

**UNIVERSITY OF BOLTON**

**SCHOOL OF ENGINEERING**

**BEng (HONS) BIOMEDICAL ENGINEERING**

**SEMESTER ONE EXAMINATIONS 2018/19**

**MOLECULAR PRINCIPLES OF BIOMEDICAL  
ENGINEERING**

**MODULE NO: BME4002**

Date: Thursday 17<sup>th</sup> January 2019

Time: 10:00 – 13:00

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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 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, 25 marks in total.**

1. Unlike DNA, RNA contains:
  - a. Adenine.
  - b. Uracil.
  - c. Phosphate groups.
  - d. Thymine.
  
2. What is produced during transcription?
  - a. Transcription factors.
  - b. DNA molecules.
  - c. Protein.
  - d. None of the above.
  
3. The covalent bonds that contribute towards holding the tertiary structure of a protein together are called:
  - a. Disulphide bonds.
  - b. Phosphodiester bonds.
  - c. Glycosidic bonds.
  - d. Ester 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. Amino acids contain carbon, hydrogen, oxygen, and what other main element?
  - a. Nitrogen.
  - b. Phosphorous.
  - c. Iron.
  - d. Magnesium.
  
6. If a double stranded DNA molecule is found to be composed of 35% thymine, how much guanine would be expected?
  - a. 15%.
  - b. 30%.
  - c. 35%.
  - d. 40%.

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

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

8. Which of the following is a function of the mitochondria?

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

9. If 2 moles of NaCl is dissolved in 1 L of water, what is the concentration of the resulting solution?

- a. 2 M.
- b. 2 moles.
- c. 0.5 M.
- d. 0.5 moles.

10. 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.

11. Which of the following are not made of eukaryotic cells?

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

12. The fatty acids in a phospholipid molecule attach to:

- a. Inositol.
- b. Glycerol.
- c. Phosphate.
- d. Glucose.

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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 does a human cell have when it is not undergoing cell division?
- 22.
  - 23.
  - 44.
  - 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?
- 55, 95, and 72.
  - 55, 72, and 95.
  - 72, 95 and 55.
  - 95, 55, and 72.
17. The presence of a double bond makes a fatty acid:
- Saturated.
  - Hydrogenated.
  - Oxygenated.
  - Unsaturated.
18. A protein can be unfolded by a process called:
- Renaturation.
  - Denaturation.
  - Oxidation.
  - Reduction.

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19. The bond between two nucleotides is a \_\_\_\_\_:
- Phosphodiester bond.
  - Glycosidic bond.
  - Hydrogen bond.
  - Peptide bond.
20. Which of the following is not a type of chromosomal aberration?
- Inversion.
  - Duplication.
  - Isolation.
  - Translocation.
21. Which of the following mutation types results in a protein being prematurely truncated during translation?
- Silent.
  - Synonymous.
  - Nonsense.
  - Missense.
22. Which of the following is not a fibrous protein?
- Collagen.
  - Keratin.
  - Elastin.
  - Porin.
23. Which of the following statements about enzymes is NOT true?
- Enzymes act as catalysts.
  - Enzymes can provide a microenvironment in which reactions take place.
  - Enzymes are unchanged by the chemical reaction in which they are involved.
  - Enzymes are unspecific and can therefore generally recognise multiple substrates.
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.

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25. \_\_\_\_\_ are pyrimidines, \_\_\_\_\_ are purines (fill in the blanks).
- Adenine and Guanine; Cytosine and Thymine.
  - Cytosine and Guanine; Adenine and Thymine.
  - Cytosine and Thymine; Adenine and Guanine.
  - Uracil and Adenine; Thymine and Guanine.

**Total for Section A: 25 marks**

**SECTION B: Answer ALL questions in this section; 5 marks per question, 50 marks in total.**

1. Describe the different effects a point mutation within a gene can have on the resulting protein.  

**[5 marks]**
2. Describe, with the help of an illustration, the chemical composition of an amino acid.  

**[5 marks]**
3. Describe the similarities and differences between DNA and RNA.  

**[5 marks]**
4. Describe (with reference to cell membrane structure) what is meant by a "membrane" protein.  

**[5 marks]**

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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  $\text{MgCl}_2$ .  
(Molar Mass Mg = 24; Molar Mass Cl = 35).

