UNIVERSITY OF GREATER MANCHESTER

SCHOOL OF HEALTH, SCIENCE AND SOCIETY

BSc (HONS) MEDICAL BIOLOGY WITH FOUNDATION/BSc (HONS) BIOMEDICAL SCIENCE WITH FOUNDATION

SEMESTER TWO EXAMINATION 2024/2025

PRINCIPLES OF BIOMOLECULAR SCIENCE

MODULE NO: BIO3025

Date: Wednesday 15 May 2025 **Time: 10.00 am – 12.00 noon**

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.

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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. There is only 1 correct answer for each question in Section A.

1. Which of the following subatomic particles has a charge of -1?
    a. Positron
    b. Electron
    c. Neutron
    d. None of these particles have a charge of -1

2. Which of the following best describes the mass number of an element?
    a. The total number of protons and neutrons in an atom
    b. The total number of protons in an atom
    c. The total number of neutrons in an atom
    d. The mass in grams of an atom

3. Sulfur has the chemical symbol $^{32}_{16}\mathrm{S}$. Which of the following unknown elements X is an isotope of sulfur?
    a. $^{49}_{16}\mathrm{X}$
    b. $^{16}_{32}\mathrm{X}$
    c. $^{32}_{17}\mathrm{X}$
    d. $^{35}_{20}\mathrm{X}$

4. How many protons does an atom of $^{40}_{20}\mathrm{Ca}$ have?
    a. 20
    b. 40
    c. 33
    d. 60

5. Neon has the chemical symbol $^{20}_{10}\mathrm{Ne}$. Which of the following is the correct electronic configuration for neon?
    a. 2, 8, 8, 2
    b. 4, 4
    c. 8, 2
    d. 2, 8

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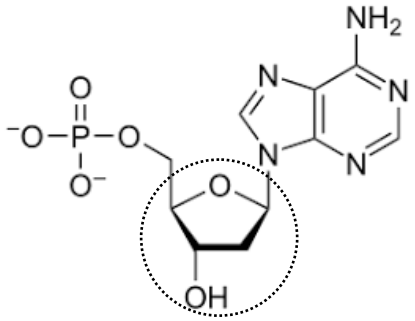
6. Lithium (Li) is in group 1 and oxygen (O) is in group 6. Together, they form the molecule Li_2O. What type of bonding is most likely in Li_2O?
   a. Covalent bonding
   b. Hydrogen bonding
   c. Ionic bonding
   d. Van der Waals bonding

7. Which of the following is the primary site of glycolysis in the cell?
   a. Mitochondria
   b. Nucleus
   c. Cytoplasm
   d. Ribosomes

8. RNA is made up of a sequence of nucleotides. Which of the following is **NOT** found in RNA?
   a. Thymine
   b. Adenine
   c. Guanine
   d. Uracil

9. An RNA nucleotide has the following structure:



   Which component of the nucleotide has been circled?
   a. The phosphate group
   b. The ribose sugar
   c. The nitrogenous base
   d. The amino acid

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10. Which of the following best describes the process of transcription?
    a. Synthesis of tRNA from DNA
    b. Synthesis of proteins from mRNA
    c. Synthesis of mRNA from DNA
    d. Synthesis of DNA from mRNA

11. What type of bonding occurs between complementary DNA nucleotides?
    a. Ionic bonding
    b. Covalent bonding
    c. Disulfide bonding
    d. Hydrogen bonding

12. What is the primary function of the lysosomes in cells?
    a. The degradation of cellular waste
    b. The transport of protein and lipids around the cell
    c. The synthesis of ATP
    d. The repair of damaged DNA

13. A mutation in a DNA sequence results in a change to a single amino acid during translation. Which of the following best describes this mutation?
    a. Silent mutation
    b. Nonsense mutation
    c. Missense mutation
    d. Chromosomal deletion

14. Which of the following template DNA sequences would the mRNA sequence **3' TAC GAG CTT ACT 5'** be made from?
    a. 5' UCU GGA CGC AAA 3'
    b. 5' UAC GAG CUU ACU 3'
    c. 5' AUG CUC GAA UGA 3'
    d. 5' UCA UUC GAG CAU 3'

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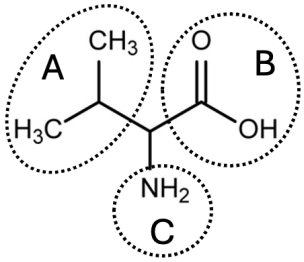
15. An alpha helix is an example of which level of protein structure?
    a. Primary structure
    b. Secondary structure
    c. Tertiary structure
    d. Quaternary structure

