AQA A-LEVEL · 7402

BIOLOGY



EXAM QUESTION PACK

3.4.1 DNA, GENES AND CHROMOSOMES

SCORE	PERCENTAGE
/236	%

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Q1.

(a) Compare and contrast the DNA in eukaryotic cells with the DNA in prokaryotic cells.

(5)

(b) Haemoglobins are chemically similar molecules found in many different species.

Differences in the primary structure of haemoglobin molecules can provide evidence of phylogenetic (evolutionary) relationships between species.

Explain how.

(5)

(Total 10 marks)

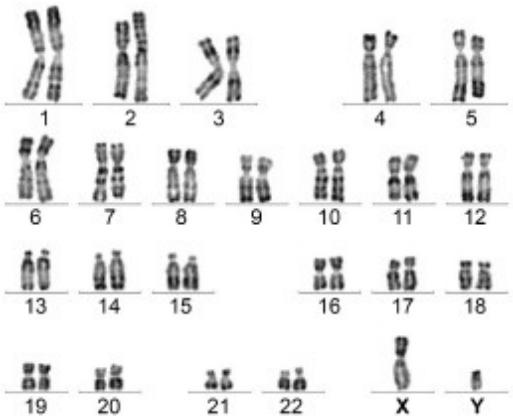
Q2.

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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_____

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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. _____

_____

_____

_____

(2)

(Total 9 marks)

Q3.

(a) Draw the general structure of an amino acid.

(1)

Table 1 shows mRNA codons and the amino acids coded for by each codon. It also shows some properties of the R group of each amino acid.

Table 1

1st base	2nd base				3rd base
	U	C	A	G	
U	Phe	Ser	Tyr	Cys	U
					C
	Leu		Stop	Stop	A
				Trp	G
C	Leu	Pro	His	Arg	U
					C
			Gin		A
					G
A	Ile	Thr	Asn	Ser	U
					C
			Lys	Arg	A
	Met				G
G	Val	Ala	Asp	Gly	U
					C
			Glu		A
					G

Key to the properties of the R group of each amino acid

No overall change Positively charged Negatively charged

(b) The genetic code is described as degenerate.

What is meant by this? Use an example from **Table 1** to illustrate your answer.

(2)

A scientist investigated changes in the amino acid sequence of a human enzyme resulting from mutations. All these amino acid changes result from single base substitution mutations.

This enzyme is a polypeptide 465 amino acids long.

Table 2 shows the result of three of the base substitutions.

Table 2

Amino acid number	Correct amino acid	Amino acid inserted as a result of mutation
203	Val	Ala
279	Glu	Lys
300	Glu	Lys

(c) What is the minimum number of bases in the gene coding for this polypeptide?

Answer = _____

(1)

(d) Use information from **Table 1** to tick (✔) one box that shows a single base substitution mutation in DNA that would result in a change from Val to Ala at amino acid number 203

CAA ⟶ CGA ☐

GUU ⟶ GCA ☐

GUU ⟶ GUC ☐

CAC ⟶ CGG ☐

(1)

(e) A change from Glu to Lys at amino acid 300 had no effect on the rate of reaction catalysed by the enzyme. The same change at amino acid 279 significantly reduced the rate of reaction catalysed by the enzyme.

Use all the information and your knowledge of protein structure to suggest reasons for the differences between the effects of these two changes.

(3)

(Total 8 marks)

Q4.

(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.

(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)

Q5.

In a eukaryotic cell, transcription results in a molecule of pre-mRNA that is modified to produce mRNA. In a prokaryotic cell transcription produces mRNA directly.

(a) Explain this difference.

_____

_____

_____

_____

_____

_____

(2)

(b) Give **two** differences between the structure of mRNA and the structure of tRNA.

1. _____

_____

2. _____

_____

(2)

(Total 4 marks)

Q6.

(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.

_____

_____

_____

_____

_____

(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									

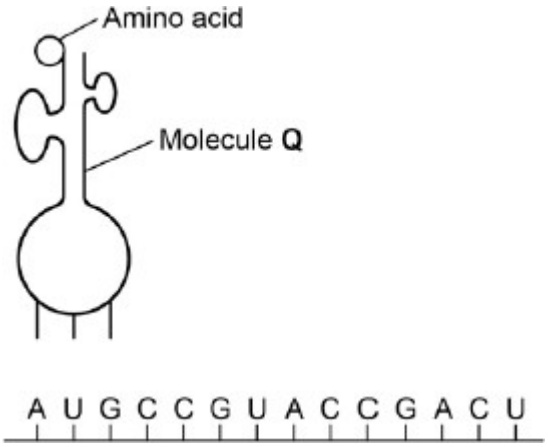
Complete **Table 2** to show the base sequence of the DNA template from which this mRNA was transcribed and the encoded amino acid sequence.

(2)

(Total 10 marks)

Q7.

The diagram below represents one process that occurs during protein synthesis.



(a) Name the process shown.

_____

(1)

(b) Identify the molecule labelled **Q**.

_____

(1)

(c) In the diagram above, the first codon is AUG. Give the base sequence of:

the complementary DNA base sequence _____

the missing anticodon _____

(2)

The table below shows the base triplets that code for two amino acids.

Amino acid	**Encoding base triplet**
Aspartic acid	GAC, GAU
Proline	CCA, CCG, CCC, CCU

(d) Aspartic acid and proline are both amino acids. Describe how two amino acids differ from one another. You may use a diagram to help your description.

_____

_____

_____

(1)

(e) Deletion of the sixth base (G) in the sequence shown in the diagram above would change the nature of the protein produced but substitution of the same base would not. Use the information in the table and your own knowledge to explain why.

(3)

(Total 8 marks)

Q8.

