Q1.

5 Fig. 5.1 shows part of a DNA molecule.

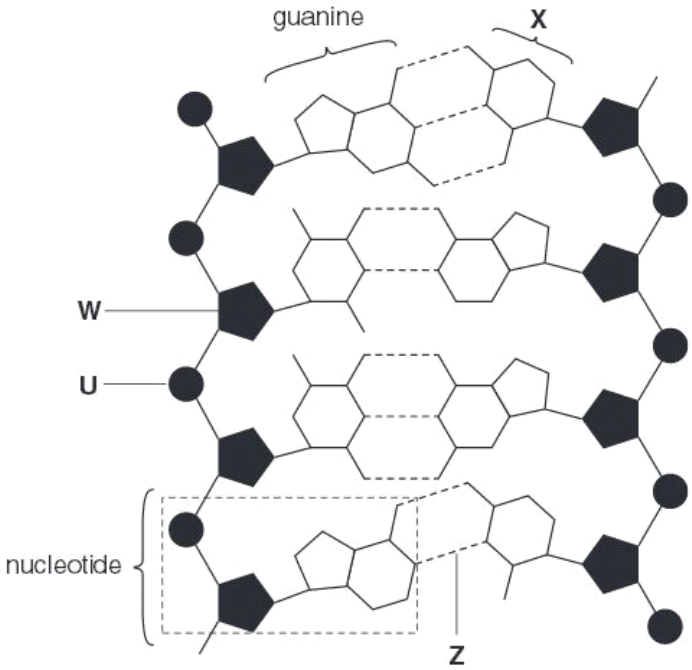


Fig. 5.1

(a) (i) Name **U** to **X**.

U .....

W .....

X .....[3]

(ii) Name the bonds indicated by **Z**.

.....[1]

(b) Describe **three** features of a polypeptide molecule that are different from those found in a DNA molecule.

.....

.....

.....

.....

.....

.....[3]

[Total: 7]

Q2.

1 Fig. 1.1 shows the replication of one strand of a DNA double helix.

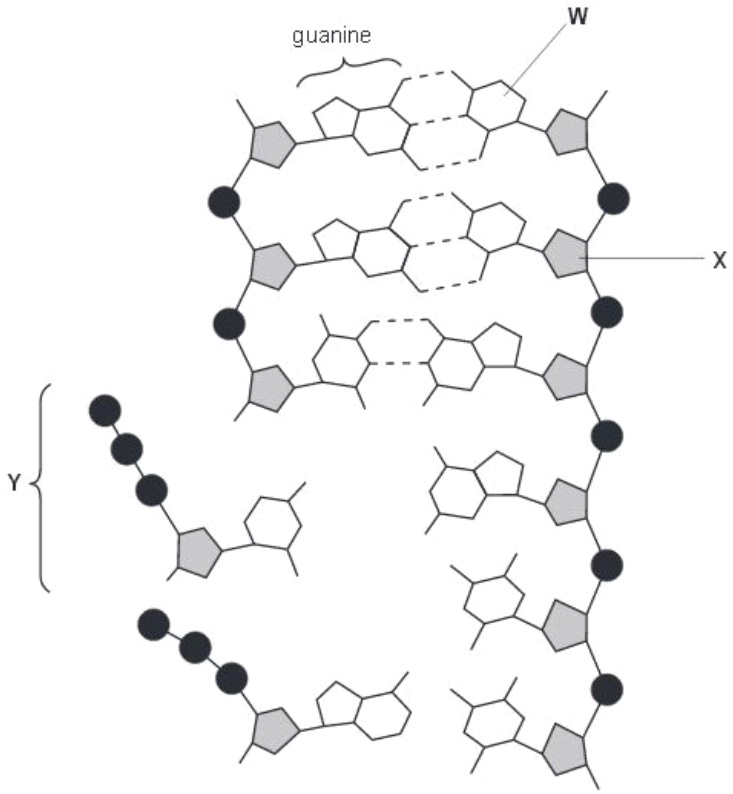


Fig. 1.1

(a) Name **W** to **Y**.

W .....

X .....

Y ..... [3]

(b) Explain how the structure of DNA enables it to replicate semi-conservatively.

.....

.....

.....

.....

.....

..... [3]

(c) Explain why it is important that an exact copy of DNA is made during replication.

.....

.....

.....

..... [2]

[Total: 8]

Q3.

3 **(a)** Complete the table by indicating with a tick (✔) or a cross (✘) whether the statements apply to proteins, DNA, messenger RNA and cellulose.

