bio letters

# bio letters

## A1.2 Topical Questions

## Markscheme

### Biology

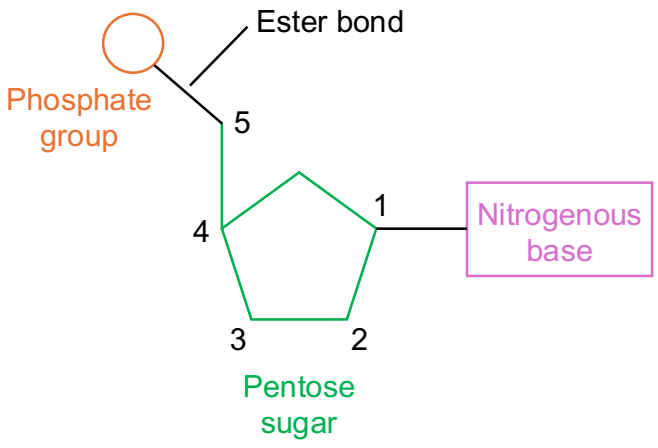
### Standard and Higher level

## Paper 2

19–08–2026

5 pages

| Question | | | Answers | Total |
|---|---|---|---|---|
| 1. | a | | living organisms use DNA as genetic material but viruses use DNA or RNA | 1 |
| 1. | b | | viruses do not carry out all life functions | 1 |
| 1. | c | | a. a nucleotide is a molecule consisting of 3 chemical groups<br>b. pentose (5-carbon) sugar is connected to the nitrogenous base at the 1' carbon and to the phosphate group at the 5' carbon within the same nucleotide<br>c. the pentose sugar can be either deoxyribose (in DNA) or ribose (in RNA)<br>d. phosphate group ($PO_4^{3-}$) is connected to the 5' carbon of one pentose sugar via an ester bond<br>e. phosphate group gives DNA its acidity and negative charge<br>f. nitrogenous base is connected to the pentose sugar at the 1' carbon<br>g. nitrogenous bases are composed of one or two carbon rings that contain nitrogen | 3 |

| Question | | | Answers | Total |
|---|---|---|---|---|
| 2. | a | | condensation | 1 |
| 2. | b | | a. an ester bond links a phosphate group to one pentose sugar<br>b. a phosphodiester bond links one phosphate group to two pentose sugars | 1 |
| 2. | c | | a. nucleotides are joined together by covalent (phosphodiester) bonds<br>b. this forms a continuous chain of alternating sugar and phosphate groups, producing a atrong sugar–phosphate backbone | 2 |
| 2. | d | | [1] mark for phosphate group<br>[1] mark for pentose sugar<br>[1] mark for nitrogen base<br>[1] mark for correct connectivity (1' carbon connected to base, 5' carbon connected to phosphate group)<br>  <br> | 4 |

| Question | | | Answers | Total |
|---|---|---|---|---|
| **3.** | **a** | | uracil | **1** |
| **3.** | **b** | | a. complementary base pairing is the specific pairing of nitrogenous bases with each other through hydrogen bonding<br>b. cytosine and guanine pair together because they both only form 3 hydrogen bonds<br>***AND***<br>c. adenine and thymine pair together because they both only form 2 hydrogen bonds<br>d. this is important because it creates structural stability and integrity that allows genetic information to be stored, replicated, and transcribed in an accurate manner | **3** |
| **3.** | **c** | | a. RNA is a polymer formed by condensation of ribonucleotides<br>b. messenger RNA (mRNA) transcribes DNA and acts as a template during protein synthesis<br>c. transfer RNA (tRNA) transfers amino acids to a growing polypeptide chain during protein synthesis<br>d. ribosomal RNA (rRNA) catalyzes protein synthesis | **3** |

| Question | | | Answers | Total |
|---|---|---|---|---|
| **4.** | **a** | | $4^{1000}$ | **1** |
| **4.** | **b** | | a. the genetic code (instructions stored in nitrogenous bases for protein synthesis) is universal because all organisms use the 5 nitrogenous bases<br>b. the conservation of the genetic code across all life forms is evidence of universal common ancestry<br>c. this is because if different organisms originated independently, it is more likely that they would evolve different genetic codes (but this is not the case) | **2** |
| **4.** | **c** | | a. genetic information in DNA is stored in the sequence of nitrogenous bases<br>b. every sequence of 3 consecutive DNA nucleotides is a codon, corresponding to a specific amino acid<br>c. the amino acids are used to build proteins, which produce the phenotype<br>d. for a DNA or RNA strand with *n* bases, there are $4^n$ possible different sequences<br>e. this makes the capacity of DNA for storing information virtually limitless, which explains the great biodiversity on Earth | **3** |

