

UNIVERSITY OF GREATER MANCHESTER
SCHOOL OF HEALTH, SCIENCE AND SOCIETY
BSc (HONS) MEDICAL BIOLOGY
BSc (HONS) BIOMEDICAL SCIENCE
SEMESTER TWO EXAMINATION 2024/2025
INTRODUCTION TO BIOCHEMISTRY
MODULE NO: BIO4007

Date: Thursday 15 May 2025

Time: 2.00 pm – 4.00 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.

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 4.4mL?
 - a. 0.44
 - b. 0.0044
 - c. 4400
 - d. 4.4×10^{-6}

2. What term describes molecules that repel water?
 - a. Hydrophobic.
 - b. Hydrophilic.
 - c. Polar.
 - d. Ionic.

3. Which of the following best describes a molecule with polar covalent bonds?
 - a. It has equal charge distribution.
 - b. It is hydrophobic.
 - c. It has dipoles.
 - d. It resists solubility.

4. What is the charge on a chloride ion?
 - a. Neutral.
 - b. Positive.
 - c. Negative.
 - d. Depends on the atom.

5. What happens to the valence electron of a sodium atom in NaCl?
 - a. It becomes shared with chlorine.
 - b. It is transferred to chlorine.
 - c. It combines with protons.
 - d. It remains unpaired.

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6. What is the maximum number of electrons that the first electron shell can hold?
- 2.
 - 8.
 - 18.
 - 32.
7. Which principle states that electrons fill the lowest energy orbitals first?
- Hund's rule.
 - Pauli exclusion principle.
 - Aufbau principle.
 - Octet rule.
8. What is the shape of a methane (CH_4) molecule?
- Linear.
 - Trigonal planar.
 - Tetrahedral.
 - Bent.
9. What is the electronic configuration of magnesium (12 electrons)?
- $1s^2 2s^2 2p^6 3s^2$.
 - $1s^2 2s^2 2p^6 3s^1$.
 - $1s^2 2s^2 2p^6 3p^2$.
 - $1s^2 2s^2 2p^6 3d^2$.
10. _____ is the determination of the proportions in which elements or compounds react with one another. (*Fill in the blank*).
- Chronometry.
 - Alkalimetry.
 - Stoichiometry.
 - Nephelometry.
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} ?
- 36.000 g s^{-1} .
 - 0.600 g s^{-1} .
 - 1.667 g s^{-1} .
 - 0.028 g s^{-1} .

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12. What is the aim of chemical bonding?
- To break valence shells.
 - To fill valence shells.
 - To create lone pairs.
 - To form non-bonding pairs.
13. If a solution of hydrochloric acid has a pH of 4, what would the concentration of H^+ in the solution be?
- $4 \times 10^{-1} \text{ M}$.
 - $1 \times 10^{-4} \text{ M}$.
 - $1 \times 10^4 \text{ M}$.
 - $-1 \times 10^{-4} \text{ M}$.
14. What is the definition of reaction rate?
- The change in concentration of a reactant or product over time.
 - The speed at which a catalyst works.
 - The amount of energy required to start a reaction.
 - The equilibrium position of a reaction.
15. What is dynamic equilibrium?
- When a reaction stops completely.
 - When reactants and products are present in concentrations that no longer change with time.
 - When the forward reaction is faster than the reverse reaction.
 - When the reverse reaction is faster than the forward reaction.
16. What ion is formed when a proton combines with water?
- Hydroxide ion.
 - Hydronium ion.
 - Hydrogen ion.
 - Oxygen ion.
17. What is a Bronsted-Lowry acid?
- A proton acceptor.
 - A proton donor.
 - A hydroxide donor
 - A hydroxide acceptor.

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18. What happens to the pH of a solution when an acid dissolves in water?
- It increases.
 - It decreases.
 - It remains the same.
 - It becomes neutral.
19. What is the conjugate base of ethanoic acid (CH_3COOH)?
- CH_3COO^- .
 - CH_3^- .
 - OH^- .
 - COO^- .
20. What is the pH of blood in a healthy individual?
- 7.0.
 - 7.35-7.45.
 - 6.5-7.0.
 - 8.0-8.5.
21. Which of the following is an aromatic compound?
- Ethane.
 - Benzene.
 - Propane.
 - Butane.
22. What is the simplest form of hydrocarbon chain with single C-C bonds called?
- Alkene.
 - Alkyne.
 - Alkane.
 - Aromatic.
23. What is the basic unit of carbohydrates?
- Disaccharide.
 - Polysaccharide.
 - Monosaccharide.
 - Oligosaccharide.

