Q1.

The diagram below shows part of a DNA molecule.

(a) Name the type of bond between:

complementary base pairs _____

adjacent nucleotides in a DNA strand _____

(2)

(b) The length of a gene is described as the number of nucleotide base pairs it contains.

Use information in above diagram to calculate the length of a gene containing 4.38×10^3 base pairs.

Answer _____ nm

(2)

Q2.

(a) Complete the table below with ticks (✓) to show which elements are found in the following biological molecules.

Biological molecules	**Element**			
	Carbon	Nitrogen	Oxygen	Phosphorus
Galactose				
Phospholipid				
RNA				
Sucrose				

(2)

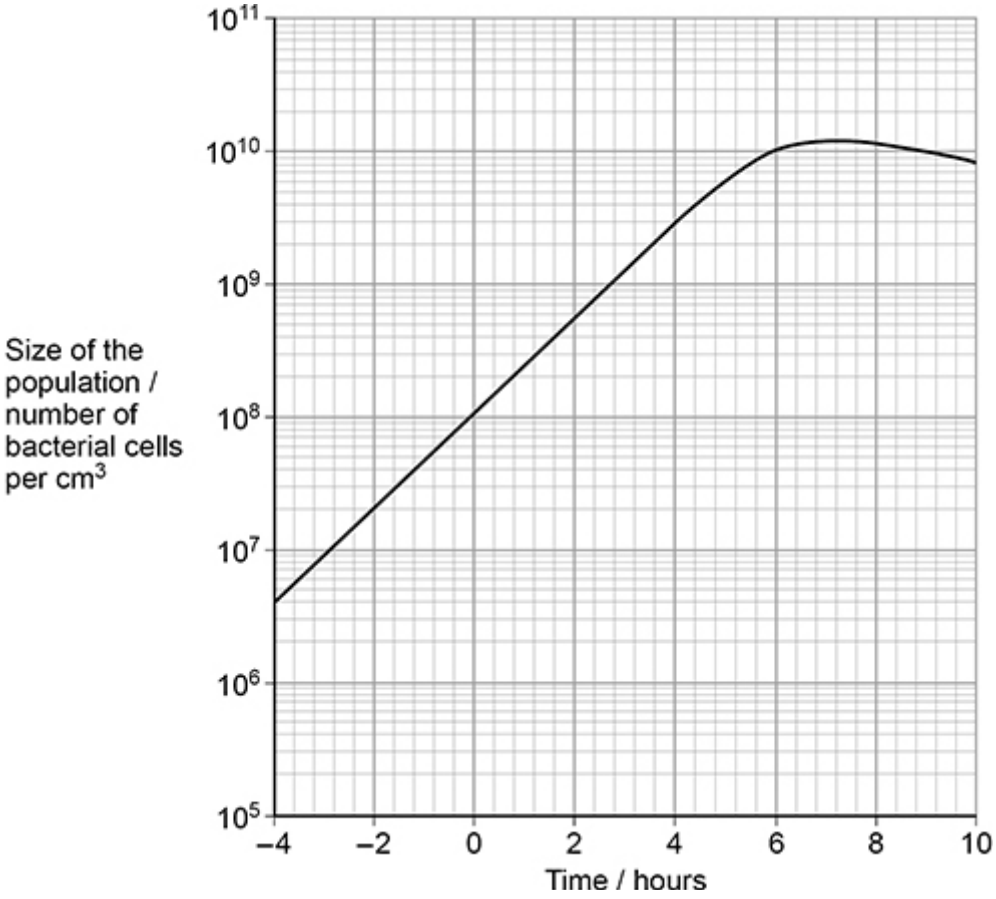
After Watson and Crick proposed the model of DNA structure, scientists investigated the possible mechanisms for DNA replication.

Two scientists grew a bacterial population, providing them with a nitrogen source containing only the heavy isotope of nitrogen, ^{15}N. As soon as all the DNA in this population contained ^{15}N, the scientists changed the nitrogen source to one containing only the lighter isotope of nitrogen, ^{14}N. They changed the nitrogen source at 0 hours.

