AQA A-LEVEL · 7402

BIOLOGY



EXAM QUESTION PACK

3.1.5 NUCLEIC ACIDS

SCORE	PERCENTAGE
/ 310	%

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Q1.

(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. _____

_____

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2. _____

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(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)

Q2.

Read the following passage.

Sizes of populations of normal intestinal bacteria are usually controlled by T cells that are produced slowly and in small numbers by the immune system. These T cells do not normally survive for very long. As a result, they do not release large amounts of cytokines. Cytokines are chemicals that can cause swelling of the lining of the intestines.

Crohn's disease is a long-lasting disease that causes swelling of the lining of the intestines. It is believed that Crohn's disease can be caused by a loss of tolerance to normal intestinal bacteria, as shown by an unusually large response by T cells. This response can be triggered by pathogenic bacteria in the intestines of people with a genetic tendency to Crohn's disease.

Some people's Crohn's disease can be controlled by a drug called 5-aminosalicylic acid (5-ASA) that reduces swelling. Another drug called 6-mercaptopurine (6-MP) may also be used. 6-MP inhibits an enzyme required to make adenine and guanine. This is effective because most cells can recycle nucleotides, but T cells are not able to do so.

Use information from the passage and your own knowledge to answer the questions.

(a) The Crohn's disease symptom of swelling of the lining of the intestines could be triggered by pathogenic bacteria in the intestines (lines 6–10).

Suggest how.

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_____

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_____

(3)

(b) Suggest the meaning of ‘a genetic tendency to Crohn’s disease’ (line 10).

(2)

(c) Suggest why 5-ASA is only effective in controlling the swelling of the lining of the intestines in **some** people with Crohn’s disease (lines 11–12).

(2)

(d) Suggest why 6-MP can be used to control the symptoms of Crohn's disease (lines 13–15).

Do **not** include details of enzyme inhibition or protein synthesis in your answer.

(3)

(Total 10 marks)

Q3.

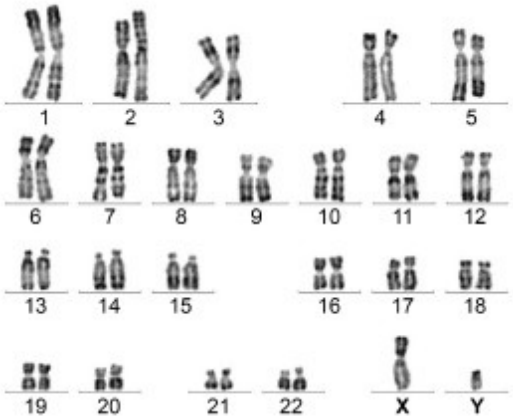
Figure 1 shows all the chromosomes present in one human cell during mitosis. A scientist stained and photographed the chromosomes. In **Figure 2**, the scientist has arranged the

images of these chromosomes in homologous pairs.

Figure 1



Figure 2



(a) Give **two** pieces of evidence from **Figure 1** that this cell was undergoing mitosis. Explain your answers.

1. _____

_____

_____

_____

_____

_____

2. _____

_____

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_____

_____

(2)

(b) Tick (✓) **one** box that gives the name of the stage of mitosis shown in **Figure 1**.

A Anaphase ☐

B Interphase ☐

C Prophase ☐

D Telophase ☐

(1)

(c) When preparing the cells for observation the scientist placed them in a solution that had a slightly higher (less negative) water potential than the cytoplasm. This did not cause the cells to burst but moved the chromosomes further apart in order to reduce the overlapping of the chromosomes when observed with an optical microscope.

Suggest how this procedure moved the chromosomes apart.

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(2)

(d) The dark stain used on the chromosomes binds more to some areas of the chromosomes than others, giving the chromosomes a striped appearance.

Suggest **one** way the structure of the chromosome could differ along its length to result in the stain binding more in some areas.

_____

_____

_____

_____

_____

(1)

(e) In **Figure 2** the chromosomes are arranged in homologous pairs.
What is a homologous pair of chromosomes?

_____

_____

_____

_____

_____

(1)

(f) Give **two** ways in which the arrangement of prokaryotic DNA is different from the arrangement of the human DNA in **Figure 1**.

1. _____

_____

_____

_____

2. _____

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_____

(2)

(Total 9 marks)

Q4.

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

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(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.

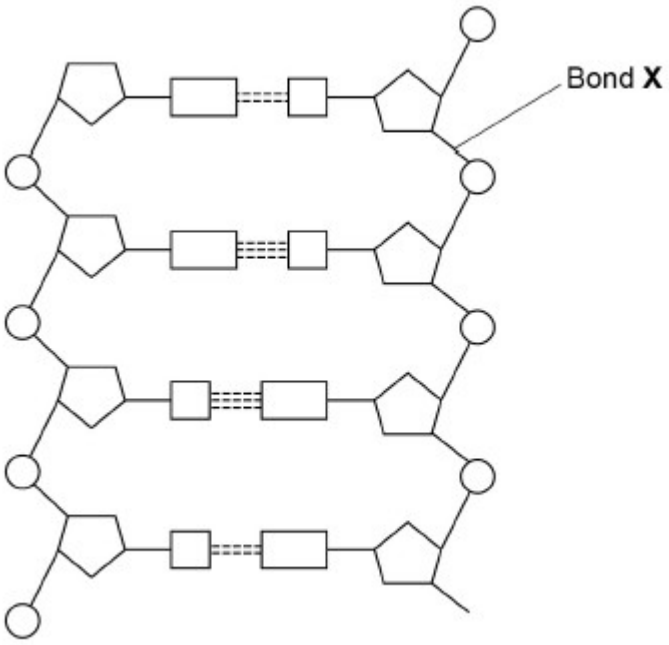
_____

(3)

(Total 6 marks)

Q5.

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. _____

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_____

_____

(2)

(Total 6 marks)

Q6.

(a) Give the **two** types of molecule from which a ribosome is made.

_____

_____

(1)

(b) Describe the role of a ribosome in the production of a polypeptide. Do **not** include transcription in your answer.

_____

_____

_____

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_____

_____

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_____

(3)

(c) The table below shows the base sequence of part of a pre-mRNA molecule from a eukaryotic cell.

Complete the table with the base sequence of the DNA strand from which this pre-mRNA was transcribed.

									DNA
A	**C**	**G**	**C**	**A**	**U**	**U**	**A**	**U**	pre-mRNA

(1)

(d) In a eukaryotic cell, the base sequence of the mRNA might be different from the sequence of the pre-mRNA.

Explain why.

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

Q7.

(a) Name **two** enzymes involved in the semi-conservative replication of DNA.

1. _____

2. _____

(2)

(b) Sometimes, damage occurs during DNA replication. One enzyme involved in repairing damage to DNA is called ATR.

ATR works as follows.

- ATR phosphorylates other enzymes involved in repairing DNA.
- ATR **also** phosphorylates substrates required to repair DNA.

When ATR phosphorylates other enzymes, these enzymes become able to bind to their substrates.

Use your knowledge of enzyme structure to suggest why.

_____

_____

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_____

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_____

_____

(2)

(c) The enzyme-catalysed reactions activated by ATR only occur if the substrates have been phosphorylated.

Use your knowledge of energy changes in enzyme-catalysed reactions to suggest why.

_____

_____

_____

_____

_____

(1)

(d) Sometimes, a mutagenic agent causes DNA to break. A different enzyme called ATM binds to the broken DNA. This leads to the activation of a protein coded for by a tumour suppressor gene. The effect of ATM binding is to stop cell division until DNA is repaired.

A mutation could result in a person having non-functional forms of the gene that produces ATM.

What can you predict about the possible effects of having a non-functional form of ATM?

