



EXAM PAPERS PRACTICE

## Nucleic acids 2

Level: CIE A Level 9700

Subject: Biology

Exam Board: Suitable for all boards

Topic: Nucleic acids 2

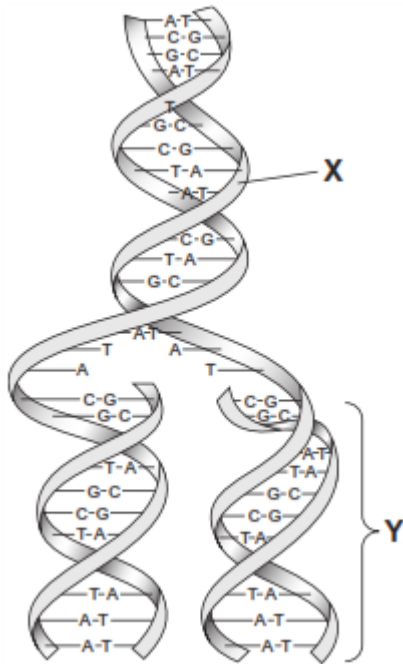
Type: Questionnaire

To be used by all students preparing for CIE Biology A Level 9700 foundation or higher tier but also suitable for students of other boards.



1

The diagram shows a molecule of DNA. It is replicating.



(a) Name **two** substances in the region labelled **X**.

1. \_\_\_\_\_
2. \_\_\_\_\_

(1)

(b) Describe how, after the parent DNA strands separated, the second strand of DNA in region **Y** was formed.

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(Extra space) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

(3)  
(Total 4 marks)

2

(a) Complete the table to give **two** differences between DNA and RNA.

Difference	DNA	RNA
1		
2		

(2)

(b) Describe the part played by RNA in protein synthesis.

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\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

(Extra space) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

(3)  
(Total 5 marks)



3

(a) Complete the table to show **two** differences between the structure of DNA and RNA.

DNA	RNA

(2)

(b) Explain how a gene codes for a protein.

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(2)

(c) What are homologous chromosomes?

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(2)

(Total 6 marks)