16. The amino acid valine has the following structure:



Which of the circled regions correctly shows the variable side chain?
    a. Region A
    b. Region B
    c. Region C
    d. None of the above

17. Which of the following bonds most commonly connects distant amino acids together in a protein?
    a. Peptide bond
    b. Disulfide bond
    c. Glycosidic bond
    d. Double bond

18. Which type of carbohydrate is **NOT** primarily used for energy storage in cells?
    a. Glycogen
    b. Starch
    c. Amylose
    d. Cellulose

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19. Which of the following best describes the physiological response after consuming a high-sugar meal?
    a. Levels of blood glucagon increase and levels of blood insulin increase
    b. Levels of blood glucagon decrease and levels of blood insulin decrease
    c. Levels of blood glucagon decrease and levels of blood insulin increase
    d. Levels of blood glucagon increase and levels of blood insulin decrease

20. Which statement below best describes the mechanism of cyanide poisoning?
    a. Cyanide is a positively charged molecule that attracts the electrons in the electron transport chain.
    b. Cyanide reacts with glucose, preventing it from being converted into pyruvate during glycolysis.
    c. Cyanide binds to electron transport chain proteins more strongly than high energy electrons, preventing respiration.
    d. Cyanide replaces oxygen in haemoglobin, preventing oxygen transport around the body.

21. NaV channels are transmembrane ion channels that allow the movement of sodium ions across the cell membrane. What type of the following best describes NaV channels?
    a. NaV is an integral membrane protein
    b. NaV is a peripheral membrane protein
    c. NaV is an external membrane protein
    d. NaV is a phospholipid

22. The enzyme maltase converts maltose into glucose. If the temperature of the reaction is decreased slightly, what will happen to the rate of the reaction?
    a. The rate will increase
    b. The rate will decrease
    c. The rate will be unaffected
    d. The enzyme will denature

23. Which of the following statements about enzymes is **FALSE**?
    a. Enzymes denature and renature as they catalyse reactions
    b. Enzymes can be free in the cytoplasm or bound to cell membranes
    c. Enzymes are often highly specific for their substrate
    d. Enzymes decrease the activation energy required for reactions

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24. Reduction is _____?
    a. The loss of electrons
    b. The process of breaking double bonds
    c. The gain of electrons
    d. The gain of protons

25. Which type of membrane transport does **NOT** require proteins?
    a. Active transport
    b. Facilitated diffusion
    c. Osmosis
    d. Endocytosis

26. Which of the following molecules can diffuse freely across cell membranes?
    a. Ribose
    b. Water
    c. Sodium ions
    d. Insulin

27. Neurotransmitter signalling at synapse is an example of what type of signalling?
    a. Autocrine
    b. Paracrine
    c. Endocrine
    d. Juxtacrine

28. In which stage of cellular respiration are the majority of ATP molecules synthesised?
    a. Glycolysis
    b. Krebs (Citric Acid) Cycle
    c. The electron transport chain
    d. Cytokinesis

29. From which organ is the hormone insulin released?
    a. Brain
    b. Pancreas
    c. Liver
    d. Stomach

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30. The gene responsible for causing Cystic Fibrosis disease is recessive (c). Which of the following genotypes will result in disease?
    a. CC
    b. Cc
    c. cc
    d. No genotype will result in disease

31. How many cycles of PCR would be required to produce 96 total molecules of DNA, assuming you started with 3 molecules?
    a. 2
    b. 5
    c. 32
    d. 96

32. In total, how many autosomal chromosomes are present in a normal human non-sex cell?
    a. 23
    b. 46
    c. 22
    d. 44

33. The interphase consists of which of the following:
    a. G1, S, G2
    b. G0, G1, G2
    c. G1, M, S
    d. G2, GS, M

34. A and B represent two uncategorised DNA sequences. After sequencing, it is revealed that A and B are 32% identical. Which of the following statements best describes A and B?
    a. A and B likely encode for two different genes
    b. A and B do not code for proteins
    c. A and B have an identical DNA sequence
    d. A and B are alleles

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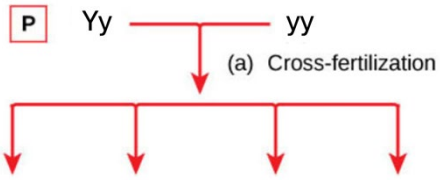
35. The following diagram shows a genetic cross between a yellow (dominant, Yy) and a green (recessive, yy) pea:



What ratio of yellow to green peas would you expect to see in the F1 generation?