During the investigation, the scientists measured the size of the population of bacterial cells.

Figure 1 shows the scientists' results.

Figure 1



(b) The generation time for a population of bacteria is the time taken for all the bacteria to divide once by binary fission.

Use **Figure 1** and the following equation to calculate the generation time for this population of bacteria. Give your answer in hours.

$$\text{Number of generations} = \frac{\log_{10}\left(\frac{\text{size of population at time } +4 \text{ hours}}{\text{size of population at time } -4 \text{ hours}}\right)}{\log_{10} 2}$$

Generation time _____ hours

(2)

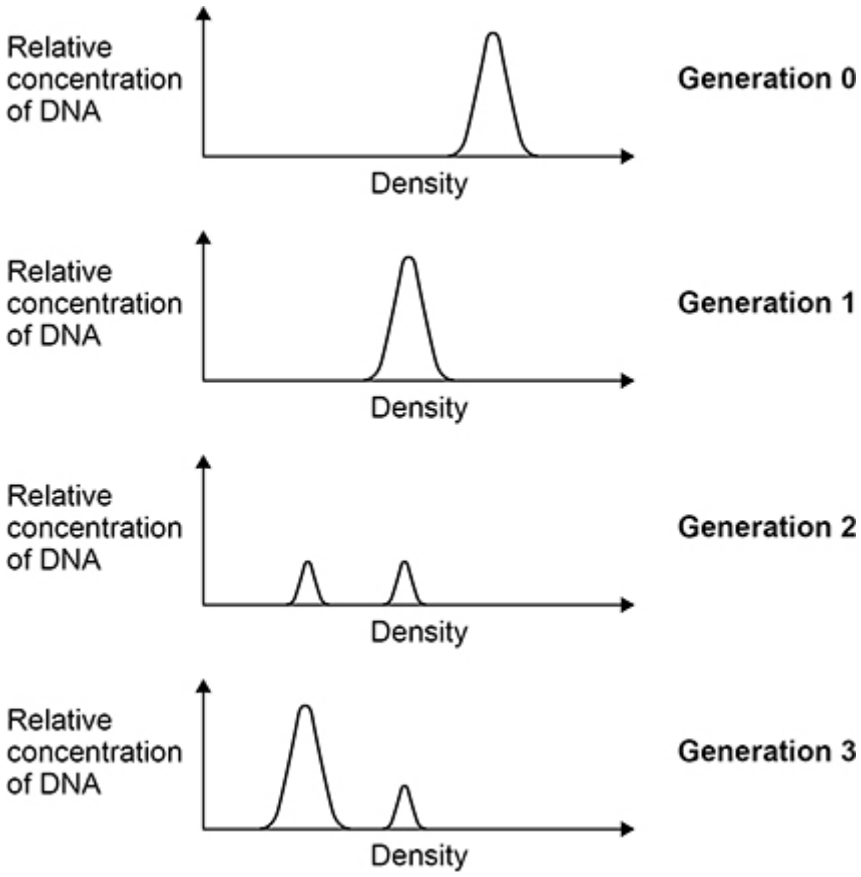
At intervals during this investigation, the scientists removed samples of the

bacterial population, isolated the DNA and measured the density of the DNA.

DNA made using ^{15}N has a higher density than DNA made using ^{14}N.

Figure 2 shows the scientists' results.

