

UNIVERSITY OF BOLTON

**SCHOOL OF CLINICAL AND BIOMEDICAL
SCIENCES**

**BSC (HONS) MEDICAL BIOLOGY
BSC (HONS) BIOMEDICAL SCIENCE**

SEMESTER TWO EXAMINATIONS 2023/24

INTRODUCTION TO BIOCHEMISTRY

MODULE NO: BIO4007

Date: Tuesday 14th May 2024

Time: 10.00 – 12.00

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.

Write ALL answers in answer booklet for both sections (including multiple choice questions), NOT on the question paper. Marks for parts of questions are shown in brackets.

This examination paper carries a total of 100 marks.

A scientific calculator is required.

There is a formulae sheet at the end of this paper.

All working must be shown.

This examination is TWO hours long.

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SECTION A: Answer ALL questions in this section; 1 mark per question, 60 marks in total. Each question has one correct answer. Please answer the questions in your answer booklet, not on the question paper. It is recommended that you spend approximately 65 minutes on this section.

1. How many L are there in 8.6mL?
 - a. 8600
 - b. 0.0086
 - c. 0.86
 - d. 8.6×10^{-6}
2. Which of the following statements about water molecules is **NOT** true?
 - a. The molecule is held together by covalent bonds.
 - b. The molecule has a dipole.
 - c. The molecule is ionic.
 - d. The molecule contains three atoms.
3. Which of the following bonds is the weakest?
 - a. Covalent.
 - b. Ionic.
 - c. Hydrogen.
 - d. Peptide.
4. Which of the following are **NOT** important when considering how electrons are configured in an atom?
 - a. Aufbau principle.
 - b. Hund's rule.
 - c. Pauli's principle.
 - d. Bronsted-Lowry rule.
5. Which of the following statements is **NOT** true?
 - a. Electrons fill orbitals of progressively higher energy.
 - b. Noble elements tend to be unreactive because they have an incomplete valence shell.
 - c. An orbital contains no more than two electrons.
 - d. Degenerate orbitals are partially filled before any orbital is completely filled

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6. Which of the following is **NOT** an example of a typical shape adopted by molecules:
- Bilateral.
 - Tetrahedral.
 - Trigonal planar.
 - Pyramidal.
7. What type of bond is found between iron and nitrogen in a molecule of haem?
- Double covalent.
 - Hydrophobic.
 - Ionic.
 - Coordinate.
8. Which of the following is the correct electronic configuration for calcium (atomic number = 20)?
- $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2$.
 - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$.
 - $1s^2 2s^2 2p^6 3s^2 3p^8$.
 - $1s^2 2s^2 2p^7 3s^2 3p^7$.
9. Which of the following equations is **NOT** balanced correctly:
- $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
 - $Cu + 2HNO_3 \rightarrow Cu(NO_3)_2 + 2H_2O + NO$
 - $2KClO_3 \rightarrow 2KCl + 3O_2$
 - $NaH + H_2O \rightarrow NaOH + H_2$
10. _____ is the determination of the proportions in which elements or compounds react with one another. (*Fill in the blank*).
- Chronometry.
 - Alkalimetry.
 - Stoichiometry.
 - Nephelometry.

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11. In a chemical reaction, 20 g of sodium hydrogen carbonate is produced. The reaction takes 12 minutes. What is the mean rate of the reaction in g s^{-1} ?

- a. 36.000 g s^{-1} .
- b. 0.028 g s^{-1} .
- c. 0.600 g s^{-1} .
- d. 1.667 g s^{-1} .

12. According to Le Chatelier's principle, which of the following does **NOT** affect the position of chemical equilibrium?

- a. Concentration.
- b. Pressure.
- c. Temperature.
- d. The presence of an enzyme.

13. If a solution of hydrochloric acid has a pH of 3, what would the concentration of H^+ in the solution be?

- a. $3 \times 10^{-1} \text{ M}$.
- b. $1 \times 10^{-3} \text{ M}$.
- c. $1 \times 10^3 \text{ M}$.
- d. $-1 \times 10^{-3} \text{ M}$.

14. Which of the following statements are **TRUE** for this reaction:



- a. H_2CO_3 acts as a base.
- b. The equilibrium shifts to the left in response to a drop in pH.
- c. The equilibrium shifts to the right in response to a drop in pH.
- d. The equation is not correctly balanced.

15. Which of the following is **NOT** an example of a common buffer?

- a. PBS.
- b. HEPES.
- c. PTEN.
- d. TRIS.