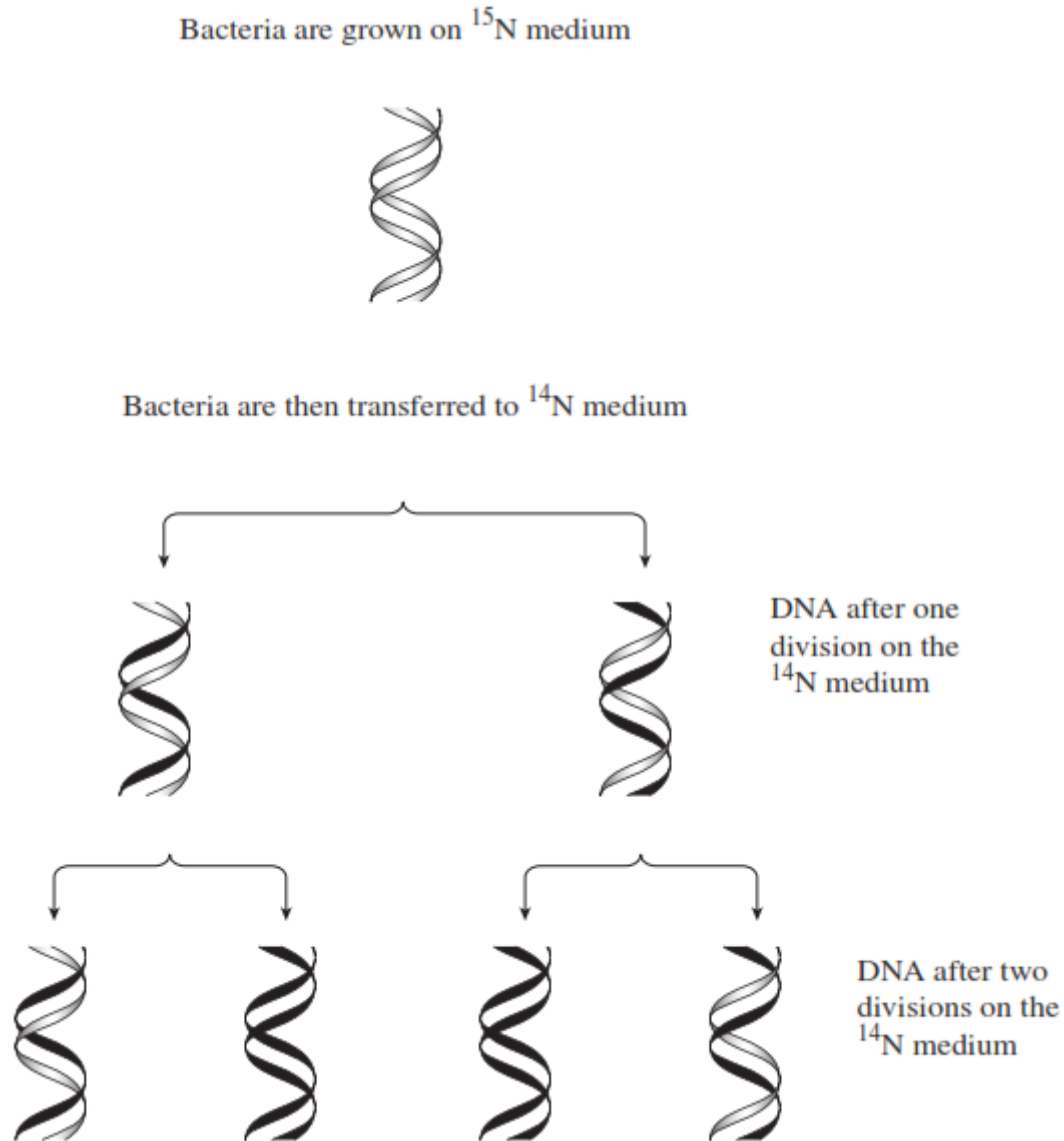
4

The bases in DNA nucleotides contain nitrogen.

Researchers grew bacteria on a medium containing  $^{15}\text{N}$  ('heavy' nitrogen) for several generations. They then transferred the bacteria to a medium containing  $^{14}\text{N}$  ('ordinary' nitrogen). They analysed DNA from the bacteria at three stages:

1. whilst the bacteria were growing on the  $^{15}\text{N}$  medium
2. after one division of the bacteria on the  $^{14}\text{N}$  medium
3. after two divisions of the bacteria on the  $^{14}\text{N}$  medium

The diagram shows their results.



- (a) Describe how the proportion of DNA that contained  $^{15}\text{N}$  changed at each division when bacteria were grown on the  $^{14}\text{N}$  medium.

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(2)



(b) The change in the proportion of DNA containing  $^{15}\text{N}$  is due to the way in which DNA replicates. Explain how.

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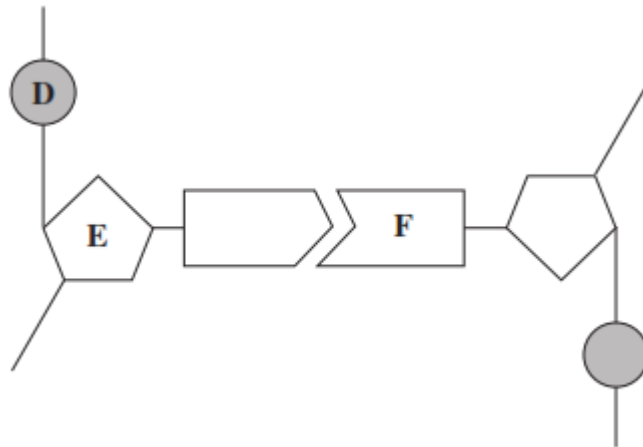
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(2)  
(Total 4 marks)

5

(a) The diagram shows one pair of nucleotides of a DNA molecule.



Name

D \_\_\_\_\_

E \_\_\_\_\_

F \_\_\_\_\_

(3)

(b) Complete the table to give **two** differences between the structure of DNA and the structure of RNA.

	DNA	RNA
1		
2		

(2)  
(Total 5 marks)

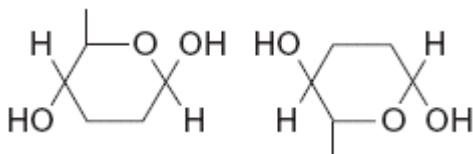


- 6 (a) The table shows some substances found in cells. Complete the table to show the properties of these substances. Put a tick in the box if the statement is correct.

Statement	Substance			
	Starch	Glycogen	Deoxyribose	DNA helicase
Substance contains only the elements carbon, hydrogen and oxygen				
Substance is made from amino acid monomers				
Substance is found in both animal cells and plant cells				

(4)

- (b) The diagram shows two molecules of  $\beta$ -glucose.