(a) Messenger RNA (mRNA) is used during translation to form polypeptides. Describe how mRNA is produced in the nucleus of a cell.

(6)

(b) Describe the structure of proteins.

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(5)

(c) Describe how proteins are digested in the human gut.

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(4)

(Total 15 marks)

Q9.

Read the following passage carefully.

A large and growing number of disorders are now known to be due to types of mitochondrial disease (MD). MD often affects skeletal muscles, causing muscle weakness.

We get our mitochondria from our mothers, via the fertilised egg cell. Fathers do not pass on mitochondria via their sperm. Some mitochondrial diseases are caused by mutations of mitochondrial genes inside the mitochondria. Most mitochondrial diseases are caused by mutations of genes in the cell nucleus that are involved in the functioning of mitochondria. These mutations of nuclear DNA produce recessive alleles.

One form of mitochondrial disease is caused by a mutation of a mitochondrial gene that codes for a tRNA. The mutation involves substitution of guanine for adenine in the DNA base sequence. This changes the anticodon on the tRNA. This results in the formation of a non-functional protein in the

mitochondrion.

There are a number of ways to try to diagnose whether someone has a mitochondrial disease. One test involves measuring the concentration of lactate in a person's blood after exercise. In someone with MD, the concentration is usually much higher than normal. If the lactate test suggests MD, a small amount of DNA can be extracted from mitochondria and DNA sequencing used to try to find a mutation.

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

(a) Mitochondrial disease (MD) often causes muscle weakness (lines 1–3). Use your knowledge of respiration and muscle contraction to suggest explanations for this effect of MD.

_____

_____

_____

_____

_____

_____

(3)

Two couples, couple **A** and couple **B**, had one or more children affected by a mitochondrial disease. The type of mitochondrial disease was different for each couple.

None of the parents showed signs or symptoms of MD.

- Couple **A** had four children who were all affected by an MD.
- Couple **B** had four children and only one was affected by an MD.

(b) Use the information in lines 5–9 and your knowledge of inheritance to suggest why:

- all of couple **A**'s children had an MD
- only one of couple **B**'s children had an MD.

Couple **A** _____

_____

_____

_____

Couple **B** _____

_____

_____

_____

(4)

(c) Suggest how the change in the anticodon of a tRNA leads to MD (lines 10–13).

_____

_____

_____

_____

_____

_____

(3)

(d) If someone has MD, the concentration of lactate in their blood after exercise is usually much higher than normal (lines 15–17). Suggest why.

_____

_____

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(3)

(e) A small amount of DNA can be extracted from mitochondria and DNA sequencing used to try to find a mutation (lines 18–19).

From this sample:

- how would enough DNA be obtained for sequencing?
- how would sequencing allow the identification of a mutation?

_____

_____

_____

_____

(2)

(Total 15 marks)

Q10.

(a) What is the name of a position of a gene on a chromosome?

_____

(1)

(b) What is meant by genetic diversity?

_____

_____

(1)

A geneticist investigated genetic diversity in four different breeds of dog. She compared DNA base sequences of the same genes from a large number of dogs from each breed.

The geneticist calculated the mean genetic diversity for each breed of dog. The value of this mean was between 0 and 1.

- A mean value of 1 shows maximum genetic diversity.
- A mean value of 0 shows no genetic diversity.

Her results are shown in the table

Breed of dog	**Mean genetic diversity**	**Standard deviation**
Airedale terrier	0.51	± 0.03
Bull terrier	0.38	± 0.02
Jack Russell terrier	0.76	± 0.01
Miniature terrier	0.47	± 0.02

(c) What do these data show about the differences in genetic diversity between these breeds of dog?

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_____

_____

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_____

(3)

(d) Miniature terriers were first bred from bull terriers in the 19th century.

Suggest **one** explanation for the observed difference in genetic diversity between miniature terriers and bull terriers.

_____

_____

_____

_____

(2)

(Total 7 marks)

Q11.

(a) (i) Why is the genetic code described as being universal?

_____

_____

(1)

(ii) The genetic code uses four different DNA bases. What is the maximum number of different DNA triplets that can be made using these four bases?

☐

(1)

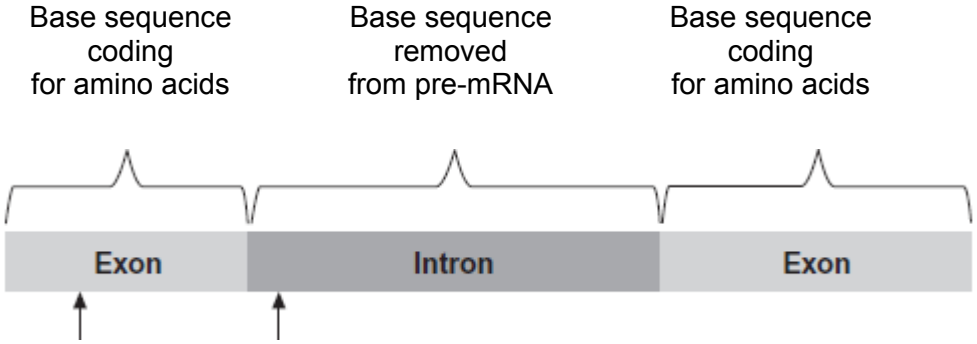
Transcription of a gene produces pre-mRNA.

(b) Name the process that removes base sequences from pre-mRNA to form mRNA.

_____

(1)

(c) The figure below shows part of a pre-mRNA molecule. Geneticists identified two mutations that can affect this pre-mRNA, as shown in the figure.



(i) **Mutation 1** leads to the production of a non-functional protein.

Explain why.

_____

_____

_____

_____

_____

_____

(3)

(ii) What effect might **mutation 2** have on the protein produced?

