

**UNIVERSITY OF BOLTON**

**SCHOOL OF CLINICAL AND BIOMEDICAL  
SCIENCES**

**BSc (Hons) MEDICAL BIOLOGY**

**SEMESTER ONE EXAMINATIONS 2022/23**

**MOLECULAR AND CELLULAR BIOLOGY**

**MODULE NO: BIO4010**

Date: Wednesday 11<sup>th</sup> January 2022

Time: 2.00 - 4.30pm

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**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 **THREE** sections.

Answer **ALL** questions from Section A (MCQS: 30 marks) and Section B (Short answer Qs: 50 marks).

Answer **ONE** question from Section C (Essay Q: 40 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 120 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, 30 marks in total.**

1. Unlike DNA, RNA contains:
  - a. Adenine.
  - b. Uracil.
  - c. Phosphate groups.
  - d. Thymine.
  
2. What is produced during translation?
  - a. tRNA.
  - b. mRNA.
  - c. Polypeptides.
  - d. None of the above.
  
3. Which family of enzymes ensure that the correct amino acid is added to the appropriate tRNA?
  - a. tRNA polymerases.
  - b. tRNA helicases.
  - c. tRNA synthetases.
  - d. tRNA replicases.
  
4. Point mutations:
  - a. Can have no effect on the resulting protein structure.
  - b. Can have a minor effect on the resulting protein structure.
  - c. Can have a major effect on the resulting protein structure.
  - d. All of the above are true.
  
5. Chromosomes independent of sex are known as what?
  - a. Chromatids
  - b. Autosomes.
  - c. Phagosomes.
  - d. Alleles.
  
6. If a double stranded DNA molecule is found to be composed of 30% cytosine, how much guanine would be expected?
  - a. 20%.
  - b. 30%.
  - c. 50%.
  - d. 70%.

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

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

8. \_\_\_\_\_ are pyrimidines, \_\_\_\_\_ are purines.

- 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 2 moles of NaCl is dissolved in 500 mL of water, what is the concentration of the resulting solution?

- a. 0.004 M.
- b. 0.5 M.
- c. 2 M.
- d. 4 M.

10. Which of the following is correct?

- a.  $M_r = \text{mass} \times \text{moles}$
- b.  $\text{Moles} = M_r \div \text{mass}$
- c.  $\text{Moles} = \text{mass} \times M_r$
- d.  $\text{Moles} = \text{mass} \div M_r$

11. Which of the following are classed as model organisms?

- a. *Drosophila melanogaster*.
- b. *Escherichia coli*.
- c. *Arabidopsis thaliana*.
- d. All of the above.

12. Which of the following enzymes is NOT involved in *in vivo* DNA replication?

- a. Helicase.
- b. Primase.
- c. Topoisomerase.
- d. Reverse transcriptase.

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13. What is the name of sequences removed from eukaryotic mRNA prior to translation?

- a. Exons.
- b. 5' UTR.
- c. Introns.
- d. Transposons.

14. In RNA, \_\_\_\_\_ codon(s) translate to \_\_\_\_\_ amino acid(s)

- a. 1; 1.
- b. 3; 1.
- c. 1; 3.
- d. 1; 20.

15. How many chromosomes does a human cell have when it is not undergoing cell division?

- a. 22.
- b. 23.
- c. 44.
- d. 46.

16. Which of the following temperatures (in °C) would be appropriate to be used as the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> temperatures respectively of a PCR cycle?

- a. 55, 95, and 72.
- b. 55, 72, and 95.
- c. 72, 95 and 55.
- d. 95, 55, and 72.

17. A genetic knock-out can be defined as what?

- a. A gene deletion that changes the genotype of the host organism.
- b. A gene addition that changes the genotype of the host organism.
- c. A gene substitution that changes the genotype of the host organism.
- d. A single base change in the DNA of the host organism.

18. Which of the following bonds is the weakest?

- a. Covalent.
- b. Ionic.
- c. Hydrogen.
- d. Peptide.

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19. The bond between two nucleotides in a single strand of DNA is an example of a/an \_\_\_\_\_:  
a. Covalent bond.  
b. Ionic bond.  
c. Hydrogen bond.  
d. Peptide bond.

20. Which of the following is not a type of chromosomal aberration?  
a. Inversion.  
b. Duplication.  
c. Isolation.  
d. Translocation.

