Helicate

HELICATE · AS AND A-LEVEL BIOLOGY · TOPIC BANK

3.1.5 Nucleic acids

Topic question bank

Version 1 · 1 October 2026

Name

Date

QUESTIONS	TOTAL MARKS	TIME	YOUR SCORE
6	46	No time limit	/ 46

Contents

Subtopic	Questions	Marks
Structure of DNA and RNA Specification 3.1.5.1	01–03	23
DNA replication Specification 3.1.5.2	04–05	13
Evaluating the model of DNA replication Specification 3.1.5.2	06	10
Total		**46**

Instructions

- Answer the questions in the spaces provided. Show all your working.
- The marks for each question are shown in brackets. Use them to judge how much detail to give.
- Work through a subtopic at a time, then mark your answers with the matching mark scheme.

Original questions by Helicate for AQA AS and A-level Biology (7401/7402), specification section 3.1.5. Not affiliated with or endorsed by AQA.

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Structure of DNA and RNA 3.1.5.1

A teacher gave a student a kit for building a model of a short section of a DNA molecule. The kit contained:

- white circles to represent phosphate groups
- grey pentagons to represent pentose sugars
- rectangles in four different colours to represent the four bases
- fixed connectors, which cannot be pulled apart
- snap connectors, which can easily be pulled apart and joined again.

0 1 . 1 Describe the structure of DNA that the student's finished model should show. Name the molecules and bonds that the model represents.

[5 marks]

Question 1 continues on the next page

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0 1 . 2 The student's model must show the bonds that join adjacent nucleotides in each strand, and the bonds that hold the two strands together.
Explain which type of connector, snap or fixed, the student should use for each of these two types of bond.

[2 marks]

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0 1 . 3 The student then used pieces from the kit to build a model of an RNA molecule.
Which changes to the DNA model would make it represent RNA?
Tick (✓) one box.

[1 mark]

Use one colour of rectangle to represent uracil instead of thymine, and keep both strands. ☐

Use one colour of rectangle to represent uracil instead of adenine, make the pentagons represent ribose, and build only one strand. ☐

Use one colour of rectangle to represent uracil instead of thymine, make the pentagons represent ribose, and build only one strand. ☐

Make the pentagons represent ribose and build only one strand, keeping the same four bases. ☐

8

Turn over for the next question

Do not write outside the box

In the 1930s, many scientists thought that DNA was too simple a molecule to carry genetic information. At that time:

- DNA was known to contain only four types of nucleotide
- early measurements suggested that the four bases were present in roughly equal amounts in DNA from every species tested
- proteins were known to be made from about 20 different types of amino acid.

0 2 . 1 Suggest why these findings led many scientists to doubt that DNA carried the genetic code.

[2 marks]

Question 2 continues on the next page

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In the late 1940s, scientists used more accurate methods to analyse DNA. They hydrolysed DNA from different sources, separated the bases by chromatography and measured the amount of each base.

Table 1 shows some of their results.

Table 1

Source of DNA	Percentage of bases				(adenine + thymine) ÷ (guanine + cytosine)
	Adenine	Cytosine	Guanine	Thymine	
Species **P** (a mammal)	30.2	19.9	19.8	30.1	1.52
Species **Q** (a bacterium)	21.4	28.5	28.7	21.4	
Virus **V** (infects bacteria)	24.6	18.5	24.1	32.8	1.35

0 2 . 2 Calculate the value of (adenine + thymine) ÷ (guanine + cytosine) for species **Q**. Give your answer to **two** decimal places.

[1 mark]

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Answer .....

Question 2 continues on the next page

Do not write outside the box

0 2 . 3 Explain how the data in Table 1 for species **P** and species **Q** do **not** support the idea that DNA has the four bases in equal amounts in every species.
Suggest what this showed scientists about whether DNA could carry genetic information.

[2 marks]

0 2 . 4 DNA from another species, **R**, is double-stranded. In this DNA, 27.3% of the bases are adenine.
Calculate the percentage of the bases in this DNA that are guanine.

[2 marks]

Answer ..... **%**

0 2 . 5 The DNA of virus **V** does not show the same pattern as the DNA of species **P** and species **Q**.
Use Table 1 to suggest an explanation for this difference.

[2 marks]

9

Turn over for the next question

Do not write outside the box

Scientists isolated ribosomes from liver cells. They added a ribonuclease to the ribosomes. A ribonuclease is an enzyme that hydrolyses all the phosphodiester bonds in RNA.

0 3 . 1 Which molecules would the ribonuclease release from the ribosomes?
Tick (✓) one box.

[1 mark]

- Amino acids ☐
- Nucleotides containing deoxyribose and one of adenine, cytosine, guanine or thymine ☐
- Nucleotides containing ribose and one of adenine, cytosine, guanine or thymine ☐
- Nucleotides containing ribose and one of adenine, cytosine, guanine or uracil ☐

0 3 . 2 The ribosomes contain RNA, but not DNA.
Give **three** ways in which a DNA molecule differs in structure from an RNA molecule.

[3 marks]

1 .....

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2 .....

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3 .....

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Question 3 continues on the next page

Do not write outside the box

0 3 . 3 The ribonuclease does not hydrolyse DNA, even though DNA also contains phosphodiester bonds.
Suggest why.

[2 marks]

6

Turn over for the next question

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DNA replication 3.1.5.2

0 4 . 1 Which statement describes the role of DNA polymerase in DNA replication?
Tick (✓) one box.

[1 mark]

It breaks hydrogen bonds between complementary bases. ☐

It forms hydrogen bonds between complementary bases. ☐

It joins adjacent DNA nucleotides in condensation reactions. ☐

It joins adjacent DNA nucleotides in hydrolysis reactions. ☐

Compound H is being investigated as a possible anticancer drug. It binds to DNA helicase and stops it working.