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16. At pH7, a solution has:
- More OH⁻ ions than H⁺ ions.
 - An equal number of OH⁻ ions and H⁺ ions.
 - Less OH⁻ ions than H⁺ ions.
 - No H⁺ ions.
17. Which of the following is the best definition of a buffer?
- A strong base and a weak acid.
 - A weak base and a strong acid.
 - A strong acid and its conjugate base.
 - A weak acid and its conjugate base.
18. Bonds formed between carbohydrate molecules are known as:
- Glycolipid bonds.
 - Hydrogen bonds.
 - Glycosidic bonds.
 - Polar bonds.
19. Organic compounds which contain a delocalised ring of electrons are known as what?
- Aliphatic compounds.
 - Aromatic compounds.
 - Algebraic compounds.
 - Alithartic compounds.
20. Starch is formed from polymerised:
- Glucose.
 - Lactose.
 - Fructose.
 - Xylose.
21. There are two forms of carbohydrates:
- Aldoses and Esters.
 - Esters and Alkanes.
 - Alkanes and Ketoses.
 - Aldoses and Ketoses.

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22. The presence of a double bond makes a fatty acid:
- Saturated.
 - Hydrogenated.
 - Oxygenated.
 - Unsaturated.
23. The fatty acids in a phospholipid molecule attach to:
- Inositol.
 - Glycerol.
 - Phosphate.
 - Glucose.
24. Lipids are primarily synthesised in the:
- Nucleus.
 - Smooth endoplasmic reticulum.
 - Mitochondria.
 - Cytosol.
25. Cholesterol is essential for normal membrane functions because it:
- Allows proteins to be incorporated in the membrane.
 - Spans the thickness of the bilayer.
 - Controls membrane fluidity.
 - Transports ions across the membrane.
26. Which of the following is **NOT** an active method where molecules pass across the plasma membrane?
- Simple diffusion.
 - Active transport.
 - Endocytosis.
 - Exocytosis.
27. At pH7, amino acids are:
- Always negatively charged.
 - Always positively charged.
 - Always uncharged.
 - Sometimes charged and sometimes uncharged.

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28. Which of the following is **NOT** a fibrous protein?
- Collagen.
 - Keratin.
 - Elastin.
 - Porin.
29. Which of the following is an example of protein secondary structure?
- Disulphide bridges.
 - Multiple subunits.
 - Dative bonding.
 - β -pleated sheets.
30. The primary structure of a protein is held together by:
- Hydrogen bonds.
 - Ionic bonds.
 - Glycosidic bonds.
 - Peptide bonds.
31. Proteins are made from long, folded chain molecules. What are these chains called?
- Polysaccharides.
 - Polypeptides.
 - Polynucleotides.
 - Fatty acids.
32. The most common covalent cross-links in proteins are sulphur–sulphur bonds that form between two amino acids with SH (thiol) groups as side chains. Which amino acid has this side chain?
- Tryptophan.
 - Methionine.
 - Cysteine.
 - Proline.
33. If a protein has become glycosylated, what group has been attached to it?
- Nucleic acid.
 - Lipid.
 - Sugar.
 - Glycerol.

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34. The overall ΔG for an anabolic reaction is:
- Positive.
 - Negative.
 - Zero.
 - Incalculable.
35. If the Standard Gibb's free energy, ΔG , for a reaction is positive then:
- The products will be favoured.
 - The reactants will be favoured.
 - The concentration of the reactants and products will be equal.
 - All of the reactant will be converted to product.
36. Which of the following statements is **TRUE**?
- All anabolic reactions require energy input to proceed.
 - All catabolic reactions require energy input to proceed.
 - All metabolic reactions require energy input to proceed.
 - All chemobolic reactions require energy input to proceed.
37. Energy is released when:
- ATP is added to a molecule of ATP.
 - A phosphate group is released from a molecule of ATP.
 - A phosphate group is either added or released from a molecule of ATP.
 - A potassium atom is released from a molecule of ATP.
38. Which of the following is **NOT** true for an enzyme-catalysed reaction?
- The E_A for the reaction is changed compared to that for the same reaction without the enzyme.
 - The overall ΔG for the reaction is smaller compared to that for the same reaction without the enzyme.
 - The enzyme structure is unchanged as a result of the reaction.
 - The enzyme can be used many times.
39. Which part of an enzyme typically binds to a substrate?
- The framework.
 - The active site.
 - The prosthetic group.
 - The side chain.