**[3 marks]**

b) How would you dilute the solution described in part (a) to make 0.5 L of a 0.5 M solution?

**[2 marks]**

**Total 5 marks**

6. Describe what happens during the process of transcription.

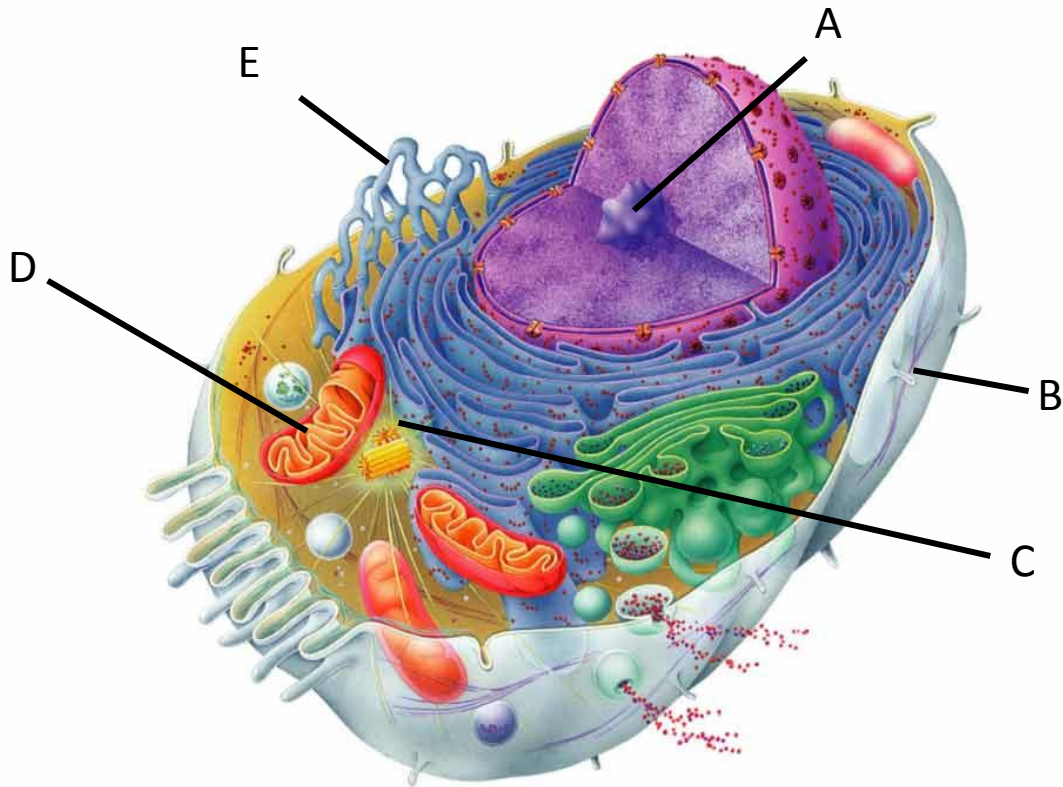
**[5 marks]**

7. Briefly describe what “ingredients” need adding to a typical polymerase chain reaction.

**[5 marks]**

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8. Name the 5 structures labelled A-E in the diagram of a eukaryotic cell shown below



[5 marks]

9. 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 heterozygous 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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**SECTION C: Answer ONE question only; 25 marks.**

1. Describe the processes utilised by a cell which allow DNA to encode for protein synthesis.

**[25 marks]**

**OR**

2. With reference to both amino acid structure and the four levels of protein structure, explain how the chemical properties of amino acid side chains influences protein folding.

**[25 marks]**

**OR**

3. Write an essay on cellular organelles. In your answer you should include an account of how organelles are involved in the functioning of a eukaryotic cell.

**[25 marks]**

**Total for Section C: 25 marks**

**END OF QUESTIONS**