On the diagram, draw a box around the atoms that are removed when the two  $\beta$ -glucose molecules are joined by condensation.

(2)

- (c) (i) Hydrogen bonds are important in cellulose molecules. Explain why.

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(2)

- (ii) A starch molecule has a spiral shape. Explain why this shape is important to its function in cells.

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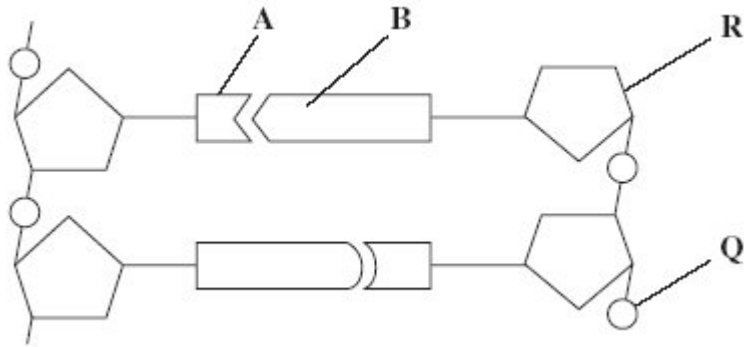
(1)

(Total 9 marks)

7

Figure 1 shows a short section of a DNA molecule.

Figure 1



(a) Name parts **R** and **Q**.

(i) **R** \_\_\_\_\_

(ii) **Q** \_\_\_\_\_

(2)

(b) Name the bonds that join **A** and **B**.

\_\_\_\_\_

(1)

(c) Ribonuclease is an enzyme. It is 127 amino acids long.

What is the minimum number of DNA bases needed to code for ribonuclease?

(1)





- (d) **Figure 2** shows the sequence of DNA bases coding for seven amino acids in the enzyme ribonuclease.

**Figure 2**

**G T T T A C T A C T C T T C T T C T T T A**

The number of each type of amino acid coded for by this sequence of DNA bases is shown in the table.

Amino acid	Number present
Arg	3
Met	2
Gln	1
Asn	1

Use the table and **Figure 2** to work out the sequence of amino acids in this part of the enzyme. Write your answer in the boxes below.

Gln						
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(1)

- (e) Explain how a change in a sequence of DNA bases could result in a non-functional enzyme.

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(3)

(Total 8 marks)

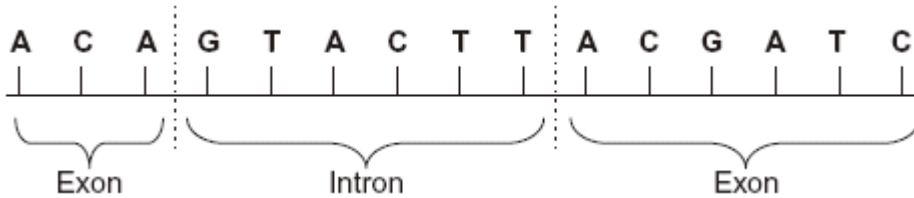


8 (a) Complete the table to show the differences between DNA, mRNA and tRNA.

Type of nucleic acid	Hydrogen bonds present (✓) or not present (✗)	Number of polynucleotide strands in molecule
DNA		
mRNA		
tRNA		

(2)

(b) The diagram shows the bases on one strand of a piece of DNA.



(i) In the space below, give the sequence of bases on the pre-mRNA transcribed from this strand.

(2)