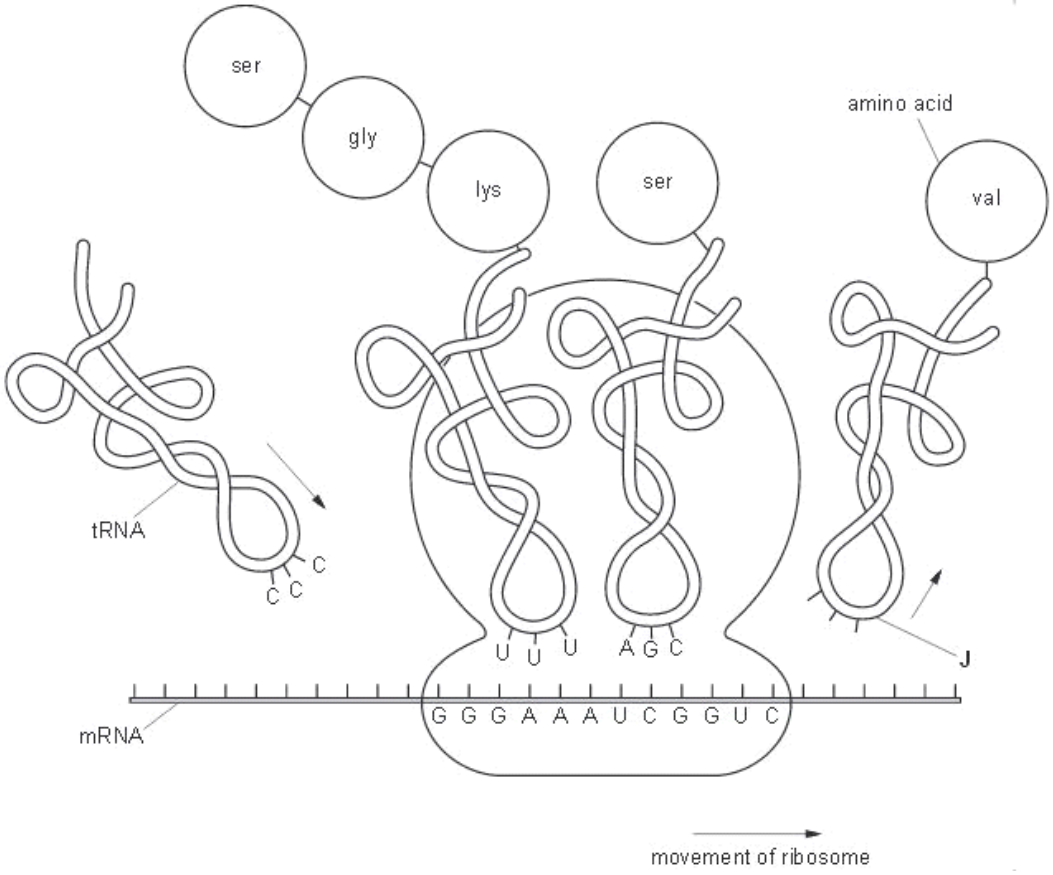
You should put a tick or a cross in each box of the table.

statement	protein	DNA	messenger RNA	cellulose
hydrogen bonds stabilise the molecule				
glucose is the subunit molecule				
subunits are joined by peptide bonds				
may be hydrolysed to amino acids				
contains uracil				

[5]

During an immune response, B-lymphocytes become plasma cells and begin to make polypeptides that are assembled into antibodies.

Fig. 3.1 is a diagram showing the formation of a polypeptide at a ribosome in a plasma cell.



(b) State the sequence of bases at **J**.

.....[1]

(c) **Use the information in Fig. 3.1** to describe the role of transfer RNA molecules in translation.

.....

.....

.....

.....

.....

.....

.....