_____

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_____

_____

(3)

(Total 8 marks)

Q8.

(a) The genetic code is **degenerate** and **non-overlapping**.

Explain the meaning of:

Degenerate _____

_____

Non-overlapping _____

_____

(2)

The table shows a short section of a messenger RNA (mRNA) molecule and the section of a polypeptide for which it codes.

mRNA	G G G	G C U	U C A	C C G	G C A	A C G
Polypeptide	glycine	alanine	serine	proline	alanine	threonine

(b) Name the bases represented in the table by:

A _____

C _____

G _____

U _____

(2)

(c) Use information in the table to give the sequence of bases in **DNA** that codes for serine.

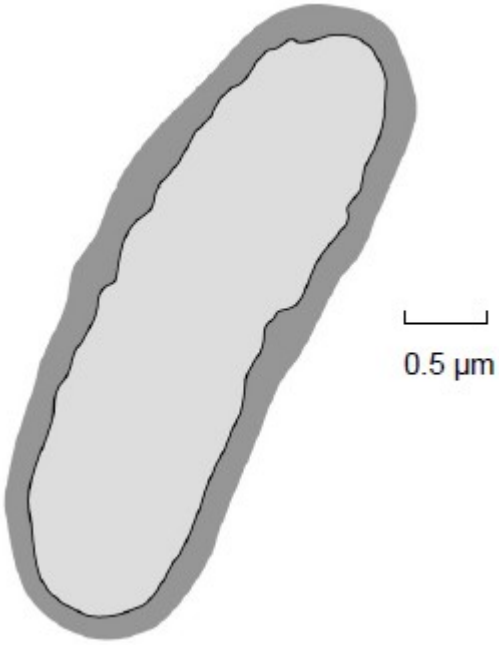
_____

(1)

(Total 5 marks)

Q9.

A bacterium is shown in the diagram.



(a) Calculate the magnification of the image.

Magnification = _____

(1)

(b) Complete the table to show the features of a bacterium and a virus.

Put a tick (✔) in the box if the feature is shown.

Surface	**Bacterium**	**Virus**
Cell-surface membrane		
Nucleus		
Cytoplasm		
Capsid		

(2)

(c) DNA and RNA can be found in bacteria.

Give **two** ways in which the nucleotides in DNA are different from the nucleotides in RNA.

1. _____

2. _____

(2)

(Total 5 marks)

Q10.

(a) DNA is a polymer of nucleotides. Each nucleotide contains an organic base.

Explain how the organic bases help to stabilise the structure of DNA.

_____

_____

_____

_____

_____

(2)

(b) Triplets of bases in a DNA molecule code for the sequence of amino acids in a polypeptide. The genetic code is frequently written as the three bases on mRNA that are complementary to a triplet on DNA. **Table 1** shows what different combinations of bases on mRNA code for. The names of amino acids are abbreviated. For example, 'Ala' stands for alanine.

Table 1

First base	Second base				Third base
	Guanine (G)	Adenine (A)	Cytosine (C)	Uracil (U)	
G	GGG Ala	GAG Glu	GCG Ala	GUG Val	G
	GGA Gly	GAA Glu	GCA Ala	GUA Val	A
	GGC Gly	GAC Asp	GCC Ala	GUC Val	C
	GGU Gly	GAU Asp	GCU Ala	GUU Val	U
A	AGG Arg	AAG Lys	ACG Thr	AUG Met	G
	AGA Arg	AAA Lys	ACA Thr	AUA Iso	A
	AGC Ser	AAC Asn	ACC Thr	AUC Iso	C
	AGU Ser	AAU Asn	ACU Thr	AUU Iso	U
C	CGG Arg	CAG Gln	CCG Pro	CUG Leu	G
	CGA Arg	CAA Gln	CCA Pro	CUA Leu	A
	CGC Arg	CAC Hist	CCC Pro	CUC Leu	C
	CGU Arg	CAU Hist	CCU Pro	CUU Leu	U
U	UGG Trp	UAG **stop**	UCG Ser	UUG Leu	G
	UGA **stop**	UAA **stop**	UCA Ser	UUA Leu	A
	UGC Cyst	UAC Tyr	UCC Ser	UUC Phe	C
	UGU Cyst	UAU Tyr	UCU Ser	UUU Phe	U

Suggest **one** advantage of showing the genetic code as base sequences on mRNA,

rather than triplets on DNA.

_____

_____

_____

(1)

(c) What name is given to a group of three bases on mRNA that codes for an amino acid?

_____

(1)

(d) Use information from **Table 1** to explain why the genetic code is described as degenerate.

_____

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_____

_____

_____

(2)

(e) Suggest the role of the mRNA base triplets UGA, UAG and UAA.

_____

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_____

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_____

(2)

(f) **Table 2** shows the sequence of mRNA bases forming part of a single gene.

Table 2

Base on DNA template									
Base on mRNA	G	U	G	U	A	C	U	G	G
Encoded amino acid									

Complete **Table 2** to show the base sequence of the DNA template from which this

mRNA was transcribed and the encoded amino acid sequence.

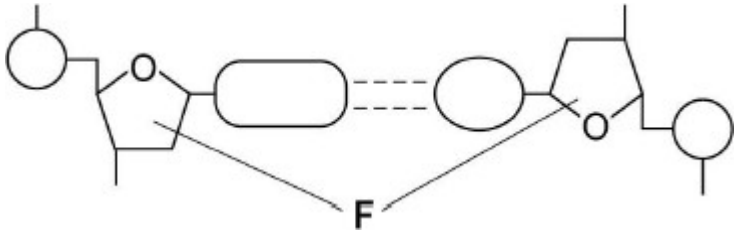
(2)

(Total 10 marks)

Q11.

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 ☐

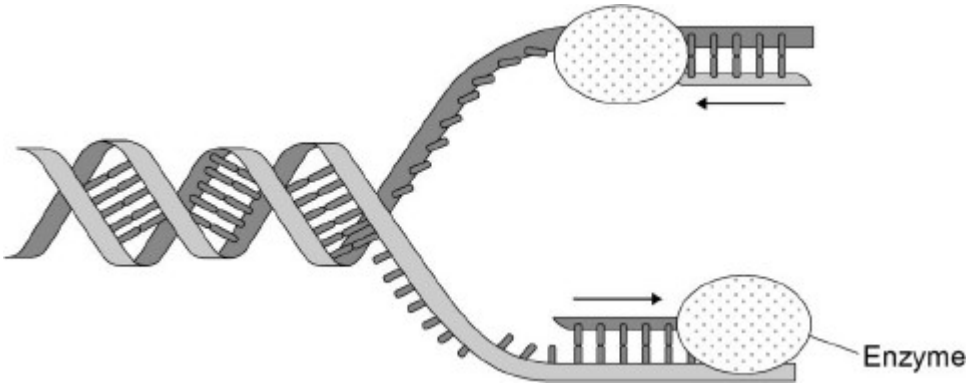
Percentage of guanine ☐

(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.

_____

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(4)

(Total 8 marks)

Q12.

Read the following passage.

Herpes simplex virus (HSV) infects nerve cells in the face, including some near the lips. Like many other viruses, HSV can remain inactive inside the body for years. When HSV becomes active, it causes cold sores around the mouth.

Human cells infected with a virus may undergo programmed cell death. While HSV is inactive inside the body, only one of its genes is transcribed. This gene is the latency-associated transcript (*LAT*) gene that prevents programmed cell death of an infected nerve cell.

Scientists have found that transcription of the *LAT* gene produces a microRNA. This microRNA binds to some of the nerve cell's own mRNA molecules. These mRNA molecules are involved in programmed cell death of nerve cells. The scientists concluded that production of this microRNA allows HSV to remain in the body for years.