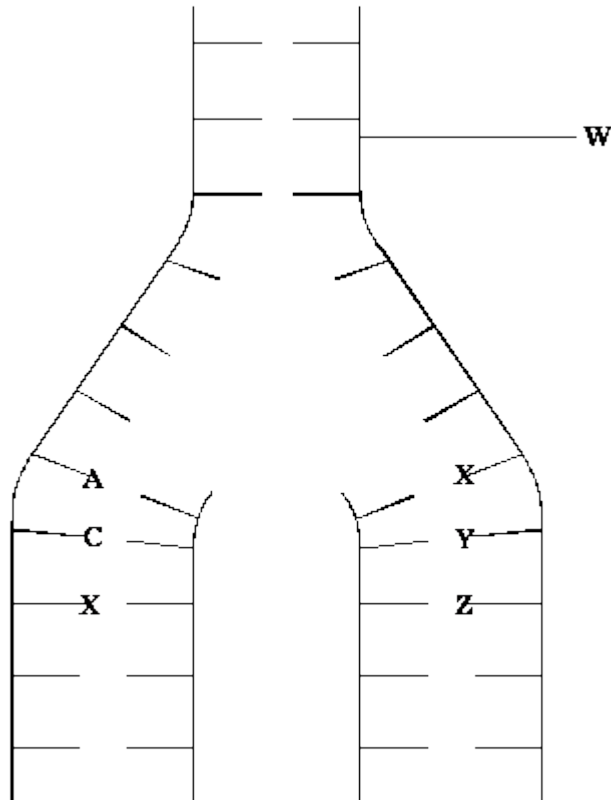
(ii) In the space below, give the sequence of bases on the mRNA produced by splicing this piece of pre-mRNA.

(1)

(Total 5 marks)



- 9 The diagram shows the process of DNA replication. The horizontal lines represent the positions of bases.



- (i) What is represented by the part of the DNA molecule labelled **W**?

\_\_\_\_\_

(1)

- (ii) In the diagram, **A** represents adenine and **C** represents cytosine.

Name the base found at

position **X**; \_\_\_\_\_

position **Y**; \_\_\_\_\_

position **Z**. \_\_\_\_\_

(3)

(Total 4 marks)

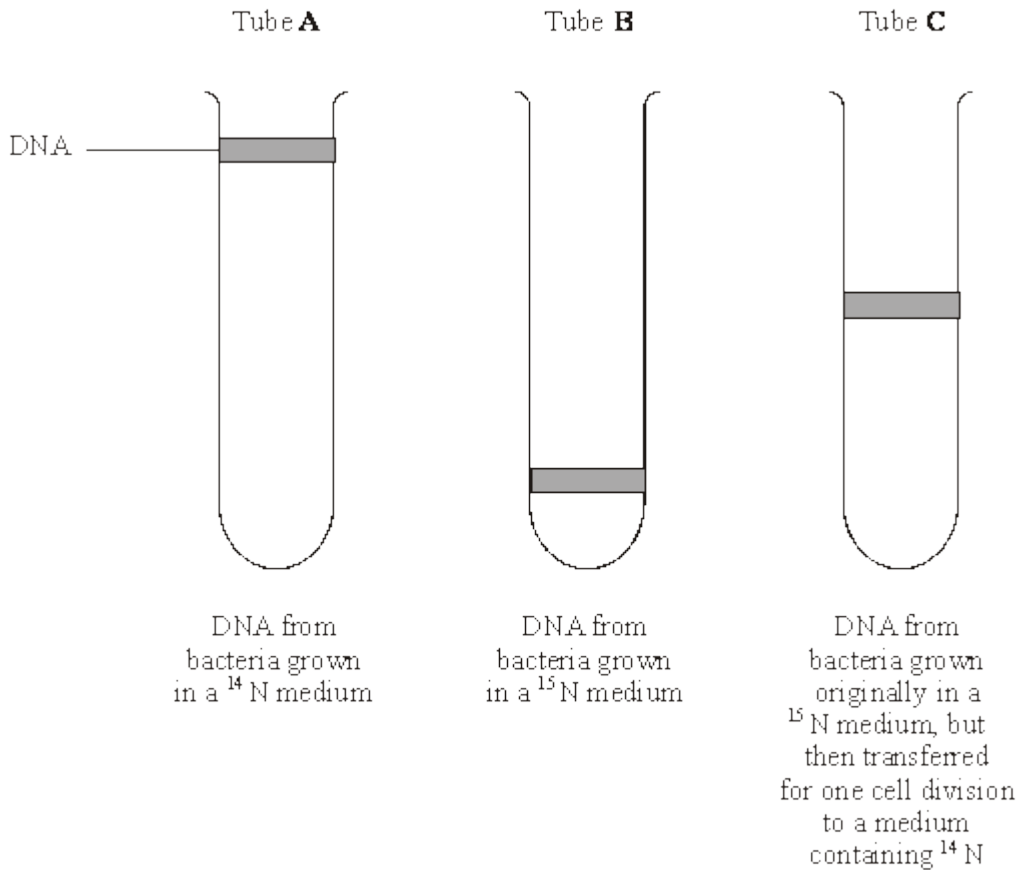
- 10 (a) Explain why the replication of DNA is described as semi-conservative.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

(2)



(b) Bacteria require a source of nitrogen to make the bases needed for DNA replication. In an investigation of DNA replication some bacteria were grown for many cell divisions in a medium containing  $^{14}\text{N}$ , a light form of nitrogen. Others were grown in a medium containing  $^{15}\text{N}$ , a heavy form of nitrogen. Some of the bacteria grown in a  $^{15}\text{N}$  medium were then transferred to a  $^{14}\text{N}$  medium and left to divide once. DNA was isolated from the bacteria and centrifuged. The DNA samples formed bands at different levels, as shown in the diagram.



