CAMBRIDGE INTERNATIONAL AS & A LEVEL BIOLOGY · 9700

BIOLOGY



EXAM QUESTION PACK

6 NUCLEIC ACIDS AND PROTEIN SYNTHESIS

SCORE	PERCENTAGE
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Chapter 6

Nucleic acids and protein synthesis

6.1 Structure and replication of DNA

800. 9700_m20_qp_12 Q: 22

What is correct for cytosine?

	has a single ring structure	is a pyrimidine	joins to its complementary base with 3 hydrogen bonds
A	✓	✓	✓
B	✓	✗	✓
C	✗	✓	✗
D	✗	✗	✓

key

✓ = correct

✗ = incorrect

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801. 9700_m20_qp_12 Q: 23

Scientists grew bacteria in a medium containing heavy nitrogen, ^{15}N, as the only source of nitrogen. After many generations, both strands of all of the bacterial DNA molecules contained heavy nitrogen.

These bacteria were then moved from the heavy nitrogen medium into a medium with only light nitrogen, ^{14}N. The bacteria divided once to form the first generation and once more to form the second generation.

A sample of bacteria was collected from the second generation and the DNA was analysed to find:

- the percentage of DNA strands that contained only light nitrogen
- the percentage of DNA molecules that contained light nitrogen **and** heavy nitrogen.

Which row shows the results of this analysis?

	percentage of DNA strands that contained only light nitrogen	percentage of DNA molecules that contained light nitrogen **and** heavy nitrogen
A	50	25
B	50	50
C	75	25
D	75	50

---

802. 9700_s20_qp_11 Q: 20

What is correct for thymine?

	has a single ring structure	is a pyrimidine	joins its complementary base with 3 hydrogen bonds
A	✓	✓	✓
B	✓	✓	✗
C	✓	✗	✗
D	✗	✗	✓

key
✓ = correct
✗ = incorrect

---

803. 9700_s20_qp_11 Q: 21

A short piece of DNA 15 base pairs long was analysed to find the number of nucleotide bases in each of the polynucleotide strands. Some of the results are shown below.

	number of nucleotide bases			
	A	C	G	T
strand 1		6		3
strand 2				4

How many nucleotides containing guanine were present in strand 1?

A 2 **B** 3 **C** 4 **D** 6

---

804. 9700_s20_qp_11 Q: 22

Scientists grew bacteria in a medium containing heavy nitrogen, ^{15}N, as the only source of nitrogen.

After many generations, all of the bacterial DNA contained heavy nitrogen.

These bacteria were then moved from the heavy nitrogen medium into a medium with only light nitrogen, ^{14}N.

Some bacteria were collected from each of the **next** three generations and their DNA was analysed.

Hybrid DNA contains both heavy and light nitrogen.

Which row shows the correct DNA of the first and third generations?

	DNA of first generation	DNA of third generation
A	all hybrid	half hybrid, half light
B	all hybrid	one quarter hybrid, three quarters light
C	half hybrid, half heavy	half hybrid, one quarter heavy, one quarter light
D	half hybrid, half light	one quarter hybrid, three quarters light

---

805. 9700_s20_qp_12 Q: 22

Some viruses have single-stranded DNA as their genetic material. This DNA molecule has to be folded to fit in the protein coat.

Which statements about single-stranded DNA are correct?

1 Single-stranded DNA cannot replicate semi-conservatively.

2 If only the percentage of cytosine is known, then the percentage of guanine can be calculated, but the percentage of adenine and thymine cannot be calculated.

3 Hydrogen bonds may be present within the DNA molecule.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

---

806. 9700_s20_qp_12 Q: 23

How many statements are true for semi-conservative replication of DNA in a eukaryotic cell?

1 The process takes place in the nucleus.

2 Adenine will line up against uracil on the complementary strand.

3 Each new molecule will contain one strand of the original molecule.

4 If the original molecule contained 40% guanine each new molecule will contain 20% guanine.

A 1 **B** 2 **C** 3 **D** 4

---

807. 9700_s20_qp_13 Q: 20

Which statements about the nucleotide containing uracil are correct?

1 Uracil is a pyrimidine.

2 The carbohydrate is always ribose.

3 Base pairing occurs with 3 hydrogen bonds.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

---

808. 9700_s20_qp_13 Q: 21

DNA replication involves several stages.

1 Each strand of DNA double helix acts as a template for the opposite strand.

2 The enzyme DNA polymerase links bases together.

3 Hydrogen bonds between bases A and T and between C and G are broken.

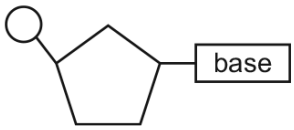
Which statements about DNA replication are correct?

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 3 only

---

809. 9700_w20_qp_11 Q: 21

The diagram represents a nucleotide containing cytosine.



Which statements about this nucleotide are correct?

1 The carbohydrate could be ribose.

2 The organic base contains nitrogen.

3 Base pairing occurs with guanine.

4 Cytosine is a purine.

A 1, 2 and 3 **B** 1, 2 and 4 **C** 1, 3 and 4 **D** 2, 3 and 4

---

810. 9700_w20_qp_11 Q: 22

A section of DNA contains 73 base pairs.

	number of bases on each strand			
	adenine	cytosine	guanine	thymine
strand 1	29	V	14	W
strand 2	21	X	Y	Z

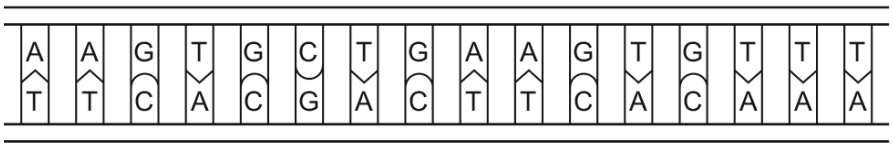
Which row represents the correct number of bases?

	V	W	X	Y	Z
A	9	21	14	9	29
B	14	29	9	9	21
C	21	9	29	9	14
D	29	9	29	14	9

---

811. 9700_w20_qp_12 Q: 20

How many hydrogen bonds are holding the two strands of this section of a DNA molecule together?



A 16 **B** 32 **C** 38 **D** 48

---

812. 9700_w20_qp_13 Q: 22

Which row represents the correct features of guanine?

	has a single ring structure	is a purine	joins its complementary base via three hydrogen bonds	pairs with thymine
A	✓	✓	✗	✓
B	✓	✗	✓	✗
C	✗	✓	✓	✗
D	✗	✗	✓	✓

key
✓ = correct
✗ = not correct

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813. 9700_w20_qp_13 Q: 23

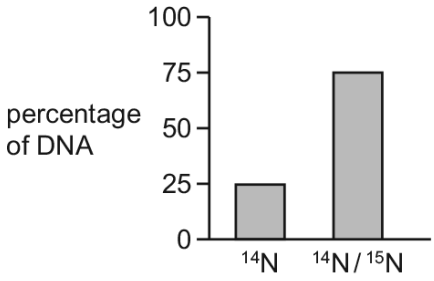
Bacteria were grown in a medium containing ^{15}N. After several generations, all of the DNA contained ^{15}N.

Some of these bacteria were transferred to a medium containing the common isotope of nitrogen, ^{14}N. The bacteria were allowed to divide once. The DNA of some of these bacteria was extracted and analysed. This DNA was all hybrid DNA containing equal amounts of ^{14}N and ^{15}N ($^{14}N/^{15}N$).

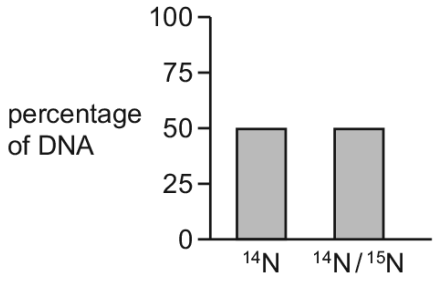
In another experiment, some bacteria from the medium with ^{15}N were transferred into a medium of ^{14}N. The bacteria were allowed to divide three times. The DNA of some of these bacteria was extracted and analysed.

What is the composition of this DNA?

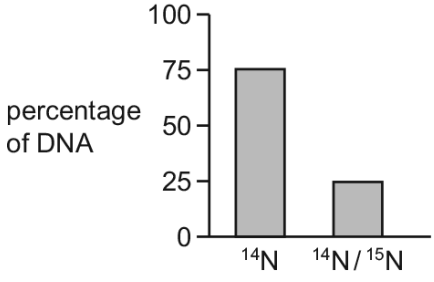
A



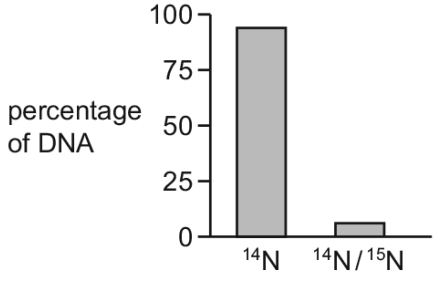
B



C



D



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814. 9700_m19_qp_12 Q: 21

A length of DNA was analysed and sequenced. 24% of its nitrogenous bases were adenine.

Which percentage of the bases will be cytosine?

A 24 **B** 26 **C** 48 **D** 76

---

815. 9700_s19_qp_11 Q: 22

A short piece of DNA, 19 base pairs long, was analysed to find the number of nucleotide bases in each of the polynucleotide strands. Some of the results are shown below.

	number of nucleotide bases			
	A	C	G	T
strand 1				4
strand 2		7		5

How many nucleotide bases containing C were present in strand 1?

A 2 **B** 3 **C** 5 **D** 7

---

816. 9700_s19_qp_11 Q: 23

Which nucleic acid bases are purines?

A adenine and cytosine

B cytosine and thymine

C guanine and adenine

D uracil and cytosine

---

817. 9700_s19_qp_12 Q: 18

Which statement correctly describes the base pairing in a molecule of DNA?

A The purine adenine forms bonds with the pyrimidine thymine.

B The purine adenine forms bonds with the pyrimidine uracil.

C The purine cytosine forms bonds with the pyrimidine guanine.

D The purine guanine forms bonds with the pyrimidine thymine.

---

818. 9700_s19_qp_12 Q: 19

Which statements about complementary base pairing are correct?

1 It allows translation to occur.

2 Purines and pyrimidines are the same size.

3 The base pairs are of equal length.

4 Uracil forms two hydrogen bonds with adenine.

A 1, 2, 3 and 4

B 1, 3 and 4 only

C 1 and 4 only

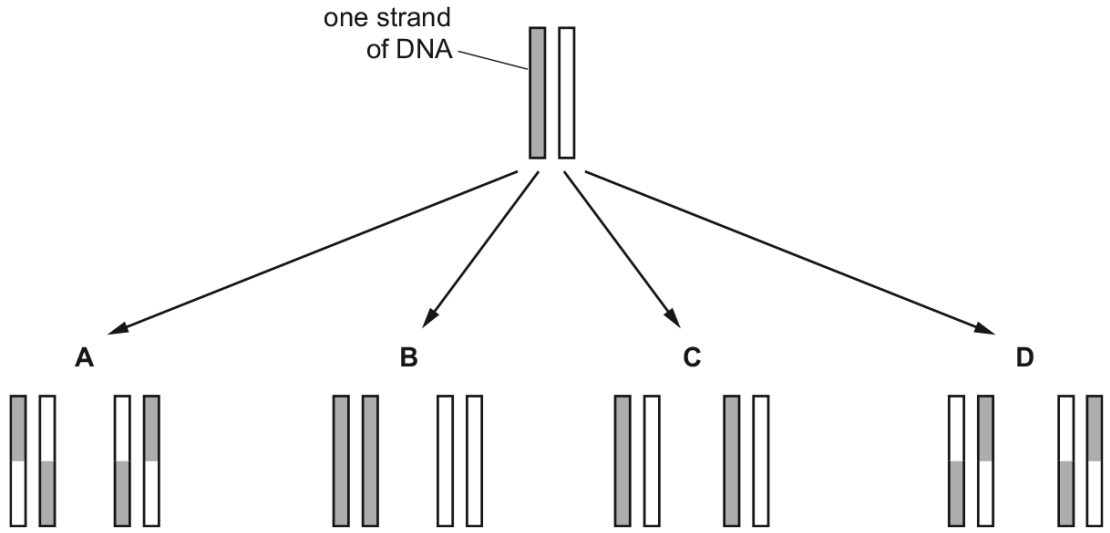
D 2 and 3 only

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819. 9700_s19_qp_12 Q: 20

The diagram shows the possible organisation of DNA molecules after one replication.

Which organisation is correct?



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820. 9700_s19_qp_12 Q: 21

The diagram shows part of the DNA sequence of a gene and a mutated sequence of the same gene.

normal DNA sequence	...CCG GAT TAT TGC GAG AAA TGG CAT TCT AGG...
mutated DNA sequence	...CCG GAT GTA TTG CGA GAA ATG CAT TCT AGG...

What are possible effects of the mutated sequence?

1 the presence of mRNA stop codons, UAG, UAA or UGA

2 a change in the sequence of amino acids

3 a non-functional protein

4 ribosomes cannot translate the mRNA

A 1, 2 and 3 **B** 1, 3 and 4 **C** 1 and 4 only **D** 2 and 3 only

---

821. 9700_s19_qp_13 Q: 24

A gene codes for the production of a protein, p53, that binds to damaged DNA during interphase and prevents its replication. A carcinogen in cigarette smoke mutates this gene.

Which statement explains why this mutation may cause cancer?

A Cells with no p53 are allowed to undergo mitosis.

B Cells with no p53 allow their damaged DNA to replicate.

C The carcinogen in cigarette smoke increases the rate of cell division.

D The p53 causes uncontrolled cell division.

---

822. 9700_s19_qp_13 Q: 25

What is the role of DNA polymerase?

A condensation reactions to produce DNA nucleotides for replication

B correct alignment of RNA nucleotides along a template strand of DNA

C formation of bonds to complete the sugar-phosphate backbone

D formation of glycosidic bonds between complementary base pairs

---

823. 9700_s19_qp_13 Q: 26

Which row represents the correct features of the nitrogenous base thymine?

	has a single ring structure	is a purine	forms two hydrogen bonds with its complementary base	pairs with cytosine
A	✓	✓	✗	✗
B	✓	✗	✓	✗
C	✗	✓	✗	✓
D	✗	✗	✓	✓

key
✓ = correct
✗ = not correct

---

824. 9700_s19_qp_13 Q: 27

Meselson and Stahl investigated DNA in bacteria. They grew bacteria in a medium with only heavy nitrogen, ^{15}N, until all of the bacterial DNA was heavy.

These bacteria were moved from a heavy nitrogen medium and cultured in a medium with only light nitrogen, ^{14}N.

A sample of bacteria was collected from the second generation and their DNA analysed.

Hybrid DNA contains both heavy and light DNA.

Which row shows the percentage of heavy DNA strands and the percentage of hybrid DNA molecules in the second generation produced in the medium containing light nitrogen?

	percentage of heavy DNA strands	percentage of hybrid DNA molecules
A	25	25
B	25	50
C	50	25
D	50	50

---

825. 9700_s19_qp_13 Q: 28

The table shows the DNA triplet codes for some amino acids.

amino acid	DNA triplet code	amino acid	DNA triplet code
arginine	GCA	glycine	CCA
arginine	GCC	glycine	CCG
arginine	GCG	glycine	CCT
asparagine	TTA	lysine	TTC
asparagine	TTG	lysine	TTT
STOP	ATC	proline	GGA
cysteine	ACA	proline	GGC
cysteine	ACG	valine	CAC

The base sequence on the DNA strand coding for a polypeptide is shown.

CCA TTC ACG GCG TTA GCA

Two mutations occur in this sequence during DNA replication.

Which mutated DNA would have **no** effect on the polypeptide synthesised?

A CCA ATC ACG GCG TTG GCA

B CCA TTC ACA GCA TTA GCA

C CCA TTC ACG CCG TTA GCC

D CCT TTC ACG GCG TTA GGA

---

826. 9700_w19_qp_11 Q: 21

Which components could be found in nucleotides of rRNA?

1 any one of two different nitrogenous bases with a double ring structure

2 any one of two different purine bases

3 any one of three different nitrogenous bases with a single ring structure

4 any one of three different pyrimidine bases

A 1, 2, 3 and 4 **B** 1 and 2 only **C** 1 and 4 only **D** 3 and 4 only

---

827. 9700_w19_qp_11 Q: 22

How many statements are true for semi-conservative replication of DNA in a prokaryotic cell?

1 the process takes place in the cytoplasm

2 an adenine nucleotide will line up against a uracil on the template strand

3 each new DNA molecule will contain one strand from the parent molecule

4 if the parent molecule contained 40% guanine nucleotides each new DNA molecule will contain 20% guanine nucleotides

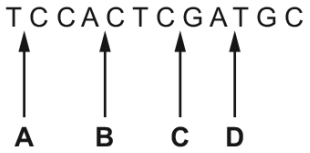
A 1 **B** 2 **C** 3 **D** 4

---

828. 9700_w19_qp_12 Q: 22

The RNA triplet UAG acts as a stop codon terminating the synthesis of a polypeptide. The diagram shows a strand of DNA which codes for four amino acids.

Where would an insertion mutation of a thymine nucleotide result in the termination of translation?



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829. 9700_w19_qp_12 Q: 23

What is correct for uracil?

	It has a single ring structure	It is a purine	It joins its complementary base with 2 hydrogen bonds
A	✓	✓	✓
B	✓	✗	✓
C	✗	✓	✗
D	✗	✗	✓

key

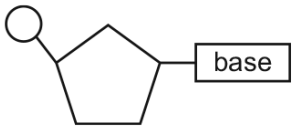
✓ = correct

✗ = not correct

---

830. 9700_w19_qp_13 Q: 20

The diagram represents a nucleotide containing guanine.



Which statements about this nucleotide are correct?

1 The carbohydrate can be ribose or deoxyribose.

2 Base pairing occurs with three hydrogen bonds.

3 Guanine is a purine.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

---

831. 9700_w19_qp_13 Q: 22

Meselson and Stahl investigated DNA in bacteria. They grew bacteria in a medium with only heavy nitrogen, ^{15}N, until all of the bacterial DNA was heavy.

These bacteria were moved from a heavy nitrogen medium and cultured in a medium with only light nitrogen, ^{14}N.

A sample of bacteria was collected from the first generation and their DNA analysed.

Hybrid DNA contains heavy DNA and light DNA.

Which row shows the percentage of light DNA strands and the percentage of hybrid DNA molecules in the first generation produced in the medium containing light nitrogen?

	percentage of light DNA strands	percentage of hybrid DNA molecules
A	25	50
B	50	50
C	50	100
D	75	100

---

832. 9700_m18_qp_12 Q: 23

A culture of bacteria was allowed to reproduce using nucleotides containing the heavy isotope of nitrogen (^{15}N). After several generations, all of the bacterial DNA molecules contained heavy nitrogen.

DNA was extracted from a sample of the culture, mixed with caesium chloride solution and spun at high speed in a centrifuge. In this process, DNA molecules of different masses separate into bands at different positions in the centrifuge tube. The heavier the DNA molecules, the closer to the bottom of the centrifuge tube that a band forms.

The diagram shows the position of the DNA molecules containing heavy nitrogen in the centrifuge tube.



The culture of bacteria was then allowed to reproduce using nucleotides containing the light isotope of nitrogen (^{14}N).

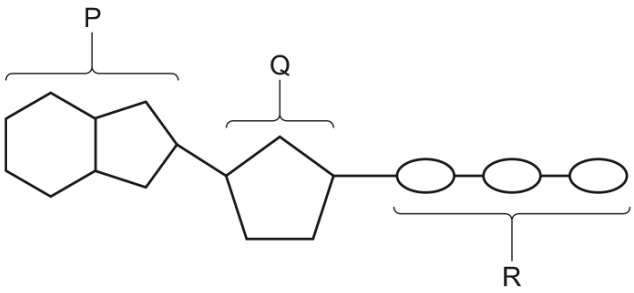
DNA samples were taken and separated by centrifugation after the bacteria had divided once and again after the bacteria had divided twice.

In which positions would the DNA be found after the cells had divided once and after the cells had divided twice?

	after dividing once	after dividing twice
A	half at K and half at L	quarter at K, quarter at M and half at L
B	half at K and half at M	quarter at K, quarter at M and half at L
C	all at L	half at K and half at L
D	all at M	half at L and half at M

833. 9700_m18_qp_12 Q: 24

The diagram represents a molecule of ATP.



What are the components of ATP labelled P, Q and R?

	P	Q	R
A	adenine	deoxyribose	phosphates
B	adenosine	pentose	a phosphate group
C	adenosine	ribose	phosphorus
D	purine	pentose	phosphates

---

834. 9700_m18_qp_12 Q: 25

The table shows three anticodons for different amino acids.

amino acid	anticodon
alanine	CGU
histidine	GUA
serine	UCA

Which DNA triplet on the DNA template strand codes for the amino acid serine?

A AGU **B** TCA **C** TGT **D** UCA

---

835. 9700_s18_qp_11 Q: 22

Meselsohn and Stahl investigated DNA in bacteria. They grew bacteria in a medium with only heavy nitrogen, ^{15}N, until all of the bacterial DNA was heavy.

These bacteria were moved from a heavy nitrogen medium and cultured in a medium with only light nitrogen, ^{14}N.

A sample of bacteria was collected from the first generation in the medium containing light nitrogen and their DNA was analysed.

Hybrid DNA contains both heavy and light DNA.

Which row shows the percentage of heavy DNA strands and the percentage of hybrid DNA molecules in the first generation produced in the medium containing light nitrogen?

	percentage of heavy DNA strands	percentage of hybrid DNA molecules
A	25	50
B	50	50
C	50	100
D	75	100

---

836. 9700_s18_qp_11 Q: 23

Which is the correct DNA triplet on the original DNA template that codes for the amino acid histidine (His)?

amino acid	anticodon
Ala	CGU
His	GUA
Ser	UCA

A CAU **B** CGT **C** GTA **D** GUA

---

837. 9700_s18_qp_12 Q: 23

A section of a DNA molecule has the coding sequence: AGGCAATGGC.

Which statements are correct?

1 This coding sequence contains 3 pyrimidines.

2 The double-stranded DNA of this section contains 26 hydrogen bonds between complementary bases.

3 The double-stranded DNA of this section has 20 sugar-phosphate bonds.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

---

838. 9700_s18_qp_12 Q: 24

XNA is a laboratory-made nucleic acid made of nucleotides in which one component has been replaced by chemical X. The chemical X is not found in nature. The part of the molecule responsible for coding is not changed.

Which organic component of a DNA or RNA nucleotide has been replaced by X?

A five-carbon sugar

B phosphate group

C purine base

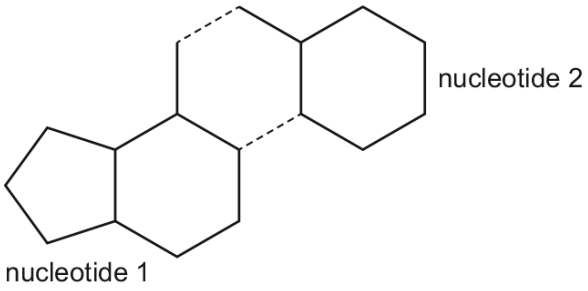
D pyrimidine base

---

839. 9700_s18_qp_13 Q: 22

The diagram shows the outline structure of two nucleotide bases which occur in DNA.

This pair is held together by two hydrogen bonds, shown as dashed lines.



Which row correctly identifies these two nucleotide bases?

	nucleotide 1	nucleotide 2
A	adenine	thymine
B	cytosine	guanine
C	guanine	cytosine
D	thymine	adenine

---

840. 9700_s18_qp_13 Q: 23

DNA polymerase catalyses condensation reactions between molecules during semi-conservative replication of DNA.

Which two molecules are joined by DNA polymerase?

A base and base

B base and nucleotide

C nucleotide and nucleotide

D phosphate and deoxyribose

---

841. 9700_w18_qp_12 Q: 23

What is the maximum number of hydrogen bonds in a length of DNA containing 700 base pairs?

A 350 **B** 700 **C** 1400 **D** 2100

---

842. 9700_w18_qp_12 Q: 24

What is the common component of the three molecules RNA, DNA, and ATP?

A adenosine

B hydrogen bonds

C phosphate

D ribose

---

843. 9700_w18_qp_13 Q: 22

Which bases found in nucleic acids are purines?

A adenine and cytosine

B guanine and adenine

C thymine and cytosine

D uracil and guanine

---

844. 9700_m17_qp_12 Q: 24

Which statement about nitrogenous bases is correct?

A Adenine is a pyrimidine with a double ring structure.

B Cytosine is a purine with a double ring structure.

C Guanine is a purine with a single ring structure.

D Uracil is a pyrimidine with a single ring structure.

---

845. 9700_s17_qp_11 Q: 13

Bacterial cells divide by a process called binary fission.

Which macromolecules must be synthesised for binary fission?

1 cell membrane proteins and RNA

2 DNA and peptidoglycan

3 enzymes and cellulose

A 1, 2 and 3 **B** 1 and 2 only **C** 2 and 3 only **D** 3 only

---

846. 9700_s17_qp_11 Q: 24

What is the smallest unit of a DNA molecule that can be altered by a mutation **and** cause a change to the coding of a polypeptide?

A base

B codon

C gene

D nucleotide

---

847. 9700_s17_qp_11 Q: 26

The table shows the role of four different proteins involved in DNA replication.

protein	helicase	topoisomerase	single-strand binding protein	DNA polymerase
role	unwinds the parental DNA double helix	breaks and rejoins the DNA strands	binds to separated DNA strands to stabilise them	synthesises strand of DNA

Which shows the function of these proteins?

	helicase	topoisomerase	single-strand binding protein	DNA polymerase
A	adds DNA nucleotides to the 3' end of a growing polynucleotide strand	prevents original strands reforming complementary base pairs	enables tension caused by unwinding to be released	makes strands available as templates
B	enables tension caused by unwinding to be released	prevents original strands reforming complementary base pairs	makes strands available as templates	adds DNA nucleotides to the 3' end of a growing polynucleotide strand
C	enables tension caused by unwinding to be released	makes strands available as templates	adds DNA nucleotides to the 3' end of a growing polynucleotide strand	prevents original strands reforming complementary base pairs
D	makes strands available as templates	enables tension caused by unwinding to be released	prevents original strands reforming complementary base pairs	adds DNA nucleotides to the 3' end of a growing polynucleotide strand

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848. 9700_s17_qp_11 Q: 27

Which type of sugar and which type of bond are found in a DNA molecule?

	type of sugar	type of bond
A	non-reducing	glycosidic
B	non-reducing	hydrogen
C	reducing	peptide
D	reducing	hydrogen

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849. 9700_s17_qp_12 Q: 18

The bacterium *Escherichia coli* divides once every 50 minutes at 36 °C.

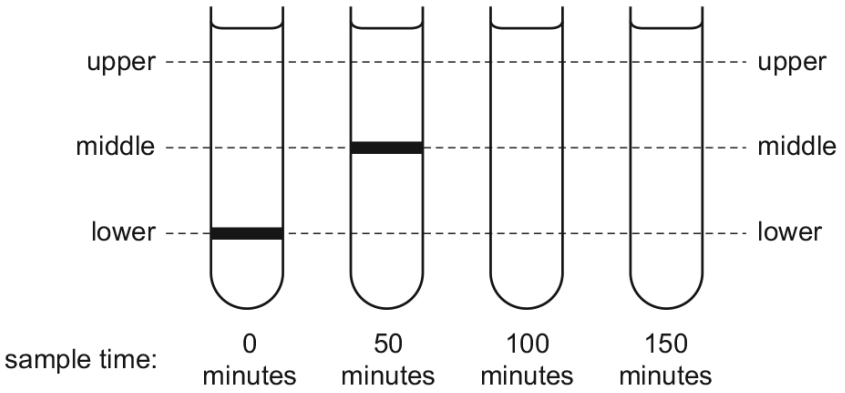
E. coli were grown on a medium containing only heavy nitrogen, ^{15}N, until all of the bacterial DNA contained heavy nitrogen (0 minutes).

Some of the bacteria were moved from a heavy nitrogen medium and cultured in a medium with only light nitrogen, ^{14}N.

Some bacteria were collected after each of three generations. Their DNA was extracted and centrifuged.

Hybrid DNA contains heavy and light nitrogen.

The diagram shows the possible positions (upper, middle and lower) of the bands of DNA. The actual positions of bands in the first two samples are shown.



Which proportion of the DNA of the sample taken at 150 minutes will be at the upper position?