Use information from the passage and your own knowledge to answer the following questions.

(a) HSV infects nerve cells in the face (line 1). Explain why it infects **only** nerve cells.

_____

_____

_____

_____

_____

_____

(3)

(b) HSV can remain inactive inside the body for years (lines 2–3). Explain why this virus can be described as **inactive**.

_____

_____

_____

_____

(2)

(c) Suggest **one** advantage of programmed cell death (line 4).

_____

_____

(1)

(d) The scientists concluded that production of this microRNA allows HSV to remain in the body for years (lines 10–12).

Explain how this microRNA allows HSV to remain in the body for years.

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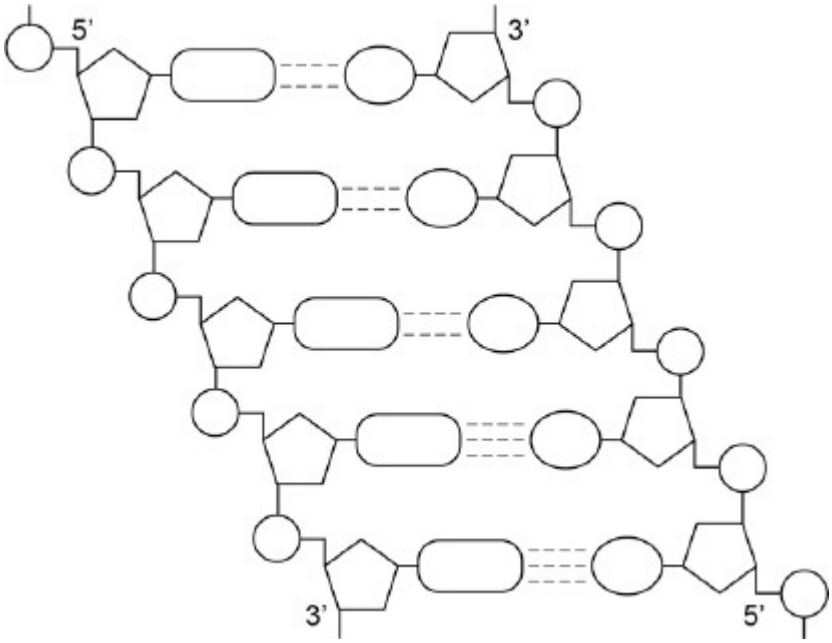
_____

(4)

(Total 10 marks)

Q13.

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.

_____

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_____

(4)

(Total 7 marks)

Q14.

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

_____

_____

(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.

_____

_____

_____

_____

_____

(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.

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

Q15.

(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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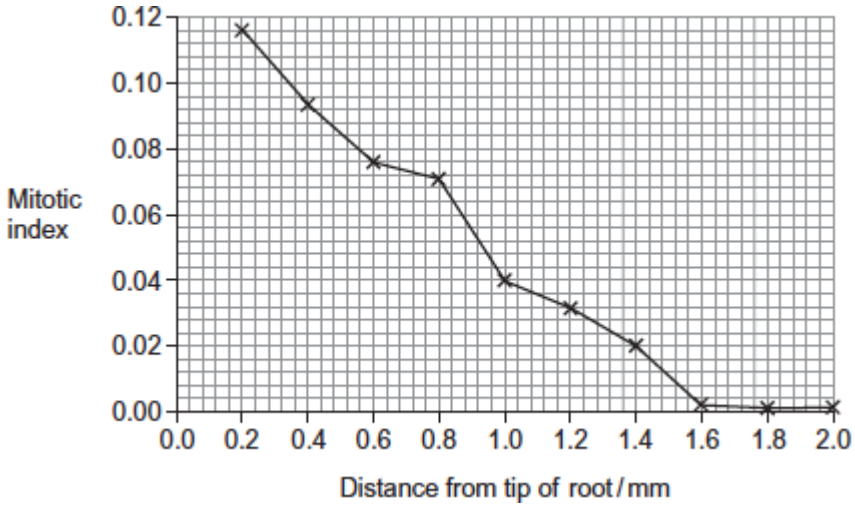
(4)

(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 arer 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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(2)

(Total 8 marks)

Q16.

(a) Explain how the structure of DNA is related to its functions.

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(6)

Scientists investigated three genes, **C**, **D** and **E**, involved in controlling cell division. They studied the effect of mutations in these genes on the risk of developing lung cancer.

The scientists analysed genes **C**, **D** and **E** from healthy people and people with lung cancer.

- If a person had a normal allele for a gene, they used the symbol N.
- If a person had two mutant alleles for a gene, they used the symbol M.

They used their data to calculate the risk of developing lung cancer for people with different combinations of N and M alleles of the genes. A risk value of 1.00 indicates no increased risk. The following table shows the scientists' results.

Gene C	Gene D	Gene E	Risk of developing lung cancer
N	N	N	1.00
M	N	N	1.30
N	N	M	1.78
N	M	N	1.45

N = at least one copy of the normal allele is present
M = two copies of the mutant allele are present

(b) What do these data suggest about the relative importance of the mutant alleles of genes **C**, **D** and **E** on **increasing** the risk of developing lung cancer? Explain your answer.

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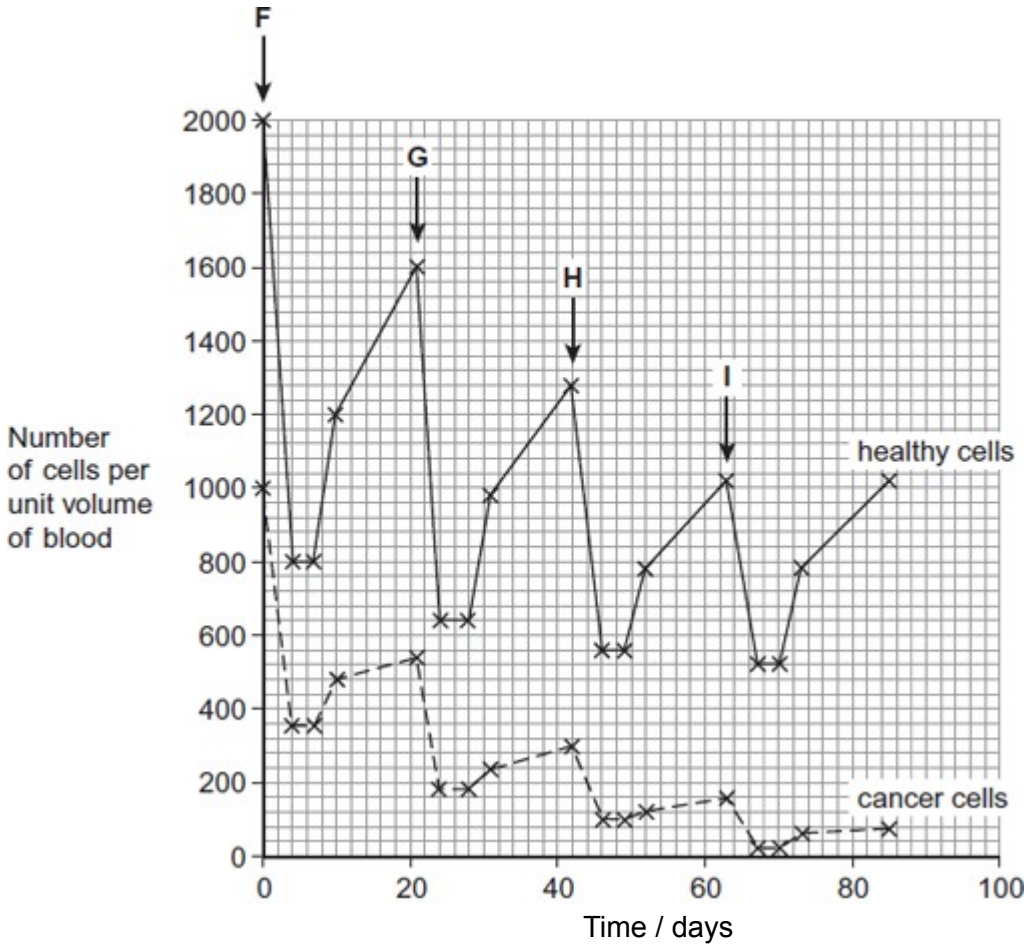
_____

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(3)

Chemotherapy is the use of a drug to treat cancer. The drug kills dividing cells.
The figure below shows the number of healthy cells and cancer cells in the blood of a patient receiving chemotherapy. The arrows labelled **F** to **I** show when the drug was given to the patient.