(i) What do tubes **A** and **B** show about the density of the DNA formed using the two different forms of nitrogen?

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(1)

(ii) Explain the position of the band in tube **C**.

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(2)



- (c) In a further investigation, the DNA of the bacterium was isolated and separated into single strands. The percentage of each nitrogenous base in each strand was found. The table shows some of the results.

DNA sample	Percentage of base present			
	Adenine	Cytosine	Guanine	Thymine
Strand 1	26		28	14
Strand 2	14			

Use your knowledge of base pairing to complete the table.

(2)

(Total 7 marks)

11

- (a) The mRNA codon for the amino acid tyrosine is UAU.

- (i) Give the DNA triplet for tyrosine.

\_\_\_\_\_

(1)

- (ii) Give the tRNA anticodon for tyrosine.

\_\_\_\_\_

(1)

- (b) Give **two** ways in which the structure of a molecule of tRNA differs from the structure of a molecule of mRNA.

1. \_\_\_\_\_

\_\_\_\_\_

2. \_\_\_\_\_

\_\_\_\_\_

(2)

(Total 4 marks)

12

New alleles arise as a result of mutations in existing genes. These mutations may occur during DNA replication.

- (a) Explain what is meant by an allele.

\_\_\_\_\_

\_\_\_\_\_

(1)



(b) Explain how DNA replicates.

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(4)

(c) Explain why a mutation involving the deletion of a base may have a greater effect than one involving substitution of one base for another.

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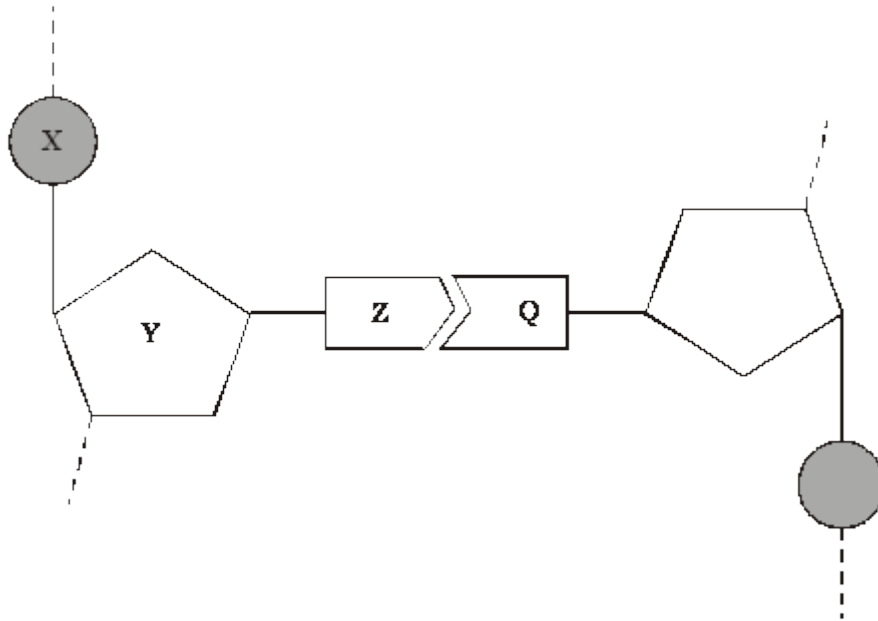
(3)

**(Total 8 marks)**



13

The diagram shows one nucleotide pair of a DNA molecule.



(a) Name the parts of the nucleotide labelled **X**, **Y** and **Z**.

**X** \_\_\_\_\_

**Y** \_\_\_\_\_

**Z** \_\_\_\_\_

(3)

(b) What type of bond holds **Z** and **Q** together?

\_\_\_\_\_

(1)

(c) A sample of DNA was analysed. 28% of the nucleotides contained thymine. Calculate the percentage of nucleotides which contained cytosine. Show your working.