21. Which of the following mutation types results in a protein being prematurely truncated during translation?  
a. Silent.  
b. Synonymous.  
c. Nonsense.  
d. Missense.

22. What is the function of a restriction endonuclease?  
a. Ligates fragments of DNA together.  
b. Synthesises new strands of DNA.  
c. Cuts DNA at specific sites.  
d. None of the above.

23. Which of the following statements is NOT true regarding DNA replication?  
a. DNA ligase removes RNA primers and replaces them with DNA sequences.  
b. The leading strand is synthesised continuously.  
c. The lagging strand is synthesised discontinuously.  
d. Helicase unwinds the parental double helix.

24. Which of the following is not an application of PCR?  
a. Cloning.  
b. Protein quantification.  
c. Gene expression studies.  
d. Mutagenesis.

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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'-G G A C T G A T T-5'

- a. 5'-C C T G A C T A A-3'
- b. 5'-C C U G A C U A A-3'
- c. 5'-G G A C T G A T T-3'
- d. 5'-G G A C U G A U U-3'

26. How many different codons are possible?

- a. 3.
- b. 20.
- c. 64.
- d. An infinite number.

27. The atomic mass of an element is equivalent to:

- a. The total number of protons in one atom.
- b. The total number of protons **and** electrons in one atom.
- c. The total number of protons **and** neutrons in one atom.
- d. The total number of protons, electrons **and** neutrons in one atom.

28. Genetic engineering can be described as:

- a. Performing a PCR reaction.
- b. Using protein to change the genetic information of an organism.
- c. Using recombinant DNA to change the genetic information of an organism.
- d. Cloning into a plasmid vector.

29. Which of the following statements about water molecules is true?

- a. The molecule is completely uncharged.
- b. The molecule is slightly charged.
- c. The molecule is ionic.
- d. The molecule has a lattice structure.

30. Which of the following is NOT required for PCR?

- a. dNTPs.
- b. Thermostable polymerase.
- c. RNA primer.
- d. DNA template.

[Total for Section A: 30 marks]  
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**SECTION B: Answer ALL questions in this section; 5 marks per question, 50 marks in total.**

1. Define a point mutation in DNA and explain why will it not always result in disease.

[5 marks]

2. Describe, with the help of illustrations, the chemical composition of a nucleotide.

[5 marks]

3. A patient presents herself at a genetic counselling clinic saying that her and her partner want to have a baby, but she is concerned that any child she has may have the autosomal recessive condition spinal muscular atrophy. She herself is a carrier for the mutation which causes the disease, and previous tests have shown that her partner is also a carrier for the same mutation. With the use of a Punnett square calculate the percentage likelihood of their baby being affected by the disease. Finally, comment on whether or not the child is more likely to have the disease if it is a biological male rather than female.

[5 marks]

4. What is meant by the term “semi-conservative DNA replication”?

[5 marks]

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

a) Describe how you would make 600 mL of a 0.8 M solution of  $\text{CaCl}_2$ .  
(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 0.4 L of a 200 mM solution?

[2 marks]

[Total 5 marks]

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6. Explain what is meant by the terms “recessively” and “dominantly” inherited traits. [5 marks]

7. How does transcription in eukaryotic cells differ to transcription in prokaryotic cells? [5 marks]

8. Design PCR primers (18 bases in length) which would be required to copy the target region (red) of the following sequence below (Figure 1). What would be the size (in base pairs) of the resulting product?

5' tccatg cgccgcagtaacaattgctcaagcagattatcgccagcagctccgaatagcgccctcccctgccg tgcagct3'

Figure 1: DNA sequence for Question 8 [5 marks]

9. Explain the difference between genomic (gDNA), recombinant (rDNA) and complementary DNA (cDNA). [5 marks]





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**SECTION C: Answer ONE question only; 40 marks.**

1. Explain how a cell can use the information contained within DNA to synthesise proteins. You should include an explanation of the genetic code in your answer.

[40 marks]

**OR**

2. Write an essay on the polymerase chain reaction, with reference to the purpose, mechanism and reagents involved. You should include in your answer an account of how the reaction conditions can be optimised in the event of the experiment not initially working.

[40 marks]

**OR**

3. Explain why model organisms are necessary for scientific research. Using *Drosophila* as your example, discuss how it can be used to observe non-sex linked and sex-linked disorders.

[40 marks]

**[Total for Section C: 40 marks]**

**END OF QUESTIONS**