(c) Calculate the rate at which healthy cells were killed between days 42 and 46.

_____ cells killed per unit volume of blood per day

(1)

(d) Describe similarities and differences in the response of healthy cells and cancer cells to the drug between times **F** and **G**.

_____

_____

_____

_____

_____

_____

(3)

(e) More cancer cells could be destroyed if the drug was given more frequently.

Suggest why the drug was **not** given more frequently.

_____

_____

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(2)

(Total 15 marks)

Q17.

(a) DNA helicase is important in DNA replication. Explain why.

_____

_____

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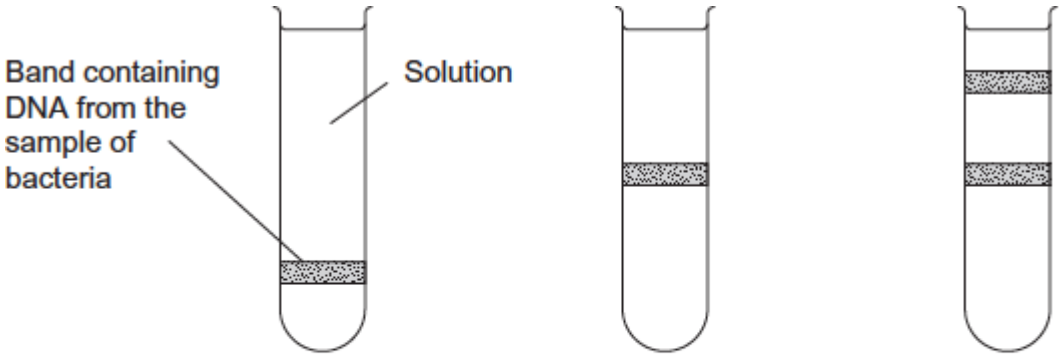
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(2)

Scientists investigating DNA replication grew bacteria for several generations in a nutrient solution containing a heavy form of nitrogen (^{15}N). They obtained DNA from a sample of these bacteria.

The scientists then transferred the bacteria to a nutrient solution containing a light form of nitrogen (^{14}N). The bacteria were allowed to grow and divide twice. After each division, DNA was obtained from a sample of bacteria.

The DNA from each sample of bacteria was suspended in a solution in separate tubes. These were spun in a centrifuge at the same speed and for the same time. The diagram shows the scientists' results.



Sample 1
Bacteria grown for several generations in a nutrient solution containing ^{15}N

Sample 2
Bacteria grown in a nutrient solution containing ^{14}N for one cell division

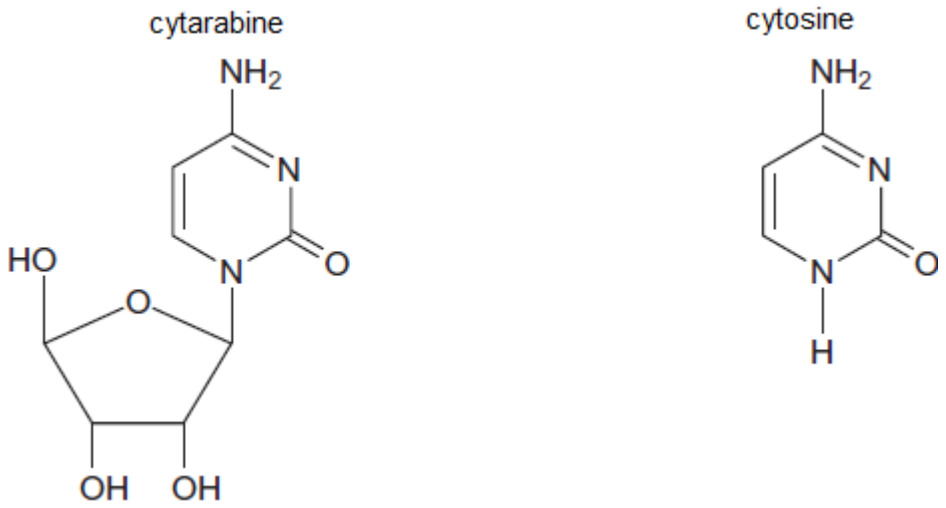
Sample 3
Bacteria grown in a nutrient solution containing ^{14}N for two cell divisions

(b) The table shows the types of DNA molecule that could be present in samples **1** to **3**. Use your knowledge of semi-conservative replication to complete the table with a tick if the DNA molecule is present in the sample.

	Type(s) of DNA molecule present in each sample		
Sample	^{15}N ^{15}N 	^{15}N ^{14}N 	^{14}N ^{14}N 
1			
2			
3			

(3)

(c) Cytarabine is a drug used to treat certain cancers. It prevents DNA replication. The diagram shows the structures of cytarabine and the DNA base cytosine.



(i) Use information in the diagram to suggest how cytarabine prevents DNA replication.

_____

_____

_____

_____

_____

(2)

(ii) Cytarabine has a greater effect on cancer cells than on healthy cells. Explain why.

_____

_____

_____

(1)

(Total 8 marks)

Q18.

(a) Describe how DNA is replicated.

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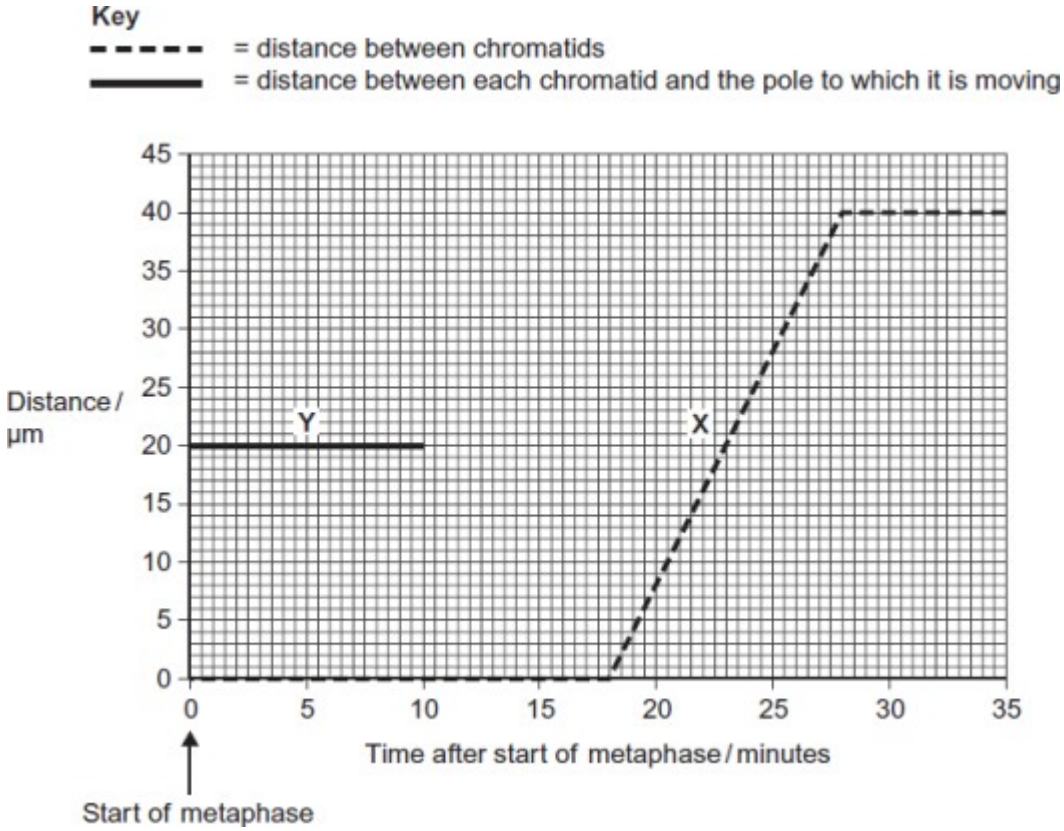
_____

_____

_____

(6)

(b) The graph shows information about the movement of chromatids in a cell that has just started metaphase of mitosis.