Answer \_\_\_\_\_ %

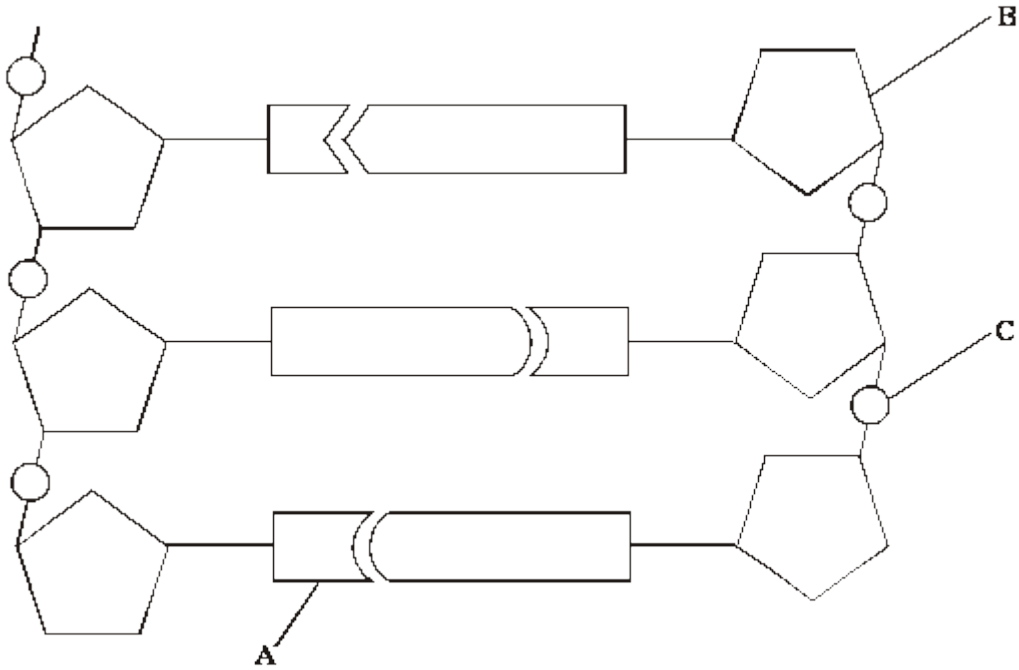
(2)

(Total 6 marks)



14

The diagram shows a short section of a DNA molecule.



(a) On the diagram draw a box round **one** nucleotide. (1)

(b) Use the letters in the diagram to indicate a part of the molecule which

(i) is **not** a base and is different in an RNA molecule;

\_\_\_\_\_

(ii) contains nitrogen.

\_\_\_\_\_

(2)

(c) (i) The sequence of bases on one strand of DNA is important for protein synthesis. What is its role?

\_\_\_\_\_

\_\_\_\_\_

(1)

(ii) How are the two strands of the DNA molecule held together?

\_\_\_\_\_

(iii) Give **one** advantage of DNA molecules having two strands.

\_\_\_\_\_

\_\_\_\_\_

(1)

(1)

(Total 6 marks)





15

(a) (i) Describe the role of DNA polymerase in DNA replication.

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(1)

(ii) Other than being smaller, give **two** ways in which prokaryotic DNA is different from eukaryotic DNA.

1. \_\_\_\_\_

2. \_\_\_\_\_

(2)

(b) The table shows the percentage of each base in the DNA from three different organisms.

Organism	Percentage of each base in DNA			
	Adenine	Guanine	Thymine	Cytosine
Human	30.9	19.9	29.4	19.8
Grasshopper	29.4	20.5	29.4	20.7
Virus	24.0	23.3	21.5	31.2

(i) Humans and grasshoppers have very similar percentages of each base in their DNA but they are very different organisms.

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

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(2)



- (ii) The DNA of the virus is different from that of other organisms. Use the table above and your knowledge of DNA to suggest what this difference is. Explain your answer.

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**[Extra space]** \_\_\_\_\_  
\_\_\_\_\_

(2)  
**(Total 7 marks)**

**16**

- (a) The events that take place during interphase and mitosis lead to the production of two genetically identical cells. Explain how.