a. 1:1
b. 3:1
c. 2:1
d. 4:0

36. Which cell type is **NOT** part of the adaptive immune response?

a. Macrophages
b. T cells
c. B cells
d. Neutrophils

37. Which of the following statements about the innate immune system is true following a second exposure to a disease?

a. The innate immune system will activate more quickly than the first exposure
b. The innate immune system will suppress the adaptive immune system
c. The innate immune system will respond less strongly than the first exposure
d. The innate immune system will switch off as soon as the infection is detected

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38. How many fatty acid chains are present in each phospholipid molecule?
    a. 0
    b. 1
    c. 2
    d. 3

39. How many different codons can be made from the four DNA nucleotides?
    a. 4
    b. 20
    c. 64
    d. 80

40. A mutation in an enzyme prevents the addition of a poly-A tail to newly synthesised mRNA molecules. What is the likely impact on the mRNA?
    a. The mRNA will be more stable
    b. The mRNA will be less stable
    c. The mRNA will be translated faster
    d. The mRNA will be mostly unaffected

(Total for Section A: 40 marks)

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

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

41. This question is about LiBr (MW: 87)

    a) How many grams of LiBr would be required to be added to 0.6 L of water to make a 1.5 M solution ?

    (2 marks)

    b) What is the concentration of a solution with a volume of 4 litres containing 280 g of LiBr?

    (2 marks)

    c) Using the concentration calculated in question 1b, what would the concentration be if the solution was heated and 1.6 L of water were lost?

    (3 marks)

    d) How much water would you need to add if you were to dilute Solution 1c to final concentration of 0.5 M?

    (3 marks)

Total 10 marks

42. Compare and contrast the differences between meiosis and mitosis.

5 marks

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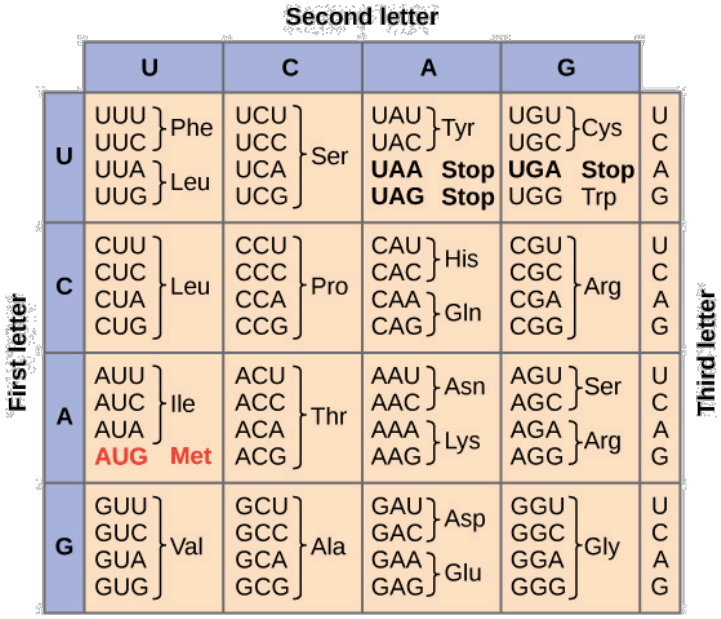
43. Mutations in Gene A have been associated with disease in humans. The first 21 bases of the non-template DNA sequence for Gene A are given below:

5' ATG GGA CAG GGC AGA TGG GAC… 3'



a) Write down the mRNA sequence that would be transcribed from the first 21 bases of Gene A.

(1 mark)

b) Using the codon table provided, translate the first 21 bases of gene A.

(2 marks)

c) In some people, a mutated version of Gene A can be inherited with the sequence below. Identify the type of mutation that has taken place.

5' ATG GGA CAG GGC TGA TGG GAC… 3'

(2 marks)

Question 43 continued over the page…

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Question 43 continued

d) Predict and explain the effect that this might have on any proteins produced by the mutated version of Gene A.

(2 marks)

e) A mutation in Gene A causes a recessive disease. Ellie has the genotype (Aa) and Rooban has the genotype (AA). Construct a Punnett square to determine the probability that their offspring will inherit the disease.