(i) What was the duration of metaphase in this cell?

☐ minutes

(1)

(ii) Use line **X** to calculate the duration of anaphase in this cell.

☐ minutes

(1)

(iii) Complete line **Y** on the graph.

(2)

(c) A doctor investigated the number of cells in different stages of the cell cycle in two tissue samples, **C** and **D.** One tissue sample was taken from a cancerous tumour. The other was taken from non-cancerous tissue. The table shows his results.

	Percentage of cells in each stage of the cell cycle	
Stage of the cell cycle	Tissue sample **C**	Tissue sample **D**
Interphase	82	45
Prophase	4	16
Metaphase	5	18
Anaphase	5	12
Telophase	4	9

(i) In tissue sample **C**, one cell cycle took 24 hours. Use the data in the table to calculate the time in which these cells were in interphase during one cell cycle. Show your working.

Time cells in interphase _____ hours

(2)

(ii) Explain how the doctor could have recognised which cells were in interphase when looking at the tissue samples.

_____

_____

_____

(1)

(iii) Which tissue sample, **C** or **D**, was taken from a cancerous tumour? Use information in the table to explain your answer.

_____

_____

_____

_____

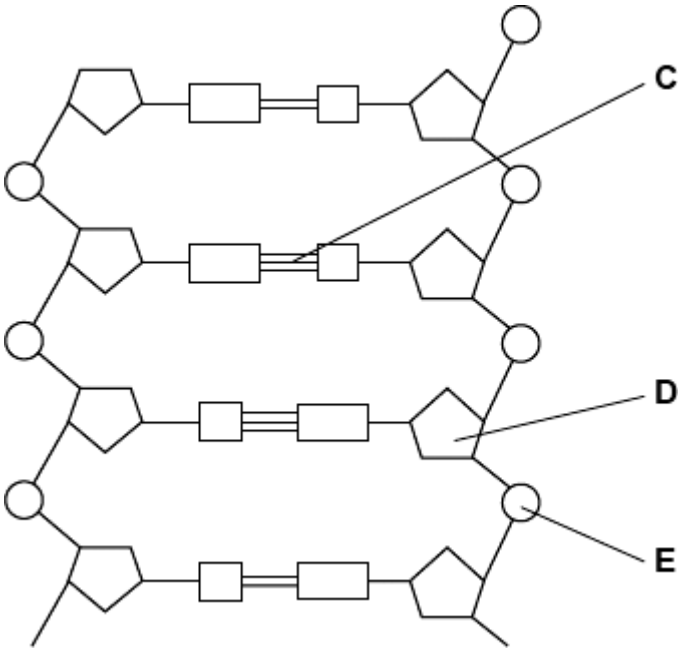
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(2)

(Total 15 marks)

Q19.

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?

_____

_____

_____

(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

_____

_____

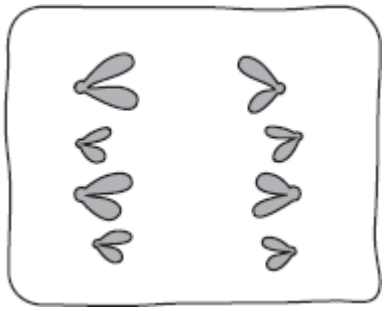
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(1)

(Total 8 marks)

Q20.

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



(i) Name this stage.

_____

(1)

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

_____

_____

_____

_____

_____

(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.

_____

_____

_____

_____

_____

(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?

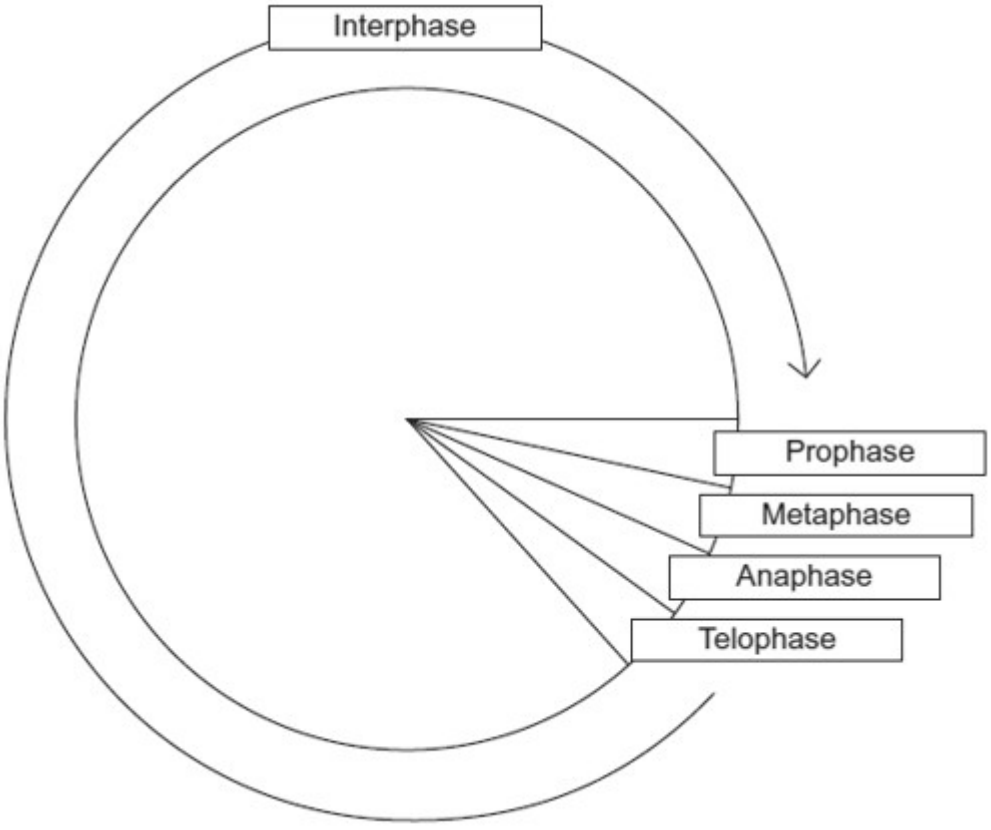
☐

(1)

(Total 6 marks)

Q21.

The diagram shows a cell cycle.



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

(i) metaphase

_____

_____

_____

_____

_____

(2)

(ii) anaphase.

_____

_____

_____

_____

_____

(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.

_____

_____

_____

(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.

_____

_____

_____

_____

_____

(2)

(Total 9 marks)

Q22.

Write an essay on using DNA in science and technology.