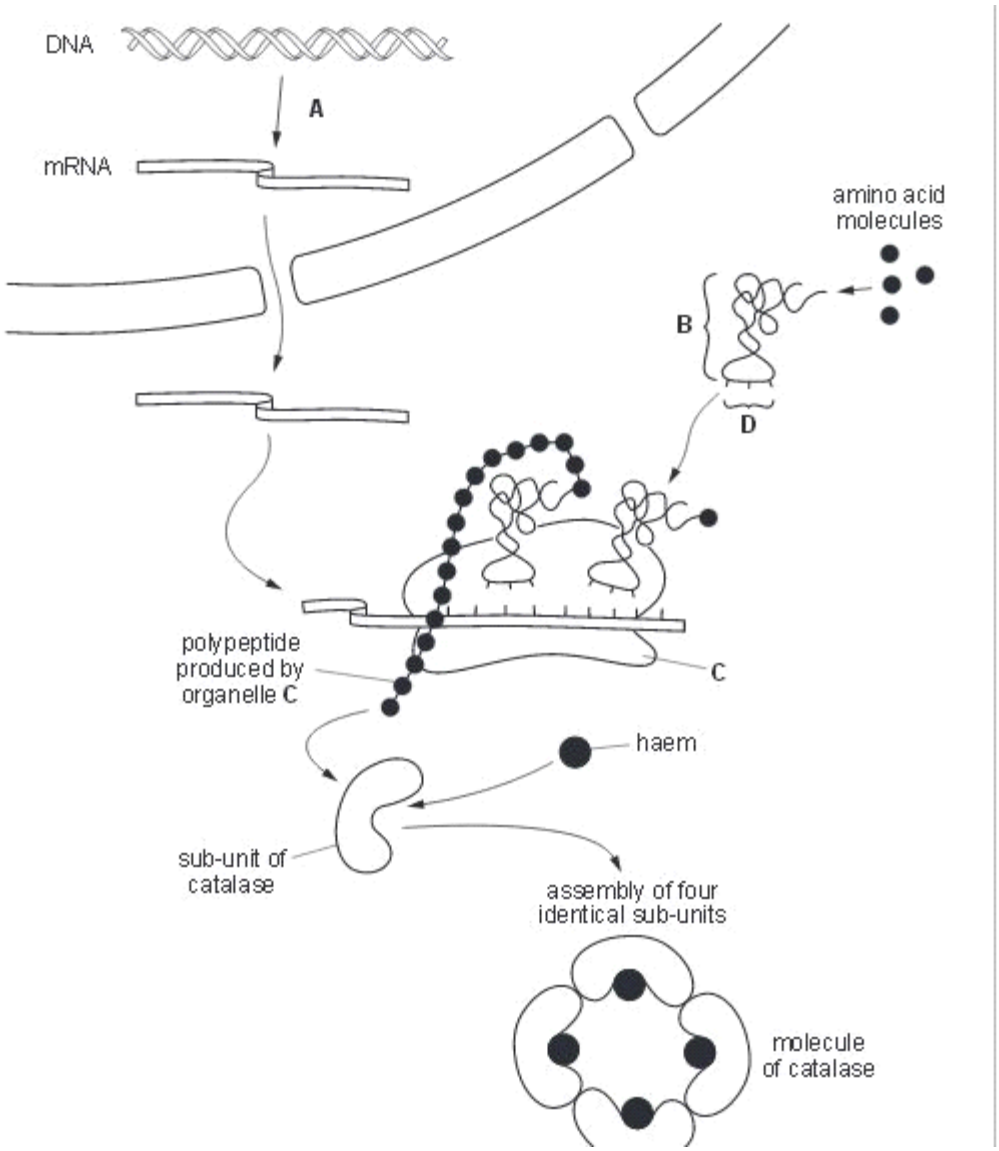
.....

.....[5]

Q4.

4 Catalase is an enzyme with a molecular structure composed of four identical sub-units.

Fig. 4.1 is a diagram that shows how catalase is produced in cells.



(a) With reference to Fig. 4.1,

(i) name

process **A** .....

molecule **B** .....

structure **C** .....

sequence of bases **D** .....[4]

Q.5

5 **(a)** Name the stage during the mitotic cell cycle when replication of DNA occurs.

.....[1]

(b) Fig. 5.1 shows details of DNA replication.

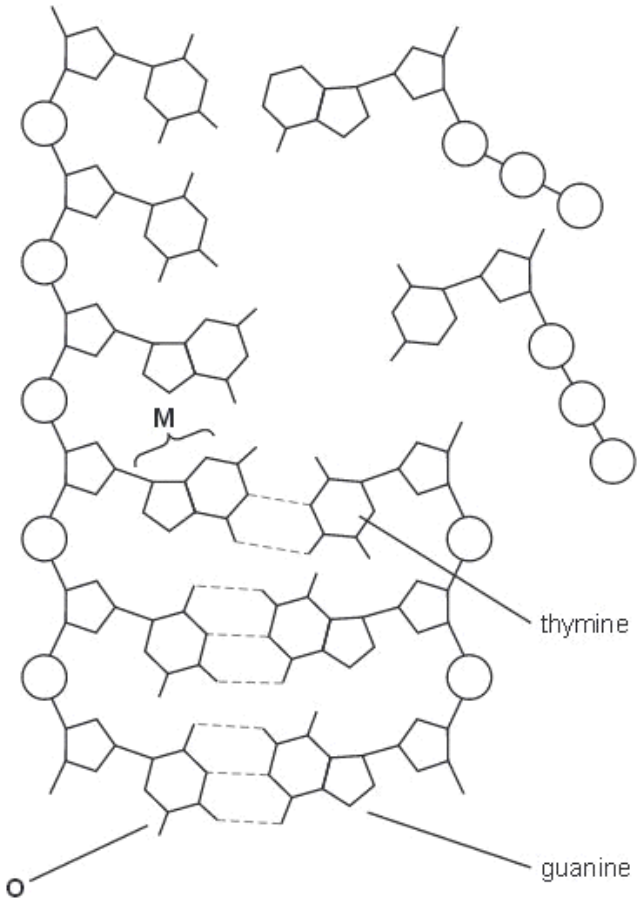


Fig. 5.1

(i) Name the bonds shown by the dashed lines on Fig. 5.1.

.....[1]

(ii) Name the nitrogenous bases, **M** and **O**.

M .....

O .....[1]

(c) Explain why DNA replication is described as *semi-conservative*.