Explain your answer.

_____

_____

_____

_____

(2)

(Total 8 marks)

Q12.

The Amish are a group of people who live in America. This group was founded by 30 Swiss people, who moved to America many years ago. The Amish do not usually marry people from outside their own group.

One of the 30 Swiss founders had a genetic disorder called Ellis-van Creveld syndrome. People with this disorder have heart defects, are short and have extra fingers and toes. Ellis-van Creveld syndrome is caused by a faulty allele.

In America today, about 1 in 200 Amish people are born with Ellis-van Creveld syndrome. This disorder is very rare in people in America who are not Amish.

(a) In America today, there are approximately 1250 Amish people who have Ellis-van Creveld syndrome. Use the information provided to calculate the current Amish population of America.

Amish population _____

(1)

(b) The faulty allele that causes Ellis-van Creveld syndrome is the result of a mutation of a gene called *EVC.* This mutation leads to the production of a protein that has one amino acid missing.

(i) Suggest how a mutation can lead to the production of a protein that has one amino acid missing.

_____

_____

_____

_____

_____

(2)

(ii) Suggest how the production of a protein with one amino acid missing may lead to a genetic disorder such as Ellis-van Creveld syndrome.

_____

_____

_____

_____

_____

(2)

(Total 5 marks)

Q13.

(a) The genetic code is described as being degenerate. What does this mean?

_____

_____

_____

(1)

(b) What is a codon?

_____

_____

_____

_____

_____

(2)

(c) (i) What is the role of RNA polymerase during transcription?

_____

_____

_____

(1)

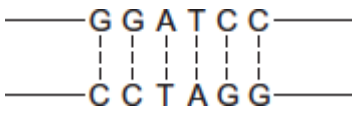
(ii) mRNA can be converted to cDNA.

Name the enzyme used in this process.

_____

(1)

(d) The diagram shows the base sequence on DNA where a restriction endonuclease cuts DNA.



Use evidence from the diagram to explain what is meant by a palindromic recognition sequence on DNA.

_____

_____

_____

(1)

(Total 6 marks)

Q14.

Phenylketonuria is a disease caused by mutations of the gene coding for the enzyme PAH. The table shows part of the DNA base sequence coding for PAH. It also shows a mutation of this sequence which leads to the production of non-functioning PAH.

DNA base sequence coding for PAH	C	A	G	T	T	C	G	C	T	A	C	G
DNA base sequence coding for non-functioning PAH	C	A	G	T	T	C	C	C	T	A	C	G

(a) (i) What is the maximum number of amino acids for which this base sequence could code?

(1)

(ii) Explain how this mutation leads to the formation of non-functioning PAH.

_____

_____

_____

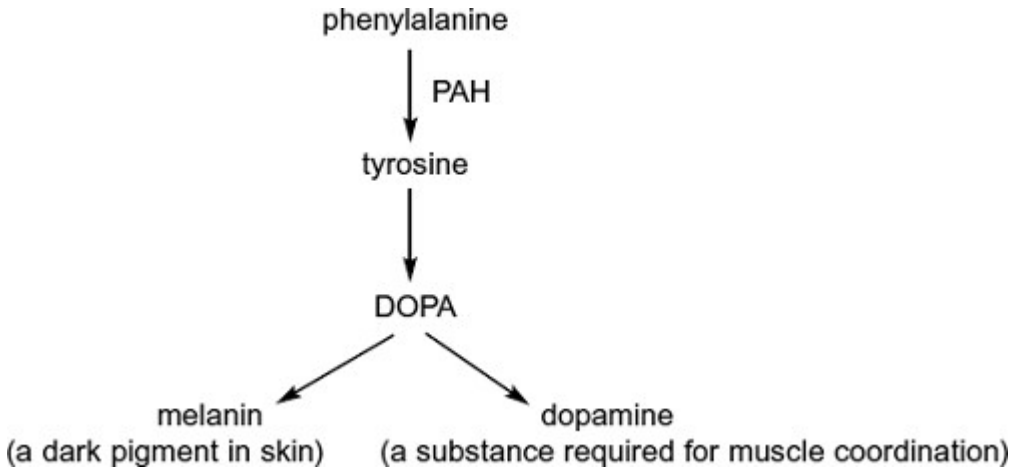
_____

_____

_____

(3)

PAH catalyses a reaction at the start of two enzyme-controlled pathways.
The diagram shows these pathways.



(b) Use the information in the diagram to give **two** symptoms you might expect to be visible in a person who produces non-functioning PAH.

1. _____

2. _____

(2)

(c) One mutation causing phenylketonuria was originally only found in one population in central Asia. It is now found in many different populations across Asia. Suggest how the spread of this mutation may have occurred.

_____

_____

_____

(1)

(Total 7 marks)

Q15.

The diagram shows a short sequence of DNA bases.

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

(a) (i) What is the maximum number of amino acids for which this sequence of DNA bases could code?



(1)

(ii) The number of amino acids coded for could be fewer than your answer to part (a)(i).

Give **one** reason why.

_____

_____

(1)

(b) Explain how a change in the DNA base sequence for a protein may result in a change in the structure of the protein.

_____

_____

_____

_____

_____

_____

(3)

(c) A piece of DNA consisted of 74 base pairs. The two strands of the DNA, strands **A** and **B**, were analysed to find the **number** of bases of each type that were present. Some of the results are shown in the table.

	Number of bases			
	C	G	A	T
Strand **A**	26			
Strand **B**	19		9	

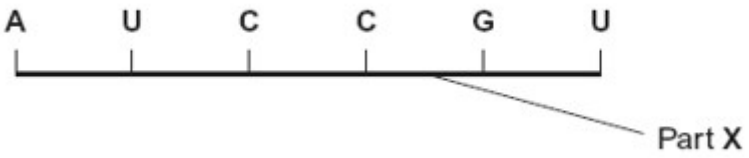
Complete the table by writing in the missing values.