(Total 25 marks)

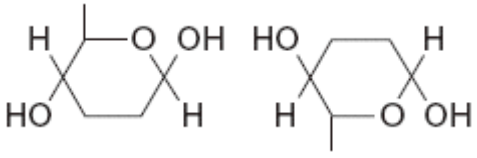
Q23.

(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 β-glucose.



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

(2)

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

_____

_____

_____

_____

(2)

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

_____

_____

_____

(1)

(Total 9 marks)

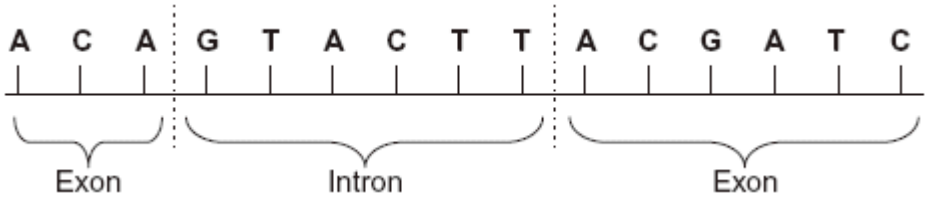
Q24.

(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)

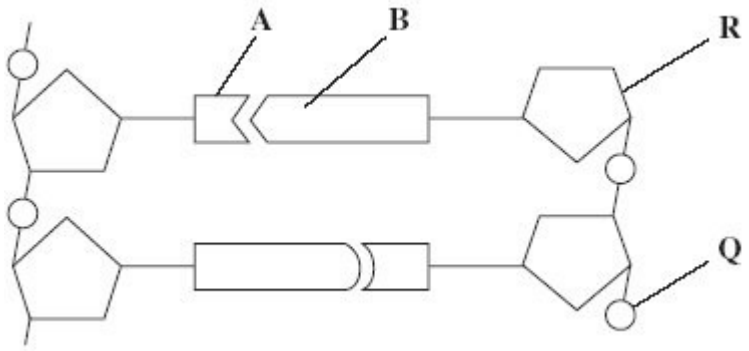
(ii) In the space below, give the sequence of bases on the mRNA produced by splicing this piece of pre-mRNA.

(1)
(Total 5 marks)

Q25.

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						

(1)

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

_____

_____

_____

_____

_____

_____

(3)

(Total 8 marks)

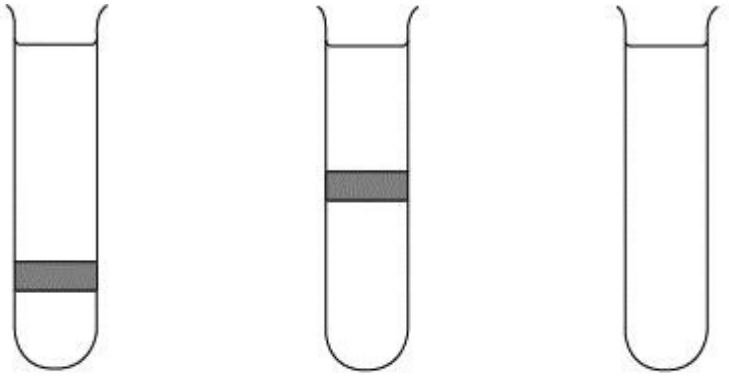
Q26.

(a) There are two forms of nitrogen. These different forms are called isotopes. ^{15}N is a heavier isotope than the normal isotope ^{14}N.

In an investigation, a culture of bacteria was obtained in which all the nitrogen in the DNA was of the ^{15}N form. The bacteria (generation 0) were transferred to a medium containing only the normal isotope, ^{14}N, and allowed to divide once. A sample of these bacteria (generation 1) was then removed. The DNA in the bacteria of generation 1 was extracted and spun in a high-speed centrifuge.

The bacteria in the ^{14}N medium were allowed to divide one more time. The DNA was also extracted from these bacteria (generation 2) and spun in a high speed centrifuge.

The diagram shows the results of this investigation.



Generation 0 DNA from bacteria with ^{15}N only

Generation 1 DNA from bacteria which have divided once in a ^{14}N medium

Generation 2 DNA from bacteria which have divided twice in a ^{14}N medium

(i) Which part of the DNA molecule contains nitrogen?

_____

(1)

(ii) Explain why the DNA from generation 1 is found in the position shown.

_____

_____

_____

_____

(2)

(iii) Complete the diagram to show the results for generation 2.

(2)

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

Organism	Adenine%	Guanine%	Thymine%	Cytosine%
Human		19		
Bacterium	24	26	24	26
Virus	25	24	33	18

(i) Complete the table to show the percentages of different bases in human DNA.

(2)

(ii) The structure of virus DNA is different from the DNA of the other two organisms. Giving evidence from the table, suggest what this difference might be.

_____

_____

_____

_____

(2)

(Total 9 marks)

Q27.

(a) Nucleic acids, such as DNA, are polymers, made up of many repeating monomer units. Name the monomer from which nucleic acids are made.

_____

(1)

(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	31.2	18.8	18.8	31.2
Cow	27.9	22.1	22.1	27.9
Salmon	29.4	20.6	20.6	29.4
Rat	28.6			
Virus	24.7	24.1	18.5	32.7

(i) Calculate the missing figures for rat DNA and write them into the table.

(2)

(ii) The virus has single-stranded DNA as its genetic material. Explain the evidence from the table which suggests that the DNA is single-stranded.

_____

_____

_____

_____

(2)

(Total 5 marks)

Q28.

(a) Starch and protein are biologically important polymers.

(i) Explain what is meant by a polymer.

_____

_____

(1)

(ii) Give **one** example of a biologically important polymer other than starch or protein.

_____

(1)

(b) In an investigation, the enzyme amylase was mixed in a test tube with a buffer solution and a suspension of starch. The amylase broke down the starch to maltose. When all the starch had been broken down, a sample was removed from the test tube and tested with biuret reagent.

(i) Explain why a buffer solution was added to the amylase-starch mixture.

_____

_____

_____

(2)

(ii) What colour would you expect the sample to go when tested with biuret reagent?

_____

(1)

(iii) Give an explanation for your answer to part (ii)

_____

_____

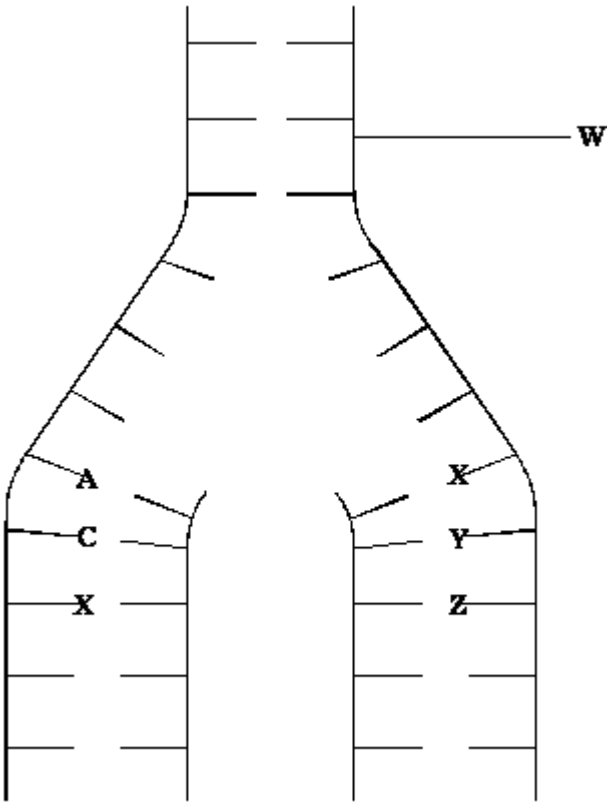
_____

(2)

(Total 7 marks)

Q29.