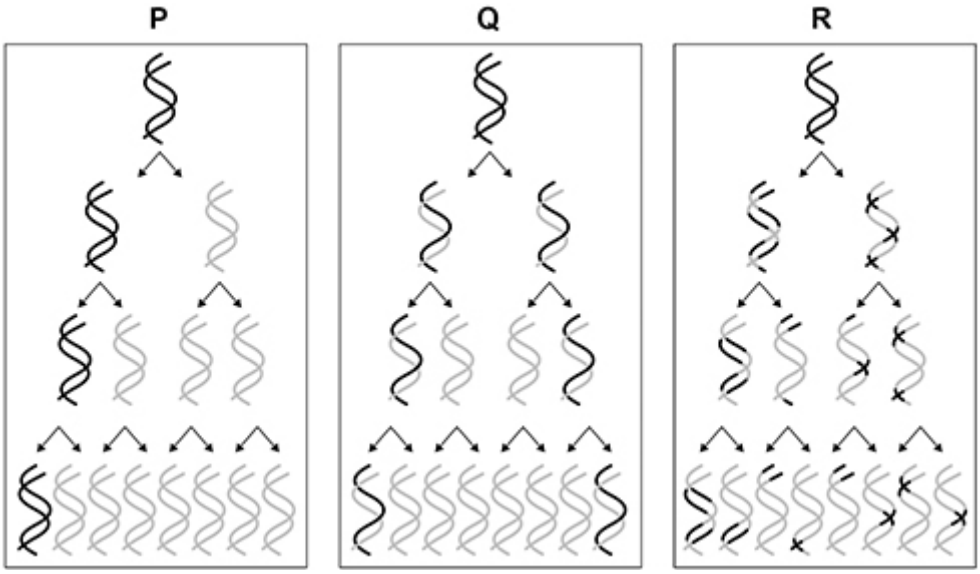
Figure 2



There are **three** possible models of DNA replication.

These models are shown in **Figure 3**.

Figure 3



(c) Which of these models, **P**, **Q** or **R**, is supported by the results shown in **Figure 2**?

Give the letter and name of the model supported and explain why the results do **not** support the other models.

Model _____

Name _____

Explanation for first **unsupported** model _____

_____

Explanation for second **unsupported** model _____

_____

(3)

(Total 7 marks)

Q3.

(a) Describe the structure of DNA.

(5)

Q4.

(a) Describe how a phosphodiester bond is formed between two nucleotides within a DNA molecule.

(2)

(b) The two DNA strands of a particular gene contain 168 guanine bases between them. The relationship between the numbers of guanine bases (G), adenine bases (A), thymine bases (T) and cytosine bases (C) in these two strands of DNA is shown in the following equation.

$$G = 4(A + T) – C$$

Use this information and your understanding of DNA structure to calculate the maximum number of amino acids coded by this gene.

Show your working.

Answer _____

(2)

(c) Name the protein associated with DNA in a chromosome.

_____

(1)

(d) In the process of semi-conservative DNA replication, the two strands within a DNA molecule are separated. Each then acts as a template for the formation of a new complementary strand.

Describe how the separation of strands occurs.

_____

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

Q5.

(a) Describe the role of DNA polymerase in the semi-conservative replication of DNA.

_____

_____

_____

_____

_____

_____

_____

_____

(2)

Q6.

(a) Name the **two** scientists who proposed models of the chemical structure of DNA and of DNA replication.

_____

(1)

A scientist replicated DNA in a test tube. To do this, he mixed an enzyme with identical single-stranded DNA fragments and a solution containing DNA nucleotides.

(b) Name the enzyme used in this DNA replication.

_____

(1)

(c) Use your knowledge of semi-conservative replication of DNA to suggest:

1. the role of the single-stranded DNA fragments _____

_____

_____

_____

_____

2. the role of the DNA nucleotides. _____

_____

_____

_____

_____

(3)

(Total 5 marks)

Q7.

(a) Draw **and** label a single DNA nucleotide.

(2)

(b) Give **two** features of DNA **and** explain how each one is important in the semi-conservative replication of DNA.

1. _____

_____

_____

_____

_____

2. _____

_____

_____

_____

_____

(2)

(c) Replication of mitochondrial DNA (mtDNA) is different from that of nuclear DNA.

The replication of the second strand of mtDNA **only** starts after two-thirds of the first strand of mtDNA has been copied.

A piece of mtDNA is 16 500 base pairs long and is replicated at a rate of 50 nucleotides per second.

Tick (✓) the box that shows how long it would take to copy this mtDNA.

A 330 seconds ☐

B 440 seconds ☐

C 550 seconds ☐

D 660 seconds ☐

(1)

(Total 5 marks)

Q8.

(a) Describe the role of **two** named enzymes in the process of semi-conservative replication of DNA.