(2)

(Total 7 marks)

Q16.

The diagram shows part of a pre-mRNA molecule.



(a) (i) Name the **two** substances that make up part **X**.

_____ and _____

(1)

(ii) Give the sequence of bases on the DNA strand from which this pre-mRNA has been transcribed.

_____

(1)

(b) (i) Give one way in which the structure of an mRNA molecule is different from the structure of a tRNA molecule.

_____

_____

(1)

(ii) Explain the difference between pre-mRNA and mRNA.

_____

_____

_____

(1)

(c) The table shows the percentage of different bases in two pre-mRNA molecules. The molecules were transcribed from the DNA in different parts of a chromosome.

Part of chromosome	**Percentage of base**			
	A	**G**	**C**	**U**
Middle	38	20	24	
End	31	22	26	

(i) Complete the table by writing the percentage of uracil (U) in the appropriate boxes.

(1)

(ii) Explain why the percentages of bases from the middle part of the chromosome and the end part are different.

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

Q17.

The body markings of cheetahs vary, in particular the pattern of bands on their tails. Cheetahs are solitary animals but the young stay with their mother until they are between 14 and 18 months old.

Scientists investigated the banding pattern on the tails of cheetahs living in the wild.

- They drove a car alongside a walking cheetah and used binoculars to study the tail pattern.
- They gave each cheetah a banding pattern score based on the width of the dark and light bands on the end of the tail.
- They scored the width of the bands on the right and left side of the tail using a 5 point scale of width.

A typical pattern on the right side of one cheetah's tail is shown in **Figure 1**.

Figure 1

Band number 1 2 3 4 5 6 7



Band width score 3 1 1 4 3 3 3

The scientists collected data from each cheetah on four separate occasions. **Figure 2** shows the data for one of the cheetahs.

Figure 2

Side of tail	**Mean band width score (± standard deviation)**						
	Band 1	**Band 2**	**Band 3**	**Band 4**	**Band 5**	**Band 6**	**Band 7**
Right	3.00 (± 0.82)	1.00 (± 0.00)	1.00 (± 0.00)	3.75 (± 0.50)	2.75 (± 0.50)	3.00 (± 0.00)	3.00 (± 0.00)
Left	3.75 (± 0.50)	3.25 (± 0.50)	2.00 (± 0.50)	3.00 (± 0.00)	2.00 (± 0.00)	2.50 (± 0.50)	3.00 (± 0.50)

(a) The scientists only used data from cheetahs which were fully grown. Suggest why.

_____

_____

(1)

(b) The scientists estimated the width of the bands on the same cheetah on four separate occasions. They did not always get the same score.

(i) Give **two** pieces of evidence from **Figure 2** which show that the scientists sometimes obtained different scores for the same band.

1. _____

_____

2. _____

_____

(2)

(ii) The method the scientists used resulted in them getting different scores for the same band. Suggest why.

_____

_____

(1)

(c) What is the evidence from **Figure 2** that the dark and light bands do **not** form rings of equal width around the tail?

_____

_____

(1)

(d) The scientists found the difference in banding pattern between

- offspring in the same family
- cheetahs chosen randomly.

Explain how scientists could use this information to show that some variation in tail banding was genetic.

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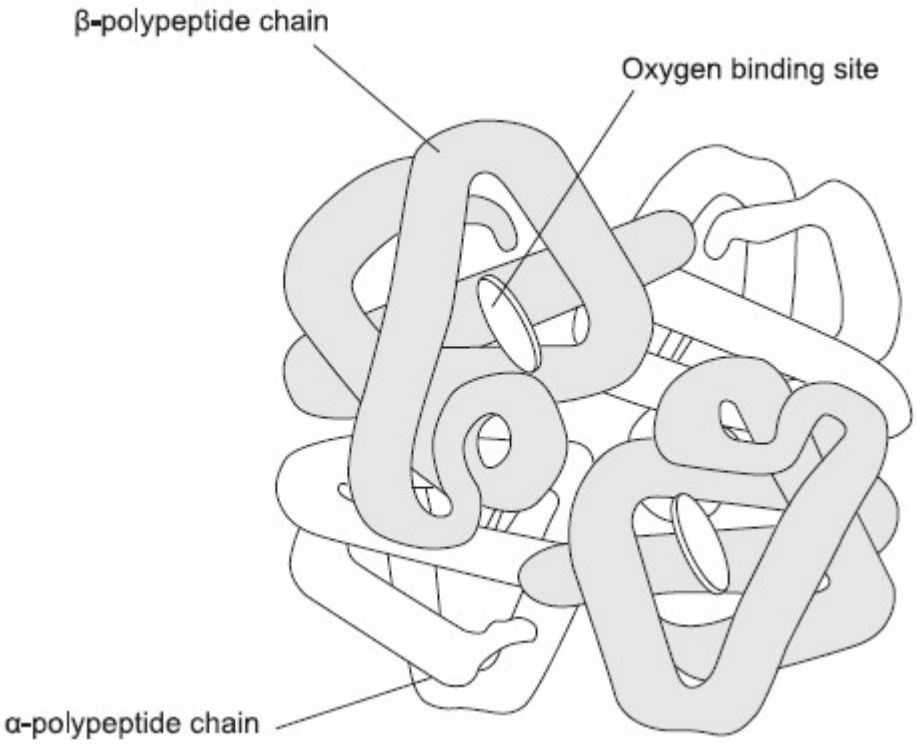
_____

(3)

(Total 8 marks)

Q18.

The diagram shows a molecule of haemoglobin.