0 4 . 2 Explain why cells treated with compound H cannot replicate their DNA.

[2 marks]

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Question 4 continues on the next page

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The DNA of one species of bacterium is a single circular molecule containing 4.2×10^6 base pairs. Replication starts at one point on the molecule. It then continues in both directions around the circle at the same time, until the whole molecule has been replicated. In each direction, 875 base pairs are replicated every second.

0 4 . 3 Calculate the time taken to replicate the whole DNA molecule.
Give your answer in minutes.

[2 marks]

Answer ..... **minutes**

A section of DNA in a human cell is 1600 base pairs long. 28% of the bases in this section are adenine.

The cell divides by mitosis, and then both daughter cells divide by mitosis, giving four cells. The DNA is replicated once before each division.

0 4 . 4 Calculate the total number of free DNA nucleotides containing thymine that are used to replicate this section of DNA during the two rounds of replication.

[2 marks]

Answer .....

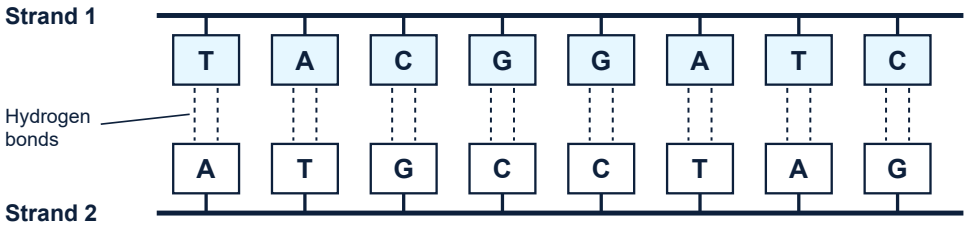
7

Turn over for the next question

Do not write outside the box

Figure 1 shows a short section of a DNA molecule before replication.

Figure 1



0 5 Describe how this section of DNA is replicated by semi-conservative replication. In your answer, give the base sequence of each new strand, and explain why the two DNA molecules produced are identical to the original molecule.

[6 marks]

6

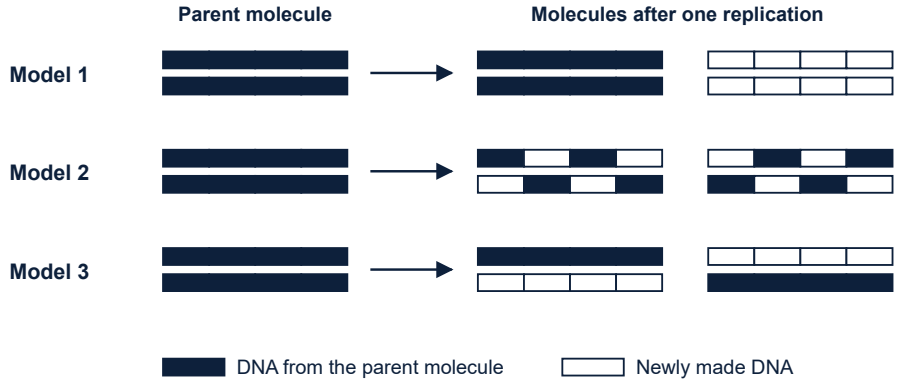
Turn over for the next question

Do not write outside the box

Evaluating the model of DNA replication 3.1.5.2

A double helix could, in principle, be copied in more than one way. Figure 2 shows three ways it might be copied. Each shows a parent molecule and the two molecules produced from it by one round of copying.

Figure 2



Scientists tested these models with the following experiment.

- They grew bacteria for many generations in a medium where the only source of nitrogen contained the light isotope, ^{14}N.
- They then moved the bacteria to a medium where the only source of nitrogen contained the heavy isotope, ^{15}N. This was generation 0.
- After each generation, they took a sample of bacteria and extracted the DNA.
- They centrifuged the DNA in a solution that forms a density gradient. DNA settles at the position in the tube that matches its density. DNA containing ^{15}N is denser than DNA containing ^{14}N.

The scientists found the positions of light DNA and heavy DNA in the tube using DNA from bacteria grown only in ^{14}N medium or only in ^{15}N medium. Intermediate density is halfway between light and heavy.

0 6 . 1 Explain why the scientists grew the bacteria in the ^{14}N medium for many generations before moving them to the ^{15}N medium.

[1 mark]

Question 6 continues on the next page

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0 6 . 2 Complete the table to show the results the scientists would expect after one generation and after two generations if Model 1 were correct.

[2 marks]

Generation	Predicted percentage of DNA at each density for Model 1		
	Light	**Intermediate**	**Heavy**
1			
2			

Question 6 continues on the next page

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Table 2 shows the scientists' results. No DNA was found at any other density.

Table 2

Generation	Percentage of DNA at each density		
	Light	Intermediate	Heavy
0	100	0	0
1	0	100	0
2	0	52	48
3	0	27	73

0 6 . 3 Evaluate how well the results in Table 2 support each of the three models in Figure 2.

[4 marks]

0 6 . 4 In generation 2, the scientists found 52% intermediate DNA and 48% heavy DNA, not exactly 50% of each.
Suggest **one** reason why.

[1 mark]

Question 6 continues on the next page

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0 6 . 5 After generation 3, the scientists moved the remaining bacteria back into ^{14}N medium and allowed them to divide once.
Assume that, at generation 3, 25% of the DNA was intermediate and 75% was heavy, and that Model 3 is correct.
Predict the percentage of DNA that would be light, intermediate and heavy after this division.

[2 marks]

Light ..... %

Intermediate ..... %

Heavy ..... %

10

END OF QUESTIONS

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