(3 marks)

Total 10 marks

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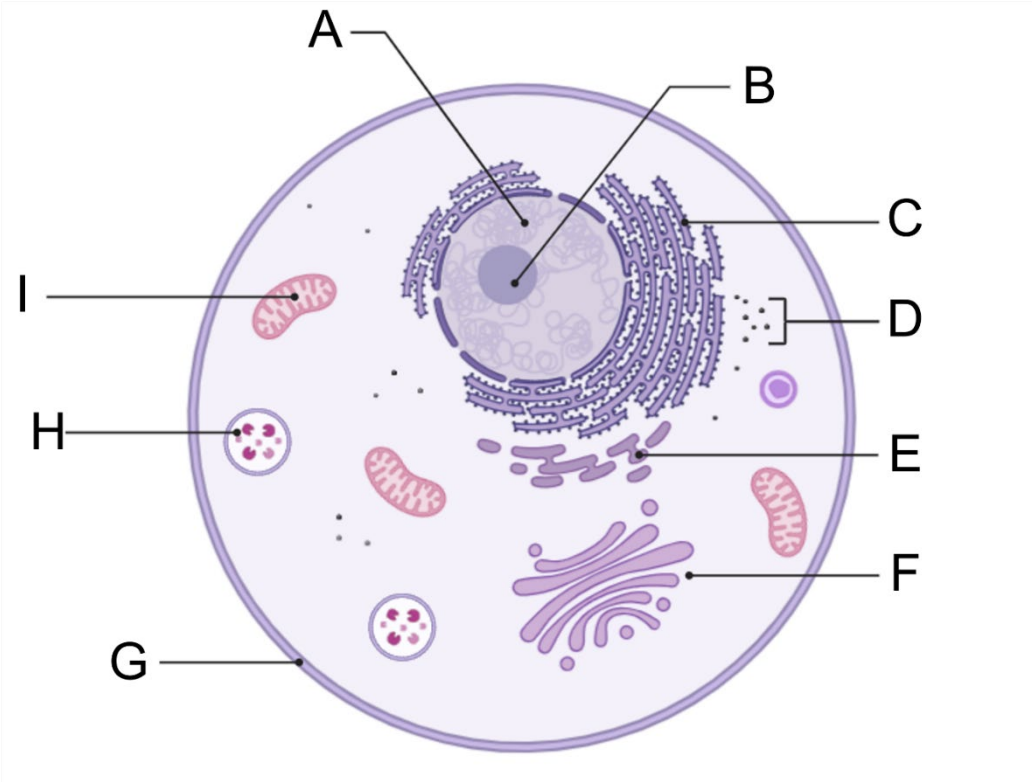
44. Below is an unlabelled diagram of a human cell:



a) Label the cell organelles by matching them with the letters provided. **DO NOT** write any answers on your exam script.

(2 marks)

b) Using one example, explain how the structure of an organelle supports its cellular function.

(3 marks)

Total 5 marks

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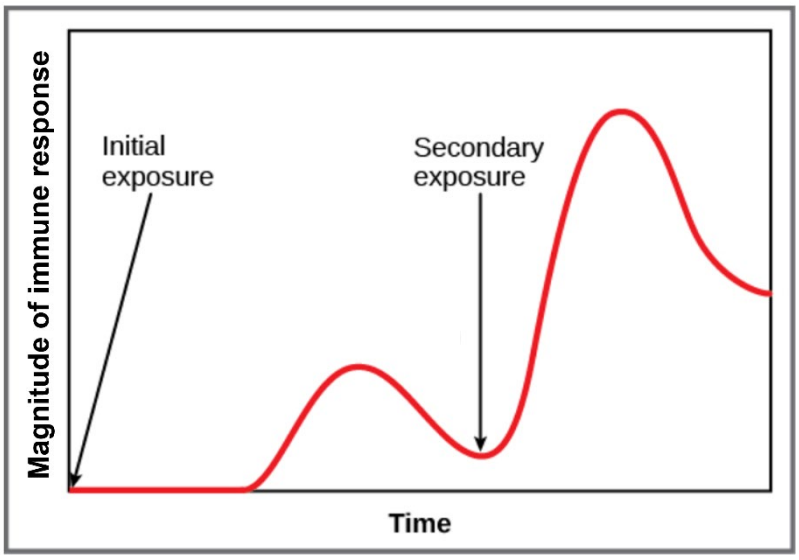
45. A graph showing the magnitude of an immune response after initial and secondary exposure is shown below.



a) State whether the graph shows the response of the adaptive or innate immune system.

(1 mark)

b) Explain why the magnitude of the immune response is greater in the secondary exposure when compared to the initial exposure.

(4 marks)

Total 5 marks

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46. Penicillin is a competitive inhibitor that targets the enzyme transpeptidase and is used as a potent antibiotic.

    a) Explain what is meant by the term competitive inhibitor.

    (2 marks)

    b) A mutation in the transpeptidase enzyme of some bacteria allows them to become resistant to penicillin. With reference to enzyme-substrate interactions, explain how this might occur.

    (3 marks)

Total 5 marks

(Total for Section B: 40 marks)

END OF QUESTIONS