| Question | | | Answers | Total |
|---|---|---|---|---|
| 5. | a | | a. linker DNA connects adjacent nucleosomes<br>b. H1 linker histone binds DNA where it enters/exits the nucleosome core | 1 |
| 5. | b | | histones play a vital role in eukaryotic DNA organization so mutations that alter their function are likely to be selected against | 1 |
| 5. | c | | a. RNA is synthesized 5′ to 3′ while the DNA template is read 3′ to 5′<br>b. ribosomes bind at the 5′ end of mRNA and move towards its 3′ end | 2 |

| Question | | | Answers | Total |
|---|---|---|---|---|
| 6. | a | | a. each complementary pair contains one purine and one pyrimidine<br>b. A–T and C–G pairs therefore have approximately equal lengths<br>c. this maintains a constant distance/equidistance between the two sugar–phosphate backbones | 3 |
| 6. | b | | a. consists of two polynucleotide strands<br>b. strands form a double helix<br>c. strands are antiparallel<br>d. each strand has a sugar–phosphate backbone linked by phosphodiester bonds<br>e. sugar–phosphate backbones lie on the outside of the helix<br>f. nitrogenous bases are positioned toward the inside<br>g. complementary bases are joined by hydrogen bonds<br>h. A pairs with T and C pairs with G | 5 |
| 6. | c | | <table><tr><th>DNA</th><th>RNA</th></tr><tr><td>Double stranded</td><td>Single stranded</td></tr><tr><td>Deoxyribose sugar</td><td>Ribose sugar</td></tr><tr><td>Uses thymine but not uracil</td><td>Uses uracil but not thymine</td></tr><tr><td>Double helix</td><td>Variable shape depending on type of RNA</td></tr><tr><td>Fixed function (storage of genetic information)</td><td>Variable functions</td></tr><tr><td>Stable</td><td>Less stable</td></tr><tr><td colspan="2">Use adenine, guanine, and cytosine</td></tr><tr><td colspan="2">Sugar-phosphate backbone</td></tr></table> | 7 |

| Question | | | Answers | Total |
|---|---|---|---|---|
| **7.** | **a** | | a. nucleosomes are most basic structural unit of DNA packing in eukaryotes<br>b. histone octamer (nucleosome core) is an 8-protein complex composed of 4 pairs of histones (H2A, H2B, H3, H4)<br>c. each histone is rich in positively charged amino acids (lysine and arginine) in order to associate strongly with the negatively charged DNA<br>d. H1 linker histone binds to the DNA as it enters and exists the octamer core to control coiling<br>e. linker DNA is a section of the DNA strand that connects two nucleosomes together<br>f. core DNA is ~147 nucleotides in length of DNA wrapping around the nucleosome core<br>g. nucleosomes play an essential role in gene expression by packing DNA into 30nm fibers | **4** |
| **7.** | **b** | | a. Chargaff measured the relative amounts of nitrogenous bases in DNA from different organisms<br>b. Chargaff found that A ≈ T and G ≈ C<br>c. Chargaff also found that A ≠ C<br>d. this falsified the tetranucleotide hypothesis which stated that DNA existed as a repeating set of four nucleotides | **4** |
| **7.** | **c** | | a. the goal of the Hershey–Chase experiment was to determine whether the genetic material of living organisms is nucleic acids or proteins<br>b. a bacteriophage (a virus that infects bacteria) was grown in 2 different cultures<br>c. a culture containing radioisotopes of sulfur ($S^{35}$): the sulfur would be incorporated in the protein outer coat of the virus but not in the DNA<br>d. a culture containing radioisotopes of phosphorus ($P^{32}$): the phosphorus would be incorporated in the viral DNA but not in its outer coat<br>e. the bacteriophage was allowed to infect *Escherichia coli*<br>f. after infection, the virus was detached from the bacteria using a blender & a centrifuge was used to separate the infected bacteria from the viral coats (by weight)<br>g. *E. coli* infected with $S^{35}$ phages showed no radioactivity in the pellet<br>h. since sulfur is only found in proteins, and viral outer coatings do not enter bacterial cells, radioactivity was only detected in the supernatant<br>i. *E. coli* infected with $P^{32}$ phages showed no radioactivity in the supernatant<br>j. since phosphorus is only found in DNA, which enters the bacteria, radioactivity was only detected in the pellet<br>k. this experiment provided strong evidence that DNA is the genetic material, but further research was done by scientists to confirm this | **7** |