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40. Which of the following enzymes is an example of an enzyme that works best at a pH of around 2?

- a. Lipase.
- b. Amylase.
- c. Trypsin.
- d. Pepsin.

41. Some enzymes require non-protein helper molecules for catalytic activity. What are these non-protein molecules known as?

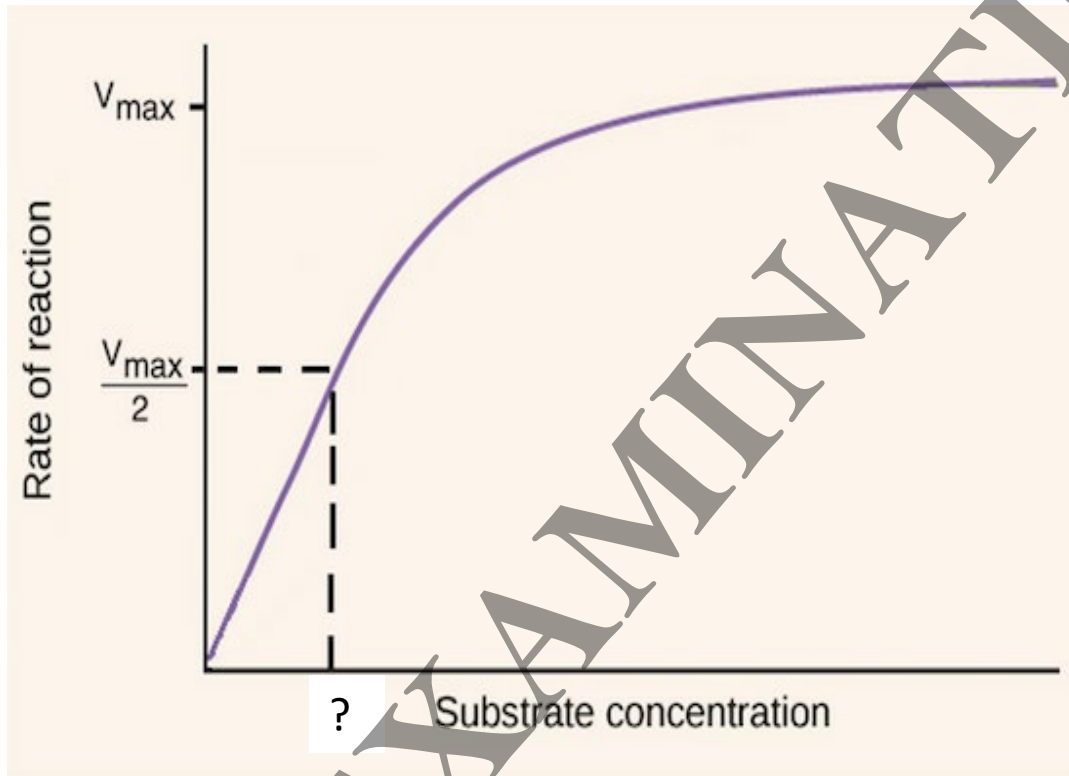
- a. Cofactors.
- b. Chaperones.
- c. Proteasomes.
- d. Ligases.

42. Which of the following is **NOT** a type of enzyme inhibition?

- a. Competitive.
- b. Accumulative.
- c. Non-competitive.
- d. Suicide.

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43. Which constant is defined as the concentration at which the enzyme velocity is 50% of its maximum (i.e. the “?” on the figure below)?



- a. K_a .
- b. K_d .
- c. K_m .
- d. K_w .

44. Which of the following is **TRUE** with regards to competitive inhibitors?

- a. V_{\max} is increased.
- b. V_{\max} is decreased.
- c. V_{\max} is unchanged.
- d. V_{\max} cannot be measured.

45. Which of the following is **NOT** a type of enzyme inhibition?

- a. Competitive.
- b. Accumulative.
- c. Non-competitive.
- d. Suicide.

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46. Which of the following are **NOT** typically found coupled to a high-performance liquid chromatography (HPLC) system?

- a. Mass spectrometry system.
- b. Ultraviolet detector.
- c. SDS-PAGE system.
- d. Photodiode array detector.

47. Which of the following is **NOT** an example of a spectroscopic technique?

- a. UV-Vis.
- b. NMR.
- c. IR.
- d. GAPDH.

48. HPLC can be used to separate protein molecules on the basis of their what?

- a. Affinity.
- b. Charge.
- c. Hydrophobicity.
- d. All of the above.