(a) What is the evidence from the diagram that haemoglobin has a quaternary structure?

_____

_____

(1)

(b) (i) A gene codes for the α-polypeptide chain. There are 423 bases in this gene that code for amino acids. How many amino acids are there in the α-polypeptide chain?

☐

(1)

(ii) The total number of bases in the DNA of the α-polypeptide gene is more than 423.

Give **two** reasons why there are more than 423 bases.

1. _____

_____

2. _____

_____

(2)

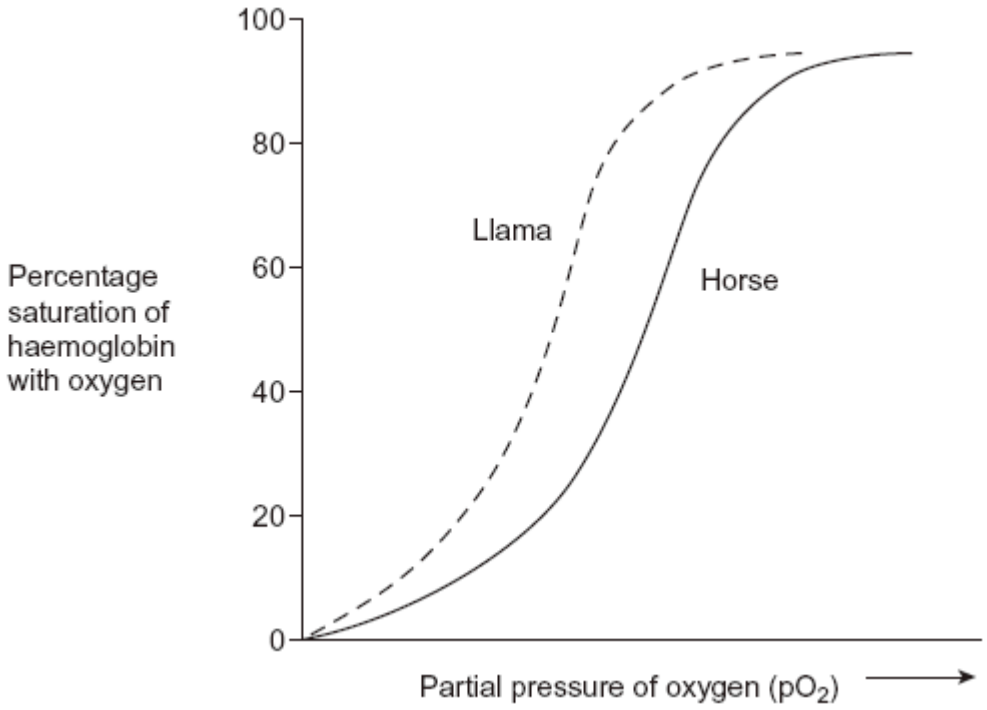
(c) The haemoglobin in one organism may have a different chemical structure from the haemoglobin in another organism. Describe how.

_____

_____

(1)

(d) The graph shows oxygen dissociation curves for horse haemoglobin and for llama haemoglobin. Horses are adapted to live at sea level and llamas are adapted to live in high mountains.



Use the graph to explain why llamas are better adapted to live in high mountains than horses.

_____

_____

_____

_____

_____

_____

(3)

(Total 8 marks)

Q19.

(a) What name is used for the non-coding sections of a gene?

_____

(1)

Figure 1 shows a DNA base sequence. It also shows the effect of two mutations on this base sequence. **Figure 2** shows DNA triplets that code for different amino acids.

Figure 1

Original DNA base sequence	A	T	T	G	G	C	G	T	G	T	C	T
Amino acid sequence												
Mutation **1** DNA base sequence	A	T	T	G	G	A	G	T	G	T	C	T
Mutation **2** DNA base sequence	A	T	T	G	G	C	C	T	G	T	C	T

Figure 2

DNA triplets	**Amino acid**
GGT, GGC, GGA, GGG	Gly
GTT, GTA, GTG, GTC	Val
ATC, ATT, ATA	Ile
TCC, TCT, TCA, TCG	Ser
CTC, CTT, CTA, CTG	Leu

(b) Complete **Figure 1** to show the sequence of amino acids coded for by the original DNA base sequence.

(1)

(c) Some gene mutations affect the amino acid sequence. Some mutations do not. Use the information from **Figure 1** and **Figure 2** to explain

(i) whether mutation **1** affects the amino acid sequence

_____

_____

_____

_____

(2)

(ii) how mutation **2** could lead to the formation of a non-functional enzyme.

_____

_____

_____

_____

_____

_____

(3)

(d) Gene mutations occur spontaneously.

(i) During which part of the cell cycle are gene mutations most likely to occur?

_____

(1)

(ii) Suggest an explanation for your answer.

_____

_____

(1)

(Total 9 marks)

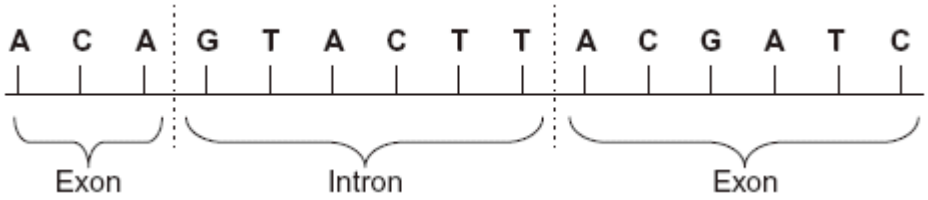
Q20.