A 25% **B** 50% **C** 75% **D** 100%

---

850. 9700_s17_qp_12 Q: 21

Which row is correct for adenine?

	has a single ring structure	is a purine	joins to its complementary base with 3 hydrogen bonds
A	✓	✓	✓
B	✓	✗	✗
C	✗	✓	✗
D	✗	✗	✓

key

✓ = correct

✗ = incorrect

---

851. 9700_s17_qp_13 Q: 18

Which statement about nucleotides is correct?

A Adenine and guanine are pyrimidines.

B ATP is a phosphorylated nucleotide.

C Purines have a single ring structure.

D Uracil replaces cytosine in RNA.

---

852. 9700_s17_qp_13 Q: 19

Scientists have made a nucleic acid (HNA) that has a sugar with the same number of carbon atoms as glucose instead of deoxyribose. Although genetic information can be stored by HNA, naturally occurring DNA polymerase cannot replicate HNA.

Which statements could explain why naturally occurring DNA polymerase cannot replicate HNA?

1 DNA polymerase cannot form bonds between the sugars of two HNA nucleotides.

2 DNA polymerase cannot form hydrogen bonds between two HNA nucleotides.

3 HNA nucleotides do not fit into the active site of DNA polymerase.

4 The shape of an HNA nucleotide is slightly larger than that of a DNA nucleotide.

A 1, 2, 3 and 4 **B** 1 and 4 only **C** 2 and 3 only **D** 3 and 4 only

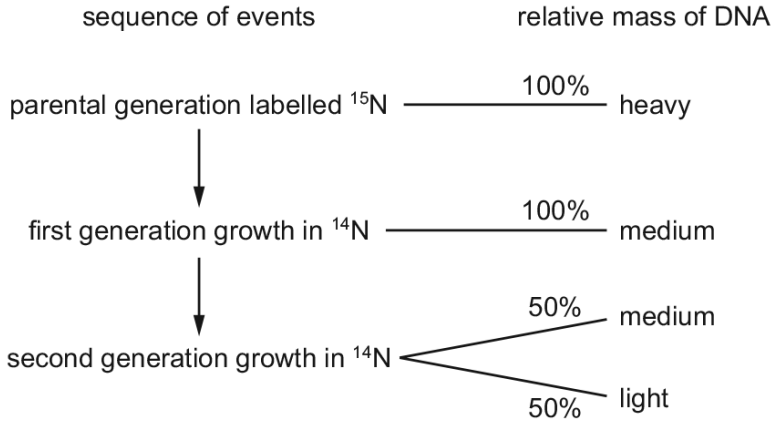
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853. 9700_s17_qp_13 Q: 20

Meselson and Stahl investigated DNA replication by growing bacteria in a culture containing heavy nitrogen, ^{15}N, until all the DNA was labelled.

These bacteria, the parental generation, were then transferred to a culture containing only light nitrogen, ^{14}N, and allowed to replicate for two generations.

DNA was extracted from each generation of bacteria and its relative mass estimated. The flow diagram shows the results.



Which row explains the relative mass of the DNA in the second generation grown in ^{14}N?

	50% medium DNA molecules		50% light DNA molecules	
	strand 1	strand 2	strand 1	strand 2
A	only ^{15}N	only ^{14}N	only ^{14}N	only ^{14}N
B	only ^{15}N	only ^{15}N	only ^{14}N	only ^{14}N
C	only ^{15}N	only ^{15}N	only ^{14}N	only ^{15}N
D	only ^{15}N	half ^{14}N, half ^{15}N	only ^{14}N	half ^{14}N, half ^{15}N

---

854. 9700_w17_qp_11 Q: 19

Which row represents the correct features of the nitrogenous base adenine?

	has a single ring structure	is a purine	joins its complementary base by three hydrogen bonds	pairs with thymine
A	✓	✓	✗	✗
B	✓	✗	✓	✗
C	✗	✓	✗	✓
D	✗	✗	✗	✓

key
✓ = true
✗ = false

---

855. 9700_w17_qp_11 Q: 20

The codons UGU and UGC code for the amino acid cysteine, which can form disulfide bonds in a polypeptide.

The codon UGG codes for the amino acid tryptophan, which does not contain a sulfur atom.

The codon UGA is a stop signal.

The DNA triplet code for the 10th amino acid in a particular polypeptide is ACA.

Which single base substitutions in this triplet code will result in **no** disulfide bond being formed with the 10th amino acid in the polypeptide?

A ACC and ACG

B ACG and ACT

C ACT and ACC

D ACT only

---

856. 9700_w17_qp_12 Q: 22

What is the **maximum** number of hydrogen bonds in a length of DNA containing 700 nucleotides?

A 350 **B** 700 **C** 1050 **D** 2100

---

857. 9700_w17_qp_12 Q: 23

Which statements concerning DNA and RNA are correct?

1 Adenine and guanine are bases that have a double ring structure; cytosine, thymine and uracil are bases with a single ring structure.

2 An adenine nucleotide from DNA is the same as an adenine nucleotide from RNA; DNA adenine pairs with thymine and RNA adenine pairs with uracil.

3 The base pairing that occurs in a double DNA helix and when RNA is synthesised during transcription is always according to the rule that a purine pairs with a pyrimidine.

4 The two polynucleotides on a DNA molecule run in opposite directions so that the double helix formed has two strands that are parallel to each other.

A 1, 2 and 3 **B** 1, 2 and 4 **C** 1, 3 and 4 **D** 2, 3 and 4

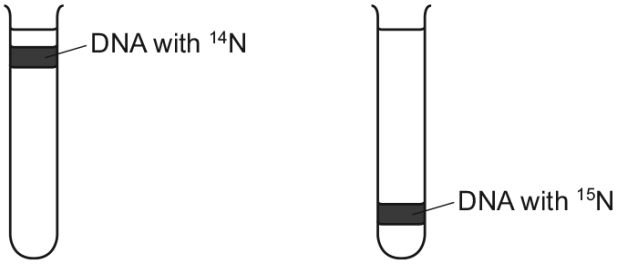
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858. 9700_w17_qp_12 Q: 24

Two sets of bacteria were grown using different types of nitrogen-containing growth media.

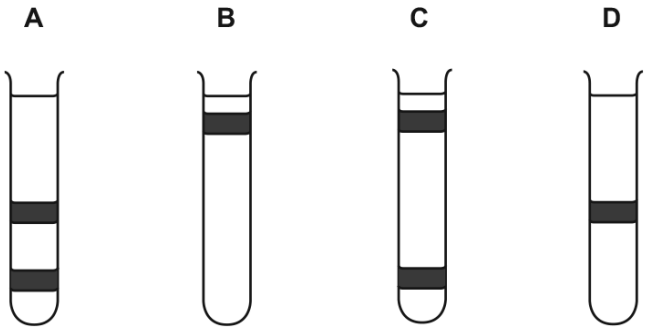
One set was grown in a medium containing the 'heavy' isotope of nitrogen, ^{15}N, until all the DNA was labelled. The other set was grown in a medium containing the 'light' isotope of nitrogen, ^{14}N, until all the DNA was labelled.

The DNA from each set of bacteria was extracted and centrifuged. The diagram shows the position in the centrifuge tubes of this DNA.



Bacteria with ^{15}N labelled DNA were transferred to a medium containing ^{14}N and allowed to reproduce once. The DNA of the new generation of bacteria was extracted and centrifuged.

Which tube shows the position of DNA from this new generation of bacteria?



859. 9700_w17_qp_12 Q: 25

The diagram shows the nucleotide sequence of a small section of a gene which is transcribed.

GCGCGCGGCGCG

The table shows the amino acids coded for by 10 mRNA codons.

mRNA codon	amino acid
AAG	Lys
ACG	Thr
CGG CGC CGU	Arg
CCG	Pro
GCC GCG	Ala
GGC	Gly
UGC	Cys

What is the order of the four amino acids in the polypeptide translated from this small section of a gene?

A Ala-Ala-Cys-Ala

B Ala-Arg-Gly-Ala

C Arg-Ala-Pro-Arg

D Arg-Arg-Thr-Arg

860. 9700_w17_qp_13 Q: 25

A single substitution in an allele of the gene coding for haemoglobin results in sickle cell haemoglobin.

The mRNA sequence for three amino acids for normal haemoglobin is shown.

CCUGAAGAG

The mRNA sequence for sickle cell haemoglobin is shown.

CCUGUAGAG

The table shows some of the triplet codes for two amino acids.

DNA triplet codes	amino acid
CTC	Glu
CTT	Glu
CAT	Val
CAC	Val

Which row is correct for the substituted DNA nucleotide of the allele and the substituted amino acid of the protein?

	DNA nucleotide	new amino acid
A	A	Glu
B	A	Val
C	T	Glu
D	T	Val

---

861. 9700_w17_qp_13 Q: 26

What is the **minimum** number of hydrogen bonds in a length of DNA containing 700 base pairs?

A 350 **B** 700 **C** 1400 **D** 2100

---

862. 9700_m16_qp_12 Q: 20

21.2% of the bases in a molecule of DNA are cytosine.

What percentage would be adenine?

A 21.2% **B** 28.8% **C** 42.4% **D** 57.6%

---

863. 9700_s16_qp_11 Q: 20

DNA contains the ……X…… base ……Y…… which is joined to adenine with ……Z…… hydrogen bonds.

Which row correctly completes the statement about DNA?

	X	Y	Z
A	purine	thymine	three
B	purine	uracil	three
C	pyrimidine	thymine	two
D	pyrimidine	uracil	two

---

864. 9700_s16_qp_12 Q: 19

Which statements about complementary base pairing are correct?

1 Cytosine forms three hydrogen bonds with guanine.

2 Purines and pyrimidines are different sizes.

3 It allows transcription to occur.

4 The base pairs are of different lengths.

A 1, 2 and 3 **B** 1, 2 and 4 **C** 1, 3 and 4 **D** 2, 3 and 4

---

865. 9700_s16_qp_12 Q: 20

Bacteria were grown in a medium containing ^{15}N. After several generations, all of the DNA contained ^{15}N. Some of these bacteria were transferred to a medium containing the common isotope of nitrogen, ^{14}N. The bacteria were allowed to divide once. The DNA of some of these bacteria was extracted and analysed. This DNA was all hybrid DNA containing equal amounts of ^{14}N and ^{15}N.

The remaining bacteria were left in the medium with ^{14}N and allowed to divide one more time. The DNA of some of these bacteria was extracted and analysed.

What is the composition of this DNA?

A 25% hybrid DNA

B 50% hybrid DNA

C 75% hybrid DNA

D 100% hybrid DNA

---

866. 9700_s16_qp_12 Q: 22

The diagram shows the nucleotide sequence of a small section of a gene which is transcribed.

TTCTTCCCGTTC

The table shows the amino acids coded for by 10 mRNA codons.

mRNA codon	amino acid
AAG	Lys
ACG	Thr
CGG CGC CGU	Arg
CCG	Pro
GCC GCG	Ala
GGC	Gly
UGC	Cys

What is the order of the four amino acids in the polypeptide translated from this small section of a gene?

A Cys-Cys-Gly-Cys

B Lys-Lys-Gly-Lys

C Lys-Lys-Pro-Lys

D Thr-Thr-Pro-Thr

---

867. 9700_s16_qp_13 Q: 19

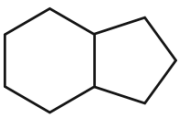
Which diagram shows a correct ring structure and named nucleic acid base?

A



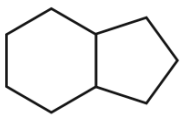
adenine

B



cytosine

C



thymine

D



uracil

---

868. 9700_s16_qp_13 Q: 20

Which statements are correct?

1 Adenine and cytosine are both purines.

2 The DNA nucleotide containing adenine is different from the RNA nucleotide containing adenine.

3 Purines only form base pairs with pyrimidines.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

---

869. 9700_s16_qp_13 Q: 21

A short piece of DNA 18 base pairs long was analysed to find the number of nucleotide bases in each of the polynucleotide strands. Some of the results are shown below.

	number of nucleotide bases			
	adenine	cytosine	guanine	thymine
strand 1		4		7
strand 2		5		

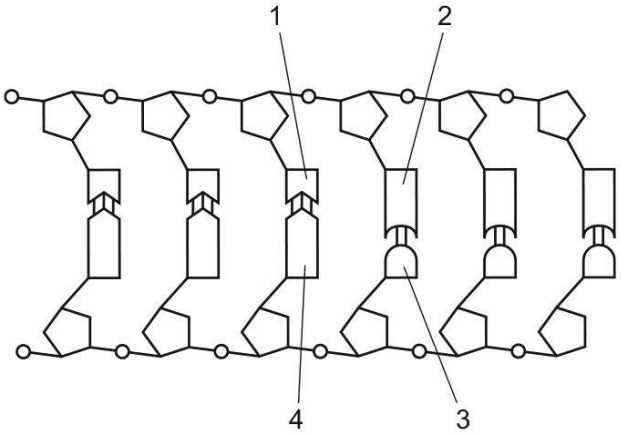
How many nucleotides containing thymine were present in strand 2?

A 2 **B** 4 **C** 5 **D** 7

---

870. 9700_w16_qp_11 Q: 19

The diagram shows part of a DNA molecule.



Which labels represent purines?

A 1 and 2 **B** 2 and 4 **C** 3 and 1 **D** 4 and 3

---

871. 9700_w16_qp_11 Q: 20

A double stranded DNA molecule was analysed and 29% of its nucleotide bases were found to be adenine.

What percentage of its nucleotide bases will be cytosine?

A 21% **B** 29% **C** 42% **D** 58%

---

872. 9700_w16_qp_12 Q: 22

Which row represents the correct features of the nitrogenous base cytosine?

	has a single ring structure	is a purine	joins its complementary base by three hydrogen bonds
A	✓	✓	✗
B	✓	✗	✓
C	✗	✓	✗
D	✗	✗	✓

key
✓ = true
✗ = false

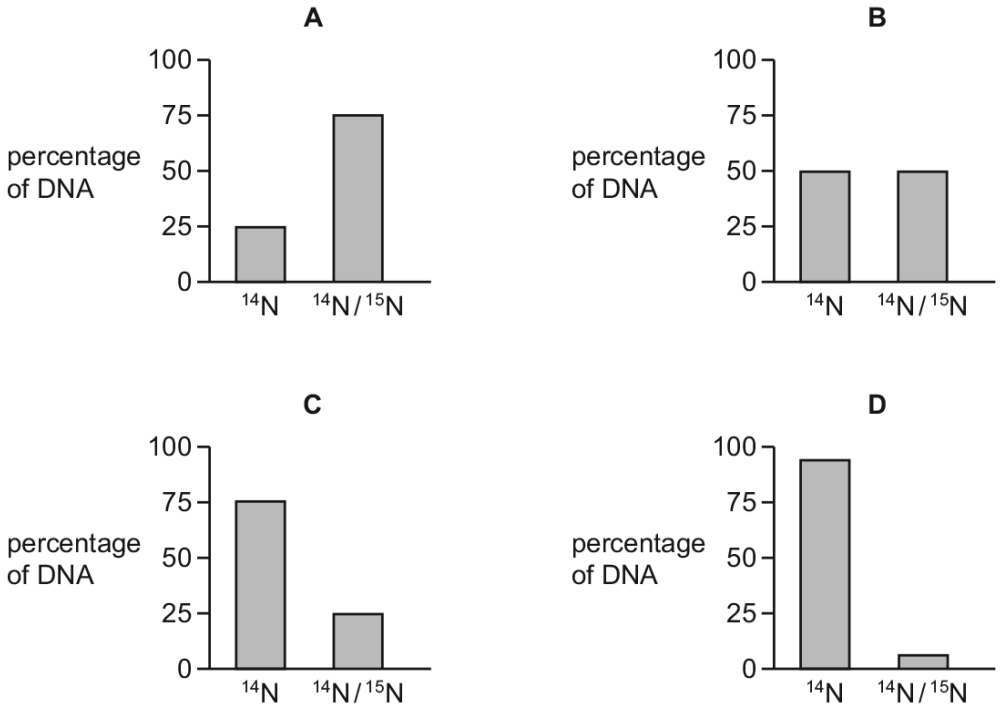
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873. 9700_w16_qp_12 Q: 23

Bacteria were grown in a medium containing ^{15}N. After several generations, all of the DNA contained ^{15}N. Some of these bacteria were transferred to a medium containing the common isotope of nitrogen, ^{14}N. The bacteria were allowed to divide once. The DNA of some of these bacteria was extracted and analysed. This DNA was all hybrid DNA containing equal amounts of ^{14}N and ^{15}N.

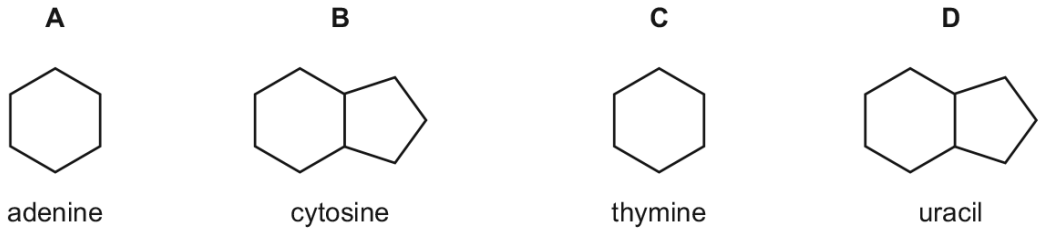
In another experiment, some bacteria from the medium with ^{15}N were transferred into a medium of ^{14}N. The bacteria were allowed to divide three times. The DNA of some of these bacteria was extracted and analysed.

What is the composition of this DNA?



874. 9700_w16_qp_13 Q: 20

Which diagram shows a correct ring structure and named nucleic acid base?



875. 9700_s15_qp_11 Q: 20

Which row shows two pairs of nucleotides formed during transcription?

	first base pair transcribed		second base pair transcribed	
	bases	number of hydrogen bonds	bases	number of hydrogen bonds
A	AU	2	CG	2
B	AU	2	CG	3
C	AU	2	TU	2
D	AU	3	CG	2

---

876. 9700_s15_qp_11 Q: 21

Which row correctly identifies the features of DNA and RNA molecules?

	DNA and RNA contain both purine and pyrimidine bases	DNA and RNA both contain a pentose sugar	hydrogen bonds form between bases in some RNA
A	✓	✓	✓
B	✓	✓	✗
C	✓	✗	✓
D	✗	✓	✗

key

✓ = correct statement

✗ = incorrect statement

---

877. 9700_s15_qp_11 Q: 22

Two polynucleotide strands make up a DNA molecule.

What is a correct description?

A The percentage of cytosine is 50% of that of guanine in the whole molecule.

B The percentage of cytosine is the same as that of guanine in each strand.

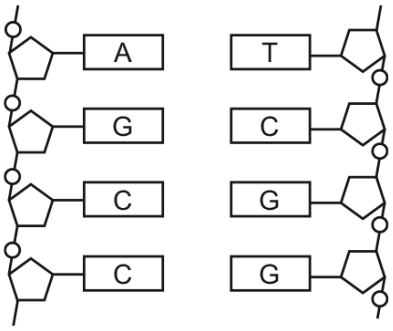
C The percentage of cytosine is the same as that of guanine in the whole molecule.

D The percentage of cytosine is the same in each strand of the molecule.

---

878. 9700_s15_qp_12 Q: 22

The diagram shows part of a DNA molecule.



How many hydrogen bonds are involved in holding these strands of DNA together?

A 11 **B** 9 **C** 8 **D** 4

---

879. 9700_s15_qp_13 Q: 20

Which row correctly describes adenine?

	complementary base	component on nucleotide strand it is attached to	ring structure
A	thymine	deoxyribose	double
B	thymine	phosphate	single
C	uracil	phosphate	double
D	uracil	ribose	single

---

880. 9700_w15_qp_11 Q: 22

Which row shows two pairs of nucleotide bases in a molecule of DNA?

	first base pair		second base pair	
	bases present	number of hydrogen bonds	bases present	number of hydrogen bonds
A	AC	2	GT	3
B	AC	3	GT	2
C	AT	2	GC	3
D	AT	3	GC	2

---

881. 9700_w15_qp_12 Q: 22

Which row shows two pairs of nucleotide bases in a molecule of DNA?

	first base pair		second base pair	
	bases present	number of hydrogen bonds	bases present	number of hydrogen bonds
A	AT	2	CG	2
B	AT	2	CG	3
C	TA	3	GC	2
D	TA	3	GC	3

---

882. 9700_w15_qp_13 Q: 22

Which row correctly describes cytosine?

	ring structure	number of hydrogen bonds it forms with its complementary base	type of base
A	double	three	purine
B	double	two	pyrimidine
C	single	three	pyrimidine
D	single	two	purine

6.2 Protein synthesis

883. 9700_m20_qp_12 Q: 24

The table shows the tRNA anticodons for four amino acids.

amino acid	tRNA anticodons
asparagine	UUA, UUG
glutamic acid	CUU, CUC
proline	GGA, GGG, GGU, GGC
threonine	UGA, UGG, UGU, UGC

A cell makes a polypeptide containing the amino acid sequence shown.

asparagine – threonine – proline – glutamic acid

Which sequence of bases on the transcribed strand of a DNA molecule could code for this part of the polypeptide?

A AATACCCCTGAA

B AATACCCCTCAA

C TTACTTGGATGG

D TTATGGGGACTT

---

884. 9700_s20_qp_11 Q: 23

A population of bacteria is exposed to the antibiotic penicillin. Most of the bacteria die.

However, some bacteria in the population have an allele coding for an enzyme that breaks down penicillin. These bacteria are able to survive.

Which could explain how these bacterial cells acquired this allele?

1 An error during DNA replication.

2 An error during transcription.

3 An error during translation.

A 1, 2 and 3 **B** 1 and 3 only **C** 1 only **D** 2 and 3 only

---

885. 9700_s20_qp_12 Q: 24

Part of the nucleotide sequence of an mRNA molecule is shown, with spaces between the codons.

CAG UAC AGC AAU CUA UAA

The translation of the codons is provided.

codon	amino acid or STOP
AAU	asn
AGC	ser
CAG	gln
CUA	leu
UAA	STOP
UAC	tyr
UAU	tyr

Which events will cause the termination of polypeptide synthesis during translation?

1 Deletion of C from the leu codon.

2 Deletion of C from the tyr codon.

3 The ribosome reaching the UAA codon.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

886. 9700_s20_qp_13 Q: 22

The sequence of bases in mRNA for the first eight amino acids in the β-polypeptide of adult haemoglobin is:

GUG–CAC–CUG–ACU–CCU–GAG–GAG–AAG.

In haemoglobin C, which is a cause of haemolytic anaemia, the sequence is:

GUG–CAC–CUG–ACU–CCU–AAG–GAG–AAG.

The coding for seven of the amino acids is listed.

amino acid	DNA triplet
glu	CTC
his	GTG
leu	GAG
lys	TTC
pro	GGA
thr	TGA
phe	AAG

Which change occurs to the amino acid sequence of adult haemoglobin to make haemoglobin C?

A Histidine is changed to leucine.

B Proline is changed to threonine.

C Glutamic acid is changed to lysine.

D Leucine is changed to phenylalanine.

---

887. 9700_s20_qp_13 Q: 23

Some antibiotics kill prokaryotes by binding to RNA polymerase.

What effect will this have on protein synthesis?

A Codons on mRNA will be unable to hydrogen bond to complementary anticodons on tRNA.

B Condensation reactions joining RNA nucleotides will not take place to form mRNA.

C DNA will not unwind and unzip to allow for base pairing with RNA nucleotides.

D Free RNA nucleotides will not base pair to exposed bases on the DNA template strand.

---

888. 9700_w20_qp_12 Q: 21

Which description of a eukaryotic gene is correct?

A a sequence of bases that forms part of a DNA molecule and codes for a protein

B a sequence of nucleotides that forms part of a DNA molecule and codes for a polypeptide

C a sequence of bases that forms part of an RNA molecule and codes for a protein

D a sequence of nucleotides that forms part of an RNA molecule and codes for a polypeptide

---

889. 9700_w20_qp_12 Q: 22

The DNA sequence CCAAGAAGTCGACAAACA is translated to synthesise the amino acid chain gly-ser-ser-ala-val-cys.

As a result of a mutation, the sequence length of the amino acid chain is shortened from six to two amino acids. A stop codon in mRNA is UGA.

Which base in the DNA sequence was changed by the mutation?

A A **B** C **C** G **D** T

---

890. 9700_w20_qp_13 Q: 24

A molecule of transfer RNA (tRNA) has the anticodon sequence UAC.

What will be the corresponding nucleotide sequence in the DNA?

A ATG **B** AUG **C** TAC **D** TUG

---

891. 9700_m19_qp_12 Q: 22

Rifampicin is an antibiotic used to treat tuberculosis (TB).

It works by inhibiting RNA polymerase in bacteria.

Which processes are directly inhibited by this antibiotic?

1 DNA replication

2 transcription

3 ATP synthesis

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 only

---

892. 9700_s19_qp_11 Q: 24

In a genetic engineering experiment a piece of double-stranded DNA containing 6000 nucleotides coding for a specific polypeptide is transcribed and translated.

What is the total number of amino acids in this polypeptide?

A 500 **B** 1000 **C** 2000 **D** 3000

---

893. 9700_s19_qp_11 Q: 25

Which statements about tRNA are correct?

1 Hydrogen bonds between bases temporarily hold tRNA against mRNA.

2 The base sequences in the tRNA molecules are the same as the base sequences in the mRNA that is being translated.

3 tRNA translates the base sequence in mRNA into the amino acid sequence in a protein.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

---

894. 9700_w19_qp_11 Q: 23

Sickle cell anaemia is caused by a mutation in an allele of the gene that codes for the β-globin polypeptide of haemoglobin.

The diagram shows the sequence of bases in a small section of the coding strand of DNA for both the Hb^A (normal) and Hb^S (sickle cell) β-globin alleles.

Hb^A CTGACTCCTGAGGAGAAGTCT

Hb^S CTGACTCCTGTGGAGAAGTCT

How will the mutation in the allele result in the production of an altered version of the β-globin polypeptide?

A A tRNA molecule with the anticodon GUG will hydrogen bond to the altered codon on mRNA.

B All the amino acids coded for after the mutation will differ from those in the Hb^A protein.

C mRNA transcribed from the Hb^S allele will contain the codon CAC instead of the codon CTC.

D The ribosome will be unable to continue translation of the Hb^S mRNA after the altered codon.

---

895. 9700_w19_qp_13 Q: 21

What is the maximum number of codon-anticodon interactions within one ribosome?

A 2 **B** 3 **C** 4 **D** 6

---

896. 9700_w19_qp_13 Q: 23

Which statements about tRNA structure are correct?

1 There is a binding site for the attachment of a specific amino acid and a different binding site for the attachment to the ribosome, so that translation can occur.

2 There is a ribose-phosphate backbone with strong phosphodiester bonds and areas within the polynucleotide chain where base pairing occurs.

3 There is an anticodon that contains the same triplet of bases as the triplet of DNA bases that has been transcribed to produce the mRNA codon.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 only **D** 2 and 3 only

---

897. 9700_s18_qp_12 Q: 25

Which statements about tRNA are correct?

1 Hydrogen bonds between bases temporarily hold tRNA against mRNA.

2 The base sequences in the tRNA molecules are the same as the base sequences in the mRNA that is being translated.

3 The specificity of the tRNA molecule for glycine and the specificity of the enzyme that loads glycine are both necessary for correct loading.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

---

898. 9700_s18_qp_13 Q: 24

What occurs during each of DNA replication and transcription and translation?

1 ATP provides energy.

2 Condensation reactions occur to form a polymer.

3 Hydrogen bonds form between purine and pyrimidine bases.

A 1, 2 and 3 **B** 1 and 2 only **C** 2 only **D** 3 only

---

899. 9700_s18_qp_13 Q: 25

Part of a sequence of DNA from a person with a genetic disease is:

TAGTAACCACAAAGG

The corresponding sequence of DNA from a person without this genetic disease is:

TAGTAAAAACCACAAAGG

The possible mRNA codons for some amino acids are shown in the table.

amino acid	mRNA codons			
1	GGU	GGC	GGA	GGG
2	AUU	AUC	AUA	
3	UUU	UUC		
4	UCU	UCC	UCA	UCG

Which amino acid is missing from a person with this genetic disease?

A 1 **B** 2 **C** 3 **D** 4

---

900. 9700_w18_qp_11 Q: 23

Following translation, the alpha polypeptide chain of haemoglobin, α-globin, undergoes modification. During this modification, the first amino acid is removed, leaving 141 amino acid residues.