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24. What is the process of synthesizing monosaccharides from simpler substances called?
- Glycolysis.
 - Gluconeogenesis.
 - Fermentation.
 - Photosynthesis.
25. What is the storage form of carbohydrates in the human body?
- Starch.
 - Cellulose.
 - Glycogen.
 - Glucose.
26. Which of the following is NOT a type of lipid?
- Triglycerides.
 - Phospholipids.
 - Steroids.
 - Proteins.
27. Where are lipids synthesised in the cell?
- Rough endoplasmic reticulum.
 - Smooth endoplasmic reticulum.
 - Golgi apparatus.
 - Mitochondria.
28. What type of bond is formed between glycerol and fatty acids in fats?
- Ionic bond.
 - Hydrogen bond.
 - Ester bond.
 - Hydrophobic interaction.
29. What is the main function of cholesterol in cell membranes?
- Energy storage.
 - Structural stability.
 - Protein synthesis.
 - DNA replication.

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30. Which molecules can easily pass through the lipid bilayer by diffusion?
- Large charged molecules.
 - Ions.
 - Hydrophobic molecules.
 - Proteins.
31. What process forms polypeptide chains?
- Transcription.
 - Translation.
 - Replication.
 - Glycolysis.
32. What is the term for an amino acid with both a positive and negative charge at physiological pH?
- Zwitterion.
 - Ion.
 - Molecule.
 - Radical.
33. What type of amino acids are normally buried in the core of the protein?
- Hydrophilic amino acids.
 - Hydrophobic amino acids.
 - Polar amino acids.
 - Charged amino acids.
34. What is the quaternary structure of a protein?
- The amino acid sequence.
 - The overall shape of a single polypeptide.
 - The interaction of multiple polypeptide chains.
 - The folding of the polypeptide chain.
35. What technique is used to separate proteins based on size?
- Western blotting.
 - SDS-PAGE.
 - PCR.
 - ELISA.

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36. What type of pathway releases energy by breaking down complex molecules?
- Anabolic pathway.
 - Catabolic pathway.
 - Biosynthetic pathway.
 - Synthetic pathway.
37. What is the unit of enthalpy change (ΔH)?
- J/mol.
 - kJ/mol.
 - cal/mol.
 - kcal/mol.
38. What is entropy (S)?
- A measure of heat energy.
 - A measure of disorder.
 - A measure of stability.
 - A measure of temperature.
39. What is the process of using an exergonic reaction to drive an endergonic one called?
- Energy coupling.
 - Energy transfer.
 - Energy synthesis.
 - Energy breakdown.
40. What is the significance of a negative ΔG in a reaction?
- The reaction is nonspontaneous.
 - The reaction is spontaneous.
 - The reaction absorbs energy.
 - The reaction releases heat.
41. How do enzymes affect the activation energy of a reaction?
- They increase the activation energy.
 - They decrease the activation energy.
 - They do not affect the activation energy.
 - They eliminate the activation energy.

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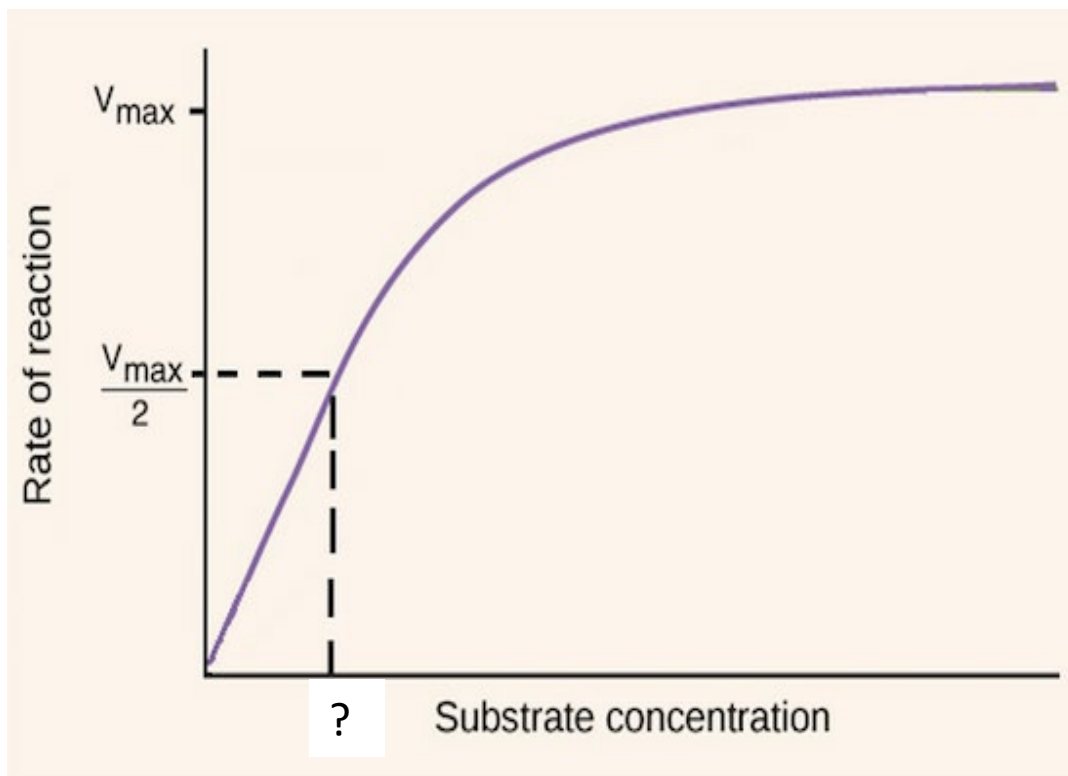
42. What is the turnover number of an enzyme?