.....

.....

.....

.....

.....[2]

(d) The enzyme that catalyses the replication of DNA checks for errors in the process and corrects them. This makes sure that the cells produced in mitosis are genetically identical.

Explain why checking for errors and correcting them is necessary.

.....

.....

.....

.....

.....[2]

[Total: 7]

Q.6

3 A molecule of messenger RNA (mRNA) was produced during the transcription of a gene. Part of the template sequence of DNA was ATGC.

Fig. 3.1 shows the part of the molecule of messenger RNA corresponding to that sequence of four bases.

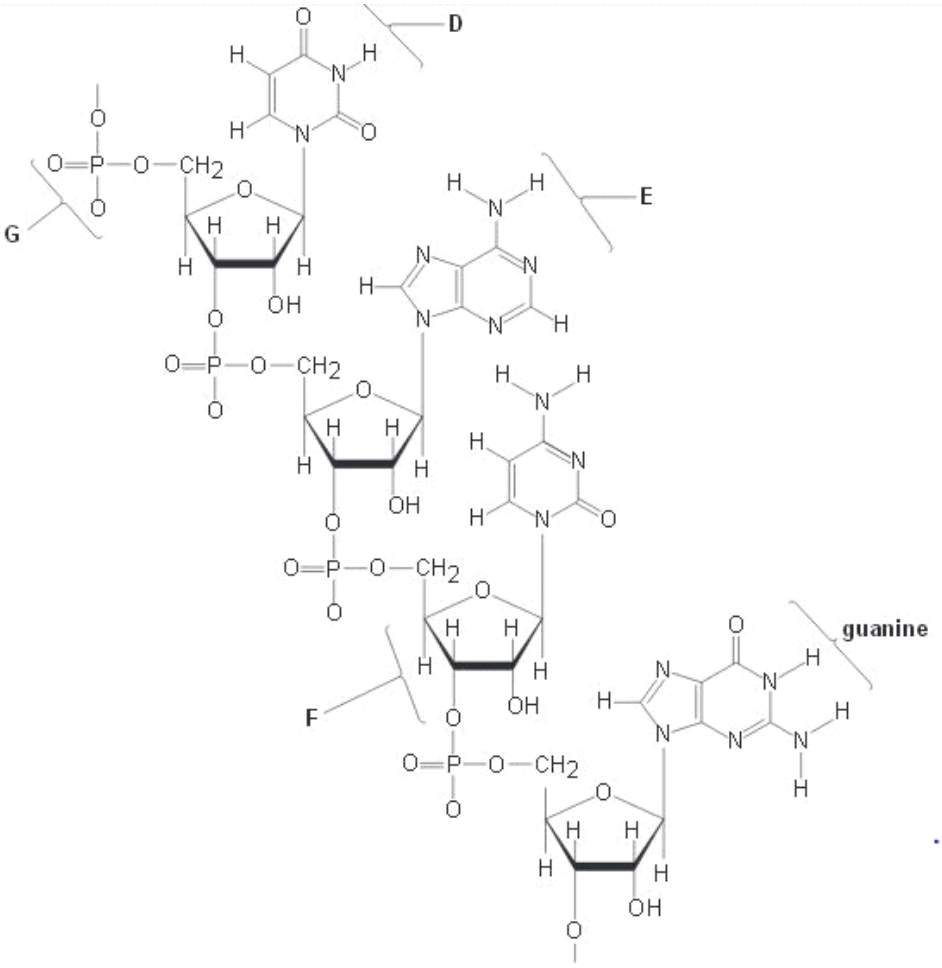


Fig. 3.1

(a) Name the parts of the mRNA molecule shown in Fig. 3.1 labelled **D**, **E**, **F** and **G**.

D .....

E .....

F .....

G ..... [4]

(b) Complete the table to show **three** ways in which mRNA differs from DNA.

	mRNA	DNA
1		
2		
3		

[3]

(c) Describe the role of mRNA after it leaves the nucleus and enters the cytoplasm of a eukaryotic cell.

.....

.....

.....

.....

.....

.....

.....

.....[4]

[Total: 11]

Q.7

2 **(a)** Complete the table to show **three** ways in which the **structure** of DNA differs from RNA.

	DNA	RNA
1		
2		
3		

[3]

(b) Table 2.1 shows two messenger RNA (mRNA) codons. Fill in the complementary transfer RNA (tRNA) anticodons in the spaces provided.

Table 2.1

mRNA codons	GCG	ACA
complementary tRNA anticodons		

[2]

(c) Calculate the minimum number of DNA nucleotides necessary to code for a polypeptide with 238 amino acids.

Show your working.

answer ..... nucleotides [2]

(d) Describe the role played by tRNA in polypeptide synthesis.

.....

.....

.....

.....

.....

.....

.....

.....