49. You are trying to separate two proteins of different sizes using size-exclusion chromatography. In what order will they elute from the column?

- a. Largest first followed by smallest.
- b. Smallest first followed by largest.
- c. Largest at the same time as smallest.
- d. Largest first, with smallest not eluting at all.

50. Which of the following is **NOT** a stage in the mass spectrometry process?

- a. Ionisation.
- b. Deflection.
- c. Adsorption.
- d. Detection.

51. Which of the following is **NOT** an example of protein post-translational modification?

- a. Methylation.
- b. Calcification.
- c. Ubiquitylation.
- d. Glycosylation.

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52. An essential amino acid is what?
- An amino acid that needs to be obtained via the diet.
 - An amino acid that can be synthesised by the body.
 - An amino acid that is toxic in high amounts.
 - An amino acid that is used as a precursor for nucleotide synthesis.
53. Where does a carboxypeptidase cut?
- In the middle of a protein.
 - At the C-terminal end of a protein.
 - At the N-terminal end of a protein.
 - At random points within in the protein.
54. What are the two most common products of amino acid deamination?
- Stearic acid and linoleic acid.
 - Cytosine and thymine.
 - Glucose and fructose.
 - Glutamate and aspartate.
55. Which of the following genetic disorders is caused by a mutation in the enzyme which produces tyrosine?
- Sickle cell anaemia.
 - Spinal muscular atrophy.
 - Phenylketonuria.
 - Cystic fibrosis.
56. Amino acids can be metabolised and used as precursors for the synthesis of a variety of molecules. Which of the following can **NOT** be made as a consequence of amino acid metabolism?
- Methionine.
 - Purines.
 - Neurotransmitters.
 - Phospholipids.

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57. Which of the following types of proteins are **NOT** one of the four common drug targets?

- a. Receptor proteins.
- b. Enzymatic proteins.
- c. Structural proteins.
- d. Transporter proteins.

58. What does the term "LD50" refer to?

- a. Median lethal dose.
- b. Minimum lethal dose.
- c. Maximum lethal dose.
- d. Modal lethal dose.

59. Which of the following terms refers to the study of the biochemical and physiological effects of drugs?

- a. Pharmacogenomics.
- b. Pharmacokinetics.
- c. Pharmacodynamics.
- d. Pharmacology.

60. Most mixed function oxidases belong to which family?

- a. Flavoprotein.
- b. Glycoside hydrolase.
- c. G-protein coupled receptors.
- d. Cytochrome P450.

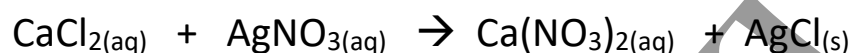
[Total for Section A: 60 marks]

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SECTION B: Answer ALL questions in this section; 5 marks per question, 40 marks in total. It is recommended that you spend approximately 55 minutes on this section.

1. a) Write the following equation in your answer book, and then balance it correctly.



1 mark

b) Calculate the mass of CaCl_2 required to make 1.5 L of a 3 M CaCl_2 aqueous solution (Molar Mass Ca = 40.08; Molar Mass Cl = 35.45).

2 marks

c) Explain how you would dilute the solution prepared in (b) to make 2 L of a 750 mM CaCl_2 aqueous solution.

2 marks

[Total 5 marks]

2. Describe two spectroscopic techniques that can be used in biochemical experiments, including an account of why the techniques are used.

5 marks

3. What is meant by the term “activation energy”, and how is this affected by enzymes?

5 marks

4. Name and describe the four levels of protein structure.

5 marks

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5. With reference to atomic structure, explain how covalent bonds form.

5 marks

6. a) What is the pH of a solution containing 2.6×10^{-5} M hydrochloric acid (HCl)?

2 marks

b) What is the concentration of OH^- in a solution with a pH of 10.2?

3 marks

[Total 5 marks]

7. Briefly discuss the stages of the urea cycle. In your answer, state why this cycle is important.

5 marks

8. Briefly discuss the different options when it comes to the administration of drugs.

5 marks

[Total for Section B: 40 marks]

END OF QUESTIONS

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FORMULAE SHEET**Molarity and dilution**

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

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

$$M_1V_1 = M_2V_2$$

pH

$$K_w = [\text{H}^+][\text{OH}^-] = 1.0 \times 10^{-14} \text{ M}^2$$

$$\text{pH} = -\log [\text{H}^+]$$

$$[\text{H}^+] = 10^{-\text{pH}}$$