- a. The number of products formed per second.
- b. The number of substrates bound per second.
- c. The number of enzyme molecules per cell.
- d. The number of active sites per enzyme.

43. What is a coenzyme?

- a. A protein that inhibits enzyme activity.
- b. A non-protein helper that binds reversibly with an enzyme.
- c. A substrate that binds to the active site.
- d. A product of an enzymatic reaction.

44. 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 .

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45. What is the effect of a non-competitive inhibitor on V_{\max} ?
- V_{\max} is increased.
 - V_{\max} is decreased.
 - V_{\max} is unchanged.
 - V_{\max} is eliminated.
46. What is the primary form in which nitrogen is removed from amino acids?
- Urea.
 - Ammonia.
 - Nitrite.
 - Nitrate.
47. What is the main site for urea production in the body?
- Kidney.
 - Liver.
 - Pancreas.
 - Bladder.
48. What is the main function of ubiquitin in protein metabolism?
- Synthesizing proteins.
 - Targeting proteins for degradation.
 - Transporting amino acids.
 - Modifying proteins post-translation.
49. What are essential amino acids?
- Amino acids synthesized by the body.
 - Amino acids obtained from the diet.
 - Amino acids synthesized in the liver.
 - Amino acids synthesized in the pancreas.
50. What is phenylketonuria?
- A disorder affecting protein synthesis.
 - A disorder affecting the urea cycle.
 - A disorder affecting phenylalanine metabolism.
 - A disorder affecting carbohydrate metabolism.

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51. What is mass spectrometry principally used to determine?
- Molecular concentration.
 - Molecular structure.
 - Relative molecular mass.
 - Molecular interactions.
52. What is the first step in mass spectrometry?
- Ionisation.
 - Vaporisation.
 - Detection.
 - Separation.
53. What is the stationary phase in HPLC?
- The liquid flowing through the column.
 - The adsorbent packed in the column.
 - The detector.
 - The sample.
54. What is one application of HPLC in the NHS?
- Analysing haemoglobin variants.
 - Measuring protein synthesis.
 - Detecting DNA mutations.
 - Observing cell division.
55. You are trying to separate two proteins of different sizes using size-exclusion chromatography. In what order will they elute from the column?
- Largest first followed by smallest.
 - Smallest first followed by largest.
 - Largest at the same time as smallest.
 - Largest first, with smallest not eluting at all.
56. What are the two main areas of pharmacology?
- Pharmacodynamics and pharmacokinetics.
 - Pharmacodynamics and pharmacogenetics.
 - Pharmacokinetics and pharmacogenetics.
 - Pharmacodynamics and pharmacophysiology.

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57. What does pharmacodynamics establish?
- What the body does to the drug.
 - What the drug does to the body.
 - The chemical composition of the drug.
 - The genetic effects of the drug.
58. What is the EC₅₀?
- The concentration required to give 50% of the maximal effect.
 - The concentration required to give 50% inhibition.
 - The concentration required to give 50% of the toxic effect.
 - The concentration required to give 50% improvement in symptoms.
59. What is the role of the MHRA in the UK?
- To approve new drugs for marketing.
 - To conduct clinical trials.
 - To manufacture drugs.
 - To distribute drugs.
60. Most mixed function oxidases belong to which family?
- Flavoprotein.
 - Glycoside hydrolase.
 - G-protein coupled receptors.
 - Cytochrome P450.

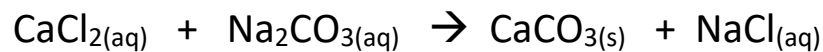
[Total for Section A: 60 marks]

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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.

61. 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 2.5 L of a 5 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 500 mL of a 400 mM CaCl_2 aqueous solution.

(2 marks)

Total 5 marks

62. Describe how water dissolves ionic salts like NaCl.

5 marks

63. a) What is the pH of a solution containing 4.3×10^{-3} M hydrochloric acid (HCl)?

(2 marks)

- b) What is the concentration of OH^- in a solution with a pH of 12.9?

(3 marks)

Total 5 marks

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64. Describe how catalysts affect the rate of chemical reactions.

5 marks

65. Describe, with the use of a figure, the structure and function of phospholipids in cell membranes.

5 marks

66. Describe, with the use of a figure, the technique of SDS-PAGE and its purpose in protein analysis.

5 marks

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

5 marks

68. Describe the different routes of drug administration and their advantages and disadvantages.

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

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

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

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