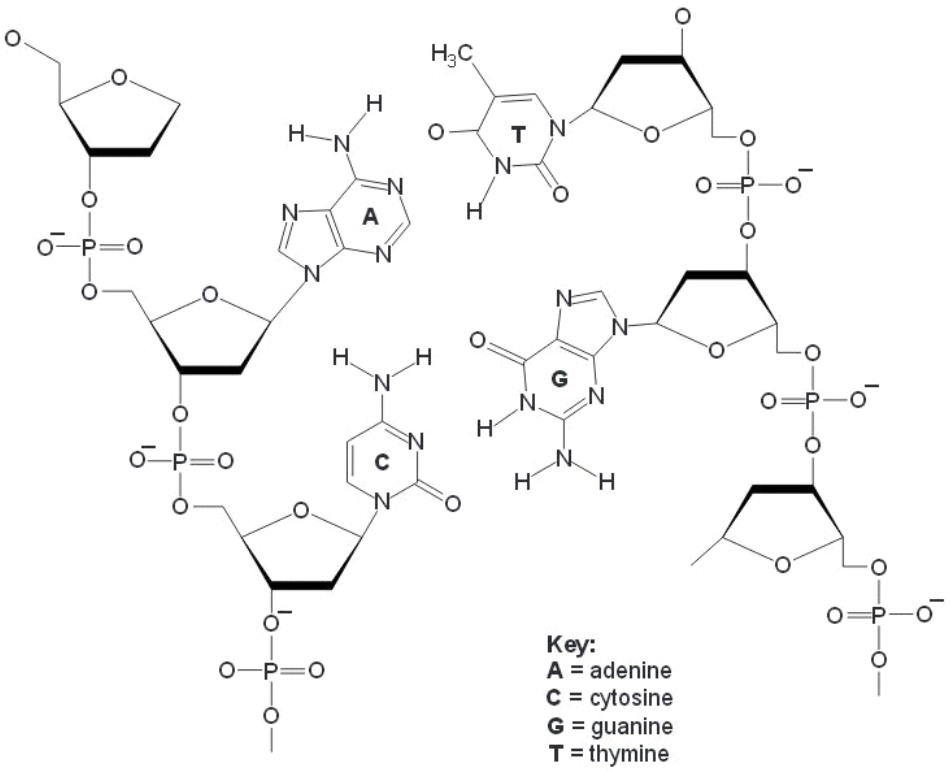
..... [4]

[Total: 11]

Q.8

16

6 Fig. 6.1 shows part of a DNA molecule.



(a) (i) Complete Fig. 6.1 by drawing on the hydrogen bonds between the two base pairs shown. **[2]**

(ii) State the importance of hydrogen bonding in DNA structure.

.....

.....

.....

.....

.....[2]

In the 1950s, Erwin Chargaff determined the relative quantities of the four bases in DNA in different organisms. His results provided important evidence for the model of DNA proposed by James Watson and Francis Crick in 1953. Some of Chargaff's data is shown in Table 6.1.

Table 6.1

organism	percentage of adenine	percentage of thymine	percentage of guanine	percentage of cytosine
Escherichia coli (bacterium)	24.7	23.6	26.0	25.7
a yeast	31.3	32.9	18.7	17.1
wheat	27.3	27.1	22.7	22.8
octopus	33.2	31.6	17.6	17.6
sea urchin	32.8	32.1	17.7	17.3
chicken	28.0	28.4	22.0	21.6
human	29.3	30.0	20.7	20.0

(b) With reference to Fig. 6.1, explain how the data in Table 6.1 helps to confirm the arrangement of bases in DNA.

.....

.....

.....

.....

.....

.....

.....

.....[3]

(c) Table 6.2 shows Chargaff's data for a virus.

Table 6.2

organism	percentage of adenine	percentage of thymine	percentage of guanine	percentage of cytosine
a virus	24.0	31.2	23.3	21.5

(i) State how the result for the virus differs from the results for all the organisms given in Table 6.1.

.....

.....

.....[1]

(ii) Suggest why the results for the virus are different from all the other organisms.

.....

.....[1]

[Total: 9]

Q.9

4 DNA and RNA are important biological molecules that are involved in the production of polypeptides.

(a) Fig. 4.1 shows two nucleotides joined by a covalent bond.

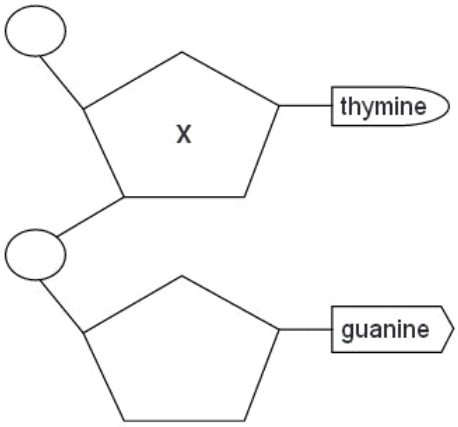


Fig. 4.1

(i) Fig. 4.1 represents part of a DNA molecule, **not** part of an RNA molecule.

