following sequence: **ATGTTTCCTGAGGCGGCAGGCGGGTGA**

		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	

- a. Write down the mRNA sequence that would be produced from gene A. [1]
- b. Using the codon table provided, write down the amino acid sequence that would be produced from gene A. [2]
- c. A mutation in gene A has resulted in the amino acid proline (Pro) changing to the amino acid Glycine (Gly). Write down one possible DNA sequence for gene A following this mutation. [2]

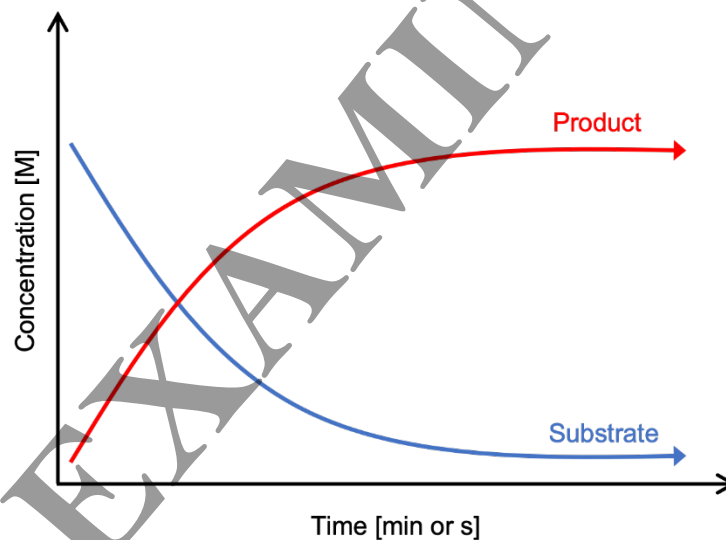
[5 marks]

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4. This question is about the chemical properties of water and sodium chloride.

- Draw the electronic structures of Hydrogen (${}^1_1\text{H}$), Oxygen (${}^{16}_8\text{O}$), Sodium (${}^{23}_{11}\text{Na}$) and Chlorine (${}^{35}_{17}\text{Cl}$). **[3]**
- Draw the electronic structures of water (H_2O) and Sodium chloride (NaCl). **[1]**
- Briefly describe the key features of hydrogen bonding and ionic bonding. Use diagrams to support your answer. **[3]**
- Unlike water, sodium and chloride ions are unable to diffuse freely across cell membranes. Briefly explain why, referring to their differing chemical properties in your answer. **[3]**

[10 marks]



Please turn the page

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Principles of Biomolecular Science
Module No. BIO3025

5. The enzyme maltase converts maltose into glucose. The above graph shows how the concentrations of maltose and glucose change over time under the following conditions: Temperature = 37 °C, pH = 7, concentration of maltose = 1 M, concentration of maltase = 0.01 M.

For each of the following conditions, copy this graph and add new lines to illustrate how the concentrations of product and substrate will differ compared to the original reaction.

- a. Temperature = 20 °C [1]
- b. pH = 12 [1]
- c. Concentration of maltase = 0.1 M [1]
- d. Concentration of maltose = 3 M [2]

[5 marks]

6. Describe the two types of eukaryotic cell division, highlighting any similarities and differences.

[5 marks]

[Total for Section B: 40 marks]

END OF QUESTIONS

PAST EXAMINATION