(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)

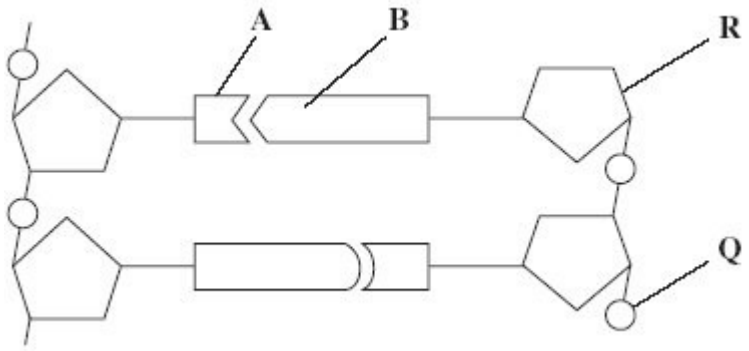
(ii) In the space below, give the sequence of bases on the mRNA produced by splicing this piece of pre-mRNA.

(1)
(Total 5 marks)

Q21.

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.

_____

_____

_____

_____

_____

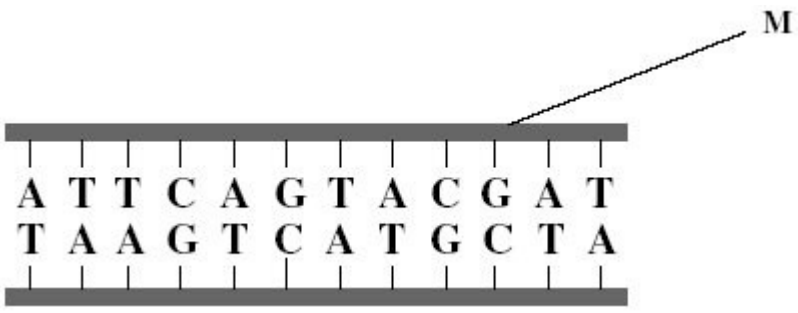
_____

(3)

(Total 8 marks)

Q22.

The diagram shows part of a DNA molecule.



(a) Name the **two** components of the part of the DNA molecule labelled **M**.

1. _____

2. _____

(2)

(b) What is the maximum number of amino acids for which this piece of DNA could code?



(1)

(c) Scientists calculated the percentage of different bases in the DNA from a species of bacterium. They found that 14% of the bases were guanine.

(i) What percentage of the bases in this species of bacterium was cytosine?

Answer _____

(1)

(ii) What percentage of the bases in this species of bacterium was adenine?

Answer _____

(1)

(d) The scientists found that, in a second species of bacterium, 29% of the bases were guanine.

Explain the difference in the percentage of guanine bases in the two species of bacterium.

_____

_____

_____

_____

(2)

(Total 7 marks)

Q23.

(a) What is meant by a gene?

_____

_____

(2)

The polymerase chain reaction (PCR) can be used to obtain many copies of a particular gene.

(b) Explain how the strands of DNA are separated during the PCR.

_____

_____

_____

_____

(2)

(c) In a particular PCR, two different primers are added to the DNA.

(i) Why are primers required?

_____

_____

(1)

(ii) Suggest why two different primers are required.

_____

_____

(1)

(d) Starting with a single molecule of DNA, the polymerase chain reaction was allowed to go through three complete cycles. How many molecules of DNA would be produced?

Answer _____

(1)

(Total 7 marks)

Q24.

Figure 1 shows part of a sarcomere.

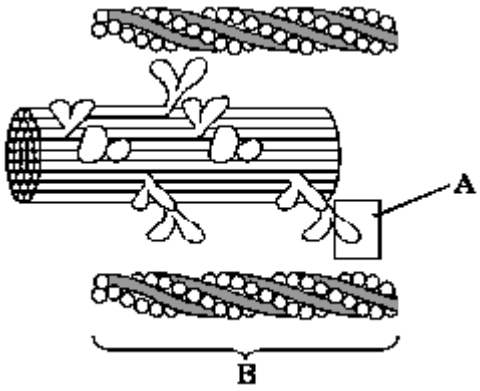


Figure 1

(a) (i) Name the main protein in structure **B**.

_____

(1)

(ii) Name the structure in box **A**.

_____

(1)

(b) (i) Describe how calcium ions cause the myofibril to start contracting.

_____

_____

_____

_____

(2)

(ii) Describe the events that occur within a myofibril which enable it to contract.

_____

_____

_____

_____

_____

_____

(3)

Slow and fast skeletal muscle fibres differ in a number of ways. Slow fibres get their ATP from aerobic respiration while anaerobic respiration provides fast fibres with their ATP. **Figure 2** shows a bundle of fast and slow fibres seen through an optical microscope. The fibres have been stained with a stain that binds to the enzymes which operate in the electron transport chain.

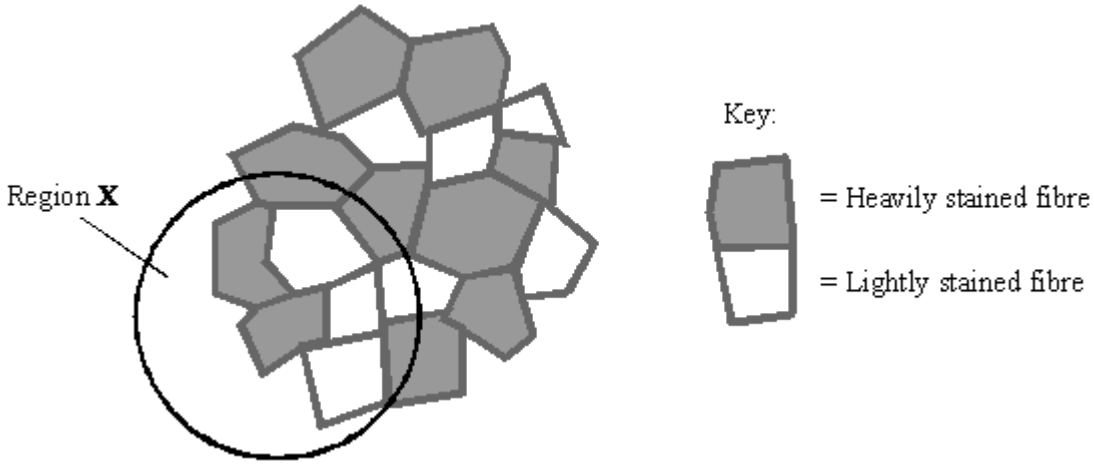


Figure 2

(c) (i) Describe how you could calculate the percentage of fast fibres in this bundle.