Explain why.

.....

.....

..... [1]

(ii) Name the covalent bond between the two nucleotides.

..... [1]

(iii) Name component X.

.....

..... [1]

(b) Outline the role of transfer RNA (tRNA) in the production of a polypeptide.

.....

.....

.....

.....

.....

..... [2]

(c) Describe how a peptide bond is formed between two amino acids during polypeptide production.

You may use the space below to help with your answer.

.....

.....

.....

.....

.....

..... [3]

[Total: 8]

Q.10

4 The two strands of a DNA molecule are held together by hydrogen bonds between complementary base pairs.

Ex

(a) Explain why the hydrogen bonding between the two strands of DNA is important for it to carry out its functions.

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

Switching genes on and off allows proteins to be synthesised only when required.

Processes **P** and **Q** occur when a gene is switched on, as shown in Fig. 4.1.

Fig. 4.1

(b) Name processes **P** and **Q**.

P .....

Q .....[1]

DNA is a very stable molecule. This means that it is not broken down either chemically or by enzymes during the normal life of the cell.

In contrast, mRNA is described as being highly labile. This means that most mRNA molecules are broken down in the cytoplasm within a few hours of their release from the nucleus.

(c) Suggest the significance of:

(i) DNA being very stable

.....

.....

.....[2]

(ii) mRNA being highly labile.

.....

.....

.....[2]

[Total: 9]

Q.11

4 Fig. 4.1 shows the two base pairs in a DNA molecule.

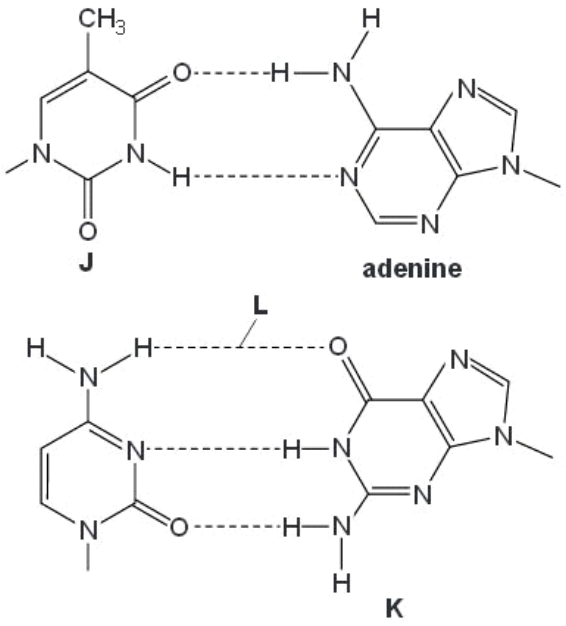


Fig. 4.1

(a) Name the bases labelled **J** and **K** and the bond labelled **L**.

J .....

K .....

L ..... [3]

Q.12

5 **(a)** Complete the table to **describe** three differences between DNA replication and DNA transcription.

For Examiner Use

DNA replication	DNA transcription

[3]

(b) Errors during replication may lead to gene mutations.

Define the term *gene mutation*.

.....

.....

.....

..... [2]

Q.13

2 Read the following passage.

> A method called *in vitro* translation is often used by scientists to produce proteins in the laboratory. The method uses extracts from animal cells, plant cells or bacteria. These are chosen because they have high levels of protein synthesis. The cells are treated so that the cell walls, if present, and cell membranes are broken down and then treated so that any of the cell's own DNA and mRNA are destroyed. When mRNA from any source is added to these extracts, it will be translated into the corresponding protein.

(a) Explain why:

(i) the cells are chosen on the basis of their high level of protein synthesis

.....

.....

.....

..... [2]

(ii) the cell walls (if present) and cell membranes need to be broken down

.....

.....

..... [1]

(iii) the cell's own mRNA needs to be destroyed

.....

.....

..... [1]

(iv) mRNA from any source can be translated in any type of extract.

.....

.....

.....

..... [2]

(b) State **two** differences between the cell structures used in translation in prokaryotes and eukaryotes.

.....

.....

.....

..... [2]

(c) Scientists usually find that the method of *in vitro* translation is less efficient than *in vivo* translation, which occurs in cells.

Suggest a reason for this.

.....

.....

..... [1]

[Total: 9]

Q.14

(c) Table 3.1 shows some mRNA codons and the amino acids for which they code.

Table 3.1

amino acid	abbreviation	mRNA codons					
glutamic acid	glu	GAA	GAG	–	–	–	–
phenylalanine	phe	UUU	UUC	–	–	–	–
lysine	lys	AAA	AAG	–	–	–	–
proline	pro	CCA	CCC	CCG	CCU	–	–
threonine	thr	ACA	ACC	ACG	ACU	–	–
valine	val	GUA	GUC	GUG	GUU	–	–
cysteine	cys	UGC	UGU	–	–	–	–
arginine	arg	CGC	CGA	CGU	CGG	AGA	AGG

Fig. 3.2 shows,

- the sequence of three amino acids in the human lysozyme polypeptide
- part of a possible sequence of nucleotide bases for the mRNA that codes for these amino acids
- one of the corresponding nucleotide bases in the DNA.

amino acids	arg	cys	glu
mRNA	.....	.....	GAA
DNA	GCA	.....	.....