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)

Q30.

Read the following passage.

Malaria is a disease so deadly that it has devastated armies and destroyed great civilisations. It has been estimated that in the course of history malaria has been responsible for the death of one out of every two people who have ever lived. Even today, with all the advantages of modern technology, it is still responsible for some three million deaths a year.

The first half of the twentieth century was a time of hope for malarial control. The drugs chloroquine and proguanil had just been discovered and there seemed a real possibility of a malaria-free world. Unfortunately, this honeymoon ended almost as soon as it had started, with the emergence of drug-resistant parasite populations. Scientists now accept that whatever new drug they come up with, it is likely to have a very limited effective life. As a result, they are increasingly looking at combinations of drugs.

The approach to malaria control which holds the best hope is the production of a vaccine. One of these is being developed by a researcher in South America. His vaccine is based on a small synthetic polypeptide called SPf66 which is dissolved in a saline solution and given as an injection. A series of early trials on human volunteers produced confusing results. In one trial the effectiveness of the vaccine was claimed to be 80% while, in others, the results were statistically insignificant. Not only were the results inconclusive but the methods used were challenged by other scientists. In particular, the controls were considered inappropriate.

Another, possibly more promising, approach has been the development of a DNA-based vaccine. In theory, all that is required is to identify the DNA from the parasite which encodes key antigens. Unfortunately, scientists have hit snags. Although they have succeeded in sequencing the human genome, the genome of the malarial parasite has created major difficulties. This is partly because of the very high proportion of the bases adenine and thymine. In some places these two bases average 80%, and on chromosomes 2 and 3 nearly 100% of the bases present are adenine and thymine. Because of this, it has proved impossible to cut the relevant DNA with the commonly available restriction enzymes into pieces of a suitable size for analysis.

Use information from the passage and your own knowledge to answer the following questions.

(a) Explain how a resistant parasite population is likely to arise and limit the life of any new anti-malarial drug (lines 8 - 9).

_____

_____

_____

_____

_____

_____

(3)

(b) A person has a 1 in 500 probability of being infected by a chloroquine-resistant strain of malarial parasite and a 1 in 500 probability of being infected by a proguanil-resistant strain. Use a calculation from these figures to explain why scientists are “increasingly looking at combinations of drugs” (lines 9 - 10).

_____

_____

_____

_____

(2)

(c) (i) Explain why trials of the SPf66 vaccine needed a control.

_____

_____

(1)

(ii) The controls for the SPf66 vaccine trials were considered inappropriate (line

17).

Suggest how the control groups in these trials should have been treated.

_____

_____

_____

_____

(2)

(d) In some of the DNA of a malarial parasite, the proportion of adenine and thymine bases averages 80% (lines 22 - 23). In this DNA what percentage of the nucleotides would you expect to contain

(i) phosphate; _____

(ii) guanine? _____

(2)

(e) (i) Use your knowledge of enzymes to explain why restriction enzymes only cut DNA at specific restriction sites.

_____

_____

_____

_____

_____

_____

(3)

(ii) Restriction enzymes that can cut the DNA of chromosomes 2 and 3 produce pieces that are too small for analysis. Explain why these restriction enzymes produce small DNA fragments.

_____

_____

_____

_____

(2)

(Total 15 marks)

Q31.

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

_____

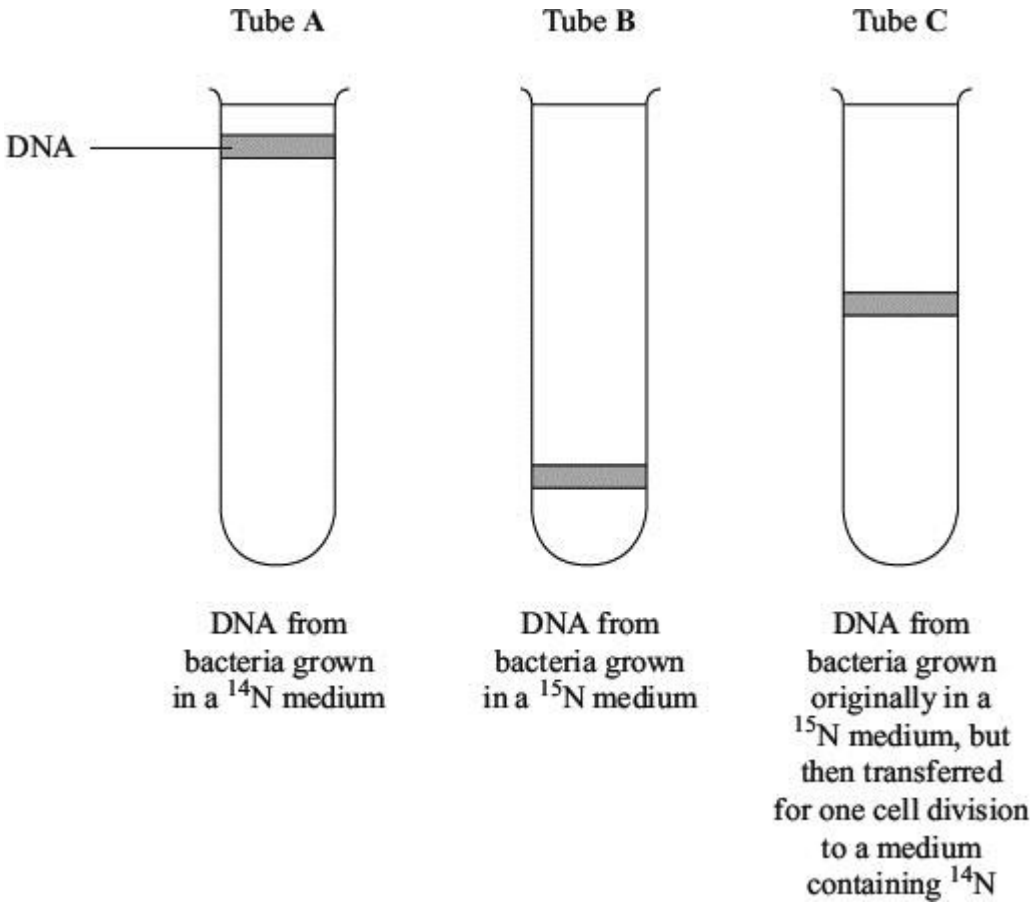
_____

_____

_____

(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}N, a light form of nitrogen. Others were grown in a medium containing ^{15}N, a heavy form of nitrogen. Some of the bacteria grown in a ^{15}N medium were then transferred to a ^{14}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?

_____

_____

(1)

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

_____

_____

_____

_____

(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.

	Percentage of base present			
DNA sample	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)

Q32.

(a) Describe and explain how the structure of DNA results in accurate replication.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) Describe the behaviour of chromosomes during mitosis and explain how this results in the production of two genetically identical cells.

_____

_____

_____

_____

_____

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_____

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_____

_____

_____

_____

_____

_____

_____

(7)

(c) A cancerous tumour is formed by uncontrolled mitotic division. This results in a mass of cells with an inadequate blood supply. Drugs are being developed which only kill cells in a low oxygen environment. Suggest how these drugs could be useful in the treatment of cancer.

_____

_____

_____

_____

(2)

(Total 13 marks)

Q33.

(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)

Q34.

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.

_____

_____

_____

_____

_____

_____

_____

_____

(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.

