

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	Medium

Time allowed: 60
Score: /43
Percentage: /100

Question 1a

a)
The 3D shape of DNA is known as a double helix.

State whether it is possible for a strand of RNA to form a double helix.

[1 mark]

[1 mark]

Question 1b

b) State how the two strands of the DNA molecule are held together.

[1 mark]

Question 1c

c) State the part of a DNA molecule that contains nitrogen.

[1 mark]

Question 1d

d) Molecular modeling helped scientists determine the structure of DNA. Identify the two scientists credited with discovering the structure of DNA and explain why their model convinced other scientists.

[2 marks]

Question 2a

a) Using appropriate shapes to represent chemical structures, draw **and** label a single RNA nucleotide.

[2 marks]

Question 2b

- b) A section of DNA was found to contain the following percentages of bases, as shown in the table below.

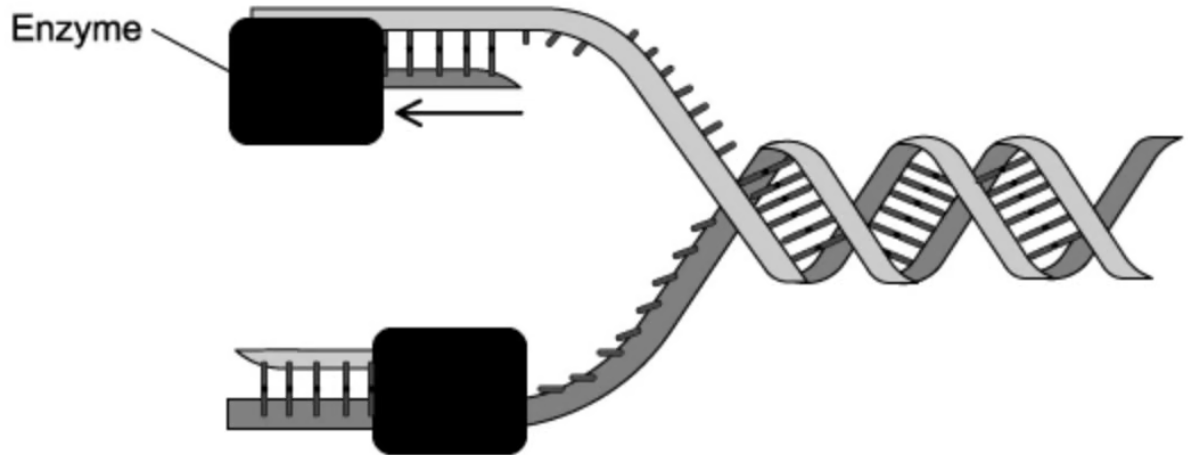
	%			
	Adenine	Cytosine	Guanine	Thymine
Sense strand	15			27
Antisense strand		23		

Use your knowledge of DNA structure to complete the table by filling in the missing boxes.

[2 marks]

Question 2c

c) The diagram below shows DNA replication.



Identify the enzyme shown in the diagram and describe its function.

[3 marks]

Question 2d

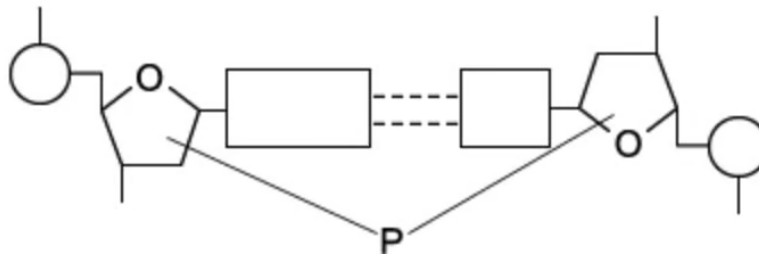
- d) Indicate with a tick or ticks (✓) in the table below the chemical group(s) that appear(s) at the two ends of a single strand of DNA.

	Deoxyribose sugar	Phosphate
3' (3-prime) end		
5' (5-prime) end		

[1 mark]

Question 3a

- a) The diagram below shows a base pair within a molecule of DNA.



Identify part **P** of this section of DNA.

[1 mark]

Question 3b

- b) Scientists sequenced the gene for a hormone, in order to understand more about why some individuals stop producing this hormone. The scientists determined that the gene consisted of 1 500 base pairs; 30% of the total bases were cytosine.

How many nucleotides of adenine and guanine were there in this sample of DNA?