How many nucleotides does the gene coding for α-globin contain?

A 141 **B** 142 **C** 423 **D** 426

---

901. 9700_w18_qp_13 Q: 23

A length of double-stranded DNA contains 120 nucleotides and codes for a section of a polypeptide.

What is the maximum length of this section of a polypeptide?

A 20 amino acids

B 40 amino acids

C 60 amino acids

D 120 amino acids

---

902. 9700_m17_qp_12 Q: 25

Rifampicin is an antibiotic used to treat tuberculosis.

It works by inhibiting RNA polymerase in bacteria.

Which of these processes will be **directly** inhibited by this antibiotic?

1 ATP synthesis

2 transcription

3 translation

A 1 and 2 **B** 1 and 3 **C** 2 only **D** 3 only

---

903. 9700_m17_qp_12 Q: 26

Meselson and Stahl investigated DNA in bacteria. They grew bacteria in a medium with only heavy nitrogen, ^{15}N, until all of the bacterial DNA contained only heavy nitrogen.

These bacteria were then moved from the heavy nitrogen medium and cultured in a medium with only light nitrogen, ^{14}N.

Some bacteria were collected from each of the **next** three generations and their DNA was analysed.

Hybrid DNA contains both heavy and light nitrogen.

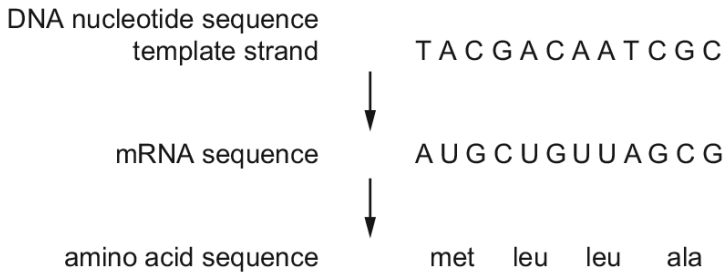
Which row shows the correct DNA of the first and third generations?

	DNA of first generation	DNA of third generation
A	all hybrid	half hybrid, half light
B	all hybrid	one quarter hybrid, three quarters light
C	half hybrid, half heavy	half hybrid, one quarter heavy, one quarter light
D	half hybrid, half light	one quarter hybrid, three quarters light

---

904. 9700_m17_qp_12 Q: 27

The diagram shows the stages in the production of part of a polypeptide.



Which feature of the triplet code is illustrated by the information given?

A An amino acid can be coded for by more than one triplet.

B The triplet code is non-overlapping and is only read in one direction.

C The triplet code is universal for the DNA of all organisms.

D There are some triplets that code for 'start' and 'stop'.

---

905. 9700_s17_qp_11 Q: 25

Which statements about tRNA are correct?

1 contains base pairing

2 contains hydrogen bonds

3 is single stranded

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

---

906. 9700_s17_qp_12 Q: 19

Different tissues in a plant were supplied with a radioactively labelled substance to identify which tissues were actively synthesising mRNA.

Which radioactively labelled substances would be most suitable for this experiment?

1 adenine

2 ribose

3 inorganic phosphate

4 uracil

A 1, 2, 3 and 4

B 1, 2 and 3 only

C 2 and 4 only

D 4 only

---

907. 9700_s17_qp_12 Q: 20

Electron micrographs may show large numbers of ribosomes forming chains along mRNA molecules.

What is the advantage of this arrangement, compared to when ribosomes appear singly on the mRNA?

A Different polypeptides can be produced simultaneously.

B Fewer tRNA molecules are required to translate the polypeptide.

C Large polypeptide chains can be produced.

D Polypeptides can be produced more rapidly.

---

908. 9700_s17_qp_13 Q: 21

Which statement is correct?

A During transcription, mRNA is synthesised from DNA nucleotides to have the same sequence of nucleotides as the DNA strand on which it was made.

B During transcription, tRNA is synthesised from RNA nucleotides and carries codons that are complementary to the sequence of nucleotides on the DNA strand on which it was made.

C During translation, mRNA is synthesised from RNA nucleotides to have the complementary sequence of nucleotides to that of the DNA strand on which it was made.

D During translation, ribosomes join amino acids in a sequence determined by mRNA with the complementary sequence of nucleotides to that of the DNA strand on which it was made.

---

909. 9700_w17_qp_11 Q: 18

The following statements describe the process of translation.

1 A peptide bond forms between adjacent amino acids.

2 Hydrogen bonds form between the anticodon and the codon.

3 mRNA binds to the ribosome.

4 tRNA enters the ribosome carrying a specific amino acid.

In which order does this process take place?

A $3 \rightarrow 2 \rightarrow 1 \rightarrow 4$

B $3 \rightarrow 4 \rightarrow 2 \rightarrow 1$

C $4 \rightarrow 2 \rightarrow 1 \rightarrow 3$

D $4 \rightarrow 2 \rightarrow 3 \rightarrow 1$

---

910. 9700_w17_qp_11 Q: 21

A student produced a table of differences between RNA and DNA. The table contains one mistake.

Which row has the mistake?

	RNA	DNA
A	contains ribose	contains deoxyribose
B	contains uracil	contains thymine
C	found throughout cell	found only in nucleus
D	single polynucleotide per molecule	two polynucleotides per molecule

---

911. 9700_w17_qp_13 Q: 23

Rifampicin is an antibiotic used to treat tuberculosis.

It works by inhibiting RNA polymerase in bacteria.

Which of these processes are prevented by this antibiotic?

1 DNA replication

2 transcription

3 translation

A 1, 2 and 3 **B** 1 and 2 only **C** 2 and 3 only **D** 3 only

---

912. 9700_w17_qp_13 Q: 24

A gene codes for the sequence of amino acids in a single polypeptide. Haemoglobin consists of two α-globins and two β-globins.

How many genes are needed to code for a single haemoglobin molecule?

A 1 **B** 2 **C** 4 **D** 8

---

913. 9700_m16_qp_12 Q: 19

What does the enzyme DNA polymerase synthesise in a cell?

A a polypeptide using DNA as a template

B a strand of DNA using a polypeptide as a template

C a strand of DNA using DNA as a template

D a strand of mRNA using DNA as a template

---

914. 9700_m16_qp_12 Q: 21

One gene provides the code for the production of which type of molecule?

A amino acid

B DNA

C nucleotide

D polypeptide

---

915. 9700_m16_qp_12 Q: 22

The table shows the mode of action of two antibacterial drugs that can affect the synthesis of proteins.

antibacterial drug	rifampicin	streptomycin
mode of action	binds to RNA polymerase	causes errors in translation

If bacteria are treated with **both** drugs, what will be the immediate effects?

1 Transcription will stop, but faulty proteins may continue to be synthesised.

2 If translation has started, proteins may be faulty.

3 Translation will be inhibited.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

---

916. 9700_s16_qp_11 Q: 22

The statements describe the features of some nucleic acids.

1 carry an amino acid to a ribosome

2 carry a genetic code sequence out of the nucleus

3 carry a genetic code sequence to a ribosome

4 hold amino acids in position for translation

Which functions are carried out by tRNA?

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

---

917. 9700_s16_qp_12 Q: 6

Which biological molecules **always** contain the element nitrogen?

A amino acids, cellulose, mRNA

B amino acids, DNA, lipids

C enzymes, mRNA, tRNA

D membrane proteins, starch, tRNA

---

918. 9700_s16_qp_12 Q: 21

Which statements about tRNA are correct?

1 It contains base pairing.

2 It contains hydrogen bonds.

3 It contains uracil.

4 It is single stranded.

A 1, 2, 3 and 4 **B** 1, 3 and 4 only **C** 1 and 2 only **D** 2 and 3 only

---

919. 9700_w16_qp_11 Q: 21

When a gene mutation occurs, which of the following may be altered, resulting in the production of a non-functional protein?

1 amino acid sequence

2 DNA nucleotide sequence

3 mRNA nucleotide sequence

A 1, 2 and 3 **B** 1 and 2 only **C** 2 and 3 only **D** 2 only

---

920. 9700_w16_qp_13 Q: 18

Gene mutations in either the *BRCA1* or the *BRCA2* genes are responsible for the majority of hereditary breast cancer in humans.

The proteins produced by the two genes migrate to the nucleus where they interact with other proteins, such as those produced by the tumour suppressor gene, *p53*, and the DNA repair gene, *RAD51*.

Which combination of gene activity is most likely to result in breast cancer?

	gene		
	BRCA1 or *BRCA2*	*p53*	*RAD51*
A	✓	✓	✓
B	✓	✓	✗
C	✓	✗	✓
D	✗	✗	✗

key

✓ = gene produces normal protein

✗ = gene produces abnormal protein or no protein

---

921. 9700_w16_qp_13 Q: 22

The following events occur during transcription.

1 Bonds break between complementary bases.

2 Bonds form between complementary bases.

3 Sugar-phosphate bonds form.

4 Free nucleotides pair with complementary nucleotides.

Before the mRNA molecule leaves the nucleus, which events will have occurred twice?

A 1, 2, 3 and 4 **B** 1, 3 and 4 only **C** 2, 3 and 4 only **D** 1 and 2 only

---

922. 9700_s15_qp_12 Q: 20

What is needed to transcribe DNA?

A DNA ligase

B DNA polymerase

C ribosomes

D RNA polymerase

---

923. 9700_s15_qp_12 Q: 21

In a ribosome, which bond holds together two adjacent amino acids?

A disulfide

B hydrogen

C ionic

D peptide

---

924. 9700_s15_qp_13 Q: 4

Ribosomes exist as separate subunits that bind together during protein synthesis.

What do these subunits consist of?

A mRNA and protein

B mRNA and tRNA

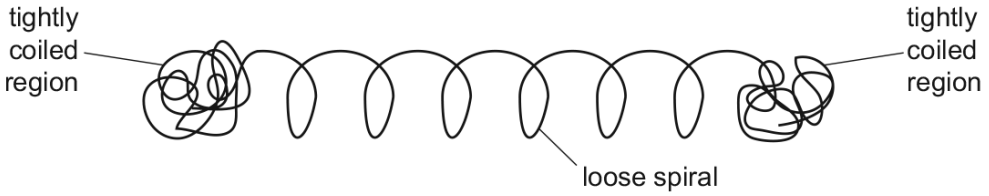
C rRNA and protein

D rRNA and tRNA

---

925. 9700_s15_qp_13 Q: 11

The protein glutenin gives bread dough its elasticity. The diagram represents a polypeptide of glutenin.



What describes the structure of glutenin?

A quaternary structure because there are both globular and fibrous regions

B quaternary structure because there are both spiral and tightly coiled regions

C secondary structure because the loose spiral is an α-helix

D tertiary structure because the different regions form a 3D shape

---

926. 9700_s15_qp_13 Q: 21

Which row shows two pairs of nucleotides formed when mRNA is translated?

	first base pair translated		second base pair translated	
	bases present	number of hydrogen bonds	bases present	number of hydrogen bonds
A	AT	2	TU	2
B	AU	2	AT	2
C	AU	2	GC	3
D	AU	3	GC	3

---

927. 9700_s15_qp_13 Q: 22

Sickle cell anaemia is caused by a mutation in an allele of the gene that codes for the β-globin polypeptide of haemoglobin.

The diagram shows the sequence of bases in a small section of the coding strand of DNA for both the HbA (normal) and HbS (sickle cell) β-globin alleles.

HbA CTGACTCCTGAGGAGAAGTCT

HbS CTGACTCCTGTGGAGAAGTCT

How will the mutation in the HbS allele result in the production of an altered version of the β-globin polypeptide?

A A tRNA molecule with the anticodon GUG will hydrogen bond to the altered codon on mRNA.

B All the amino acids coded for after the mutation will differ from those in the HbA protein.

C mRNA transcribed from the HbS allele will contain the codon CAC instead of the codon CTC.

D The ribosome will be unable to continue translation of the HbS mRNA after the altered codon.

---

928. 9700_w15_qp_11 Q: 20

The statements describe the features of some nucleic acids.

1 carry an amino acid to a ribosome

2 carry a genetic code sequence out of the nucleus

3 carry a genetic code sequence to a ribosome

Which functions are carried out **only** by mRNA?

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

---

929. 9700_w15_qp_11 Q: 21

The antibiotic chloramphenicol prevents prokayotes from reproducing by inhibiting the enzyme which catalyses the formation of peptide bonds during translation.

What will be prevented by the action of this antibiotic?

A binding of amino acids to tRNA

B condensation of amino acids

C pairing between codons and anticodons

D positioning of amino acids by tRNA

---

930. 9700_w15_qp_12 Q: 19

Which metabolic processes will be very active in a cell that has just completed cytokinesis?

1 ATP formation

2 DNA replication

3 protein synthesis

A 1, 2 and 3 **B** 1 and 3 only **C** 2 only **D** 3 only

---

931. 9700_w15_qp_12 Q: 20

What occurs during DNA replication and transcription and translation?

1 ATP provides energy.

2 Condensation reactions occur to form a polymer.

3 Hydrogen bonds form between purine and pyrimidine bases.

A 1, 2 and 3 **B** 1 and 2 only **C** 2 only **D** 3 only

---

932. 9700_w15_qp_12 Q: 21

Ricin is a toxic protein which inactivates ribosomes.

Which effect will this have on protein synthesis?

A Amino acids will be unable to bind to the binding sites on specific tRNA molecules.

B Anticodons on mRNA molecules will not base pair to codons on tRNA molecules.

C Peptide bonds will not form between adjacent amino acids in the growing polypeptide.

D RNA nucleotides will be unable to join by condensation reactions to form rRNA.

---

933. 9700_w15_qp_13 Q: 21

Some antibiotics kill prokaryotes by binding to RNA polymerase.

What effect will this have on protein synthesis?

A Codons on mRNA will be unable to hydrogen bond to complementary anticodons on tRNA.

B Condensation reactions joining RNA nucleotides will not take place to form mRNA.

C DNA will not unwind and unzip to allow for base-pairing with RNA nucleotides.

D Free RNA nucleotides will not base-pair to exposed bases on the DNA template strand.

Chapter 6

Nucleic acids and protein synthesis

6.1 Structure and replication of DNA

66. 9700_s20_qp_22 Q: 1

Picornaviruses are small viruses that are 30 nm in diameter. Picornaviruses are able to enter the cells of mammals and birds and can replicate within these cells.

Fig. 1.1 shows the entry of a picornavirus into its host cell.

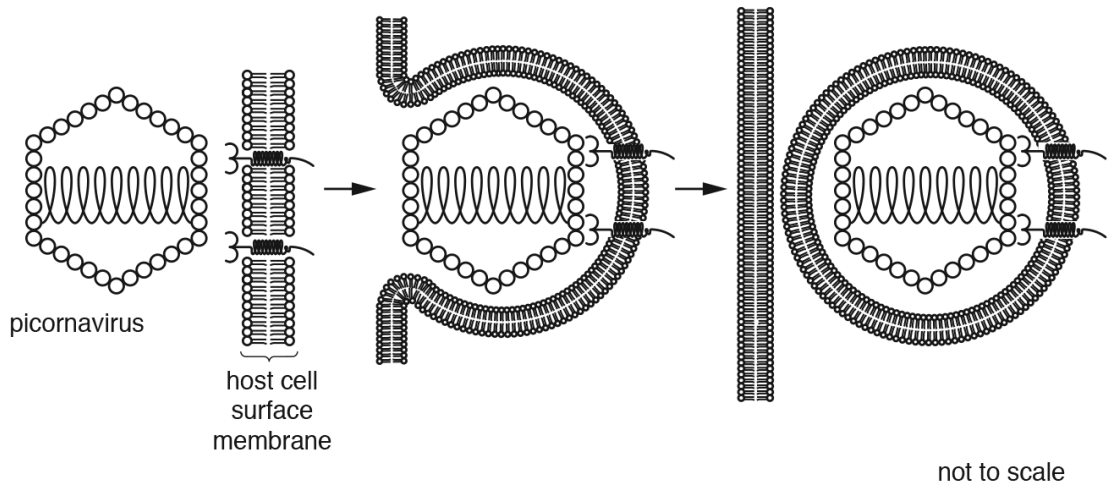


Fig. 1.1

(a) State the key features of a virus, such as picornavirus.

.....

.....

.....

.....

.....

..... [2]

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(b) State, with reasons, whether a picornavirus can be seen using the light microscope.

.....

.....

.....

.....

.....

.....

..... [3]

(c) With reference to Fig. 1.1, describe how the picornavirus enters the host cell.

.....

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 8]

---

67. 9700_m19_qp_22 Q: 6

Plant and animal cells carry out mitosis to form two genetically identical cells from one original cell.

(a) State **other** reasons why mitosis is important in **both** plants and animals.

.....

.....

.....

.....

..... [2]

(b) Plant cells require microtubules to form structures that are needed for mitosis.

Name **one** of these structures.

..... [1]

(c) During the mitotic cell cycle, free nucleotides are used for the synthesis of both types of nucleic acid: RNA and DNA.

Complete sentences **A**, **B**, **C** and **D** to provide information about nucleotides and the synthesis of nucleic acids.

Write the correct term in the spaces provided in each sentence.

A Each nucleotide has three main components: a ..... group, a ..... (5 carbon) sugar and a nitrogenous organic base.

B The nitrogenous organic base of a nucleotide is either a purine or a ..... .

C In a DNA nucleotide, the sugar is deoxyribose and in an RNA nucleotide the sugar is ..... .

D The synthesis of RNA from a template strand of DNA is known as ..... .

[5]

(d) A virus named *Pandoravirus salinus* was discovered in 2013 by French scientists.

The virus was so large that the scientists initially thought that *P. salinus* was a bacterium.

P. salinus was confirmed to be a virus after further research.

(i) List **three** key features of viruses.

1 .....

2 .....

3 .....

[3]

(ii) The dimensions of viruses are usually stated in nanometres (nm).

As *P. salinus* is so big, it has been described as 1 μm long and 0.5 μm wide.

Convert the **width** of *P. salinus* to nanometres.

width = ... nm [1]

[Total: 12]

68. 9700_s19_qp_23 Q: 1

Fig. 1.1 is a diagram showing the structure of a section of a DNA molecule.

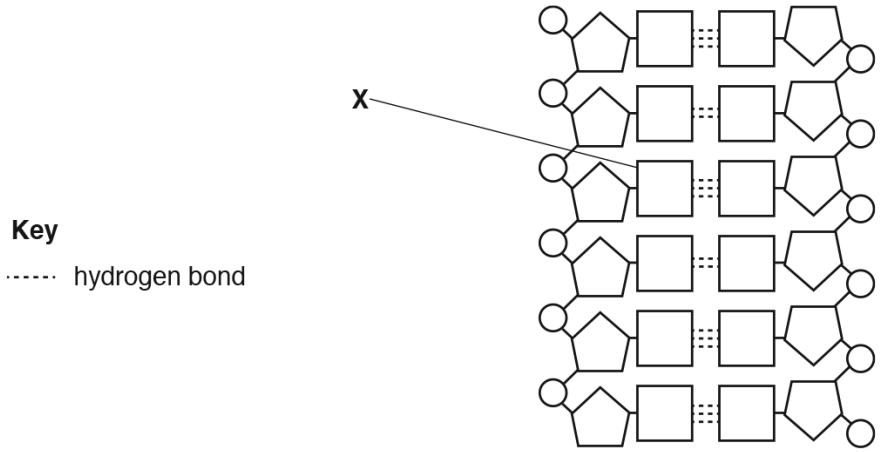


Fig. 1.1

(a) Draw a circle around **one** monomer of DNA in Fig. 1.1. [1]

(b) Name the two bases forming the base pair at **X** in Fig. 1.1 **and** give a reason for your answer.

bases .....

reason .....

.....

.....

..... [2]

(c) The statements 1–5 describe events that occur during DNA replication.

1 DNA polymerase forms a phosphodiester bond
2 DNA double helix forms
3 hydrogen bonds break
4 hydrogen bonds form
5 two strands of the double helix separate

Write the numbers 1 to 5 in the spaces below to show the order in which these events occur. The first one has been done for you.

..... **3** .... [1]

(d) The telomere is a region found at the end of a chromosome.

Outline the function of telomeres.

.....

.....

..... [2]

[Total: 6]

---

69. 9700_w19_qp_22 Q: 4

Carbohydrates, proteins and nucleic acids are types of biological molecule. Within each type, there are examples of molecules that can be described as polymers.

(a) A polymer is a large molecule composed of smaller repeating molecules known as monomers.

Complete Table 4.1 to produce a summary of some named biological polymers.

Table 4.1

polymer	constituent monomer	type of bond between monomers
amylose	glucose	
cellulose	glucose	
collagen		peptide
DNA	DNA nucleotide	
glycogen		glycosidic

[4]

(b) Explain why an amylose molecule and a cellulose molecule have very different structures, even though they both have glucose as the constituent monomer.

.....

.....

.....

.....

.....

.....

..... [2]

(c) Polymerisation of DNA nucleotides occurs during the semi-conservative replication of a molecule of DNA during interphase.

Describe the semi-conservative replication of DNA.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 11]

70. 9700_m18_qp_22 Q: 6

In a dividing cell, DNA replication occurs before mitosis.

(a) Steps in DNA replication are outlined in Fig. 6.1.

Complete Fig. 6.1 by filling in the gaps using the most appropriate terms.

1 Helicase enzyme allows the DNA double helix to unwind and the hydrogen bonds between the two strands to break, exposing the four bases,

..... (A),

..... (T),

..... (C) and

..... (G).

2 An enzyme molecule attaches to each of the two separated parental strands. The two enzyme molecules move in opposite directions, each catalysing the formation of a new strand of DNA. This enzyme is known as

..... .

3 DNA ..... ,
the monomers of DNA, are activated with two additional phosphates and are free in the nucleus for the synthesis of the new strands.

4 The bases of the DNA monomers form hydrogen bonds with the bases on each separated parental strand of DNA, according to the rules of

..... .

5 One DNA strand is synthesised continuously and the other is synthesised in sections known as Okazaki fragments. The fragments are joined by an

enzyme, ... , which catalyses the formation of phosphodiester bonds.

6 The result of replication is two DNA molecules, each one containing an original parental strand and a newly synthesised strand. This type of replication is described as

..... .

Fig. 6.1

[6]

(b) Fig. 6.2 is a photomicrograph of root tip cells at different stages in the cell cycle. A cell in interphase is labelled.

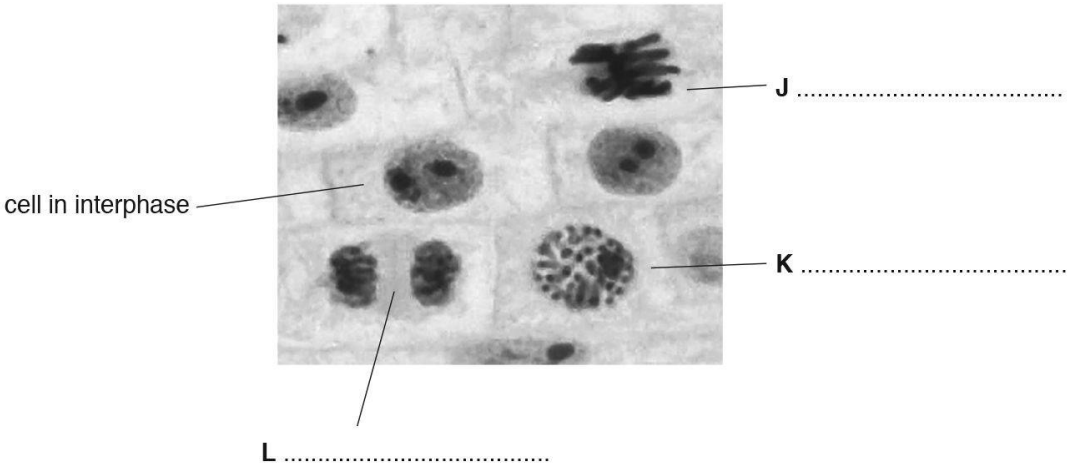


Fig. 6.2

(i) Name the stage of mitosis shown in each of cells **J**, **K** and **L** in Fig. 6.2.

Write your answer in the space next to each letter on Fig. 6.2. [3]

(ii) Explain how it is possible to deduce that the labelled cell in interphase shown in Fig. 6.2 is in late, rather than early, interphase.

.....

.....

..... [1]

(iii) Describe the stage of mitosis shown in cell **J**.

.....

.....

.....

..... [2]

[Total: 12]

71. 9700_s17_qp_23 Q: 5

(a) Describe the process of DNA replication.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....[5]

(b) State the name of the part of the chromosome that prevents the loss of genes during DNA replication.

.....[1]

(c) During DNA replication, the use of an incorrect base in the newly synthesised strand can lead to a mutation.

(i) A transversion event is where a pyrimidine is used in the newly synthesised strand instead of a purine, or the other way round.

Name the **two** possible bases that could be used instead of cytosine in a transversion event.

.....[1]

(ii) A transition event is where an incorrect purine is used or an incorrect pyrimidine is used.

Suggest why transversion events are **less** likely to occur than transition events.

.....

.....

.....[2]

(d) Outline how mutations can cause healthy cells to become tumour cells.

.....

.....

.....

.....

.....

.....[3]

[Total: 12]

72. 9700_w16_qp_22 Q: 3

High fructose corn syrup, made from maize, can be used as a replacement for sucrose to sweeten food and drink products.

Commercial production of high fructose corn syrup involves the enzyme glucose isomerase, extracted from bacteria.

(a) Fructose and sucrose are both sugars.

State two structural differences between fructose and sucrose.

1 .....

.....

.....

2 .....

.....

.....[2]

(b) The glucose isomerase used in the production of high fructose corn syrup is extracted from a strain of a bacterium, *Thermus thermophilus*, which is found in hot springs. The enzyme has an optimum temperature of 95 °C.

Suggest **and** explain the advantages of using glucose isomerase from *T. thermophilus* to produce high fructose corn syrup, rather than using glucose isomerase that has an optimum temperature of 37 °C.

.....

.....

.....

.....

.....

.....

.....[3]

(c) The commercial production of high fructose corn syrup uses immobilised glucose isomerase.

Fig. 3.1 shows the effect of pH on the activity of immobilised glucose isomerase compared to glucose isomerase free in solution.

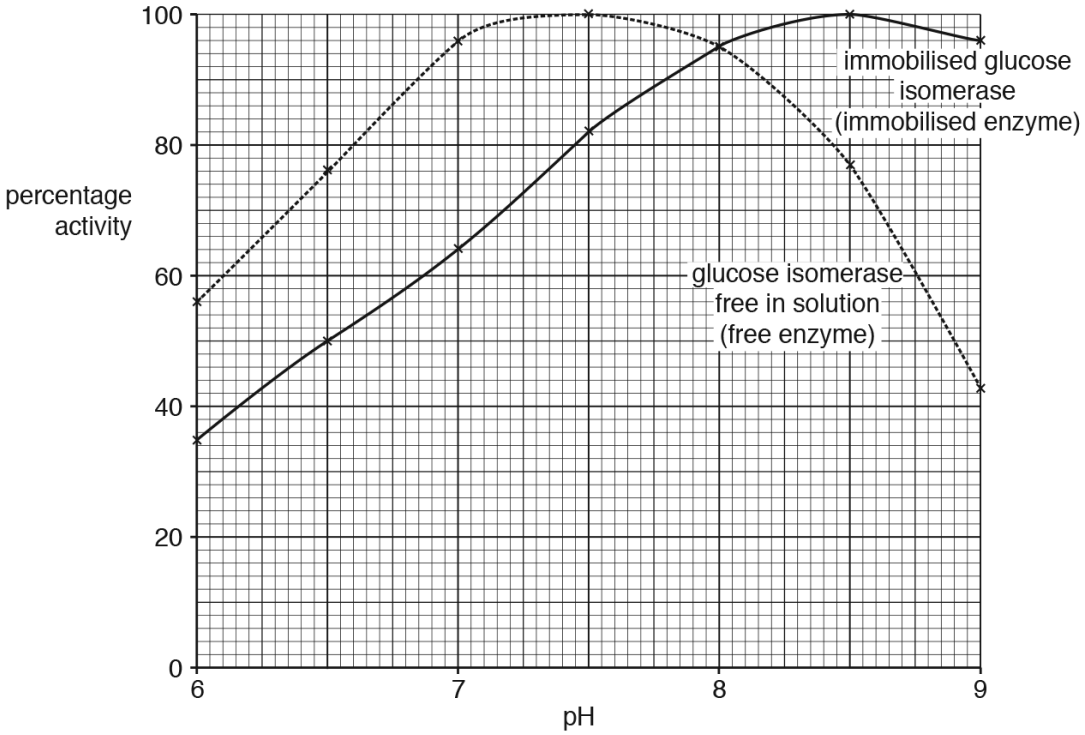


Fig. 3.1

With reference to Fig. 3.1, describe the differences shown between the immobilised enzyme and the free enzyme as pH changes.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....[3]

(d) The amino acid sequence of the enzyme glucose isomerase has been determined. The first five amino acids of this sequence are shown in Table 3.1.

