2.5 Nucleic Acids: Structure & DNA Replication

Question Paper

Course	DP IB Biology
Section	2. Molecular Biology
Topic	2.5 Nucleic Acids: Structure & DNA Replication
Difficulty	Hard

Time allowed: 60

Score: /43

Percentage: /100

Question 1a

a)
The ends of a DNA strand are referred to as the 3' end and the 5' end.

Describe the aspects of DNA structure that give rise to this naming system.

[3 marks]

[3 marks]

Question 1b

b)
Adenine/thymine and guanine/cytosine form hydrogen-bonds with each other in complementary base-pairing within the DNA double helix. These bases can also form bonds with other molecules in order to carry out their function.

i)
Suggest **one** other molecule that might form bonds with the bases in a DNA molecule.

[1 mark]

ii)
State the role of the molecule identified in part i).

[1 mark]

[2 marks]

Question 1c

c)
The structure of DNA has many characteristics that enable it to carry out its function.

i)
Identify **two** structural features that help DNA to carry out its function.

[2 marks]

ii)
For each feature identified at part i), explain how it assists with DNA function.

[2 marks]

[4 marks]

Question 2a

a)
Explain why only bases that are complementary to the bases on the template strand can be added to the new DNA strand during DNA replication.

[2 marks]

[2 marks]

Question 2b

b)
Ultraviolet exposure can cause guanine to be oxidised to 8-oxyguanine, which is no longer complementary to cytosine. Instead, during replication, 8-oxyguanine can form bonds with adenine, resulting in a base pair.

Outline the possible consequences of this change.

[3 marks]

[3 marks]

Question 2c

c)
In the absence of mutagens, the rate of mutations during DNA replication is very low, approximately 160 bases per cell cycle.

Given that the human genome contains 3.2 billion base pairs, calculate the percentage copying error rate of each cell cycle.

[1 mark]

[1 mark]

Question 3a

a)
Even the smallest DNA molecules are very long.

- A kilobase (Kb) is a unit equivalent to 1000 base pairs of a DNA molecule.
- One Kb of double stranded DNA has a length of 0.34 μm.

The DNA in the nucleus of a cell from a fruit fly (*Drosophila*) is 5.6 cm long.

Calculate the number of Kb in the DNA of the fruit fly. Give your answer to the nearest whole number.

[2 marks]

[2 marks]

Question 3b

b)
The amount of DNA found in the nucleus of cells can vary amongst people, with each human chromosome containing between 5×10^4 and 26×10^4 Kb of DNA.

Suggest **one** reason why people might have different quantities of DNA to each other.

[1 mark]

[1 mark]

Question 3c

c)
Other than for use in replication, explain **one** advantage of DNA molecules having two strands.

[1 mark]

[1 mark]

Question 4a

a)
A section of DNA contains 1,200 base pairs.

- The number of guanine molecules on strand one was counted as 156.
- The number of cytosine molecules on strand one was counted as 209.
- The number of adenine molecules on strand two was counted as 264.

Complete the table below to include the total number of each base present in the section, and the % composition of each base.

	Number of molecules present	% composition
Adenine		
Cytosine		
Guanine		
Thymine		

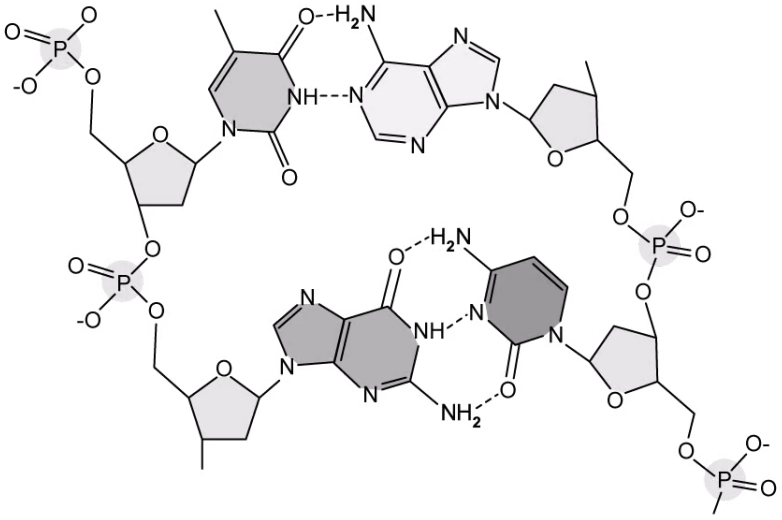
[4 marks]

[4 marks]

Question 4b

b)
The image below shows a section of the skeletal formula of a DNA molecule.

Number the carbon atoms of all the pentose sugars shown in the image using the standard numbering format.



[2 marks]

[2 marks]

Question 4c

c)
The DNA nucleotides are covalently bonded together in the sugar-phosphate backbone between the pentose sugar and the phosphate group, however, they are hydrogen bonded together between the bases.
Explain why both types of bonds are important for the functioning of DNA.

[2 marks]

[2 marks]

Question 4d

d)
During DNA replication both DNA strands act as a template, whereas in transcription only one strand acts as a template.
Outline what is meant by the word 'template' in this context.

[1 mark]

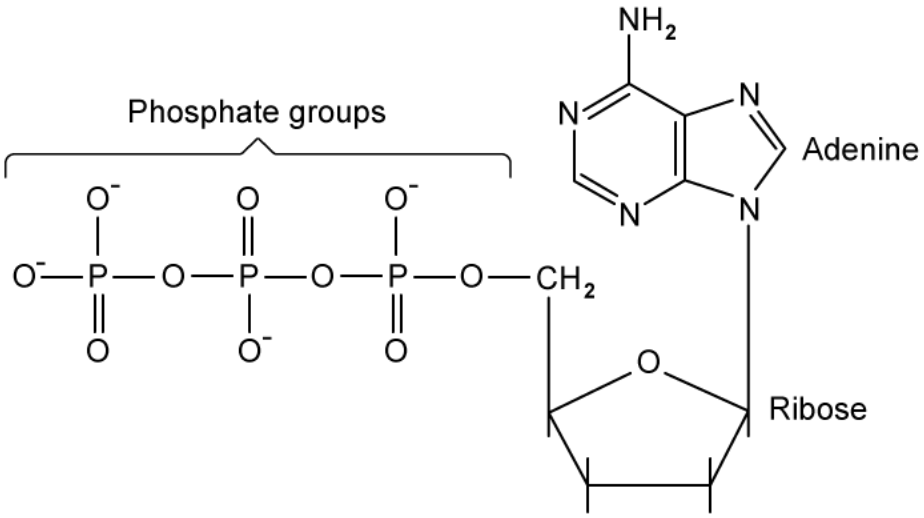
[1 mark]

Question 5a

One mark is available for clarity of communication throughout this question.

a)
ATP is a source of energy used in cells and is produced from processes such as respiration.

The structure of ATP is shown in the diagram below.



Use the information in the diagram, as well as your own knowledge, to compare and contrast the structure of ATP with an adenine DNA nucleotide.

[4 marks]

[4 marks]

Question 5b

b)
Explain how the structure of DNA allows replication.

[4 marks]

[4 marks]

Question 5c

c)
Outline the steps in the experiment that Meselson and Stahl carried out to determine the semi-conservative nature of DNA replication.

[7 marks]

[7 marks]