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AS Level Biology

Topic 2: Nucleic Acids, ATP and Water

AQA Biology (7401) | Question Paper | 100 marks

Instructions

- Answer **all** questions.
- In calculations show your working and give your answer to an appropriate number of significant figures.
- In extended-response questions you should write in clear, well-organised continuous prose.
- There are 16 questions in this paper. The total mark is **100**.

Name: _____ Class: _____

Date: _____ Teacher: _____

1. This question is about the components of nucleotides.

(a) Name the three components that make up a single DNA nucleotide. **(3)**

(b) Name the four bases found in DNA. **(2)**

(c) State which one of the DNA bases is replaced in RNA, and name the base that replaces it. **(2)**

2. This question is about the structure of DNA.

(a) Name the type of reaction that joins two nucleotides together. **(1)**

(b) Name the bond that forms between the phosphate of one nucleotide and the sugar of the next in a polynucleotide strand. **(1)**

(c) Name the type of bond that holds the two strands of a DNA molecule together. **(1)**

(d) State the base-pairing rules in DNA. **(2)**

3. A sample of DNA was analysed and found to contain 28% adenine.

(a) State the percentage of thymine present in this DNA sample, and explain your answer. **(2)**

(b) Calculate the percentage of cytosine present in this DNA sample. Show your working. **(2)**

4. This question is about the role of DNA.

(a) Explain how the structure of DNA makes it a stable molecule suitable for storing genetic information. **(3)**

(b) DNA in eukaryotic cells is described as a double helix. State two further features of eukaryotic DNA. **(2)**

(c) State two ways in which the DNA found in the nucleus of a eukaryotic cell differs from the DNA found in prokaryotic cells. **(2)**

5. This question is about semi-conservative replication of DNA.

(a) Name the enzyme that breaks the hydrogen bonds between the two strands of DNA at the start of replication. **(1)**

(b) Name the enzyme that joins adjacent nucleotides together on the new strand. **(1)**

(c) Describe the process of semi-conservative replication of DNA. **(5)**

(d) Explain why this method of DNA replication is described as 'semi-conservative'. **(2)**

6. Meselson and Stahl provided evidence for semi-conservative replication using nitrogen isotopes. Bacteria were grown in a medium containing the heavy isotope ^{15}N, then transferred to a medium containing the light isotope ^{14}N.

(a) Explain why the DNA grown in ^{15}N medium was heavier (more dense) than DNA grown in ^{14}N medium. **(2)**

(b) After one round of replication in ^{14}N medium, all the DNA was of intermediate density. Explain how this result supports semi-conservative replication. **(3)**

7. This question is about ATP.

(a) State what the abbreviation ATP stands for. **(1)**

(b) Name the three components of a molecule of ATP. **(3)**

(c) Name the reaction by which ATP is broken down to release energy, and name the enzyme that catalyses it. **(2)**

(d) Write a word equation for the hydrolysis of ATP. **(2)**

8. ATP is described as the 'universal energy currency' of cells.

(a) Explain why ATP is a suitable molecule for transferring energy in cells. **(4)**

(b) Name the reaction by which ATP is re-synthesised from ADP and inorganic phosphate. **(1)**

(c) State two processes in a cell for which the energy released from ATP can be used. **(2)**

9. This question is about the structure of a water molecule.

(a) Explain why a water molecule is described as *polar*. **(3)**

(b) Name the type of bond formed between adjacent water molecules. **(1)**

10. Water has a number of properties that make it important for living organisms.

(a) Water is described as a metabolite. State what this means and give one example of a reaction in which water is involved. **(2)**

(b) Explain why water is a good solvent for many substances in living organisms. **(3)**

(c) Water has a high specific heat capacity. Explain why this is important for organisms living in water. **(3)**

11. Water has a high latent heat of vaporisation and strong cohesion between molecules.

(a) Explain how the high latent heat of vaporisation of water helps organisms to cool down. **(3)**

(b) Explain how cohesion between water molecules is important in the transport of water in plants. **(3)**

(c) State how the high surface tension of water, caused by cohesion, is useful to some organisms. **(1)**

12. This question is about inorganic ions in organisms.

(a) State the role of iron ions (Fe^{2+}) in the human body. **(1)**

(b) State the role of hydrogen ions (H^{+}) in determining the properties of solutions. **(1)**

(c) State the role of phosphate ions (PO_4^{3-}) in living organisms. **(2)**

(d) State the role of sodium ions (Na^{+}) in the absorption of glucose. **(2)**

13. This question is about the comparison of DNA and RNA.

(a) State two ways in which the structure of an RNA molecule differs from that of a DNA molecule. **(2)**

(b) State one structural feature that DNA and RNA have in common. **(1)**

(c) mRNA is a relatively short-lived molecule. Suggest why this is an advantage to a cell. **(2)**

14. A scientist analysed the base composition of a length of double-stranded DNA. The DNA contained 600 base pairs in total, of which 180 were guanine-cytosine pairs.

(a) Calculate the number of cytosine bases present in this length of DNA. Show your working. **(2)**

(b) Calculate the number of adenine bases present in this length of DNA. Show your working. **(3)**

15. This question is about the energy released from ATP and its re-synthesis in a cell.

(a) Explain why cells contain only small amounts of ATP at any one time, even though large amounts are used. **(2)**

(b) The phosphorylation of ADP to form ATP is described as an energy-requiring reaction. Suggest where the energy for this comes from in a respiring cell. **(1)**

(c) Explain why a small, soluble molecule such as ATP, rather than glucose, is used as the immediate source of energy for processes such as active transport. **(3)**

16. This question is about the importance of hydrogen bonding in biological molecules.

(a) Explain how hydrogen bonding contributes to the stability of a DNA molecule, even though each individual hydrogen bond is weak. **(2)**

(b) Explain why DNA molecules with a higher proportion of cytosine-guanine pairs are more stable (and have a higher melting temperature) than those with more adenine-thymine pairs. **(3)**

(c) Explain how hydrogen bonding between water molecules gives water a high specific heat capacity, which buffers temperature changes in cells. **(2)**