Table 3.2 (on page 11) shows the genetic code (mRNA codons).

A student was asked to use Table 3.2 to work out an mRNA nucleotide sequence that would correspond to the first five amino acids of glucose isomerase. The student's sequence is shown in Table 3.1.

Table 3.1

amino acid sequence	met	tyr	glu	pro	lys
student's nucleotide sequence	AUG	UAU	GAC	CCU	UGU
correct = ✓ incorrect = ✗					

(i) Complete Table 3.1 using a ✓ or a ✗ to indicate whether the student has used Table 3.2 correctly to identify the codons for each amino acid in the nucleotide sequence. [1]

(ii) Discuss, with reasons, how an mRNA nucleotide sequence worked out to correspond to the first five amino acids using Table 3.2 may not be the same as the mRNA nucleotide sequence for those amino acids present in the bacterial cell.

.....

.....

.....

.....

.....

.....

.....

.....[3]

Table 3.2

first position	second position				third position
	U	C	A	G	
U	phe	ser	tyr	cys	U
	phe	ser	tyr	cys	C
	leu	ser	STOP	STOP	A
	leu	ser	STOP	trp	G
C	leu	pro	his	arg	U
	leu	pro	his	arg	C
	leu	pro	gln	arg	A
	leu	pro	gln	arg	G
A	ile	thr	asn	ser	U
	ile	thr	asn	ser	C
	ile	thr	lys	arg	A
	met	thr	lys	arg	G
G	val	ala	asp	gly	U
	val	ala	asp	gly	C
	val	ala	glu	gly	A
	val	ala	glu	gly	G

[Total: 12]

73. 9700_w15_qp_21 Q: 3

Fig. 3.1 is a light micrograph of cells in the root tip of the garlic plant *Allium sativum*. It has a diploid number (2n) of 16.

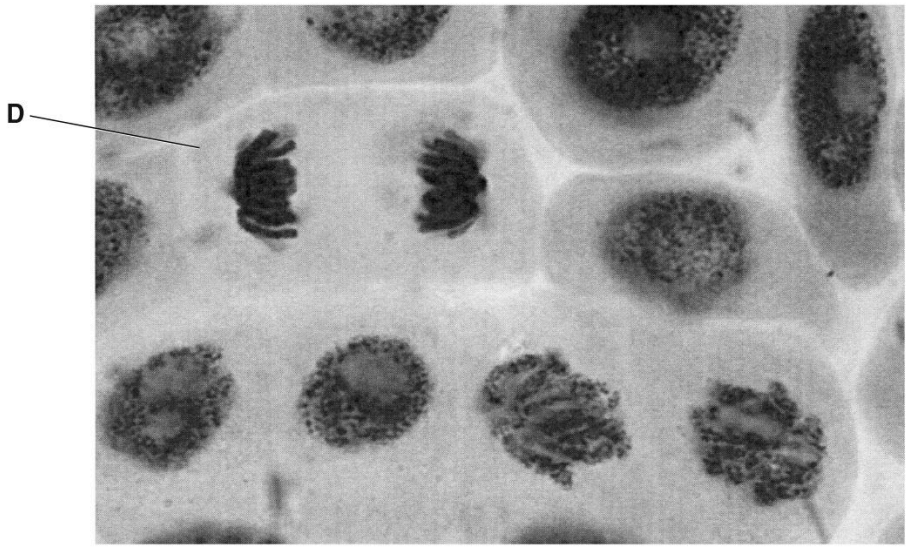


Fig. 3.1

(a) Name the stage of mitosis shown in cell **D**.

..... [1]

(b) Explain why mitosis occurs in a plant such as *A. sativum*.

.....

.....

.....

.....

..... [2]

(c) **(i)** State the haploid number of *A. sativum*.

..... [1]

(ii) Explain why a plant such as *A. sativum* produces haploid cells.

.....

.....

.....

.....

.....

.....

..... [3]

(d) DNA replication must occur before cell division.

Describe the process of DNA replication.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 12]

6.2 Protein synthesis

74. 9700_s20_qp_21 Q: 6

Fig. 6.1 shows the formation of a polypeptide during translation in a eukaryotic cell.

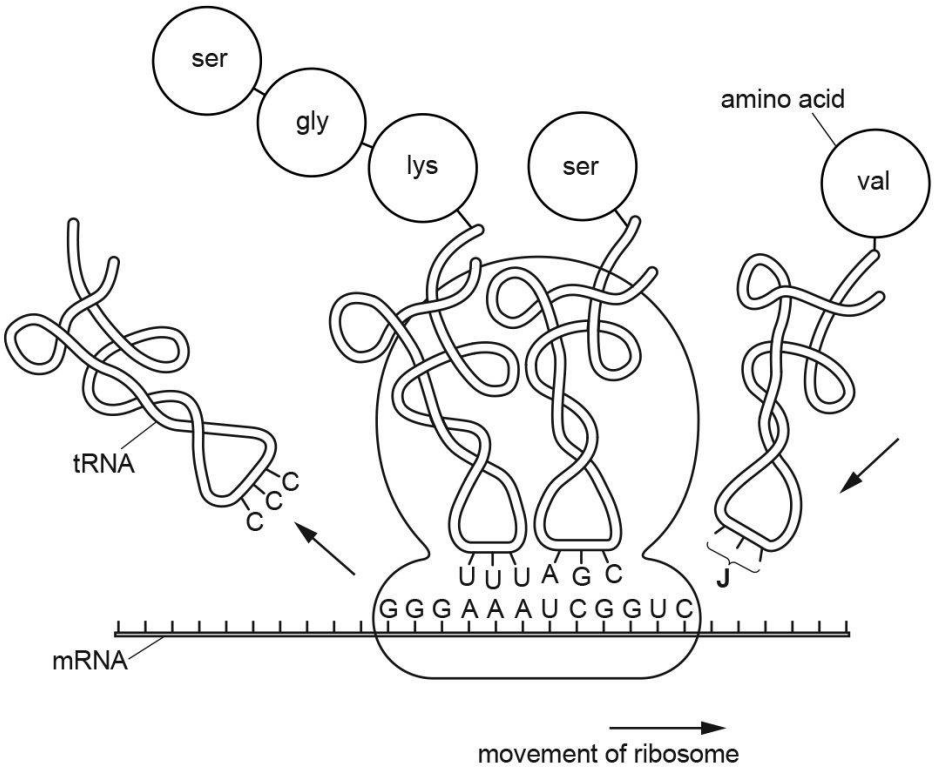


Fig. 6.1

(a) Name the purine bases shown in Fig. 6.1.

..... [1]

(b) State the name given to the group of three bases found at **J** on the tRNA molecule.

..... [1]

(c) Identify the three bases at **J**.

..... [1]

(d) State how the three bases at **J** on tRNA interact with the bases on mRNA.

..... [1]

[Total: 4]

75. 9700_s20_qp_23 Q: 5

Blood cells are formed from tissue stem cells in the bone marrow. These bone marrow stem cells go through a number of mitotic cell cycles to form the fully functioning blood cell.

Fig. 5.1 shows the three main stages of the cell cycle.

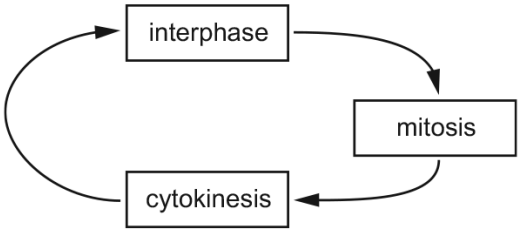


Fig. 5.1

The activity of genes changes during the mitotic cell cycle.

When genes are being expressed, the cell produces many messenger RNA (mRNA) molecules and ATP molecules.

(a) Explain what is meant by a gene.

.....

.....

.....

..... [2]

(b) Name the main stage of the cell cycle in Fig. 5.1 during which most mRNA and ATP is formed.

..... [1]

(c) Fig. 5.2 is an incomplete diagram of an ATP molecule.

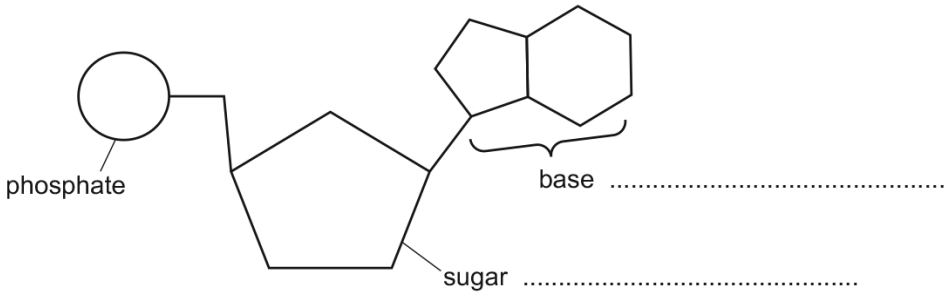


Fig. 5.2

(i) On Fig. 5.2:

- complete the diagram of the ATP molecule
- write the name of the base in the space provided
- write the name of the sugar in the space provided.

[3]

(ii) The base shown in Fig. 5.2 has a double ring structure.

State the term for a base that has a double ring structure.

..... [1]

(d) Suggest **and** explain the role of mitosis in the formation of blood cells by the bone marrow stem cells.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 10]

76. 9700_w20_qp_21 Q: 6

(a) Mutations in body cells can sometimes result in a tumour. Some tumours are cancerous.

(i) Outline how mutations can result in the development of a tumour.

.....

.....

.....

.....

..... [2]

(ii) Tumour cells have antigens on their cell surface that are not present on non-tumour cells.

These antigens are the result of gene mutations and are known as tumour specific antigens (TSA).

One type of TSA differs in structure from the protein found on the cell surface of non-tumour cells by a single amino acid.

Explain how a gene mutation could result in the production of this TSA.

.....

.....

.....

.....

..... [2]

(b) Immunotherapy is a form of treatment for cancer which aims to stimulate the immune system to destroy tumour cells.

One form of immunotherapy for cancer uses a vaccine which contains one specific type of TSA.

(i) Describe how vaccination with a specific type of TSA could lead to the destruction of tumour cells by T-lymphocytes in the body.

.....

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.....

..... [3]

(ii) Vaccines that contain tumour cells instead of a TSA are being developed for use during immunotherapy. Tumour cells are removed from a patient's body and used in a vaccine for the patient.

Suggest **one** advantage and **one** disadvantage of using a patient's tumour cells in a vaccine rather than a TSA.

advantage .....

.....

.....

disadvantage .....

.....

.....

[2]

[Total: 9]

77. 9700_w20_qp_23 Q: 5

A molecule of collagen consists of three identical polypeptides that form a triple helix.

The amino acid glycine forms one third of the amino acids in a collagen molecule.

Fig. 5.1**A** shows a polypeptide molecule during protein synthesis. A molecule of glycine is shown just before it is added to the polypeptide.

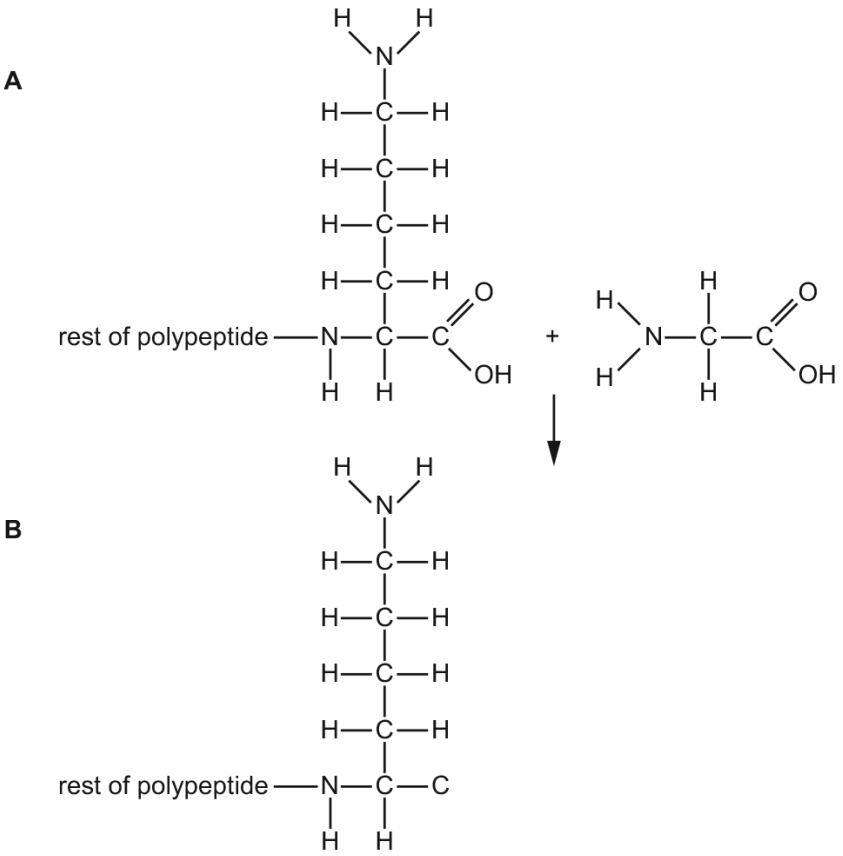


Fig. 5.1

(a) (i) Complete Fig. 5.1**B** to show the molecule of glycine added to the end of the polypeptide. [2]

(ii) State the type of reaction that occurs when glycine is added to the end of the polypeptide.

..... [1]

(iii) Explain the importance of glycine in a collagen molecule.

.....

.....

.....

.....

..... [2]

(b) Collagen is a fibrous protein.

Explain how the structure of collagen is related to its functions within the mammalian body.

.....

.....

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..... [4]

(c) The enzyme collagenase catalyses the breakdown of collagen molecules. This enzyme acts by using an induced fit mechanism.

Describe the mode of action of collagenase.

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.....

.....

..... [5]

(d) Students investigated the effect of pH on the activity of collagenase extracted from the bacterium *Bacillus licheniformis* at 50 °C.

The results are shown in Fig. 5.2.

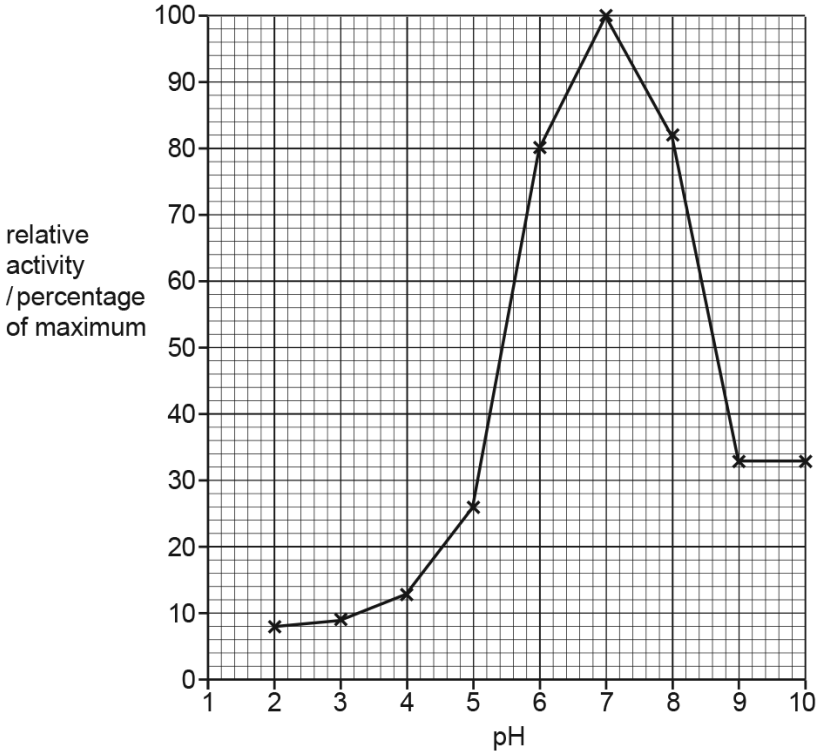


Fig. 5.2

With reference to Fig. 5.2, describe **and** explain the effect of pH on the activity of collagenase.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 18]

78. 9700_s19_qp_21 Q: 6

(a) The DNA in the nucleus is known as nuclear DNA.

(i) In the cells of the grasshopper, *Chorthippus brunneus*, 20% of the nucleotides in nuclear DNA contain thymine.

Calculate the percentage of nucleotides in the nuclear DNA of *C. brunneus* that contain guanine **and** explain your answer in terms of the structure of DNA.

percentage .....

explanation .....

.....

.....

.....

..... [3]

(ii) State another location, **other than** the nucleus, where DNA occurs in cells of *C. brunneus*.

..... [1]

(b) Fig. 6.1 is a diagram of a molecule of tRNA.

The region labelled **R** shows detail of part of the tRNA molecule.

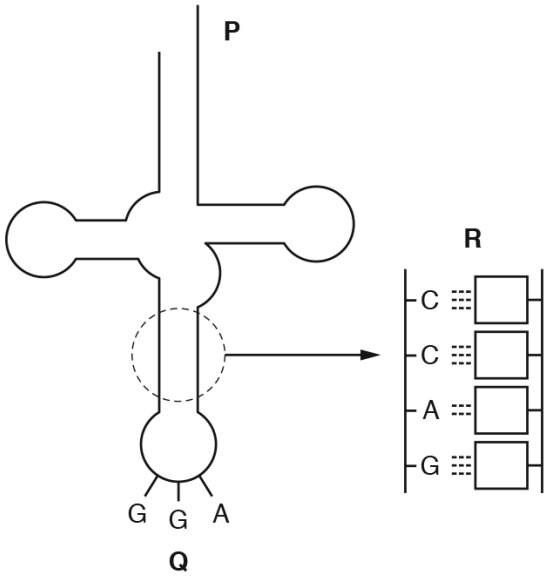


Fig. 6.1

(i) Complete Fig. 6.1 by writing the sequence of bases in the region labelled **R**. [1]

(ii) State the name of region **Q and** explain the role of region **Q** in translation.

name .....

explanation .....

.....

.....

..... [3]

(iii) State the function of region **P**.

.....

.....

..... [1]

[Total: 9]

---

79. 9700_s18_qp_22 Q: 2

In 1953, James Watson and Francis Crick published details about the structure of DNA. They used experimental results from other scientists to help them work out the structure and then built a model of a section of a DNA molecule, using pieces of wire and metal, with clamp stands to hold the model in place. This is shown in Fig. 2.1.

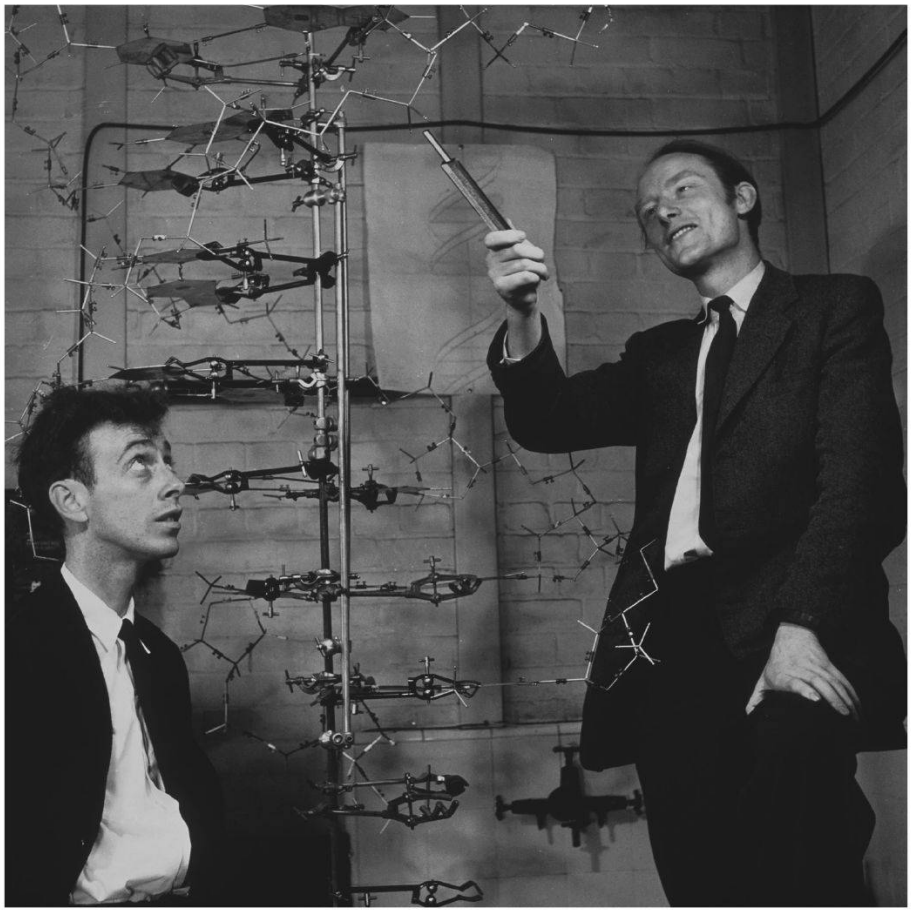


Fig. 2.1

(a) Watson and Crick used results from work carried out by Erwin Chargaff. He found that the proportions of the bases A, T, C and G were different in different species, but **within** each species:

- the proportion of A was equal to the proportion of T
- the proportion of G was equal to the proportion of C.

(i) Name the bases A, T, G and C.

A .....

T .....

G .....

C .....

[2]

(ii) Suggest **and** explain how Chargaff's findings helped Watson and Crick work out the structure of DNA.

.....

.....

.....

.....

.....

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.....

.....[3]

(b) Phoebus Levene isolated the nucleotides of DNA and identified the carbohydrate component of each nucleotide.

State the name of this carbohydrate component.

.....[1]

(c) Before the discovery of the structure of DNA as the molecule of inheritance, scientists thought that proteins were most likely to be the molecules that carried information.

Suggest how the structure of proteins made scientists think that these were the molecules that carried information.

.....

.....

.....

.....

.....[2]

[Total: 8]

80. 9700_w18_qp_22 Q: 5

DNA and RNA are nucleic acids.

(a) Explain why RNA can be described as a polymer **and** as a macromolecule.

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..... [2]

(b) The sugar component of DNA is a reducing sugar.

Outline the test for reducing sugars **and** describe the observations for a positive result.

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.....

..... [2]

(c) Nucleotides are structural components of nucleic acids. Each nucleotide consists of a pentose sugar, a phosphate group and a nitrogenous organic base.

Complete Table 5.1 to compare DNA nucleotides with RNA nucleotides as structural components of nucleic acids.

Table 5.1

feature	DNA nucleotides	RNA nucleotides
pentose sugar component		
purine bases		
pyrimidine bases		

[3]

[Total: 7]

81. 9700_w18_qp_23 Q: 3

(a) Fig. 3.1 is a diagram of a monomer of the nucleic acid, messenger RNA.

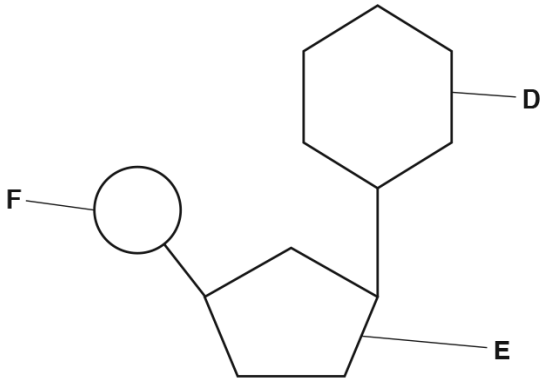


Fig. 3.1

(i) Name **D**, **E** and **F** in Fig. 3.1.

D .....

E .....

F .....

[3]

(ii) State **one** way in which the **structure** of DNA differs from the structure of messenger RNA.

.....

..... [1]

(b) Telomeres are repeating sequences of bases located at the ends of DNA molecules. These repeating sequences do not code for proteins.

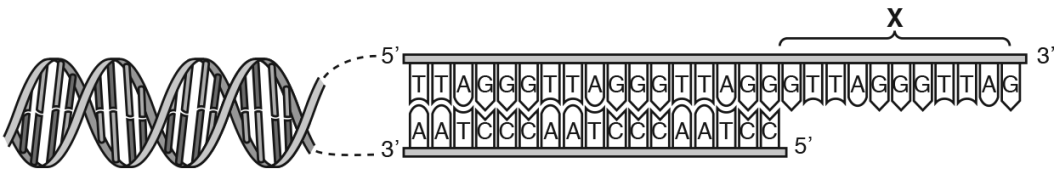
The enzyme telomerase ensures that telomeres do not shorten each time DNA is replicated.

Fig. 3.2**A** shows the end of a DNA molecule during replication. DNA polymerase cannot attach to the region labelled **X**, so it cannot complete the synthesis of the new strand without the action of telomerase.

Telomerase synthesises additional lengths of DNA that are added to the telomere. These additional lengths are used by DNA polymerase to complete the process of replication.

Fig. 3.2**B** is an enlarged view of region **X** to show the action of the enzyme telomerase.

A



B

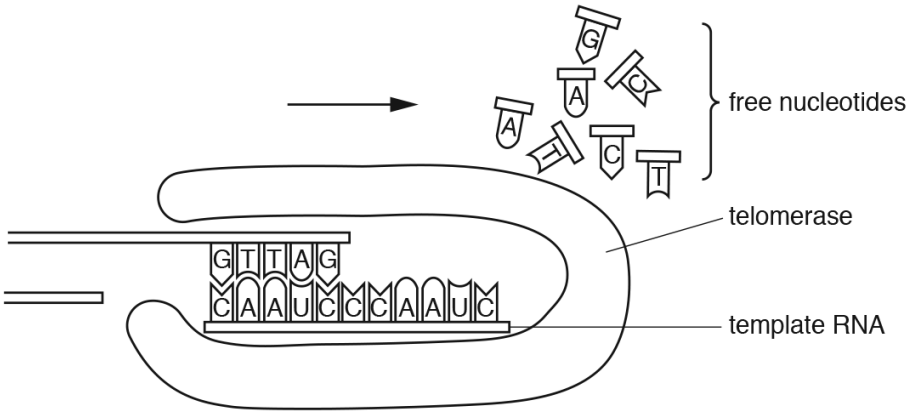


Fig. 3.2

Telomerase contains a short length of RNA that acts as a template for the synthesis of DNA as shown in Fig. 3.2**B**.

Explain how a molecule of telomerase synthesises additional lengths of DNA.

.....

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.....

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..... [4]

(c) Telomerase is not present in prokaryotic cells.

Suggest why prokaryotes do not have telomerase.

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.....

..... [1]

(d) One of the ways to diagnose lung cancer is to determine the concentration of telomerase in cells from the lining of the bronchus.

Explain why determining the activity of telomerase may be useful in the diagnosis of lung cancer.

.....

.....

.....

.....

..... [2]

[Total: 11]

82. 9700_s17_qp_21 Q: 4

(a) Fig. 4.1 shows part of a DNA molecule.