[2 marks]

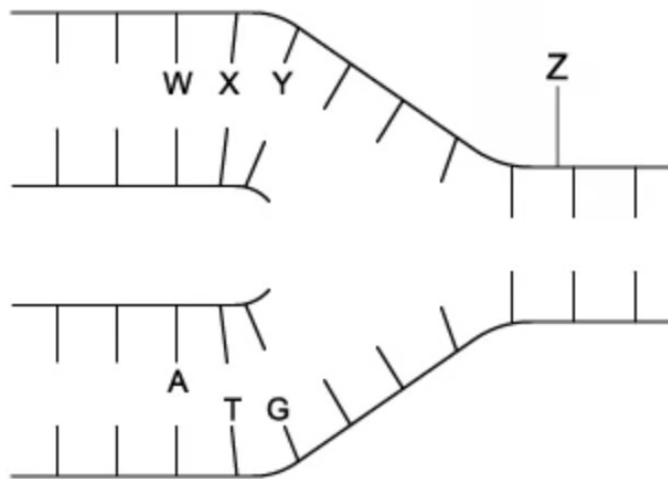
Question 3c

- c) Describe the conventional numbering system for carbon atoms in a pentose sugar such as the ribose or deoxyribose sugars found in RNA and DNA. You may sketch a diagram to illustrate your answer.

[3 marks]

Question 4a

- a) The diagram below shows the process of DNA replication. The horizontal lines represent the positions of bases.



Identify the parts of the DNA molecule represented by the labels **W**, **X**, **Y** and **Z**.

[2 marks]

Question 4b

- b) The table shows the percentage of different bases in the DNA of some organisms.

Organism	Percentage of each base			
	Adenine	Guanine	Cytosine	Thymine
Human	32.8	17.2	17.2	32.8
Caterpillar	33.1	16.9	16.9	33.1
Mouse		22.4		
Virus	24.7	24.1	18.5	32.7

Calculate the missing figures for mouse DNA and complete the table.

[2 marks]

Question 4c

- c) Humans and caterpillars have very similar percentages of each base in their DNA but are not the same class of organism.

Use your knowledge of DNA structure and function to explain how this is possible.

[3 marks]

Question 4d

- d) The DNA of the virus is different from that of the human, caterpillar and mouse. Some viruses contain single-stranded DNA that is not base-paired to a complementary strand. Use data from the table in question 4b) to show evidence for this difference.

[2 marks]

Question 5a

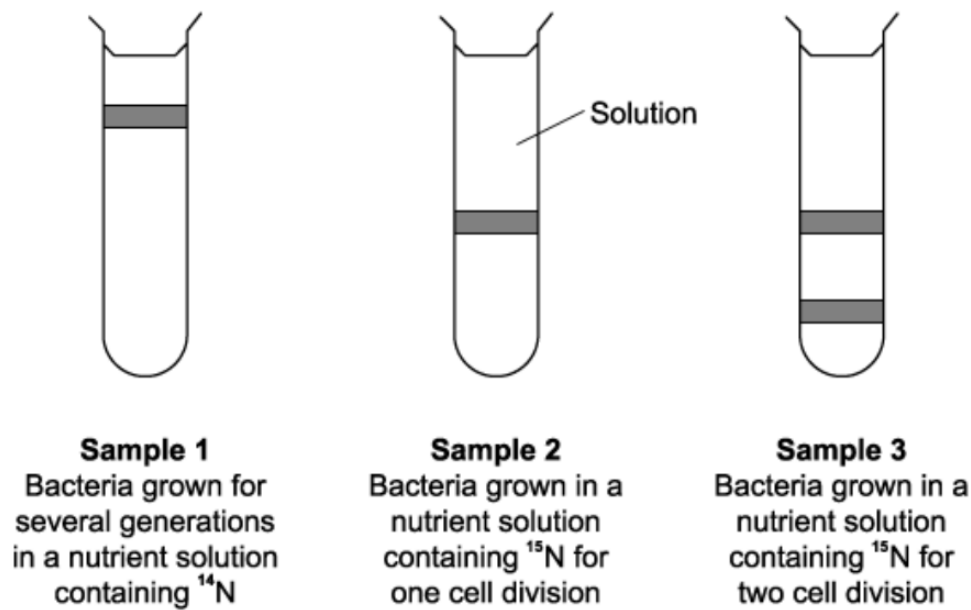
One mark is available for clarity of communication throughout this question.

- a) Describe the structural features of a DNA molecule.




[4 marks]

Question 5b

b) Meselson and Stahl grew bacteria for several generations in a solution containing light nitrogen (^{14}N) and obtained DNA from a sample of these bacteria (Sample 1). They then transferred the bacteria to a solution containing heavy nitrogen (^{15}N). This step of the process was timed so that the bacteria were allowed to grow and divide twice. After each division, they obtained DNA from a sample of bacteria (Samples 2 and 3). The DNA from each sample of bacteria was suspended in a solution in separate tubes which were then spun in a centrifuge at the same speed and duration. The diagram below shows Meselson and Stahl's results.



The table below shows the types of DNA molecule that could be present in samples 1 to 3. Complete the table with a tick (\checkmark) if the DNA molecule is present in the sample.

		Type(s) of DNA molecule present in each sample		
		$^{14}\text{N} \ ^{14}\text{N}$	$^{15}\text{N} \ ^{15}\text{N}$	$^{15}\text{N} \ ^{14}\text{N}$
Sample				
1				

2			
3			

[3 marks]

Question 5c

- c) Describe the process of semi-conservative replication of DNA in eukaryotes. In your answer, include details of any molecules, bonds or enzymes involved.

[8 marks]