_____

_____

(1)

(ii) The figure calculated by the method in part (c)(i) may not be true for the muscle as a whole. Explain why.

_____

_____

(1)

(d) The fibres in **Figure 3** correspond to those in region **X** of **Figure 2**. They were stained with a substance that binds to enzymes involved in glycolysis. Shade **Figure 3** to show the appearance of the fibres. Use the shading shown in the key.

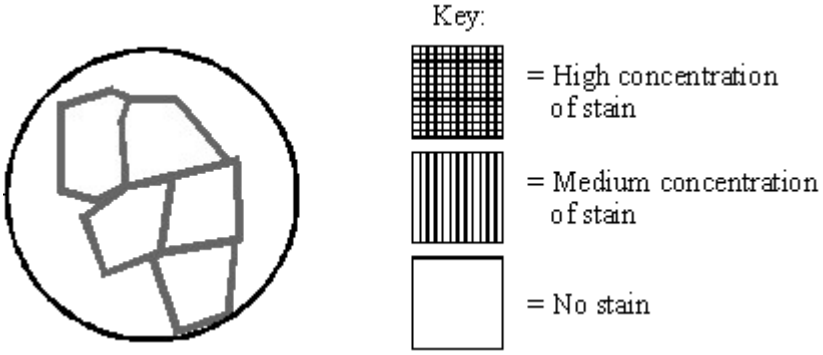


Figure 3

(2)

(e) Recent research has shown that the difference in fibre types is due in part to the presence of different forms of the protein myosin with different molecular shapes.

Explain how a new form of myosin with different properties could have been produced as a result of mutation.

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 15 marks)

Q25.

(a) (i) What is the role of RNA polymerase in transcription?

_____

_____

(1)

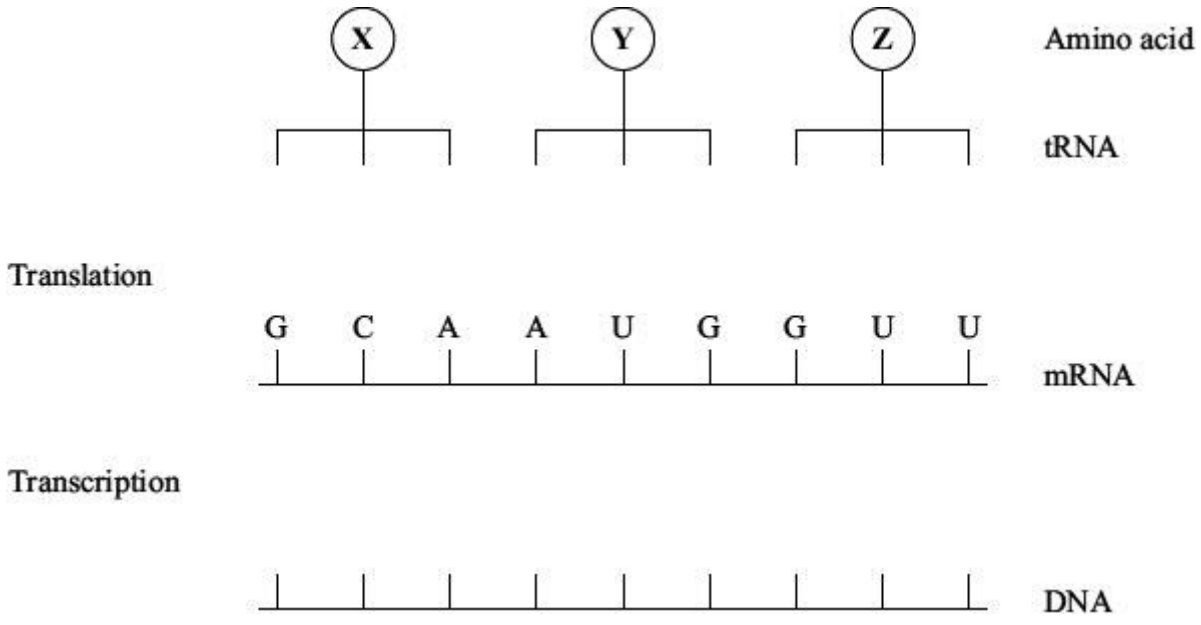
(ii) Name the organelle involved in translation.

_____

(1)

(b) **Figure 1** shows some molecules involved in protein synthesis.

Figure 1



Complete **Figure 1** to show

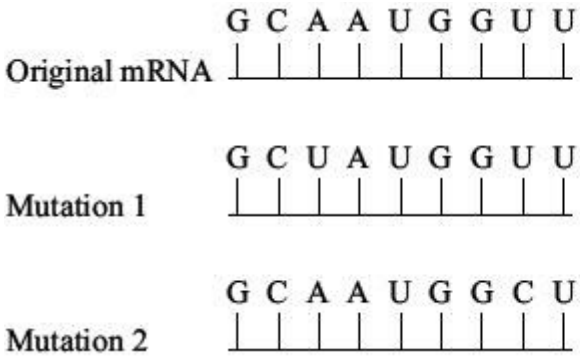
(i) the bases on the DNA strand from which the mRNA was transcribed;

(ii) the bases forming the anticodons of the tRNA molecules.