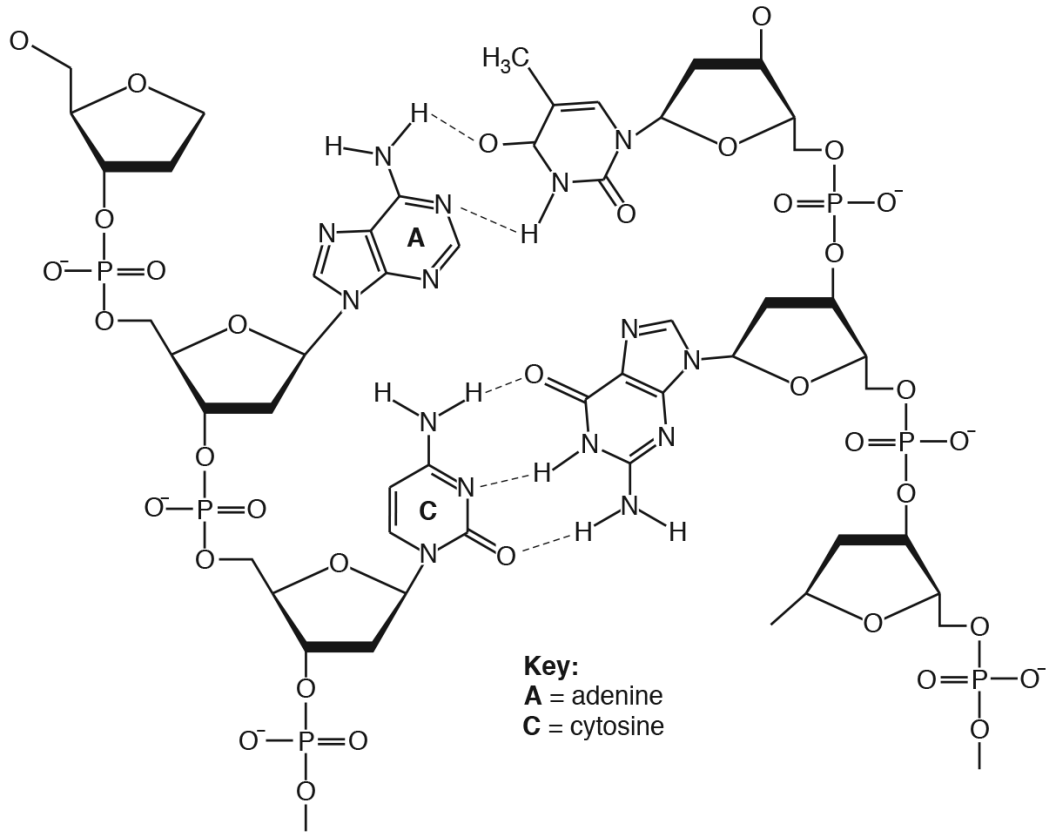


Fig. 4.1

Use Fig. 4.1 to explain how the structure of mRNA differs from the structure of DNA.

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.....

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.....

.....[4]

(b) Fig. 4.2 shows:

- the first seven amino acids of the β chain of haemoglobin
- the first amino acid in the sequence is valine (Val)
- the 21 base pairs in the sequence of DNA that code for these seven amino acids.

amino acid sequence	Val	His	Leu	Thr	Pro	Glu	Glu

base sequence in DNA	CAC	GTG	GAC	TGA	GGA	CTC	CTC
	GTG	CAC	CTG	ACT	CCT	GAG	GAG

Fig. 4.2

Table 4.1 shows the triplets of bases that code for seven amino acids.

Using Fig. 4.2 and Table 4.1, state what will happen to the sequence of amino acids in the first part of the β chain of haemoglobin:

(i) if the base pair at position 6 is deleted

.....

.....[1]

(ii) if the three base pairs at positions 7, 8 and 9 are deleted.

.....

.....[1]

Table 4.1

amino acid		DNA triplets
cysteine	(Cys)	TGT TGC
glutamic acid	(Glu)	GAA GAG
histidine	(His)	CAT CAC
leucine	(Leu)	CTT CTC CTA CTG
proline	(Pro)	CCT CCC CCA CCG
threonine	(Thr)	ACT ACC ACA ACG
valine	(Val)	GTT GTC GTA GTG
no amino acid	STOP	TAA TAG TGA

(c) DNA is involved in the processes of replication and transcription.

Complete Table 4.2 by using a tick (✓) to indicate which features apply to each of the processes. Use a cross (✗) for features that do **not** apply.

The first row has been completed for you.

Table 4.2

feature	replication	transcription
a single-stranded molecule is produced	✗	✓
hydrogen bonds are broken		
both strands of DNA act as templates		
phosphodiester bonds are formed		
DNA polymerase is used		

[4]

(d) Telomeres are parts of chromosomes. Describe the function of telomeres.

.....

.....

.....

.....

.....

.....[2]

(e) Describe the function of ribosomes in protein synthesis.

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

[Total: 16]

83. 9700_s17_qp_23 Q: 2

Fig. 2.1 is a transmission electron micrograph of a cell from a leaf.



Fig. 2.1

(a) Use the scale bar to calculate the magnification of the image in Fig. 2.1.

Write down the formula that you will use and show your working.

formula

magnification × .....[3]

(b) Name structure **X** and state **one** function of this structure.

name .....

function .....

.....[2]

(c) Name two structures, **visible** in the cell in Fig. 2.1, that contain DNA.

1 .....

2 .....[2]

(d) Plant cells can be infected with viruses.

Fig. 2.2 shows the key features of a plant virus.

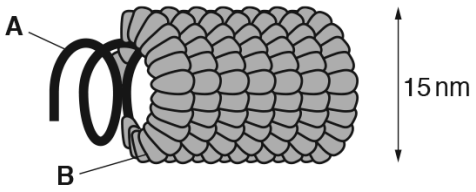


Fig. 2.2

Identify the structures labelled **A** and **B** in Fig. 2.2.

A .....

B .....[2]

(e) Some plant cells produce a polypeptide called systemin.

(i) Describe the role of DNA in the production of systemin.

.....

.....

.....

.....

.....[2]

(ii) Systemin stimulates plant cells to produce enzyme inhibitors known as serpins.

One of these serpins is a competitive inhibitor of some protease enzymes. It inhibits the protease enzymes found in herbivores, but does **not** inhibit the proteases in plants.

Suggest how this serpin inhibits **only** the protease enzymes in herbivores but **not** those in plants.

.....

.....

.....

.....

.....

.....

.....[3]

(iii) The presence of competitive inhibitors, such as serpins, increases the Michaelis-Menten constant (K_m) for the enzymes they inhibit.

Explain why the K_m value increases.

.....

.....[1]

[Total: 15]

84. 9700_w16_qp_23 Q: 4

Protein synthesis requires ribosomes, mRNA, tRNA, amino acids and enzymes.

Fig. 4.1 is a diagram of a molecule of tRNA.

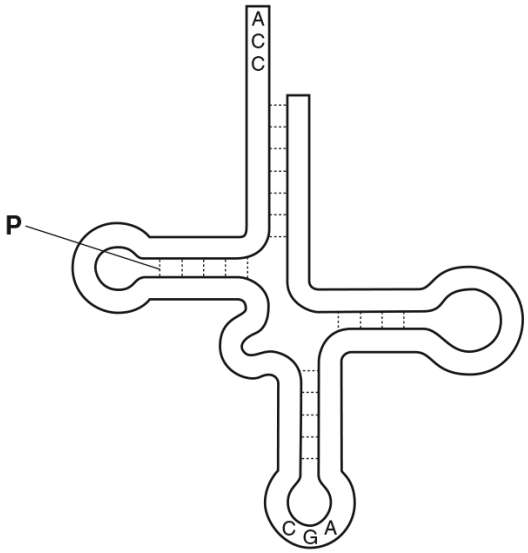


Fig. 4.1

(a) Name the bond labelled **P**.

.....[1]

(b) Use Fig. 4.1 to describe the role of tRNA in protein synthesis.

You may annotate Fig. 4.1 to help your answer.

.....

.....

.....

.....

.....

.....

.....[3]

(c) tRNA molecules are synthesised inside the nucleus of eukaryotic cells.

Outline the process by which tRNA molecules are synthesised in the nucleus.

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.....

.....

.....

.....[3]

[Total: 7]

85. 9700_s15_qp_21 Q: 6

Red blood cells are formed from cells called reticulocytes. Stem cells in the bone marrow produce reticulocytes which differentiate into red blood cells. During differentiation haemoglobin is produced.

Fig. 6.1 shows the structure of small sections of DNA and messenger RNA (mRNA) in the nucleus of a reticulocyte during transcription.

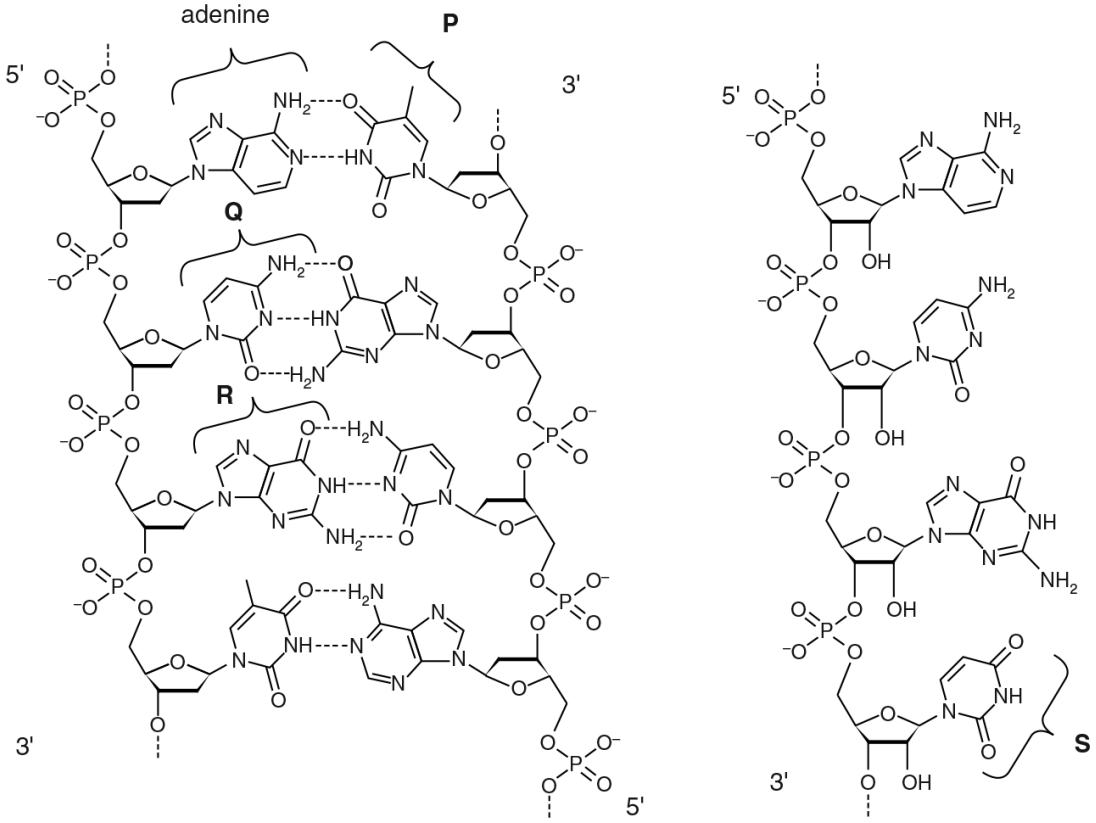


Fig. 6.1

(a) Name the bases **P** to **S**.

P .....

Q .....

R .....

S .....[4]

(b) Describe the role of the mRNA molecule shown in Fig. 6.1.

.....

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.....

.....

.....

.....

.....[3]

[Total: 7]

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86. 9700_s15_qp_23 Q: 2

DNA replication is an important event in the cell cycle.

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

.....[1]

(b) Fig. 2.1 shows pairing between two bases, **X** and **Y**, in a DNA molecule.

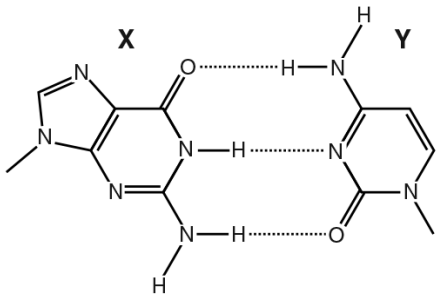


Fig. 2.1

(i) Name the type of bond shown by the dotted lines between the bases.

.....[1]

(ii) State which base, **X** or **Y**, is a pyrimidine **and** explain your answer.

.....

.....[1]

(c) The compound benzopyrene, found in tar from tobacco smoke, can become chemically changed in cells and interferes with DNA replication, causing gene mutations.

(i) State what is meant by the term *gene mutation*.

.....

.....

.....

.....

.....[2]

(ii) Mutations that occur in dividing cells of the gas exchange system may result in lung cancer.

Suggest the differences in the cell cycle of a cancer cell compared with that of a normal cell of the same type.

.....

.....

.....

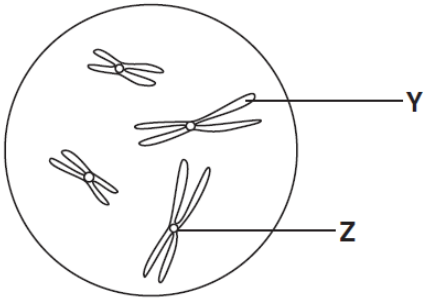
.....

.....[2]

[Total: 7]

CHAPTER 5

1. The diagram shows chromosomes in a nucleus.



What are **Y** and **Z**?

	Y	Z
A	centromere	centriole
B	centromere	chromatid
C	chromatid	centriole
D	chromatid	centromere

2. A peptide consists of ten amino acids of four different kinds.

What is the theoretical minimum number of tRNA molecules required to translate the mRNA for this peptide?

A 4

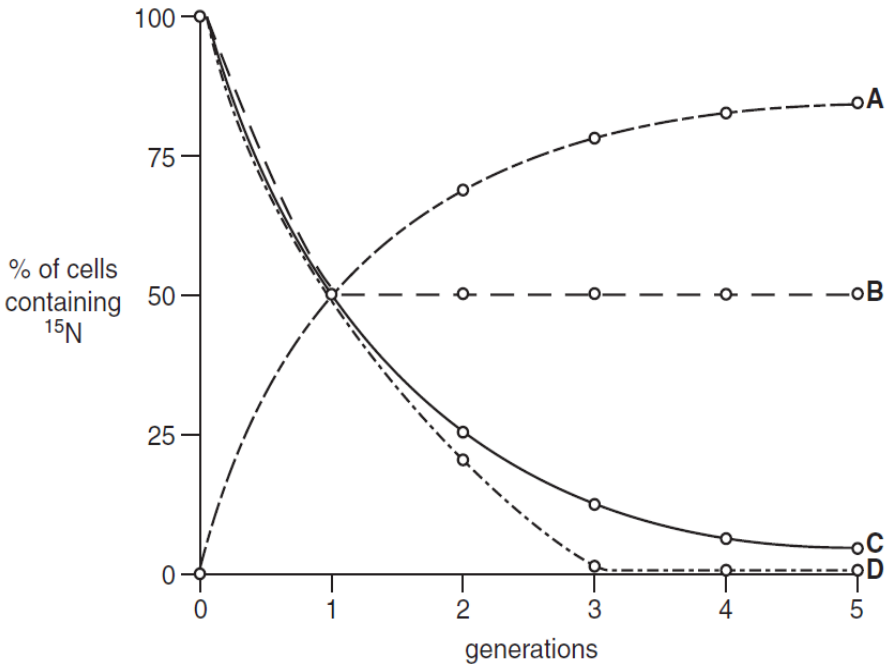
B 10

C 12

D 30

3. Bacteria were cultured in a medium containing heavy nitrogen (^{15}N) until all the DNA was labelled. These bacteria were then grown in a medium containing only normal nitrogen (^{14}N) for five generations. The percentage of cells containing ^{15}N in each generation was estimated.

Which curve provides evidence that DNA replication is semi-conservative?



4. RNA is extracted from β cells in the pancreas. It is used to make DNA coding for human insulin.

Which enzyme is used to make the DNA?

A DNA ligase

B restriction enzyme

C reverse transcriptase

D RNA polymerase

5. Which type of molecule is the end product of translation?

A amino acid

B DNA

C mRNA

D polypeptide

6. A polypeptide molecule contains the amino acid sequence, glycine – leucine – lysine – valine.

The table shows the DNA codes for these amino acids.

glycine	leucine	lysine	valine
CCC	GAA	TTT	CAA

Transfer RNA molecules with which anticodons are needed for the synthesis of this polypeptide?

A CCC GAA TTT CAA

B CCC GAA UUU CAA

C GGG CUU AAA GUU

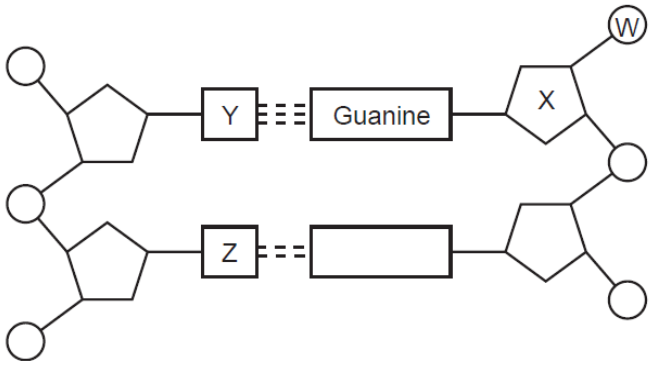
D GGG CUU UUU GUU

7. A protein contains all the common amino acids.

What would be the hypothetical minimum number of types of tRNA molecules needed for the synthesis of this protein?

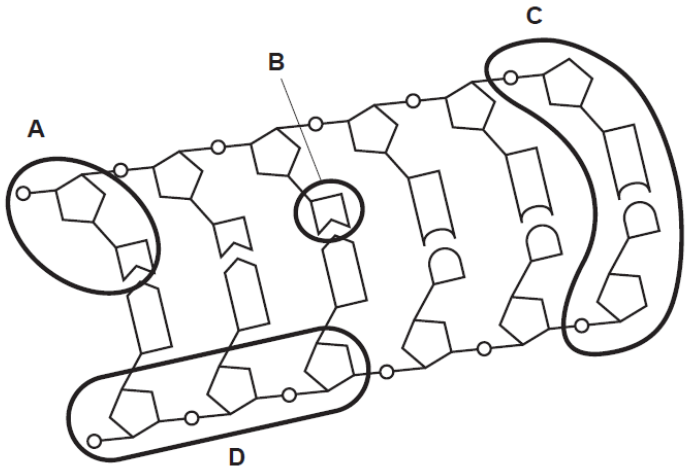
A 3 **B** 4 **C** 20 **D** 64

8. The diagram shows part of a DNA molecule.



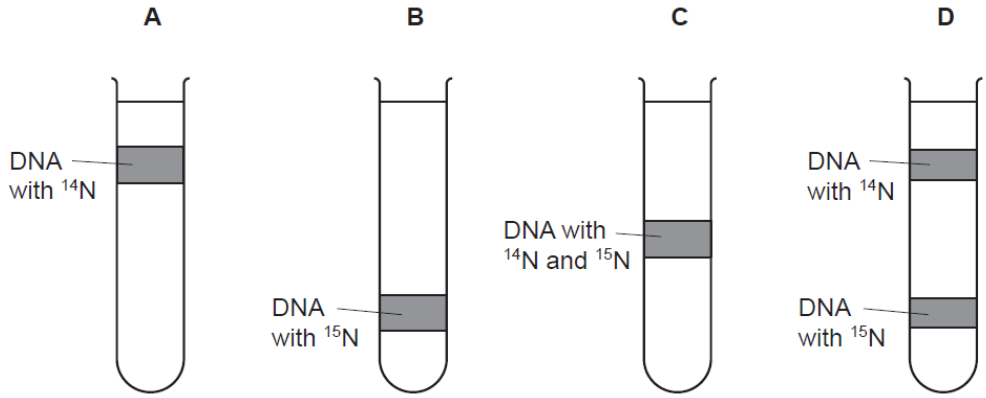
Which letters indicate cytosine, deoxyribose, phosphate and thymine?

	cytosine	deoxyribose	phosphate	thymine
A	W	X	Y	Z
B	Y	X	W	Z
C	Z	W	X	Y
D	Y	Z	X	W

9.	Which statement correctly describes the transcription of DNA? **A** It is a semi-conservative process. **B** It occurs at the surface of the ribosome. **C** It produces messenger RNA. **D** It produces polypeptides.
10.	One of the codons for the amino acid phenylalanine is UUC. Which diagram shows how the tRNA carrying phenylalanine pairs with the corresponding section of mRNA? **A** tRNA AAG mRNA UUC **B** tRNA TTG mRNA UUC **C** tRNA UUC mRNA AAG **D** tRNA UUC mRNA TTG
11.	The diagram shows part of a DNA molecule. Which part is a nucleotide? 

12. Bacteria were grown for many generations in a medium containing a heavy isotope of nitrogen, ^{15}N. They were then transferred to a medium containing the light isotope of nitrogen, ^{14}N. They were given time to replicate DNA and divide once. Their DNA was extracted, spun in a centrifuge and observed using ultra violet light. The DNA with the ^{15}N settled at a lower depth than the DNA with the ^{14}N.

Which shows the predicted results after one generation in the medium with the light isotope?



13. In a genetic engineering experiment a piece of double-stranded DNA containing 6000 nucleotides is transcribed and translated.

What is the total number of amino acids used?

A 500 **B** 1000 **C** 2000 **D** 3000

14. DNA from a chromosome is analysed and 20% of its bases are found to be cytosine.

Which percentage of uracil molecules will be found in mRNA transcribed from this DNA?

A 20 **B** 30 **C** 40 **D** 60

15. Which type of sugar and bonds are found in a DNA molecule?

	type of sugar	bonds linking complementary bases
A	hexose	hydrogen
B	hexose	peptide
C	pentose	hydrogen
D	pentose	peptide

16. A length of double-stranded DNA contains 120 nucleotides and codes for polypeptide X.

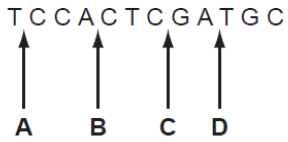
What is the maximum length of polypeptide X?

A 20 amino acids

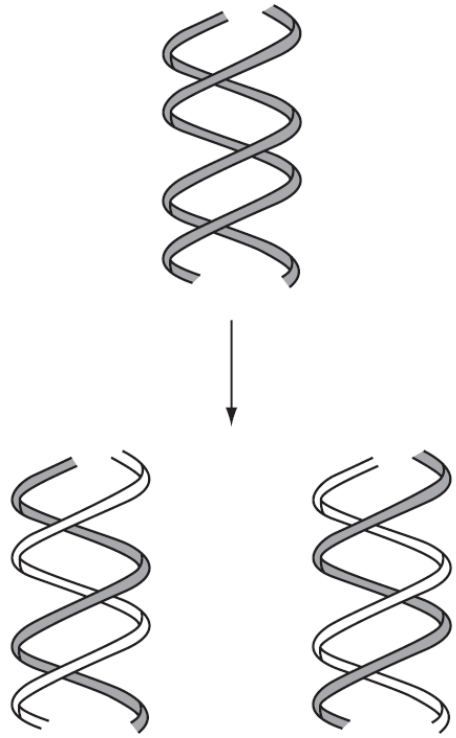
B 40 amino acids

C 60 amino acids

D 120 amino acids

17.	In a DNA molecule, the base sequence AGT codes for the amino acid serine. What is the base sequence of the anti-codon on the tRNA to which serine becomes attached? **A** AGU **B** GAU **C** TCA **D** UCA
18.	The RNA triplet UAG acts as a stop codon terminating the synthesis of a polypeptide. The diagram shows a strand of DNA which codes for four amino acids. Where would a mutation, introducing a thymine nucleotide, result in the termination of transcription? 

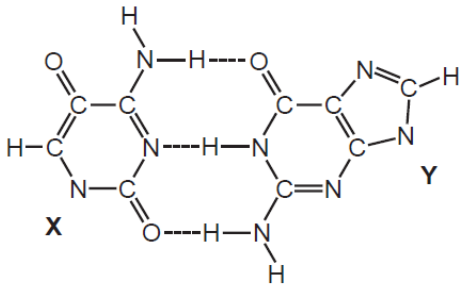
19. The diagram shows a process involving DNA.



What is the name of the process and the stage in the cell cycle at which it occurs?

	process	stage
A	replication	interphase
B	replication	prophase
C	transcription	interphase
D	transcription	prophase

20. The diagram shows two bases, **X** and **Y**, joined by hydrogen bonds (----) in DNA.



What are the correct bases?

	X	Y
A	adenine	cytosine
B	adenine	uracil
C	cytosine	guanine
D	cytosine	thymine

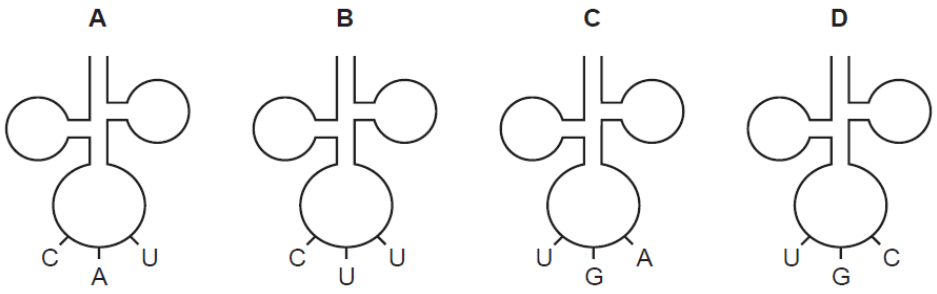
21. Part of the amino acid sequences in normal and sickle cell haemoglobin are shown.

normal haemoglobin	sickle cell haemoglobin
thr-pro-glu-glu	thr-pro-val-glu

Possible mRNA codons for these amino acids are

glutamine (glu) GAA GAG	proline (pro) CCU CCC
threonine (thr) ACU ACC	valine (val) GUA GUG

Which tRNA molecule is **not** involved in the formation of this part of the sickle cell haemoglobin?



22. In the DNA sequence for sickle cell anaemia, adenine replaces thymine in a CTT triplet, forming the triplet CAT. During synthesis of the sickle cell haemoglobin molecule, the amino acid valine is incorporated instead of glutamic acid.

What is the anticodon in the transfer RNA molecule carrying this valine?

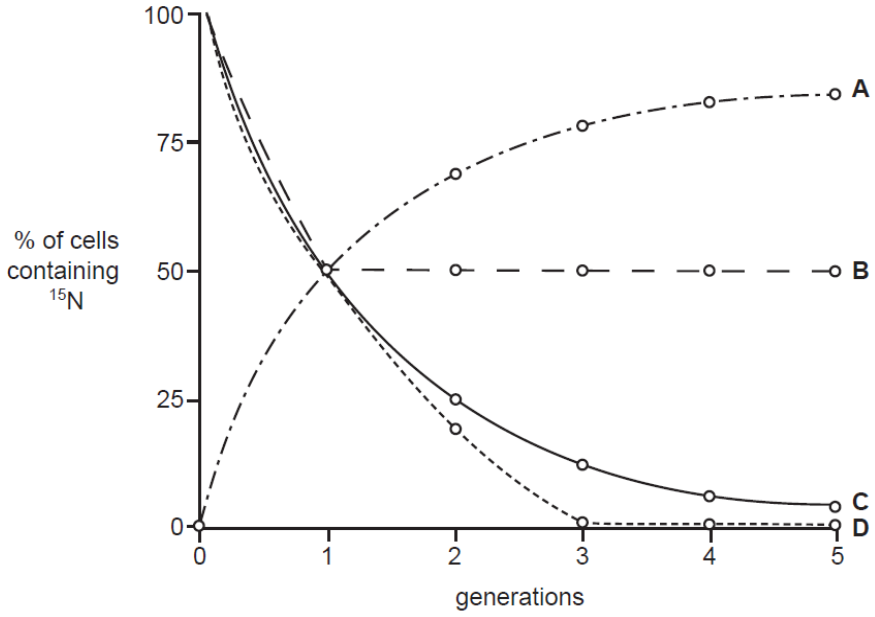
A CAU **B** CUA **C** GAU **D** GUA

23. Which statements are correct about DNA transcription and translation?

	transcription	translation
A	is semi-conservative	produces mRNA
B	produces mRNA	is semi-conservative
C	occurs at the surface of ribosomes	produces mRNA
D	produces mRNA	occurs at the surface of ribosomes

24. Bacteria were cultured in a medium containing heavy nitrogen (^{15}N) until all the DNA was labelled. These bacteria were then grown in a medium containing only normal nitrogen (^{14}N) for five generations. The percentage of cells containing ^{15}N in each generation was estimated.

Which curve provides evidence that DNA replication is semi-conservative?



25. The table shows the sugars and some bases found in RNA and DNA.

Which is correct?

	RNA	DNA
A	ribose	thymine
B	ribose	uracil
C	thymine	deoxyribose
D	uracil	ribose

26. What would be the result of analysing part of a DNA molecule?

A hexose sugars and phosphates in equal proportion, and an equal number of cytosine and guanine bases

B nucleotides and phosphates in equal proportion, and an equal number of adenine and cytosine bases

C pentose sugars and phosphates in equal proportion, and an equal number of adenine and thymine bases

D twice as many phosphates as pentose sugars, and an equal number of adenine and guanine bases

27. DNA is said to replicate in a semi-conservative way.

Results of Meselson and Stahl's experiments gave overwhelming support to this theory. They used *E. coli* which has a generation time of 50 minutes.