Fig. 3.2

(i) Use the information in Table 3.1 to complete the nucleotide sequences for the mRNA and the DNA shown in Fig. 3.2. Write your answer on Fig. 3.2. [3]

(ii) Explain why the human gene for lysozyme may have a different nucleotide sequence from the answer you have given in **(c)(i)**.

.....

.....

.....

..... [2]

Q.15

(c) One example of protein modification is the removal of the first amino acid, methionine, from a newly formed polypeptide chain to make a functioning protein.

(i) The DNA nucleotide sequence that specifies the amino acid methionine is TAC.

State the mRNA nucleotide sequence that is complementary to the DNA sequence for methionine.

..... [1]

(ii) Suggest **two** other ways in which the polypeptide chain is modified to produce the functioning protein.

.....

.....

.....

..... [2]

Q.16

There are many different variants of haemoglobin. The sequence of bases in DNA that code for the first seven amino acids in two variants of the β-globin polypeptide are shown in Fig. 3.2.

The genetic dictionary for some of the amino acids is in Table 3.1.

Variant 1

1	2	3	4	5	6	7
CAC	GTG	GAC	TGA	GGA	CTC	CTC

Variant 2

1	2	3	4	5	6	7
CAC	GTG	GAC	TGA	GGA	CAC	CTC

Fig. 3.2

amino acid	abbreviation	DNA triplets on the coding polynucleotide
valine	val	CAA, CAC, CAG, CAT
proline	pro	GGA, GGC, GGG, GGT
threonine	thr	TGA, TGC, TGG, TGT
histidine	his	GTA, GTG
glutamic acid	glu	CTC, CTT
leucine	leu	AAC, AAT, GAA, GAC, GAG, GAT

(b) Use the genetic dictionary to describe the similarities and differences between the two variants of haemoglobin.

.....

.....

.....

.....

.....

.....[3]

Q.17

Semi-conservative replication of DNA and transcription involve the formation of polynucleotide chains.

For Examiner Use

(c) State the type of reaction that occurs in the formation of a polynucleotide chain.

.....[1]

(d) Complete Table 4.1 to show **four** differences between DNA replication and DNA transcription.

Table 4.1

	replication	transcription
1		
2		
3		
4		

[4]

Q.18

5 Fig. 5.1 represents part of a DNA molecule.

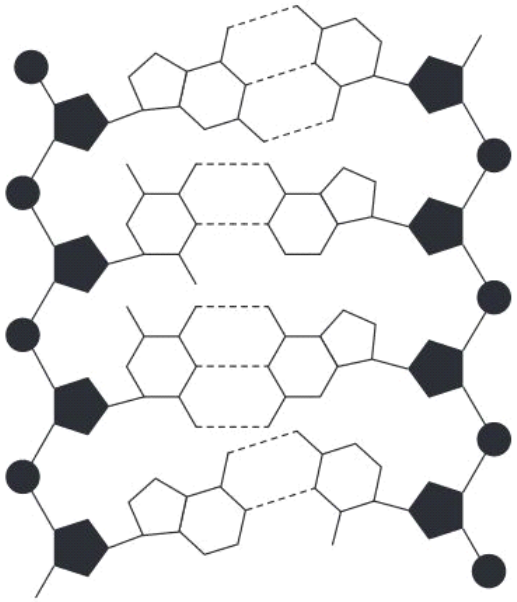


Fig. 5.1

(a) On Fig. 5.1

(i) draw a box around a nucleotide [1]

(ii) label, with the letter **P**, a phosphate group. [1]

(b) Describe how a DNA molecule replicates.

B

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

(c) DNA codes for polypeptides in cells. Transfer RNA (tRNA) is involved in this process.

Describe the role of tRNA in the production of polypeptides in cells.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 10]

Q.19

5 **(a)** State the structural features of DNA that make it a stable molecule.

For Examiner's Use

.....

.....

.....

.....

..... [2]

(b) DNA has been described as a 'carrier of coded information'.

Explain this statement.

.....

.....

.....

.....

..... [2]

(c) State when, during a cell cycle, DNA replication occurs.

..... [1]

(d) There are two alleles of the gene for the β-haemoglobin polypeptide:

- HbA (normal)
- HbS (sickle cell).

Describe **and** explain the difference between the HbA and HbS alleles of this gene.

.....

.....

.....

.....

.....

.....

..... [3]

(e) DNA polymerase is an enzyme involved in the replication of DNA.