(2)

Figure 2 shows the effects of two different mutations of the DNA on the base sequence of the mRNA. The table shows the mRNA codons for three amino acids.

Figure 2



Amino acid	mRNA codon
methionine	AUG
valine	GUC GUU
alanine	GCA GCC GCU

(c) Name the type of mutation represented by mutation 1.

_____

(1)

(d) Use the information in the table to

(i) identify amino acid **X** in **Figure 1**;

_____

(1)

(ii) explain how each mutation may affect the polypeptide for which this section of DNA is part of the code.

Mutation 1 _____

_____

_____

_____

(2)

Mutation 2 _____

_____

_____

_____

(2)

(Total 10 marks)

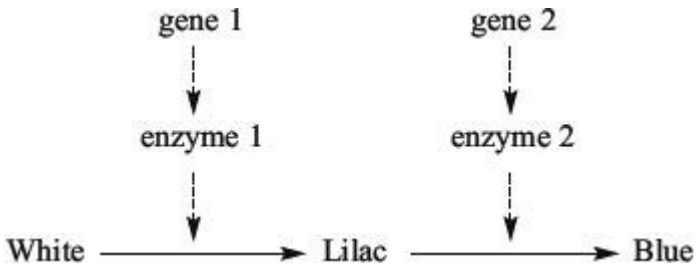
Q26.

(a) Name **one** mutagenic agent.

_____

(1)

(b) In flax plants the flowers are white, lilac or blue. The diagram shows the pathway by which the flower cells produce coloured pigments.



(i) A deletion mutation occurs in gene 1. Describe how a deletion mutation alters the structure of a gene.

_____

_____

_____

_____

(2)

(ii) Describe and explain how the altered gene could result in flax plants with white-coloured flowers.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(iii) Electrophoresis was used to separate the enzymes involved in this pathway. When extracts of the differently coloured flax petals were analysed, four different patterns of bands were produced. In the table, only bands that contain functional enzymes are shown.

Result of electrophoresis	Colour of petal
	White

Complete the table to give the colour of the petal from which each extract was taken.

(2)

(Total 9 marks)

Q27.

Mitochondria contain the genes needed for the synthesis of the enzymes involved in the electron transport chain. One of these enzymes is cytochrome oxidase. If a mutation occurs during replication of the mitochondrial genes, functional cytochrome oxidase may not be produced.

Explain why mutation of a mitochondrial gene might result in no functional cytochrome oxidase being produced.

_____

_____

_____

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_____

_____

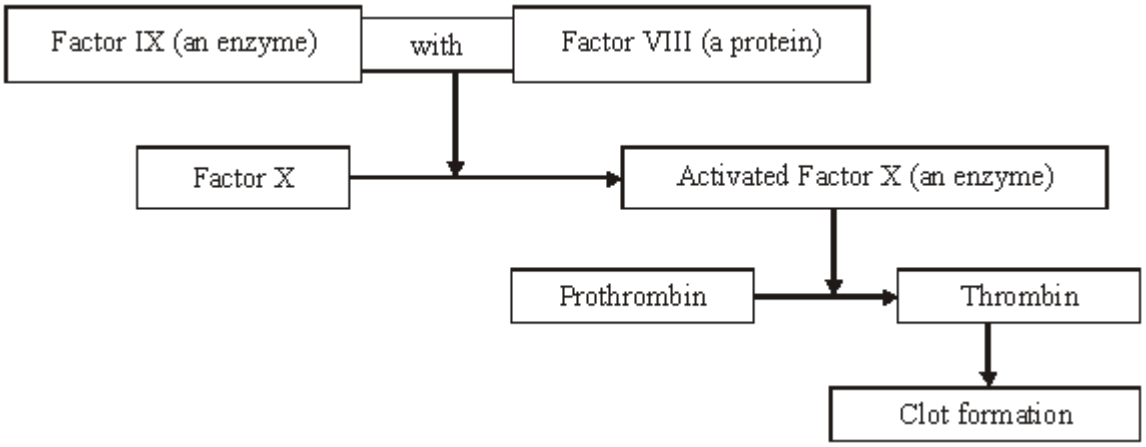
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_____

(Total 5 marks)

Q28.

The diagram shows part of the metabolic pathway involved in the clotting of blood in response to an injury.



Haemophilia is a condition in which blood fails to clot. This is usually because of a mutant allele of the gene for Factor VIII.

(a) Explain how mutation could lead to faulty Factor VIII.

_____

_____

_____

_____

(2)

(b) Use information in the diagram to explain how faulty Factor VIII causes haemophilia.

_____

_____

_____

_____

(2)

(c) A boy had haemophilia caused by faulty Factor IX. When his blood was mixed with blood from a haemophiliac with faulty Factor VIII, the mixture clotted. Suggest an explanation for clotting of the mixture.

_____

_____

_____

_____

(2)

(Total 6 marks)

Q29.

This question should be answered in continuous prose.
Quality of Written Communication will be assessed in the answer.

(i) Starting with mRNA, describe how the process of translation leads to the production of a polypeptide.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(ii) Normal tomato plants have an enzyme that softens tomatoes as they ripen. Genetically engineered tomatoes ripen and soften more slowly. A gene was inserted which reduces the amount of softening enzyme produced.

The diagram shows matching parts of the base sequences for the mRNA produced by the gene for the softening enzyme and that produced by the inserted gene.

Softening gene mRNA	…AAUCGGAAU…
Inserted gene mRNA	…UUAGCCUUA…

Suggest how the inserted gene reduces the production of the softening enzyme.

_____

_____

_____

_____

(2)

(Total 6 marks)