Here are the steps in their experiment but they are in the wrong order.

P All bacteria contain ^{15}N DNA.

Q All bacteria contain hybrid DNA (^{15}N DNA and ^{14}N DNA).

R Bacteria contain either all ^{14}N DNA or hybrid DNA.

S Bacteria grown in a ^{15}N medium for many generations.

T Bacteria transferred to a ^{14}N medium and sampled every 50 minutes.

Which sequence of letters shows the correct order of the steps in the experiment?

A $P \rightarrow Q \rightarrow R \rightarrow S \rightarrow T$

B $P \rightarrow S \rightarrow T \rightarrow R \rightarrow Q$

C $S \rightarrow P \rightarrow T \rightarrow Q \rightarrow R$

D $S \rightarrow R \rightarrow Q \rightarrow P \rightarrow T$

28. In a DNA molecule, the base sequence AGT codes for the amino acid serine.

What is the base sequence of the anti-codon on the tRNA to which serine becomes attached?

A AGU **B** GAU **C** TCA **D** UCA

29. DNA is said to replicate in a semi-conservative way.

Results of Meselson and Stahl's experiments gave overwhelming support to this theory. They used *E. coli* which has a generation time of 50 minutes.

Here are the steps in their experiment but they are in the wrong order.

P All bacteria contain ^{15}N DNA.

Q All bacteria contain hybrid DNA (^{15}N DNA and ^{14}N DNA).

R Bacteria contain either all ^{14}N DNA or hybrid DNA.

S Bacteria grown in a ^{15}N medium for many generations.

T Bacteria transferred to a ^{14}N medium and sampled every 50 minutes.

Which sequence of letters shows the correct order of the steps in the experiment?

A P → Q → R → S → T

B P → S → T → R → Q

C S → P → T → Q → R

D S → R → Q → P → T

30. In a DNA molecule, the base sequence AGT codes for the amino acid serine.

What is the base sequence of the anti-codon on the tRNA to which serine becomes attached?

A AGU **B** GAU **C** TCA **D** UCA

31. What is the minimum number of base substitutions required to change the nucleotide sequence of the HbA (normal) allele to the HbS (sickle cell) allele?

A 1 **B** 2 **C** 3 **D** 4

32. What would be the result of analysing part of a DNA molecule?

A hexose sugars and phosphates in equal proportion, and an equal number of cytosine and guanine bases

B nucleotides and phosphates in equal proportion, and an equal number of adenine and cytosine bases

C pentose sugars and phosphates in equal proportion, and an equal number of adenine and thymine bases

D twice as many phosphates as pentose sugars, and an equal number of adenine and guanine bases

33. The mechanism of action of four drugs that inhibit DNA replication is stated below.

- Aphidicholine inhibits DNA polymerase.
- Cytarabine is converted into a molecule that can substitute for a DNA nucleotide and also inhibits DNA repair mechanisms.
- Epirubicin inhibits an enzyme involved in the unwinding of DNA and separation of strands.
- Hydroxycarbamide inhibits an enzyme involved in the production of deoxyribonucleotides.

Which row correctly matches a drug to an explanation of the mechanism of action?

	explanation of mechanism of action			
	decreased pool of available nucleotides inhibits chain elongation	DNA strands not available as templates for transcription	DNA damaged during replication and cell death occurs	exposed DNA template strands unable to be copied
A	aphidicholine	epirubicin	cytarabine	hydroxycarbamide
B	epirubicin	cytarabine	hydroxycarbamide	aphidicholine
C	hydroxycarbamide	aphidicholine	epirubicin	cytarabine
D	hydroxycarbamide	epirubicin	cytarabine	aphidicholine

34. The following events occur during transcription.

1 Bonds break between complementary bases.

2 Bonds form between complementary bases.

3 Sugar-phosphate bonds form.

4 Free nucleotides pair with complementary nucleotides.

Before the mRNA leaves the nucleus, which events will have occurred twice?

A 1 and 2 only **B** 1, 3 and 4 only **C** 2, 3 and 4 only **D** 1, 2, 3 and 4

35. Which type of sugar and types of bonds are found in a DNA molecule?

	type of sugar	types of bonds
A	non-reducing	hydrogen and ionic
B	non-reducing	hydrogen and peptide
C	reducing	covalent and hydrogen
D	reducing	hydrogen and peptide

36. The table shows the tRNA anticodons for four amino acids.

amino acid	anticodon (tRNA)
asparagine	UUA
glutamic acid	CUU
proline	GGA
threonine	UGG

A cell makes a polypeptide with the following amino acid sequence.

glutamic acid – asparagine – threonine – proline

What was the sequence of bases on the DNA from which this was formed?

A GGAAATACCCTT

B CAAAATACCCCT

C CTTTTATGGGGA

D CTTTTATCCGGA

37. What does the enzyme RNA polymerase synthesise?

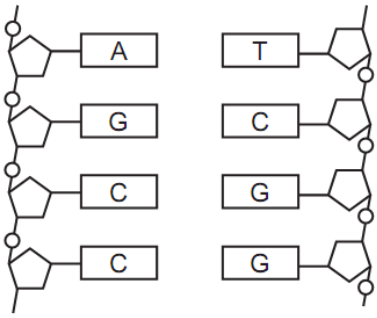
A a polypeptide from an mRNA template

B a strand of DNA from an mRNA template

C mRNA from a DNA template

D mRNA from a tRNA template

38. The diagram shows part of a DNA molecule.



How many hydrogen bonds are involved in holding these strands of DNA together?

A 11 **B** 9 **C** 8 **D** 4

39. What is the function of the enzyme DNA polymerase?

A to synthesise a polypeptide using mRNA as a template

B to synthesise a strand of DNA using a polypeptide as a template

C to synthesise a strand of DNA using DNA as a template

D to synthesise a strand of mRNA using DNA as a template

40. The following events occur in the replication of DNA.

1. bonds between complementary bases break
2. bonds between complementary bases form
3. opposite strands separate
4. sugar-phosphate bonds form
5. free nucleotides pair with complementary nucleotides on each strand

In which order do these events take place?

	first → last				
A	1	3	5	2	4
B	1	5	3	2	4
C	3	1	5	4	2
D	5	1	3	4	2

41. The sequence of bases on part of a molecule of DNA is shown.

TACAAATGACCA sense strand
ATGTTTACTGGT antisense strand

What is the sequence of bases in mRNA transcribed from this sequence?

A ATGTTTACTGGT

B AUGUUUACUGGU

C TACAAATGACCA

D UACAAAUGACCA

42. The table gives the tRNA anticodons for four amino acids.

amino acid	anticodon (tRNA)
asparagine	UUA
glutamic acid	CUU
proline	GGA
threonine	UGG

A cell makes a polypeptide with the amino acid sequence:

glutamic acid – asparagine – threonine – proline

What was the sequence of bases on the mRNA from which this was formed?

A GAAAATACCCCT

B AGGGGUGUUUUC

C TCCCCGCAAAAG

D GAAAAUACCCCU

43. Which structural feature of the DNA molecule varies?

A the arrangement of the sugar-phosphate groups

B the double helical arrangement

C the order of bases on a single nucleotide chain

D the pairing of purines with pyrimidines

44. Three polypeptides were made using synthetic mRNA molecules as shown.

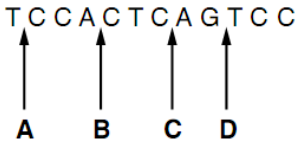
synthetic mRNA used	polypeptide produced
UUUUUUUUUUUU	phenylalanine-phenylalanine-phenylalanine-phenylalanine
AAAAAAAAAAAA	lysine-lysine-lysine-lysine
UUUAAAUUUAAA	phenylalanine-lysine-phenylalanine-lysine

What are the DNA codes for the amino acids phenylalanine and lysine?

	phenylalanine	lysine
A	AAA	TTT
B	AAA	UUU
C	TTT	GGG
D	UUU	AAA

45. The RNA triplet UAG acts as a stop codon, terminating the synthesis of a polypeptide. The diagram shows a strand of DNA which codes for four amino acids.

Where would a mutation, introducing a thymine nucleotide, result in the termination of transcription?



46. Which enzyme rejoins sections of DNA in genetic engineering?

A DNA ligase

B DNA polymerase

C restriction enzyme

D reverse transcriptase

47. When **not** involved in protein synthesis, ribosomes exist as separate subunits.

What do these subunits consist of?

A mRNA and lipid

B mRNA and tRNA

C rRNA and lipid

D rRNA and protein

48. In the DNA sequence for sickle cell anaemia, adenine replaces thymine in a CTT triplet, forming the triplet CAT. During synthesis of the sickle cell haemoglobin molecule, the amino acid valine is incorporated instead of glutamic acid.

What is the anticodon in the transfer RNA molecule carrying this valine?

A CAT **B** CAU **C** GTA **D** GUA

49. In transcription, what is transcribed and what is the product?

	transcribed	product
A	DNA	mRNA
B	DNA	polypeptide
C	mRNA	DNA
D	mRNA	polypeptide

50.

The table shows mRNA triplets and their corresponding amino acids.

mRNA triplet	GCA	GCG	GAA	GAG	AAA	AAG
amino acid	ala	ala	glu	glu	lys	lys

A tripeptide is glu-lys-ala.

Which sequence of bases in DNA could code for this tripeptide?

A CTCCGTTTT

B CTTTTCCGT

C TTCCGTCTT

D TTTCTCCGC

51.

Analysis of DNA produced the following ratios of nitrogenous bases.

source of DNA	ratio of purines to pyrimidines
bean seeds	0.99
cow heart	1.01
human liver	1.02
rat bone marrow	1.00

Which statement explains the difference in the ratios?

A Animal DNA contains more purines than pyrimidines.

B Different parts of organisms contain different proportions of purines and pyrimidines.

C DNA contains thymine instead of uracil.

D There are variations in the accuracy of analytical techniques.

52. A polypeptide has the amino acid sequence glycine – arginine – lysine – serine.

The table gives possible tRNA anticodons for each amino acid.

amino acid	tRNA anticodons
arginine	UCC GCG
glycine	CCA CCU
lysine	UUC UUU
serine	AGG UCG

Which sequence of bases on DNA would code for the polypeptide?

A CCACGCAAGAGC

B CCTTCCTTCTCG

C GGAAGGAAAAGC

D GGTTGGTTGTGC

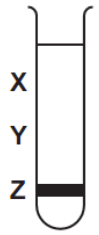
53. The table shows the percentages of nitrogenous bases in four samples of nucleic acids.

Which base is adenine?

sample	bases				
	A	**B**	**C**	**D**	uracil
1	19	31	30	19	nil
2	27	23	24	26	nil
3	25	25	nil	25	25
4	17	32	33	18	nil

54. A culture of bacteria had all its DNA labelled with the heavy isotope of nitrogen, ^{15}N. The culture was then allowed to reproduce using nucleotides containing normal ^{14}N. The DNA was examined using a centrifuge after one generation and again after two generations.

The diagram shows the position of the DNA band at **Z** in the centrifuge tube when the DNA was first labelled.



In which pattern would the DNA be found after the first and after the second cell generations?

	after first generation	after second generation
A	half at **X** and half at **Y**	quarter at **X**, quarter at **Z** and half at **Y**
B	half at **X** and half at **Z**	quarter at **X**, quarter at **Z** and half at **Y**
C	all at **Y**	half at **X** and half at **Y**
D	all at **Z**	half at **Y** and half at **Z**

55. What terminates the formation of a polypeptide chain during protein synthesis in cells?

A when a 'stop' codon is reached on the mRNA molecule

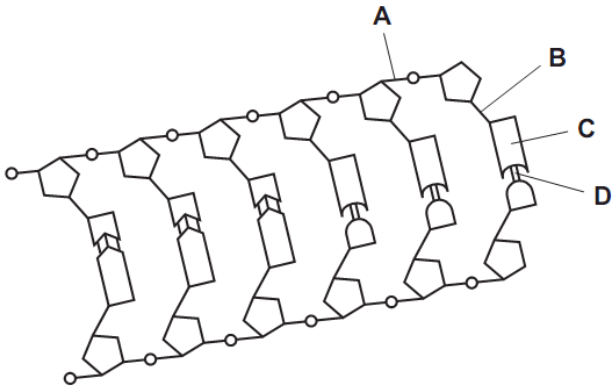
B when a 'stop' codon is reached on the tRNA molecule

C when the ribosome reaches the end of the mRNA molecule

D when the ribosome reaches the end of the tRNA molecule

56. The diagram shows part of a DNA molecule.

Where are hydrogen bonds found?



57. Which type of molecule is the end product of translation?

A amino acid

B DNA

C mRNA

D polypeptide

58. An unidentified single-stranded molecule was described as having the following features.

- complementary base pairing along some of its length
- an area that can attach to a ribosome
- a site to which a specific amino acid attaches

What is the unidentified molecule?

A DNA polymerase

B messenger RNA

C RNA polymerase

D transfer RNA

59. Some antibacterial drugs can affect the synthesis of proteins.

antimicrobial drug	rifampicin	streptomycin	tetracycline
mode of action	binds to RNA polymerase	genetic code misread during translation	prevents binding of tRNA to ribosome

Which is the correct set of immediate effects of these drugs?

antimicrobial drug	rifampicin	streptomycin	tetracycline
A	defective protein synthesised	mRNA does not bind to ribosome	amino acids not added to growing chain
B	mRNA not synthesised	defective protein synthesised	amino acids not added to growing chain
C	mRNA not synthesised	mRNA does not bind to ribosome	transcription prevented
D	transcription prevented	defective protein synthesised	mRNA does not bind to ribosome

60. What is the function of the enzyme RNA polymerase?

A to form a polypeptide using mRNA as a template

B to form a strand of DNA using mRNA as a template

C to form a strand of mRNA using DNA as a template

D to form a strand of mRNA using tRNA as a template

61. The table gives the tRNA anticodons for four amino acids.

amino acid	anticodon (tRNA)
asparagine	UUA
glutamic acid	CUU
proline	GGA
threonine	UGG

A cell makes a polypeptide with the amino acid sequence:

glutamic acid – asparagine – threonine – proline

What was the sequence of bases on the strand of the DNA which was complimentary to the mRNA from which this polypeptide was formed?

A CTTTTATGGGGA

B CUUUUAUGGGGA

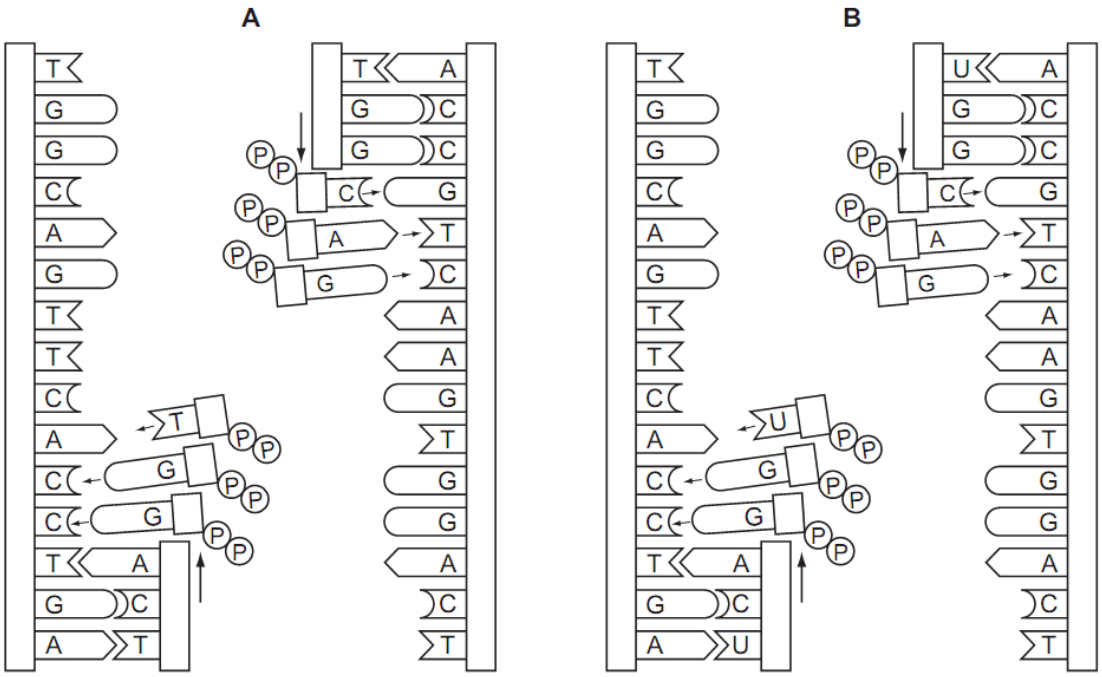
C GAAAATACCCCT

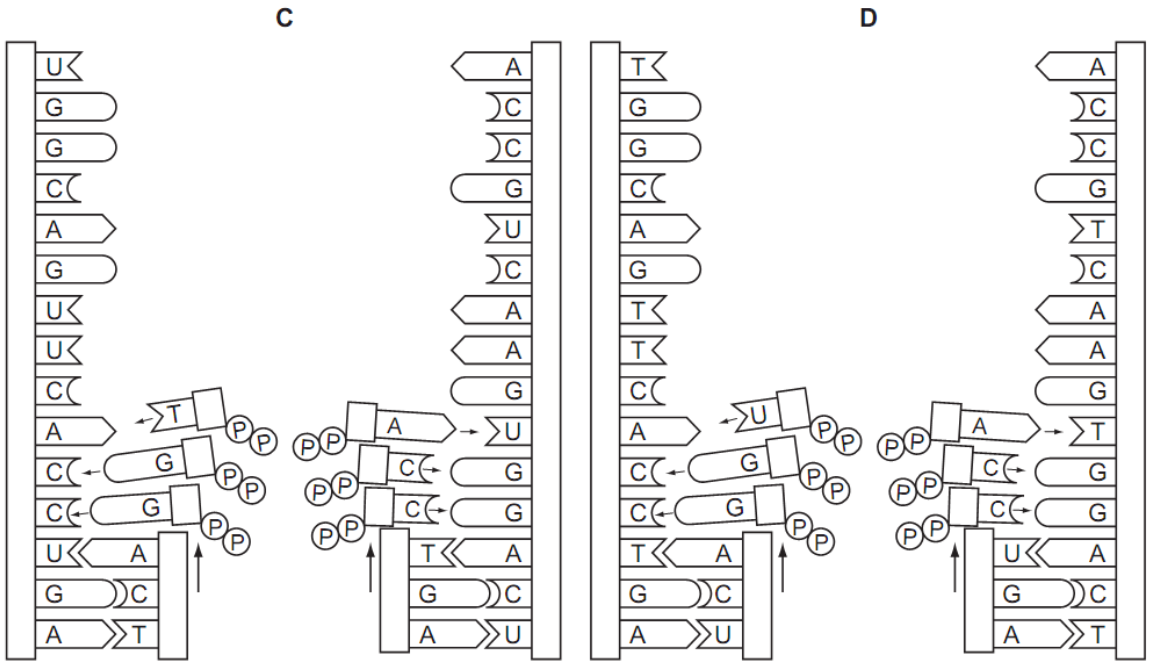
D GAAAAUACCCCU

62. The following statements describe events that take place during DNA replication and transcription.

Which statement is **not** correct?

		DNA replication	transcription
A	adenine pairs with thymine	yes	no
B	both DNA polynucleotide chains act as templates	yes	no
C	the original DNA molecule is changed after the process	no	yes
D	uracil pairs with adenine	no	yes

63.	A peptide consists of ten amino acids of four different kinds. What is the theoretical minimum number of tRNA molecules required to translate the mRNA for this peptide? **A** 4 **B** 10 **C** 12 **D** 30
64.	What does the enzyme DNA polymerase synthesise in a cell? **A** a polypeptide using DNA as a template **B** a strand of DNA using a polypeptide as a template **C** a strand of DNA using DNA as a template **D** a strand of mRNA using DNA as a template
65.	Which diagram shows the semi-conservative replication of a section of a molecule of DNA? 



66. DNA was extracted from the salivary glands of a fruit fly and a human cheek cell.

In which way did the DNA molecules differ?

A in the ratio of adenine to thymine

B in the sequence of the nucleotides

C in the type of pentose sugar

D in the types of nucleotide

67. Which statement describes the semi-conservative replication of DNA?

A Parental DNA is broken down into nucleotides and reassembled with new nucleotides.

B Parental DNA is split into triplets and new triplets are added.

C Parental DNA is split into two strands, each of which is replicated.

D Parental DNA remains intact and a new daughter DNA copy is built from new nucleotides.

68. The table shows the percentages of nitrogenous bases in four samples of nucleic acids.

Which base is adenine?

sample	percentage of nitrogenous bases				
	A	**B**	**C**	**D**	uracil
1	19	31	30	19	nil
2	27	23	24	26	nil
3	25	25	nil	25	25
4	17	32	33	18	nil

69. The table shows the role of four different proteins involved in DNA replication.

protein	helicase	topoisomerase	single-strand binding protein	DNA polymerase
role	unwinds the parental DNA double helix	breaks and rejoins the DNA strands	binds to separated DNA strands to stabilise them	synthesises strand of DNA

Which shows the function of these proteins?

	helicase	topoisomerase	single-strand binding protein	DNA polymerase
A	adds DNA nucleotides to the 3' end of a growing polynucleotide strand	prevents original strands reforming complementary base pairs	enables tension caused by unwinding to be released	makes strands available as templates
B	enables tension caused by unwinding to be released	prevents original strands reforming complementary base pairs	makes strands available as templates	adds DNA nucleotides to the 3' end of a growing polynucleotide strand
C	enables tension caused by unwinding to be released	makes strands available as templates	adds DNA nucleotides to the 3' end of a growing polynucleotide strand	prevents original strands reforming complementary base pairs
D	makes strands available as templates	enables tension caused by unwinding to be released	prevents original strands reforming complementary base pairs	adds DNA nucleotides to the 3' end of a growing polynucleotide strand

70. The table shows the percentages of bases in DNA from various types of cell.

source of DNA	percentage of bases in DNA			
	adenine	guanine	thymine	cytosine
calf thymus	28.2	21.5	27.8	22.5
bull spleen	27.9	22.7	27.3	22.1
bull sperm	28.6	22.2	27.2	22.0
rat bone marrow	28.7	21.4	28.4	21.5
yeast	31.3	18.7	32.9	17.1

What is a valid deduction from these data?

A All cells from the same species have approximately the same content of DNA.

B Small differences in DNA from different cells have large effects.

C The four bases show complementary base pairing.

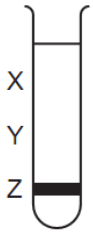
D The structure of DNA is different in yeast and animal cells.

71. Which row shows the correct combination?

	triplet code	codon	anticodon
A	DNA	mRNA	tRNA
B	DNA	tRNA	mRNA
C	mRNA	DNA	tRNA
D	tRNA	mRNA	DNA

72. A culture of bacteria had all its DNA labelled with the heavy isotope of nitrogen (^{15}N). A sample was taken and spun in a centrifuge.

The diagram shows the position of the DNA band at Z in the centrifuge tube.



The culture was then allowed to reproduce using nucleotides containing the normal isotope of nitrogen (^{14}N). Samples were taken and spun in a centrifuge after one generation and again after two generations.

In which pattern would the DNA be found after the first and after the second generations?

	after first generation	after second generation
A	half at X and half at Y	quarter at X, quarter at Z and half at Y
B	half at X and half at Z	quarter at X, quarter at Z and half at Y
C	all at Y	half at X and half at Y
D	all at Z	half at Y and half at Z

73. Male bees are haploid. They develop from unfertilised eggs. Female bees are diploid.

Which statements are correct?

1 All male bees are genetically identical.

2 Male bee sperm cells are produced by mitosis.

3 New combinations of genes only occur in female bees.

A 1 and 2 only **B** 1 and 3 only **C** 2 and 3 only **D** 1, 2 and 3

74. In a genetic engineering experiment a piece of double-stranded DNA containing 6000 nucleotides coding for a specific polypeptide is transcribed and translated.

What is the total number of amino acids in this polypeptide?

A 500 **B** 1000 **C** 2000 **D** 3000

75. What makes the exact copying of DNA molecules possible?

A base pairing

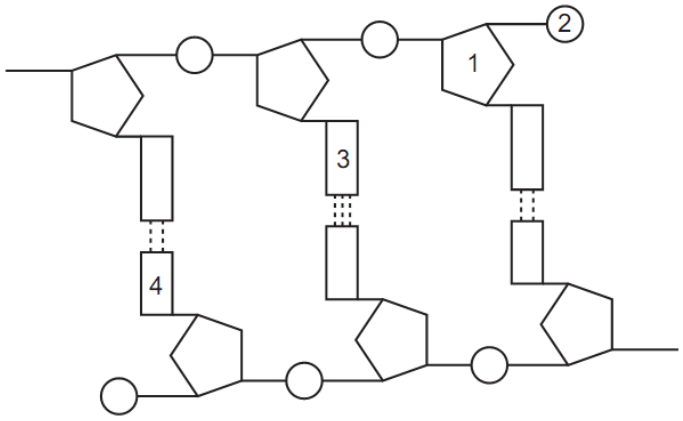
B hydrogen bonding between nucleotides

C sugar-phosphate backbone

D the double helix shape

76.	Which molecule has its synthesis directly controlled by DNA? **A** amylase **B** cholesterol **C** glycogen **D** phospholipid
77.	Bacteria were grown in a medium containing ^{15}N. After several generations, all of the DNA contained ^{15}N. Some of these bacteria were transferred to a medium containing the common isotope of nitrogen, ^{14}N. The bacteria were allowed to divide once. The DNA of some of these bacteria was extracted and analysed. This DNA was all hybrid DNA containing equal amounts of ^{14}N and ^{15}N. The remaining bacteria were left in the medium with ^{14}N and allowed to divide one more time. The DNA of some of these bacteria was extracted and analysed. What is the composition of this DNA? **A** 25% hybrid DNA **B** 50% hybrid DNA **C** 75% hybrid DNA **D** 100% hybrid DNA
78.	Which cell components contain mRNA? 1 chloroplast 2 mitochondrion 3 nucleus 4 rough endoplasmic reticulum **A** 1, 2, 3 and 4 **B** 1, 2 and 3 only **C** 2, 3 and 4 only **D** 3 and 4 only
79.	What is the correct sequence for the processes involved in the formation of an enzyme in a cell? **A** transcription → condensation → translation → ionic bonding **B** translation → hydrogen bonding → transcription → condensation **C** transcription → translation → condensation → ionic bonding **D** translation → transcription → ionic bonding → hydrogen bonding

80. The diagram shows part of a DNA molecule.

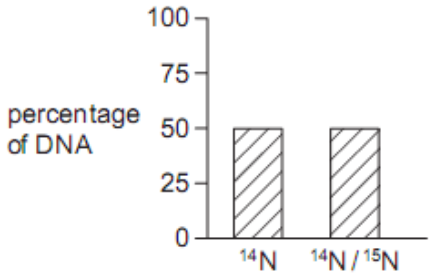


Which row correctly identifies the structures labelled 1, 2, 3 and 4?

	1	2	3	4
A	cytosine	phosphate	guanine	deoxyribose sugar
B	deoxyribose sugar	phosphate	adenine	cytosine
C	deoxyribose sugar	phosphate	cytosine	thymine
D	phosphate	deoxyribose sugar	cytosine	adenine

81. Bacteria were grown in a medium containing ^{15}N. After several generations, all of the DNA contained ^{15}N. Some of these bacteria were transferred to a medium containing the common isotope of nitrogen, ^{14}N. The bacteria were allowed to divide once. The DNA of some of these bacteria was extracted and analysed. This DNA was all hybrid DNA containing equal amounts of ^{14}N and ^{15}N.

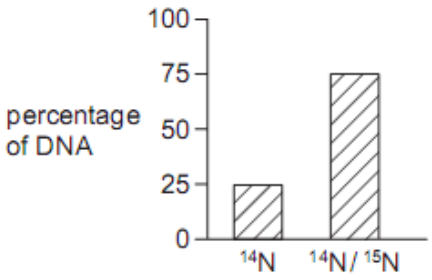
Some bacteria from the medium with ^{15}N were transferred into a medium of ^{14}N. The bacteria were allowed to divide twice. The graph shows the percentages of ^{14}N and ^{15}N in the DNA of these bacteria.