(3)

(b) Scientists investigated the function of a eukaryotic cell protein called cyclin A. This protein is thought to be involved with the binding of one of the enzymes required at the start of DNA replication.

The scientists treated cultures of cells in the following ways.
C – Control cells, untreated
D – Added antibody that binds specifically to cyclin A
E – Added RNA that prevents translation of cyclin A
F – Added RNA that prevents translation of cyclin A **and** added cyclin A protein

They then determined the percentage of cells in each culture in which DNA was replicating.

Their results are shown in the table.

Cell treatment	**Percentage of cells where DNA was replicating**
C Control	91
D Antibody that binds specifically to cyclin A	11
E RNA that prevents translation of cyclin A	10

F RNA that prevents translation of cyclin A **and** added cyclin A protein	92

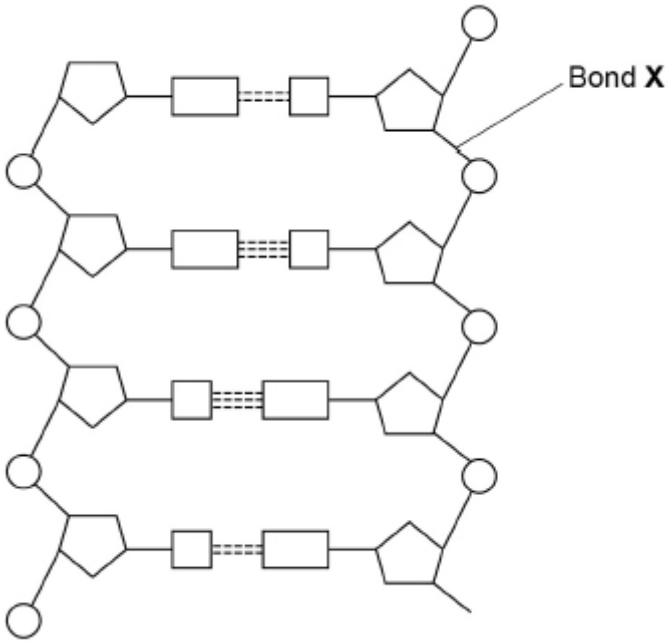
Suggest explanations for the results in the table.

(3)

(Total 6 marks)

Q9.

The diagram shows part of a DNA molecule.



(a) How many nucleotides are shown in the diagram above?

_____

(1)

(b) Name the type of bond labelled **X** in the diagram.

_____

(1)

(c) The enzymes DNA helicase and DNA polymerase are involved in DNA replication.

Describe the function of each of these enzymes.

DNA helicase _____

_____

_____

_____

DNA polymerase _____

_____

_____

_____

(2)

(d) Adenosine triphosphate (ATP) is a nucleotide derivative.

Contrast the structures of ATP and a nucleotide found in DNA to give **two** differences.

1. _____

_____

_____

_____

2. _____

_____

_____

_____

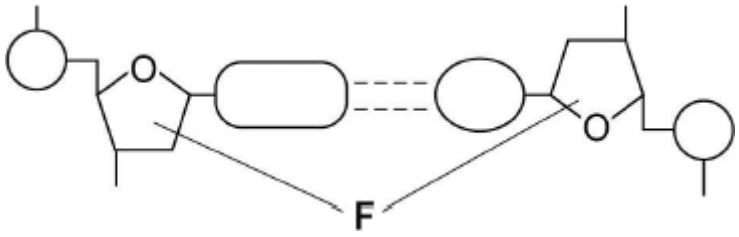
(2)

(Total 6 marks)

Q10.

Figure 1 shows one base pair of a DNA molecule.

Figure 1



(a) Name part **F** of each nucleotide.

_____

(1)

(b) Scientists determined that a sample of DNA contained 18% adenine.

What were the percentages of thymine and guanine in this sample of DNA?