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**[Extra space]** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
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(4)

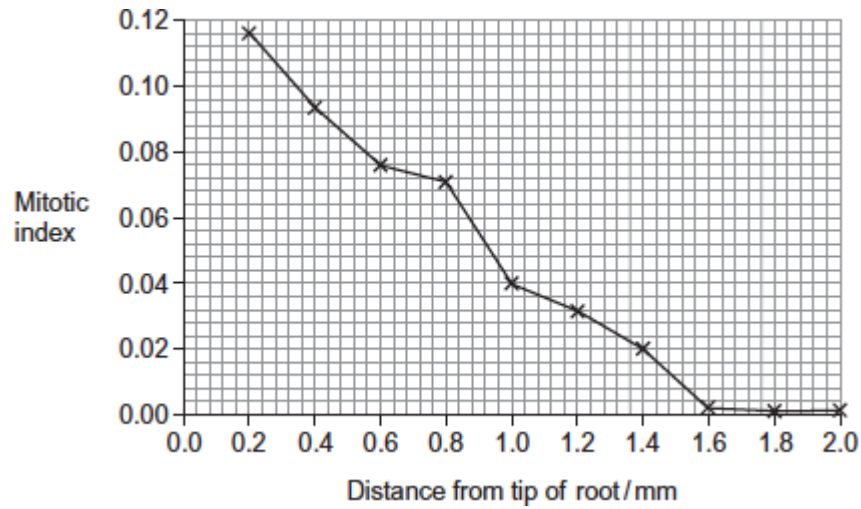


- (b) A student cut thin sections of tissue at different distances from the tip of a root. She stained the sections and viewed them with an optical microscope.

For each section, the student counted the number of cells in mitosis and the total number of cells in each field of view. She then calculated a **mitotic index** for each section using the equation:

$$\text{mitotic index} = \frac{\text{number of cells in mitosis}}{\text{total number of cells}}$$

The student's results are shown in the graph.



- (i) The student cut thin sections of tissue to view with an optical microscope. Explain why it was important that the sections were thin.

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(2)



- (ii) What does the graph show about the growth of roots?  
Use the data to explain your answer.

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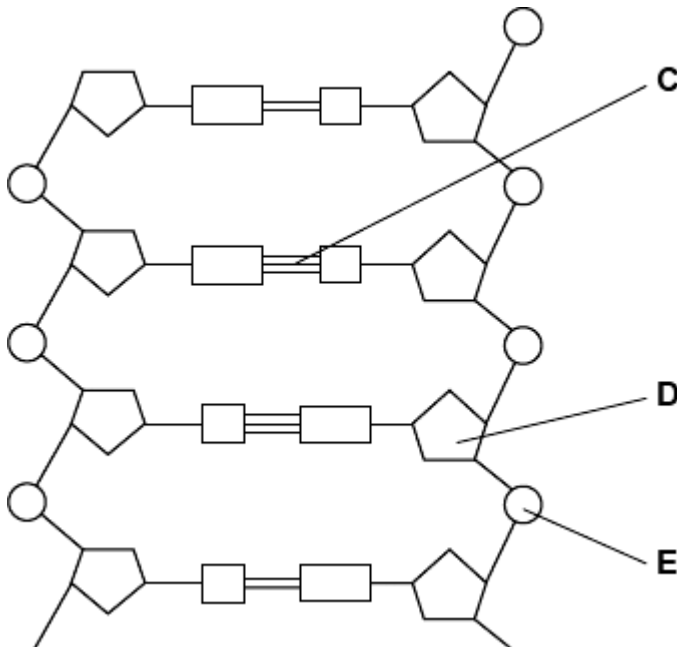
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(2)

(Total 8 marks)

17

The diagram shows part of a DNA molecule.



- (a) (i) DNA is a polymer. What is the evidence from the diagram that DNA is a polymer?

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(1)

- (ii) Name the parts of the diagram labelled **C**, **D** and **E**.

Part **C** \_\_\_\_\_

Part **D** \_\_\_\_\_

Part **E** \_\_\_\_\_

(3)



(iii) In a piece of DNA, 34% of the bases were thymine.

Complete the table to show the names and percentages of the other bases.

Name of base	Percentage
Thymine	34
	34

(2)

(b) A polypeptide has 51 amino acids in its primary structure.

(i) What is the minimum number of DNA bases required to code for the amino acids in this polypeptide?

(1)

(ii) The gene for this polypeptide contains more than this number of bases.