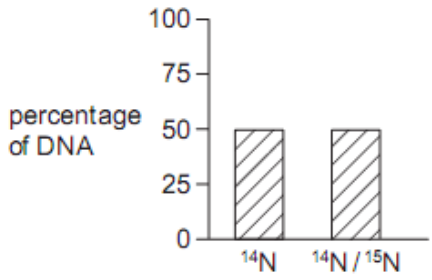
Some bacteria from the medium with ^{15}N were transferred into a medium of ^{14}N. The bacteria were allowed to divide three times.

What would be the percentages of ^{14}N and ^{15}N in the DNA extracted from these bacteria?

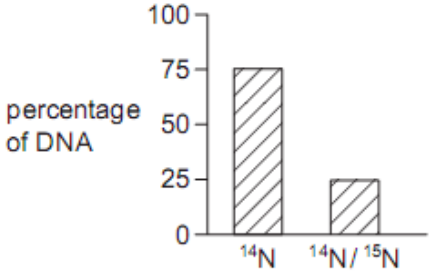
A



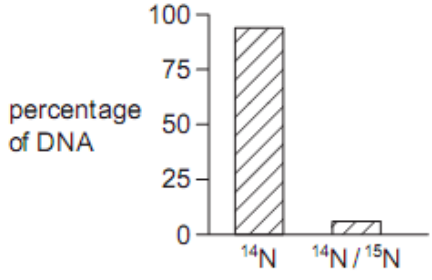
B



C



D



82. What makes the exact copying of DNA molecules possible?

A base pairing

B hydrogen bonding between nucleotides

C sugar-phosphate backbone

D the double helix shape

83. Which molecule has its synthesis directly controlled by DNA?

A amylase

B cholesterol

C glycogen

D phospholipid

84. A gene codes for the production of a protein, p53, that binds to damaged DNA during interphase and prevents its replication. A carcinogen in cigarette smoke mutates this gene.

Which statement explains why this mutation may cause cancer?

A Lack of p53 allows cells to undergo mitosis.

B Lack of p53 allows cells with damaged DNA to replicate.

C The carcinogen in cigarette smoke increases the rate of cell division.

D The p53 causes uncontrolled cell division.

85. In a genetic engineering experiment a piece of double-stranded DNA containing 6000 nucleotides coding for a specific polypeptide is transcribed and translated.

What is the total number of amino acids in this polypeptide?

A 500 **B** 1000 **C** 2000 **D** 3000

86. Bacteria were grown in a medium containing ^{15}N. After several generations, all of the DNA contained ^{15}N. Some of these bacteria were transferred to a medium containing the common isotope of nitrogen, ^{14}N. The bacteria were allowed to divide once. The DNA of some of these bacteria was extracted and analysed. This DNA was all hybrid DNA containing equal amounts of ^{14}N and ^{15}N.

The remaining bacteria were left in the medium with ^{14}N and allowed to divide one more time. The DNA of some of these bacteria was extracted and analysed.

What is the composition of this DNA?

A 25 % hybrid DNA

B 50 % hybrid DNA

C 75 % hybrid DNA

D 100 % hybrid DNA

Q1.

5 Fig. 5.1 shows part of a DNA molecule.

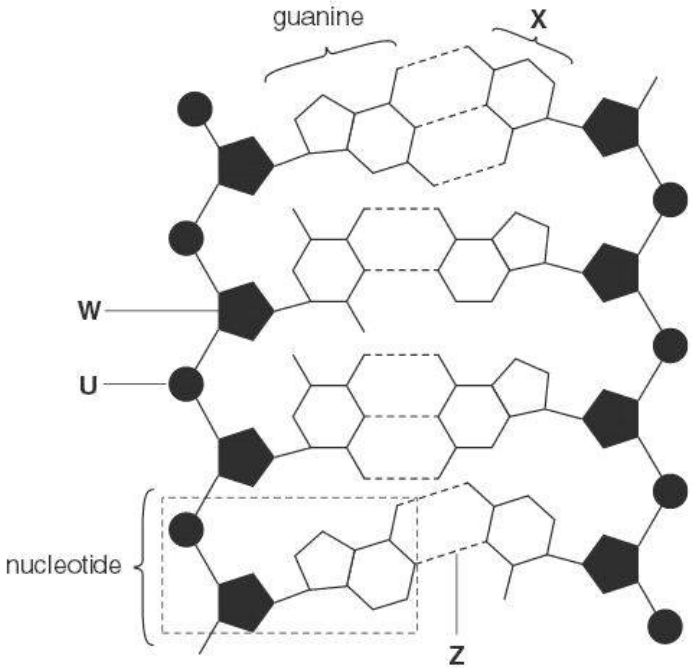


Fig. 5.1

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(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.

STEMUP.CO.UK

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

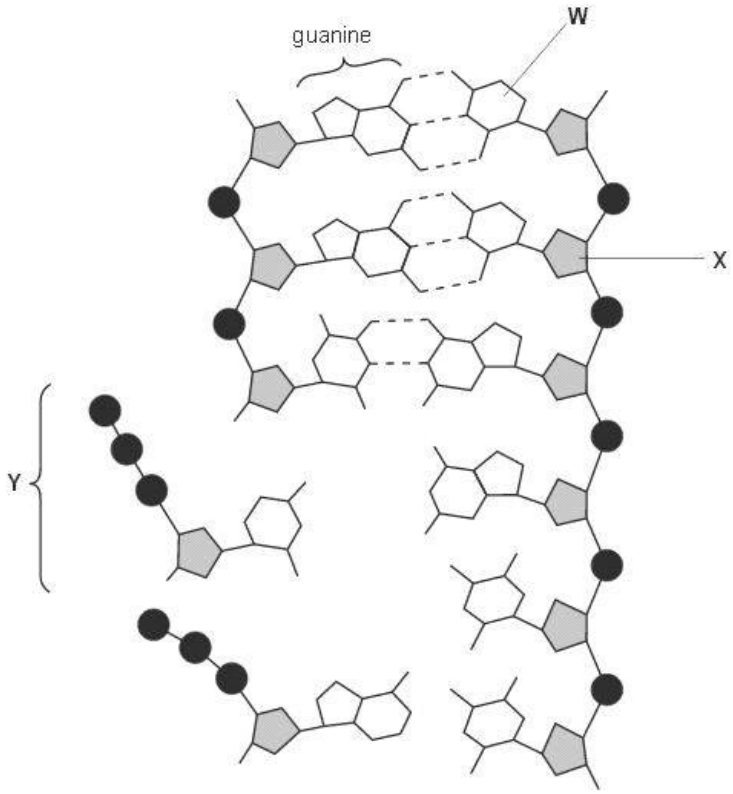


Fig. 1.1

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

W .....

X .....

Y ..... [3]

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(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.

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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.

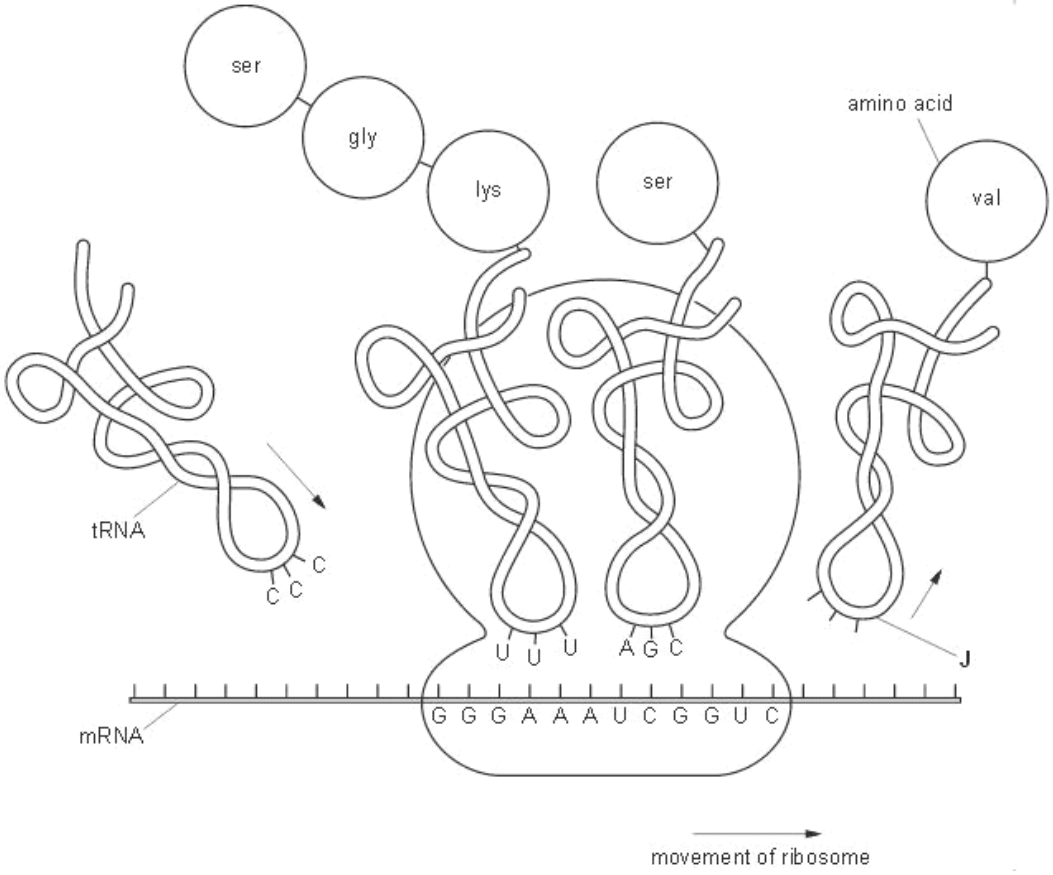
statement	protein	DNA	messenger RNA	cellulose
hydrogen bonds stabilise the molecule				
glucose is the subunit molecule				
subunits are joined by peptide bonds				
may be hydrolysed to amino acids				
contains uracil				

[5]

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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]

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

.....

.....

.....

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.....

.....

.....

.....

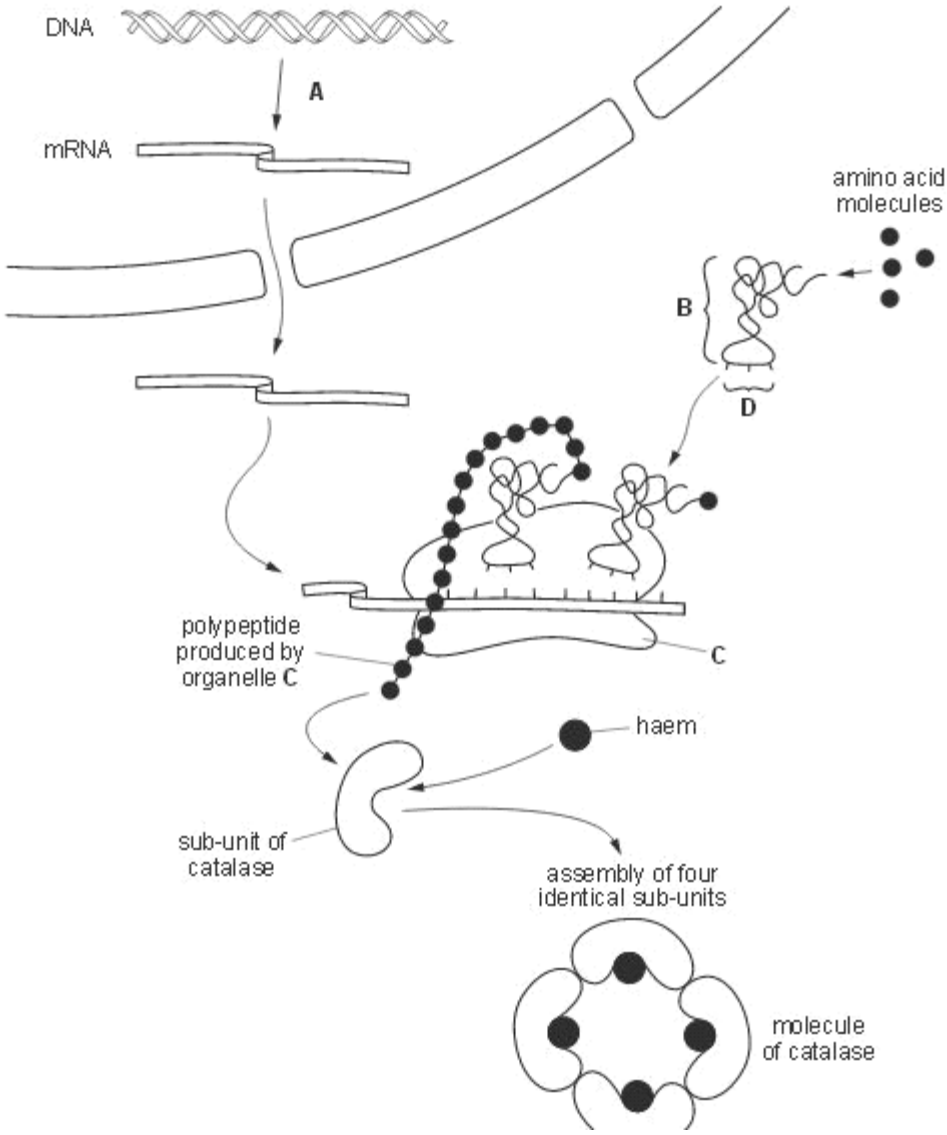
.....[5]

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.

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(a) With reference to Fig. 4.1,

(i) name

process **A** .....

molecule **B** .....

structure **C** .....

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

Q.5

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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.

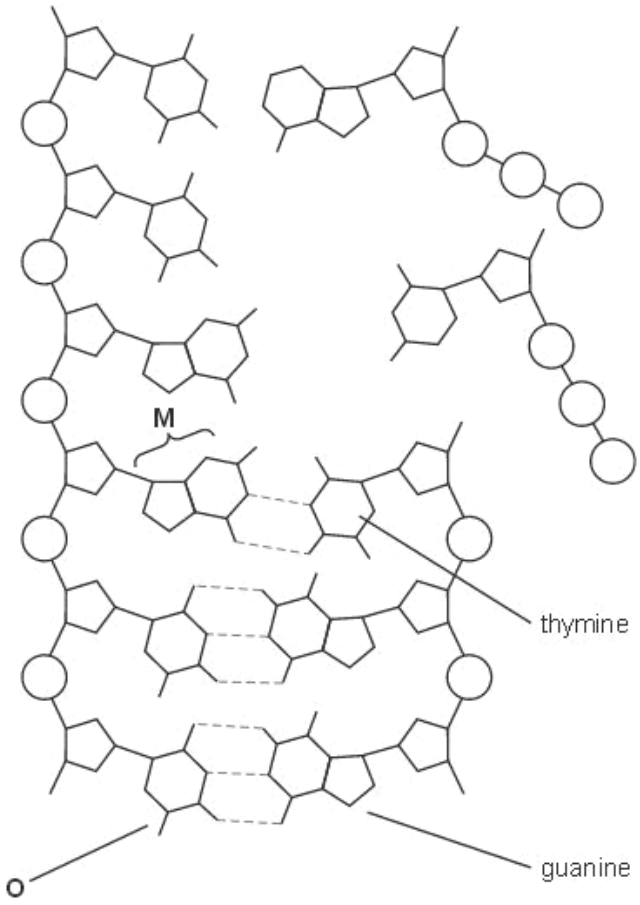


Fig. 5.1

(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]

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(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.

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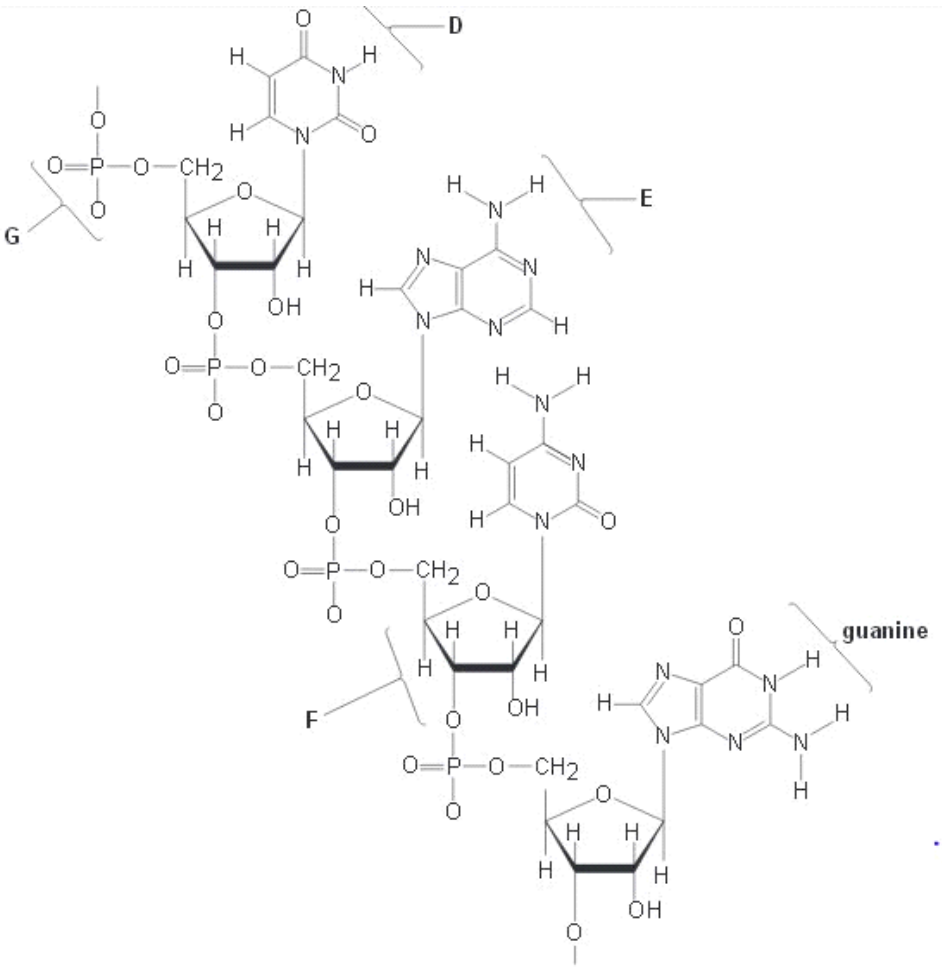


Fig. 3.1

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

D .....

E .....

F .....

G ..... [4]

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(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

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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]

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

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

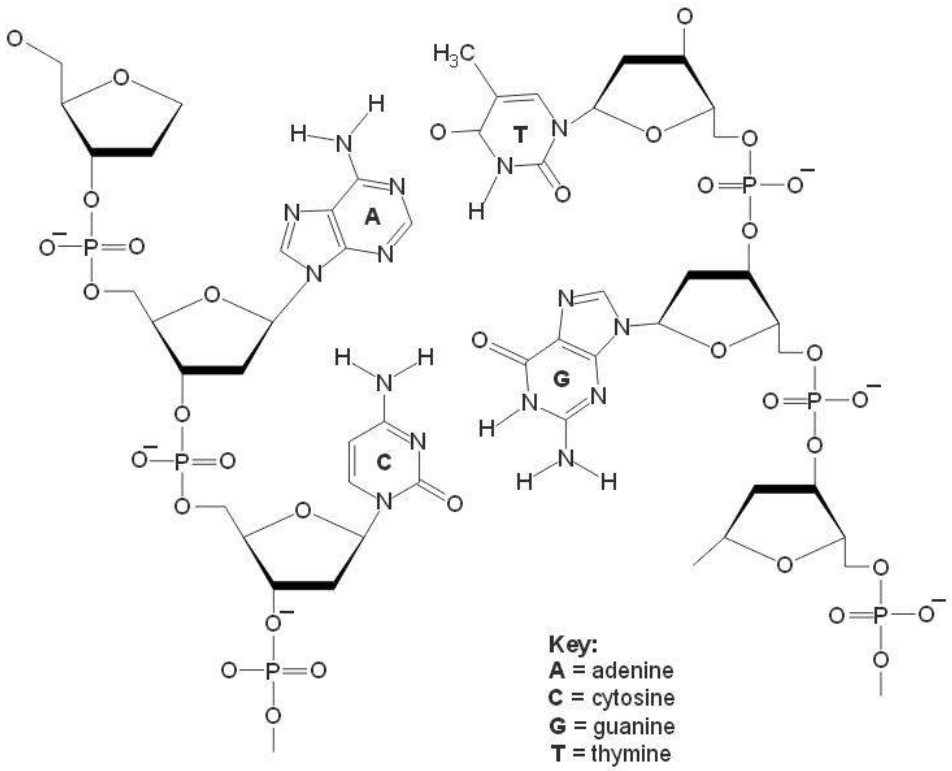
[Total: 11]

Q.8

16

6 Fig. 6.1 shows part of a DNA molecule.

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(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]

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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]

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(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.

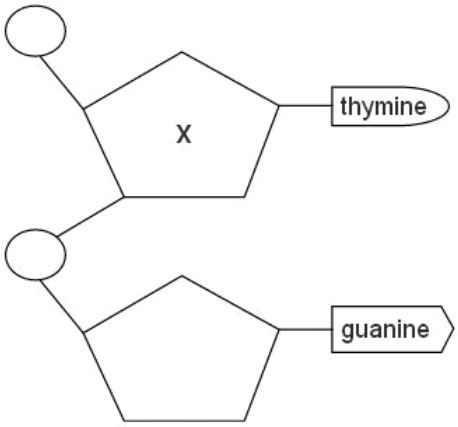


Fig. 4.1

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(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]

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(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

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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]

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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

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

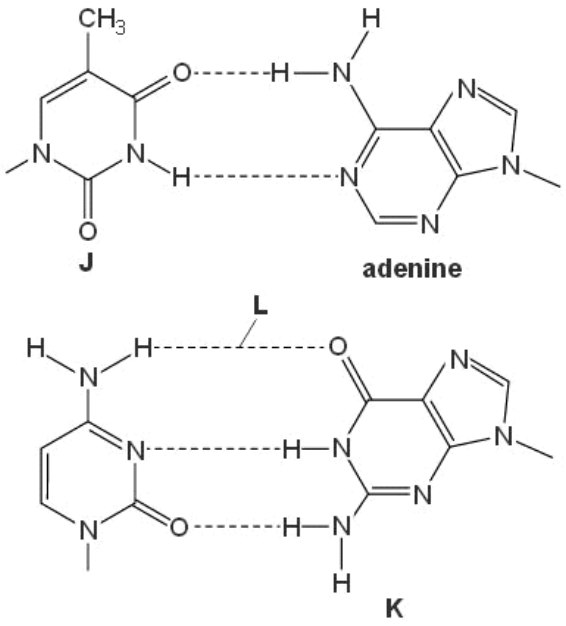


Fig. 4.1

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

J .....

K .....

L ..... [3]

Q.12

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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

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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]

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(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

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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

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(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

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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.

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Table 4.1

	replication	transcription
1		
2		
3		
4		

[4]

Q.18

5 Fig. 5.1 represents part of a DNA molecule.

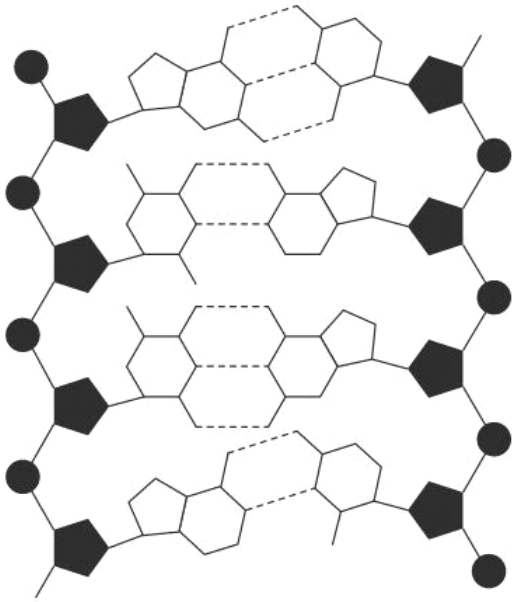


Fig. 5.1

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(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]

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(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]

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(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.

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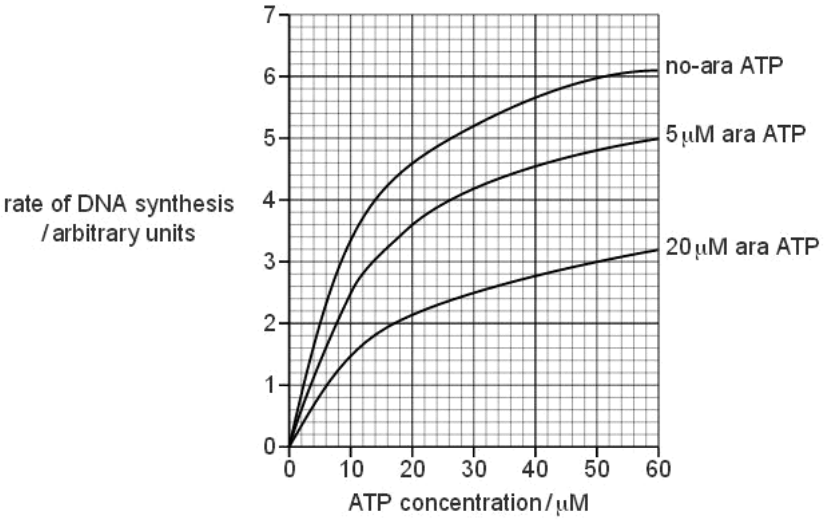


Fig. 5.1

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

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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.

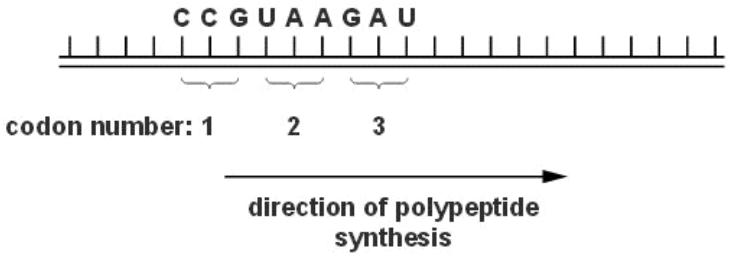


Fig. 5.1

(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]

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(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

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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]

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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.

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Nucleic acids and protein synthesis – AS 9700 Biology June 2022

1. June/2022/Paper_11/No.22

Bacterial cells with DNA containing only the 'heavy' isotope of nitrogen (^{15}N) are allowed to reproduce for three generations in a culture medium containing the normal isotope of nitrogen (^{14}N).

Which percentage of the DNA molecules produced contain strands with the heavy isotope of nitrogen?

	first generation %	second generation %	third generation %
A	50	25	12.5
B	75	50	25
C	100	50	25
D	100	75	50

2. June/2022/Paper_11/No.23

A bacterial circular DNA molecule is 2 600 150 base pairs long. 26% of the bases are adenine.

How many cytosine bases would be in the DNA molecule?

A 624 036 **B** 676 039 **C** 1 248 072 **D** 1 352 078

3. June/2022/Paper_11/No.24

Which statement relating to the structure of DNA is correct?

A Two DNA strands are joined to each other by phosphodiester bonds.

B The alignment of bases to form a double helix is only achieved between antiparallel strands.

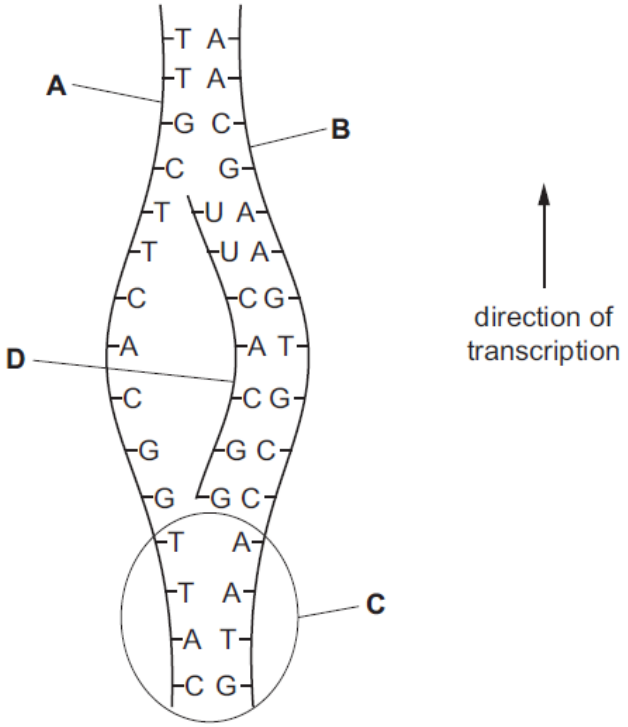
C Three hydrogen bonds are formed between all base pairs containing purines.