_____

_____

_____

_____

_____

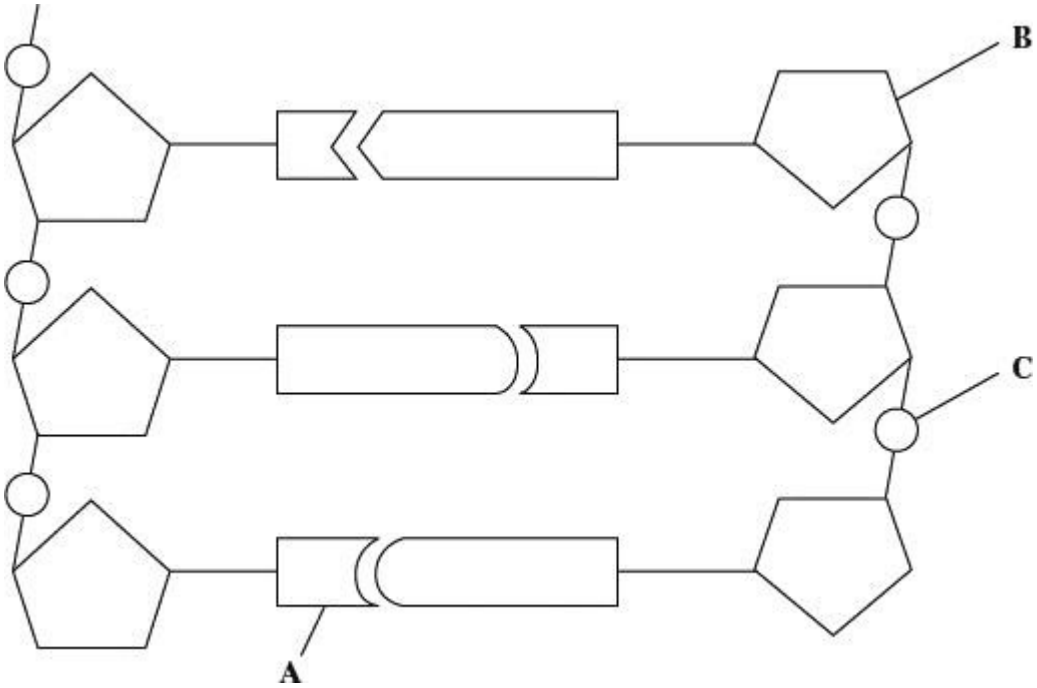
_____

(3)

(Total 8 marks)

Q35.

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?

_____

(1)

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

_____

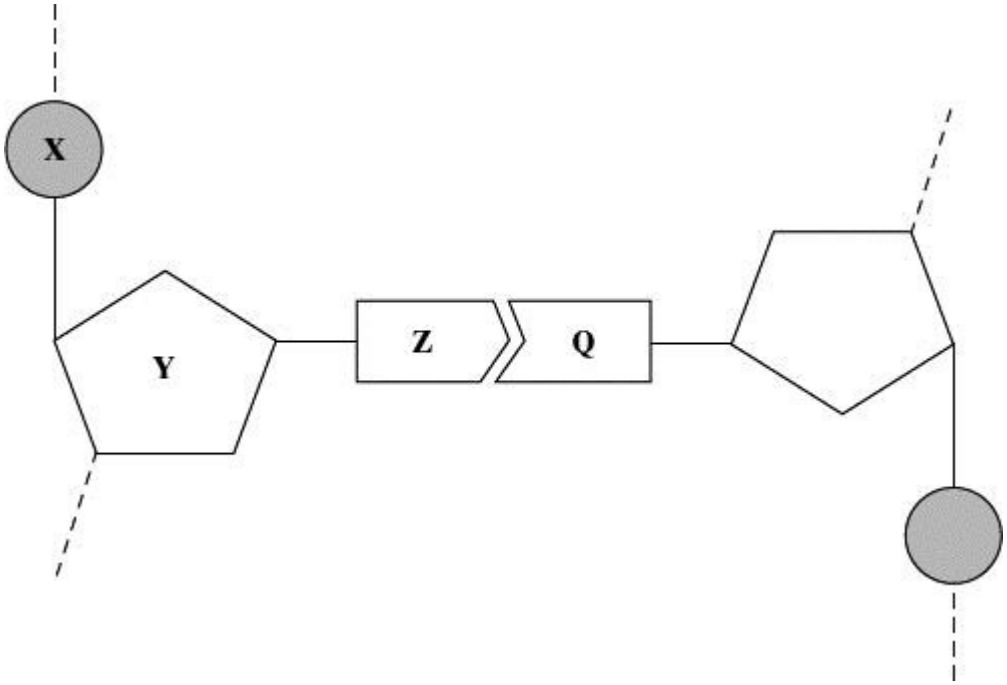
_____

(1)

(Total 6 marks)

Q36.

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.

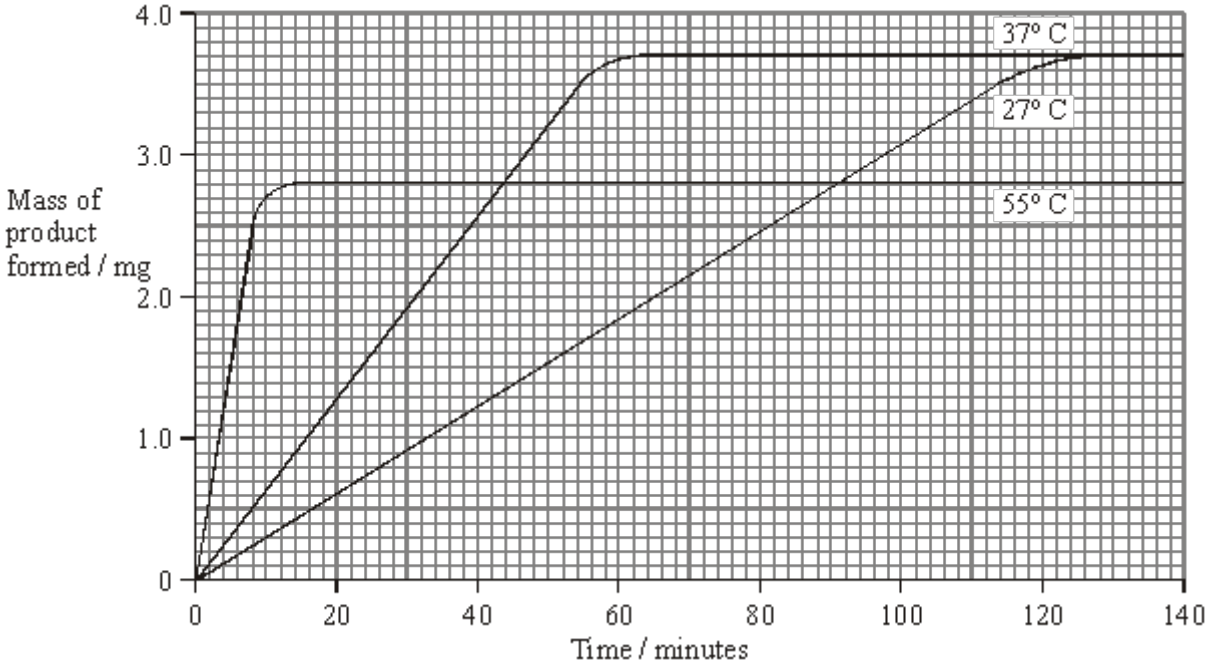
Answer _____ %

(2)

(Total 6 marks)

Q37.

A student carried out an investigation into the mass of product formed in an enzyme-controlled reaction at three different temperatures. Only the temperature was different for each experiment. The results are shown in the graph.



(a) Use your knowledge of enzymes to explain

(i) why the initial rate of reaction was highest at 55 °C;

_____

_____

_____

_____

(2)

(ii) the shape of the curve for 55 °C after 20 minutes.

_____

_____

_____

_____

_____

_____

(3)

(b) Explain why the curves for 27 °C and 37 °C level out at the same value.

_____

_____

_____

_____

(2)

(Total 7 marks)