

UNIVERSITY OF BOLTON

SCHOOL OF ENGINEERING

**BEng (HONS) BIOMEDICAL ENGINEERING and
BEng (HONS) MEDICAL ENGINEERING**

SEMESTER ONE EXAMINATIONS 2019/20

**MOLECULAR PRINCIPLES OF BIOMEDICAL
ENGINEERING**

MODULE NO: BME4002

Date: Thursday 16th January 2020

Time: 10:00am – 12:00pm

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 and Section B.

Answer **ONE** question from Section C.

Write all answers in answer booklet.

Marks for parts of questions are shown in brackets.

This examination paper carries a total of 100 marks.

All working must be shown. A numerical solution to a question obtained by programming an electronic calculator will not be accepted.

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SECTION A: Answer ALL questions in this section; 1 mark per question, 30 marks in total.

1. Which of the following are found in both DNA and RNA?
 - a. Ribose, phosphate groups, and adenine.
 - b. Deoxyribose phosphate groups, and guanine.
 - c. Phosphate groups, guanine, and cytosine.
 - d. Phosphate groups, guanine, and thymine.

2. What is produced during translation?
 - a. tRNA.
 - b. mRNA.
 - c. Polypeptides.
 - d. None of the above.

3. The covalent bonds that hold the primary structure of a protein together are called:
 - a. Disulphide bonds.
 - b. Phosphodiester bonds.
 - c. Glycosidic bonds.
 - d. Peptide bonds.

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. At pH7, amino acids are:
 - a. Always negatively charged.
 - b. Always positively charged.
 - c. Always uncharged.
 - d. Sometimes charged and sometimes uncharged.

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6. If a double stranded DNA molecule is found to be composed of 20% cytosine, how much uracil would be expected?

- a. 20%.
- b. 30%.
- c. 80%.
- d. 0%.

7. When NaCl is dissolved in water, the NaCl is the _____ and the resulting homogenous liquid is the _____.

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

8. Which of the following is a function of the smooth endoplasmic reticulum?

- a. Detoxification of poisons.
- b. Production of ATP.
- c. rRNA synthesis.
- d. Protein folding.

9. If 1 mole of MgCl_2 is dissolved in 0.5 L of water, what is the concentration of the resulting solution?

- a. 1 M.
- b. 2 M.
- c. 0.5 M.
- d. 20 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 not made of eukaryotic cells?

- a. Humans.
- b. Protists.
- c. Bacteria.
- d. Plants.

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12. Which of the following is attached to glycerol in a triglyceride?
- Inositol.
 - Fatty acid.
 - Phosphate.
 - Glucose.
13. Which of the following is not a stage of cell signalling?
- Transduction.
 - Response.
 - Osmosis.
 - Reception.
14. In RNA, _____ codon(s) translate to _____ amino acid(s)
- 1; 1.
 - 3; 1.
 - 1; 3.
 - 1; 20.
15. How many chromosomes do human gametes have?
- 22.
 - 23.
 - 44.
 - 46.
16. Which of the following is NOT required for PCR?
- dNTPs.
 - Thermostable polymerase.
 - RNA primer.
 - DNA template.
17. Which of the following statements is NOT correct about the phospholipid molecules in the plasma membrane?
- Each phospholipid molecule has three nonpolar tails.
 - Each phospholipid molecule has one polar head.
 - The phospholipid tails are not hydrophobic.
 - The phospholipid heads face outward.

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18. 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?

- a. Tryptophan.
- b. Methionine.
- c. Cysteine.
- d. Proline.

19. The bonds between DNA base pairs are:

- a. Phosphodiester bonds.
- b. Glycosidic bonds.
- c. Hydrogen bonds.
- d. Peptide bonds.

20. Chromosomal translocations involve:

- a. The deletion of DNA from a chromosome.
- b. The duplication of DNA within a chromosome.
- c. The swapping of DNA between two non-homologous chromosomes.
- d. The insertion of DNA into a chromosome.

21. Which of the following mutation types results in a single amino acid being changed in the protein being coded for?

- a. Silent.
- b. Synonymous.
- c. Nonsense.
- d. Missense.

22. Amino acids are joined together into a protein chain by which of the following?

- a. Ribosomes.
- b. DNA polymerase.
- c. Hydrogen bonds.
- d. Messenger RNA.

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23. Which of the following is not an important factor in protein folding?
- Hydrophobicity.
 - Charge.
 - Absorbance.
 - Hydrophilicity.
24. The enzyme used in PCR starts copying at which of the following positions?
- At the end of free single-stranded RNA
 - At any open point.
 - At RNA primers attached to either end of the desired gene.
 - At DNA primers attached to either end of the desired gene.
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'
- 5'-C C T G A C T A A-3'
 - 5'-C C U G A C U A A-3'
 - 5'-G G A C T G A T T-3'
 - 5'-G G A C U G A U U-3'
26. Which of the following are true regarding ribosomes?
- They are where translation occurs.
 - They are found in prokaryotes and eukaryotes.
 - They can be found free in the cytosol of eukaryotic cells, or bound to rough endoplasmic reticulum.
 - All of the above are true.
27. Which of the following takes the genetic code from the nucleus to the cytoplasm?
- mRNA.
 - tRNA.
 - DNA.
 - Ribonucleotides.

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28. What is produced during transcription?

- a. Transcription factors.
- b. DNA molecules.
- c. Protein.
- d. None of the above.

29. Which of the following is **not** a step in PCR?

- a. Extension
- b. Denaturing
- c. Ligating
- d. Annealing

30. 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.

[Total for Section A: 30 marks]

END OF SECTION A

PLEASE TURN THE PAGE FOR SECTION B...

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SECTION B: Answer ALL questions in this section; 5 marks per question, 40 marks in total.

1. Explain why a DNA mutation may not necessarily lead to a diseased cell.

[5 marks]

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

[5 marks]

 3. "Amino acids are always positively charged". Discuss whether or not this is true.

[5 marks]

 4. Describe (with an illustration) the structure of a eukaryotic cell membrane.

[5 marks]

 5. You are working as a technician in a medical laboratory, and you do not have access to a calculator.
 - a) Describe how you would make 1 L of a 1 M solution of MgCl_2 .
(Molar Mass Mg = 24; Molar Mass Cl = 35).

[3 marks]

 - b) How would you dilute the solution described in part (a) to make 1 L of a 0.25 M solution?

[2 marks]
- [Total 5 marks]**

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6. Explain how the 4 different bases in DNA can code for the 20 amino acids found in proteins.

[5 marks]

7. 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 dominant condition Huntington's disease. She herself has the disease and is homozygous for the mutation which causes the disease. Previous tests have shown that her partner is not a carrier for the mutation which causes the disease. With the use of a Punnett square calculate the percentage likelihood of their baby being affected by the disease.

[5 marks]

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END OF SECTION B PLEASE TURN THE PAGE FOR SECTION C...

Past Examination Paper

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SECTION C: Answer ONE question only; 30 marks.

1. Give a detailed account of the processes of transcription and translation.

[30 marks]

OR

2. Write an essay on the structure and function of a eukaryotic cell.

[30 marks]

OR

3. Write an essay on the polymerase chain reaction, including reference to the purpose, mechanism and reagents involved.

[30 marks]

[Total for Section C: 30 marks]

END OF QUESTIONS

END OF PAPER