Explain why

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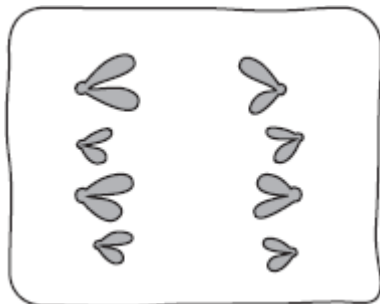
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(1)

(Total 8 marks)

18

(a) The diagram shows a stage of mitosis in an animal cell.



(i) Name this stage.

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(1)



- (ii) Describe what happens during this stage that results in the production of two genetically identical cells.

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(2)

- (b) A sample of epithelial tissue from the small intestine of an animal was analysed. Some of the cells had 8.4 units of DNA, others had only 4.2 units.

- (i) Use your knowledge of the cell cycle to explain why some cells had 8.4 units of DNA and others had only 4.2 units.

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(2)

- (ii) How many units of DNA would you expect to be present in a gamete formed in this animal as a result of meiosis?

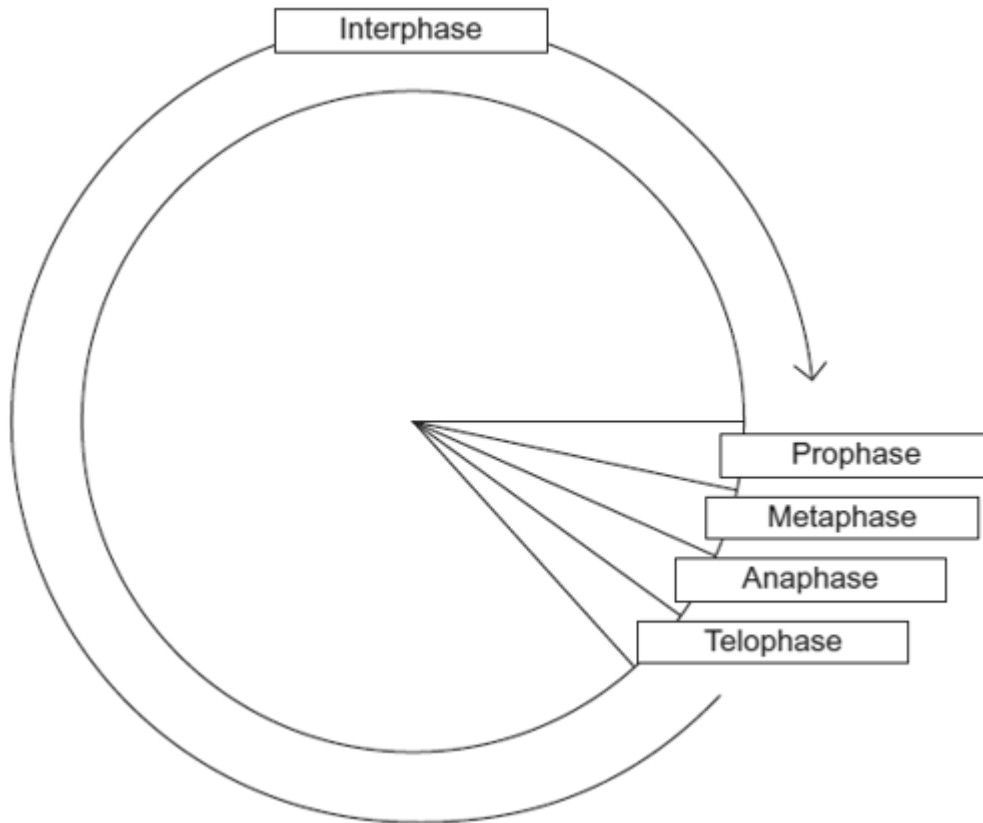
(1)

(Total 6 marks)



19

The diagram shows a cell cycle.



(a) In prophase of mitosis, the chromosomes become visible. Describe what happens in

(i) metaphase

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(2)

(ii) anaphase.

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(2)



- (b) (i) Cells lining the human intestine complete the cell cycle in a short time. Explain the advantage of these cells completing the cell cycle in a short time.

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(1)

- (ii) The time required for a cell to complete the cell cycle was 4 hours 18 minutes.

Calculate the time required in minutes for this cell to multiply to produce eight cells.  
Show your working.

Answer \_\_\_\_\_

(2)

- (c) Mikanolide is a drug that inhibits the enzyme DNA polymerase. Explain why this drug may be effective against some types of cancer.

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(2)

**(Total 9 marks)**