One of the substrates required by DNA polymerase is ATP.

ara-ATP is a chemical that affects DNA polymerase activity.

In an investigation, the effect of different concentrations of ATP on the rate of DNA synthesis was determined:

- with no ara-ATP
- with a low concentration of ara-ATP
- with a high concentration of ara-ATP.

The results of the investigation are shown in Fig. 5.1.

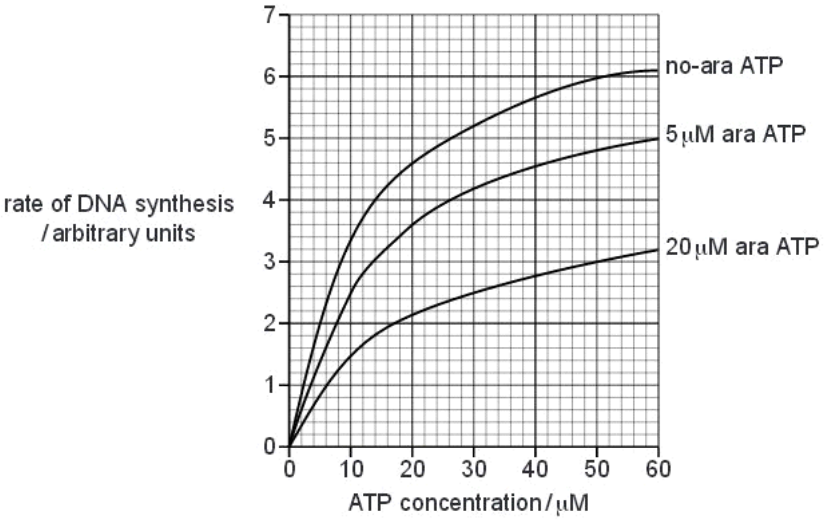


Fig. 5.1

Explain, in terms of the mode of action of enzymes, the results of the investigation shown in Fig. 5.1.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 11]

Q.20

5 **(a)** Describe the role of the ribosome in translation.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

Fig. 5.1 is a diagram of a section of mRNA showing the sequence of three of the codons.

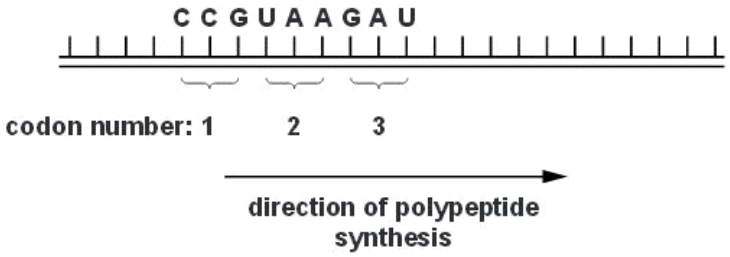


Fig. 5.1

(b) State the base sequences of:

(i) the tRNA anticodon complementary to **codon 1**

.....[1]

(ii) the DNA sequence which coded for **codon 3**.

.....[1]

(c) The three codons in Fig. 5.1 are near the start of the sequence coding for a protein.

Explain the consequence of a mutation which deletes the **U** from **codon 2**.

.....

.....

.....

.....

.....

.....

.....[3]

[Total: 9]

Q.21.

5 Table 5.1 shows the triplets of bases on the template polynucleotide of DNA for some amino acids.

Table 5.1

amino acid		DNA triplets
glutamic acid	(glu)	CTT CTC
histidine	(his)	GTA GTG
leucine	(leu)	GAA GAG GAT GAC
proline	(pro)	GGA GGG GGT GGC
threonine	(thr)	TGA TGG TGT TGC
valine	(val)	CAA CAG CAT CAC

Fig. 5.1 shows the base sequences in DNA and mRNA for the first seven amino acids of the β chain of haemoglobin.

DNA	CAC	.....	GAC	TGA	GGA	CTC	CTC
mRNA	GUG	CAC	CUG	.....	CCU	GAG	GAG
β chain	val	his	.....	thr	pro	glu	glu

Fig. 5.1

(a) (i) Use Table 5.1 to complete Fig. 5.1. [3]

(ii) State the term used to describe the sequence of amino acids in a polypeptide.

.....[1]

(b) In sickle cell anaemia, the amino acid at position 6 in the β chain is valine and not glutamic acid.

Explain how a single change in the DNA triplet for the sixth amino acid of the gene coding for the β chain leads to the production of a different amino acid sequence.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....[5]

Q.22.

(b) Fig. 2.1 shows the base sequence of a DNA triplet code used to produce mRNA. Fill in the corresponding tRNA anticodon in the space provided.

DNA triplet	T A C
tRNA anticodon	

[1]

Fig. 2.1

(c) More mRNA molecules than tRNA molecules are synthesised in cells.

Suggest a reason for this.

.....

.....

.....

..... [1]

(d) Describe the role of ribosomes in protein synthesis.

.....

.....

.....

.....

.....

.....

.....

..... [3]