Percentage of thymine ☐

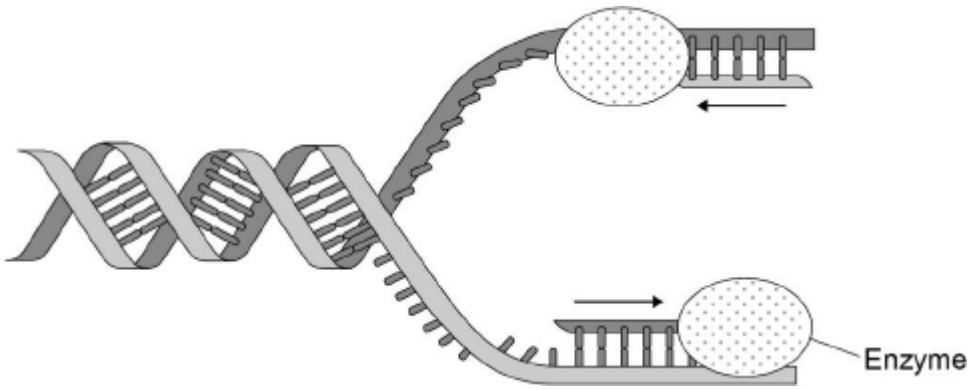
Percentage of guanine ☐

(2)

During replication, the two strands of a DNA molecule separate and each acts as a template for the production of a new strand.

Figure 2 represents DNA replication.

Figure 2



(c) Name the enzyme shown in **Figure 2**.

_____

(1)

The arrows in **Figure 2** show the directions in which each new DNA strand is being produced.

(d) Use **Figure 1, Figure 2** and your knowledge of enzyme action to explain why the arrows point in opposite directions.

_____

_____

_____

_____

_____

_____

_____

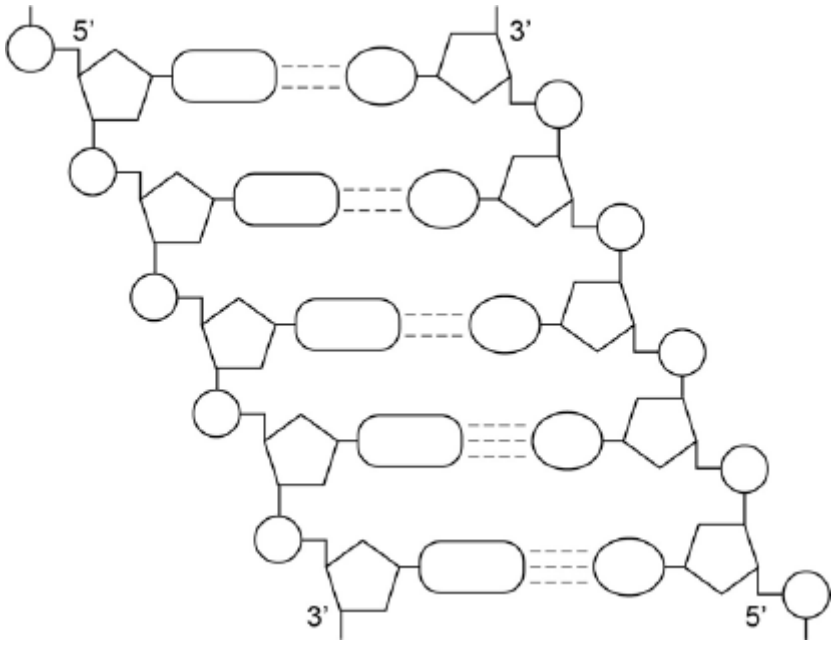
_____

(4)

(Total 8 marks)

Q11.

The following figure represents part of a DNA molecule.



(a) Draw a box around a single nucleotide.

(1)

The table below shows the percentage of bases in each of the strands of a DNA molecule.

DNA strand	**Percentage of each base**			
	A	**C**	**G**	**T**
Strand **1**	16			
Strand **2**		21	34	

(b) Complete the table by adding the missing values.

(2)

(c) During replication, the two DNA strands separate and each acts as a template for the production of a new strand. As new DNA strands are produced, nucleotides can only be added in the 5' to 3' direction.

Use the figure in part **(a)** and your knowledge of enzyme action and DNA replication to explain why new nucleotides can only be added in a 5' to 3' direction.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 7 marks)