D The number of cytosine bases always equals the number of thymine bases.

4. June/2022/Paper_11/No.25

A student sketched a diagram to represent the process of transcription.

Which part of their diagram shows the non-transcribed strand?



5. June/2022/Paper_12/No.21

Which statement describes the structure of ATP?

A It is a DNA nucleotide with two extra phosphates.

B It is a DNA nucleotide with three extra phosphates.

C It is an RNA nucleotide with two extra phosphates.

D It is an RNA nucleotide with three extra phosphates.

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6. June/2022/Paper_12/No.23

The table shows the DNA triplet codes for some amino acids.

amino acid	DNA triplet code	amino acid	DNA triplet code
arginine	GCA	glycine	CCA
arginine	GCC	glycine	CCG
arginine	GCG	glycine	CCT
asparagine	TTA	lysine	TTC
asparagine	TTG	lysine	TTT
cysteine	ACA	proline	GGA
cysteine	ACG	proline	GGC
STOP	ATC	valine	CAC

The base sequence on the template DNA strand coding for part of a polypeptide is shown.

CCA ACG GCG TTA TTC GCA

Two mutations occur in this sequence during DNA replication.

Which mutated template DNA strand would result in a shorter polypeptide?

A CCA ACA GCA TTA TTC GCA

B CCA ACG CCG TTA TTC GCC

C CCA ACG GCG TTG ATC GCA

D CCT ACG GCG TTA TTC GGA

7. June/2022/Paper_13/No.12

RNA polymerase and peptidyl transferase are both enzymes involved in protein synthesis.

Which statements describe similarities between these two enzymes?

1 They are both globular proteins.

2 They both have the same tertiary structure.

3 They are both intracellular enzymes.

A 1 and 2 **B** 1 and 3 **C** 1 only **D** 2 and 3

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8. June/2022/Paper_13/No.22

Which statement about the transcription and translation of a gene is correct?

A The non-transcribed strand of DNA has a base sequence that is identical to the mRNA produced in transcription.

B The template strand of DNA has a base sequence that is identical to the mRNA produced in transcription.

C The non-transcribed strand of DNA has a base sequence that is complementary to the tRNA molecules required in translation.

D The template strand of DNA has a base sequence that is complementary to the tRNA molecules required in translation.

9. June/2022/Paper_13/No.23

Which statement about mRNA is correct?

A The primary transcript becomes modified by the joining of introns to become mRNA.

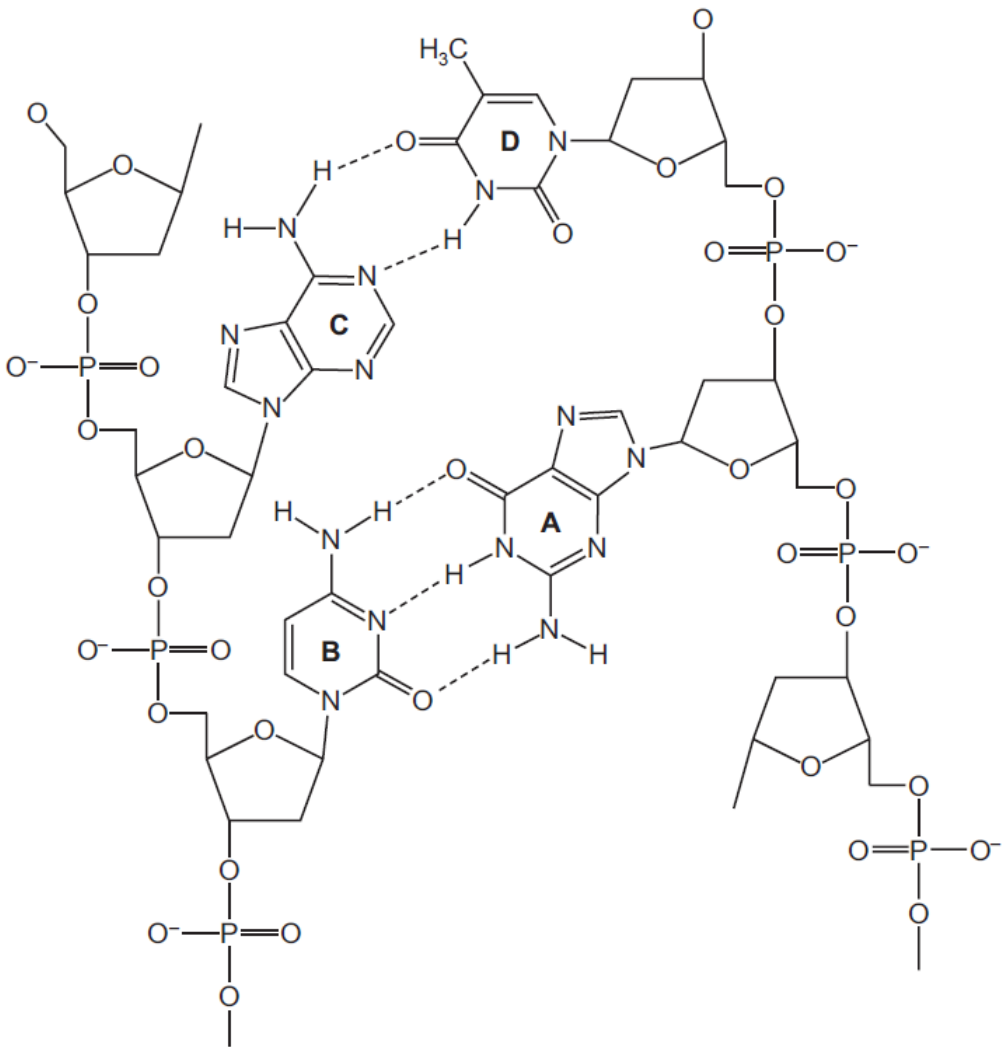
B The primary transcript is synthesised and then modified to mRNA in the nucleus.

C mRNA contains nucleotides containing the sugar deoxyribose.

D The bases in mRNA are held together by covalent bonds.

10. June/2022/Paper_13/No.24

The diagram shows part of a DNA molecule.



Which label is correct?

A adenine

B guanine

C cytosine

D thymine

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11. June/2022/Paper_13/No.25

The sequence of bases in DNA coding for the first eight amino acids in the β-polypeptide of adult haemoglobin is:

CAC GTG GAC TGA GGA CTC CTC TTC

However, in haemoglobin C, which is a cause of haemolytic anaemia, it becomes:

CAC GTG GAC TGA GGA TTC CTC TTC

Some of the DNA triplets that code for the amino acids are listed in the table.

amino acid	DNA triplet
Glu	CTC
His	GTG
Leu	GAG
Lys	TTC
Pro	GGA
Thr	TGA

Which change occurs to the amino acid sequence of normal haemoglobin to make it haemoglobin C?

A Glutamic acid is changed to lysine.

B Histidine is changed to leucine.

C Leucine is changed to lysine.

D Proline is changed to threonine.

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12. June/2022/Paper_21/No.6

The sinoatrial node, atrioventricular node and the Purkyne tissue have important roles in the cardiac cycle.

(a) State the precise location in the heart of the sinoatrial node.

..... [1]

(b) State the part of the cardiac cycle that is directly initiated by the wave of excitation sent out by the sinoatrial node.

..... [1]

(c) Part of the control of the cardiac cycle involves the contraction of the ventricle walls after the walls of the atria have finished contracting.

Outline how this control is achieved.

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..... [2]

(d) Name the valves of the heart that **open** soon after the Purkyne tissue has received an impulse from the atrioventricular node.

..... [1]

[Total: 5]

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Nucleic acids and protein synthesis – AS 9700 Biology Nov 2022

1. Nov/2022/Paper_11/No.22

Which nitrogenous bases are pyrimidines?

A adenine and thymine

B cytosine and guanine

C thymine and uracil

D uracil and guanine

2. Nov/2022/Paper_11/No.23

DNA replication in bacteria was investigated. Bacteria were grown in a medium with only heavy nitrogen, ^{15}N, until all of the bacterial DNA was heavy.

These bacteria were moved from the heavy nitrogen medium and cultured in a medium with only light nitrogen, ^{14}N. This formed the first generation.

The bacteria continued to reproduce, and a sample of bacteria was collected from the second generation and the DNA analysed.

Hybrid DNA contains heavy and light DNA.

Which row is correct for the second generation?

	percentage of heavy DNA strands	percentage of hybrid DNA molecules
A	25	25
B	25	50
C	50	25
D	50	50

3. Nov/2022/Paper_11/No.24

The sequence shows the series of bases at the start of a gene.

TAC CGA CCA CCA CAA CCA CGA...

After transcription, the mRNA was translated via tRNA into a sequence of amino acids. When this part of the polypeptide was analysed, it was found to contain the amino acids in the table.

amino acid	number present
Ala	2
Gly	3
Met	1
Val	1

What is the sequence of amino acids in this part of the polypeptide?

A Met Ala Gly Ala Gly Gly Val

B Met Ala Gly Gly Val Gly Ala

C Met Gly Ala Ala Val Ala Gly

D Met Gly Ala Ala Gly Gly Val

4. Nov/2022/Paper_11/No.25

The table shows the mode of action of two antibacterial drugs that can affect the synthesis of proteins.

antibacterial drug	rifampicin	streptomycin
mode of action	binds to RNA polymerase	causes errors in translation

If bacteria are treated with the drugs rifampicin **and** streptomycin, what will be the immediate effects?

1 Transcription will stop but faulty proteins may continue to be synthesised.

2 If translation has started, proteins may be faulty.

3 Translation will be inhibited.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

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5. Nov/2022/Paper_12/No.5

Which molecules are present in all viruses?

1 thymine

2 adenine

3 cytosine

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

6. Nov/2022/Paper_12/No.24

Which diagram correctly represents temporary hydrogen bonding during transcription?

A

A ------ U

B

C ------ G

C

G ------ C

D

T ------ U

7. Nov/2022/Paper_12/No.25

The diagram shows part of the DNA sequence of a gene and a mutated sequence of the same gene.

normal DNA sequence	...CCG GAT TAT TGC GAG AAA TGG CAT TCT AGG...
mutated DNA sequence	...CCG GAT GTA TTG CGA GAA ATG CAT TCT AGG...

What are possible effects of the mutated sequence?

1 the presence of mRNA stop codons, UAG, UAA or UGA

2 a change in the sequence of amino acids

3 a non-functional protein

4 ribosomes cannot translate the mRNA

A 1, 2 and 3 **B** 1, 3 and 4 **C** 1 and 4 only **D** 2 and 3 only

8. Nov/2022/Paper_12/No.23

A section of the polypeptide coding for the haemoglobin β-chain contains the following amino acids.

– Pro – Glu – Glu –

Patients with sickle cell anaemia have mutated β-polypeptide chains. The section of the mutated polypeptide contains the following amino acids.

– Pro – Val – Glu –

The table shows the possible anticodons for Val.

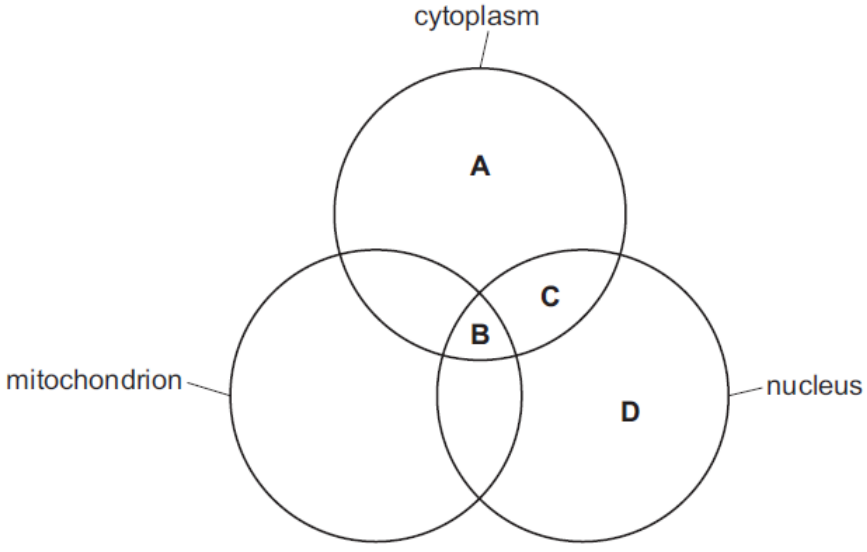
amino acid	anticodon
Val	C A A
Val	C A G
Val	C A C
Val	C A U

What is the corresponding DNA triplet code for the substituted amino acid in the mutated polypeptide?

A G T T **B** G A C **C** C T C **D** C A T

9. Nov/2022/Paper_13/No.3

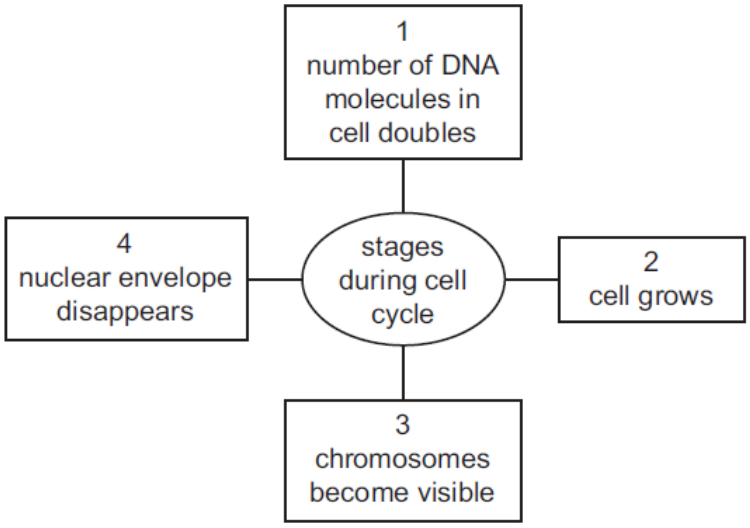
Which letter represents cell structures where mRNA may be found?



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10. Nov/2022/Paper_13/No.21

The diagram shows some of the stages that take place during the cell cycle.



Which two stages take place during interphase?

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

11. Nov/2022/Paper_13/No.22

What does a nucleotide contain?

1 an amino acid

2 a codon

3 a nitrogenous base

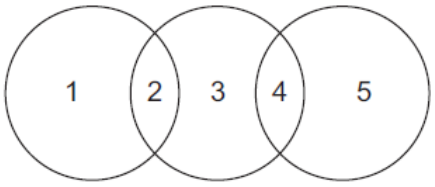
4 a sugar

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

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12. Nov/2022/Paper_13/No.23

A diagram can be used to show some relationships between different nucleic acid bases.



Which row is correct for the words that can be placed at positions 1–5?

	1	2	3	4	5
A	adenine	purine	cytosine	pairs with	guanine
B	cytosine	purine	guanine	pairs with	uracil
C	guanine	pairs with	cytosine	pyrimidine	thymine
D	thymine	pairs with	uracil	pyrimidine	adenine

13. Nov/2022/Paper_13/No.24

The bacterium *Escherichia coli* divides once every 50 minutes at 36 °C.

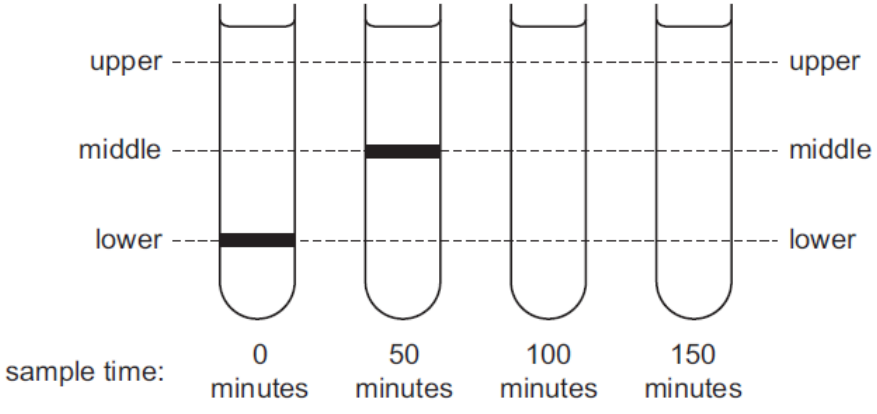
E. coli were grown on a medium containing only heavy nitrogen, ^{15}N, until all of the bacterial DNA contained heavy nitrogen.

Some of the bacteria were moved from a heavy nitrogen medium and cultured in a medium with only light nitrogen, ^{14}N (0 minutes).

These bacteria continued to reproduce and samples were extracted and centrifuged at regular intervals.

Hybrid DNA contains both heavy and light nitrogen.

The diagram shows the possible positions (upper, middle and lower) of the bands of DNA. The actual positions of bands in the first two samples are shown.



Which proportion of the DNA of the sample taken at 150 minutes will be at the upper position?

A 25% **B** 50% **C** 75% **D** 100%

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14. Nov/2022/Paper_13/No.25

Following translation, the alpha polypeptide chain of haemoglobin, α-globin, undergoes modification. During this modification, the first amino acid is removed, leaving 141 amino acid residues.

How many nucleotides does the mRNA coding for α-globin contain?

A 141 **B** 142 **C** 423 **D** 426

15. Nov/2022/Paper_21/No.3(b)

(b) A protein such as carbonic anhydrase is coded for by a gene. A gene forms part of a DNA molecule.

Fig. 3.1 is a diagram of a small section of a DNA molecule.

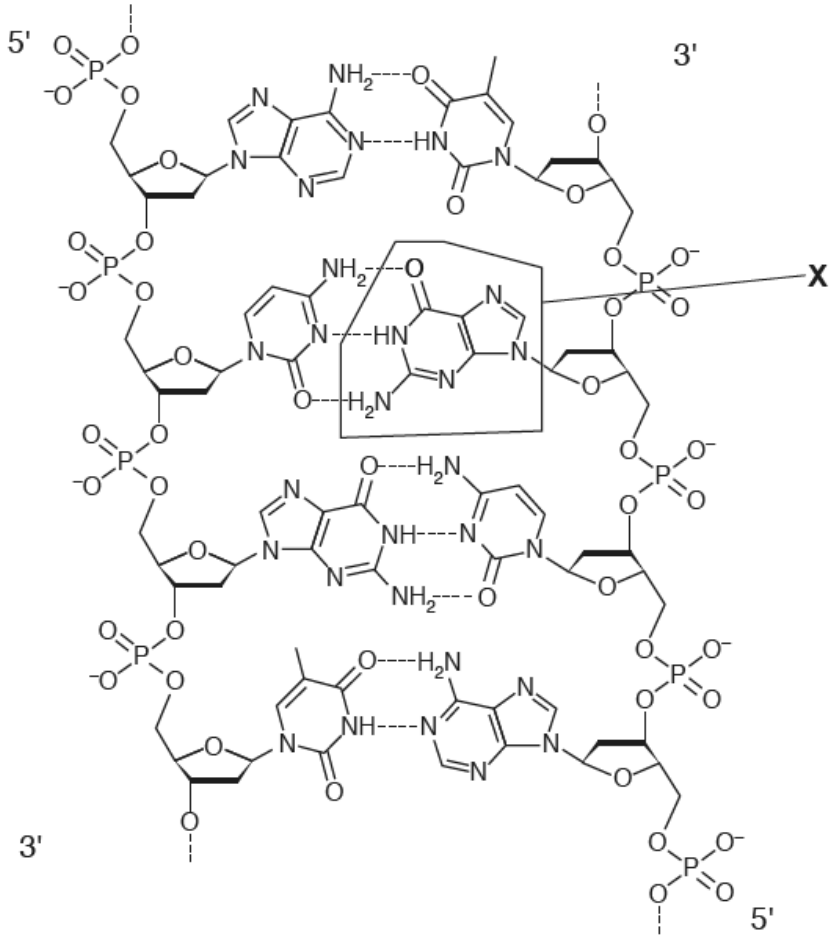


Fig. 3.1

(i) Identify the base **X and** state the evidence in Fig. 3.1 that supports this identification.

base **X** .....

evidence from Fig. 3.1 .....

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[3]

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(ii) The section of the DNA molecule in Fig. 3.1 is part of a gene coding for a polypeptide.

Base **X**, shown in Fig. 3.1, is located in an exon on the strand of DNA that is transcribed during protein synthesis. A mutation that results in the deletion of base **X** will affect the polypeptide produced.

Explain how this deletion may affect the polypeptide produced during protein synthesis.

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..... [4]

(iii) Gene mutations can occur in either introns or exons.

Suggest the effect of a gene mutation in an intron.

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16. Nov/2022/Paper_21/No.4(a)

(a) Scientists have produced structures known as virosomes, which are used in certain vaccines. Virosomes do **not** cause disease.

Fig. 4.1 is a diagram of a section through a virosome used in some vaccinations to protect against the virus which causes influenza.

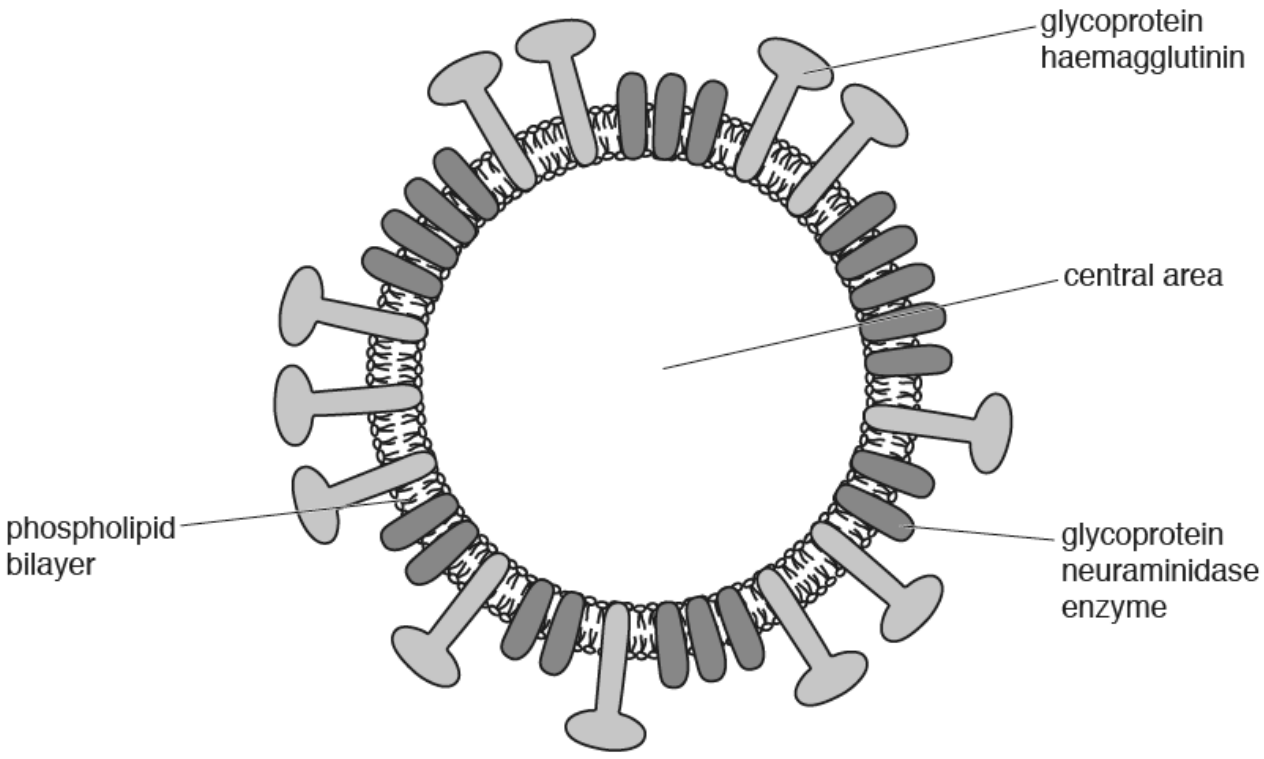


Fig. 4.1

(i) State the differences between the structure of a virosome and a virus.

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..... [2]

(ii) Explain how the structure of the virosome shown in Fig. 4.1 suggests that the central area of the virosome is aqueous.

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..... [2]

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17. Nov/2022/Paper_22/No.2(d_ f)

(b) The actual diameter of the HCMV shown in Fig. 2.1 is 0.17 micrometres (μm).

Calculate the actual diameter of the virus in nanometres (nm).

..... [1]

(c) Suggest the role of viral DNA polymerase within the host cell.

..... [1]

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(d) The virus in Fig. 2.1 is drawn as a spherical shape. Structure **T** is always the same shape. However, electron micrographs show that HCMV virions are not all the same shape.

Suggest how HCMV virions can be of different shapes.

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..... [2]

(e) With reference to Fig. 2.1**A**, state **one** similarity **and one** difference between the genetic material of HCMV and the genetic material of a typical bacterial cell.

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..... [2]

(f) HCMV is known to infect some types of human cell that carry out the mitotic cell cycle.

Studies have shown that in the presence of one tegument protein, UL69, the cell cycle stops in the G1 stage.

Outline the effects the presence of UL69 will have on the normal activity of the mitotic cell cycle.

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..... [3]

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18. Nov/2022/Paper_22/No.3(c)

(c) ACT can act on the stage of the life cycle of *P. falciparum* that occurs within red blood cells. The cells of *P. falciparum* in this stage are known as trophozoites.

Fig. 3.1 is a photomicrograph of a blood smear (thin layer of cells). Some of the red blood cells contain trophozoites.

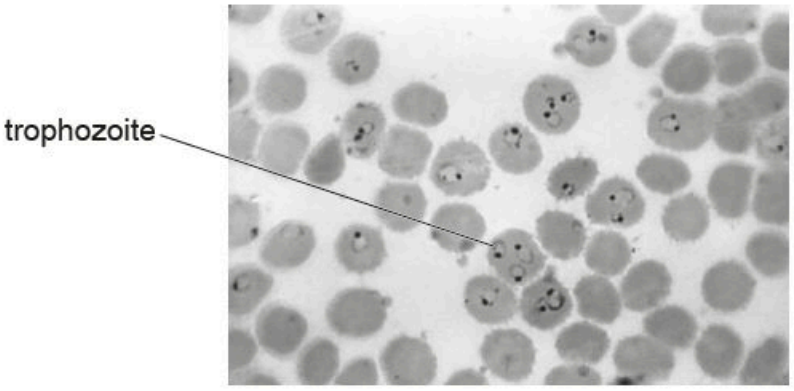


Fig. 3.1

PfK13 is a protein that has an important role in the development of the trophozoite stage of *P. falciparum*. The gene *kelch13* codes for PfK13.

Two different mutations of *kelch13*, known as F446I and C580Y, were investigated to see if they were associated with partial artemisinin resistance. Details of these mutations are summarised in Table 3.1.

Table 3.1

name of mutation	change in DNA		change in protein PfK13	
	nucleotide present in *kelch13*	nucleotide present after mutation	amino acid before mutation	amino acid after mutation
F446I	thymine (T)	adenine (A)	phenylalanine (phe)	isoleucine (ile)
C580Y	guanine (G)	adenine (A)	cysteine (cys)	tyrosine (tyr)

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(i) Using gene *kelch13* and mutation F446I as examples, explain the difference between a gene and a gene mutation.

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..... [3]

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19. Nov/2022/Paper_23/No.5(c_ d)

(c) The genetic code is described as universal.

Explain why the genetic code is described as universal.

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..... [1]

(d) Use Table 5.2 to explain why some mutations have no effect on the primary structure of a protein.

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..... [2]

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Nucleic acids and protein synthesis – AS 9700 June 2022

1. June/2023/Paper_9700/11/No.19

Which statement about messenger RNA is correct?

A In eukaryotic cells, mRNA is made by removing exons from the primary RNA transcript.

B mRNA is a single-stranded polynucleotide containing a different purine base than DNA.

C mRNA molecules contain ribose sugars joined to phosphate groups by phosphodiester bonds.

D The monomers of mRNA contain a phosphate group, deoxyribose sugar and a nitrogenous base.

2. June/2023/Paper_9700/11/No.20

Which structures are involved in transcription only?

	DNA template strand	anticodons	RNA polymerase
A	✓	✓	✗
B	✓	✗	✓
C	✗	✓	✗
D	✗	✗	✓

key

✓ = involved

✗ = not involved

3. June/2023/Paper_9700/11/No.21

One gene provides the code for the production of which type of molecule?

A amino acid

B DNA

C nucleotide

D polypeptide

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4. June/2023/Paper_9700/11/No.22

The table shows some mRNA codons that code for certain amino acids.

mRNA codon	amino acid
GCG, GCA, GCC, GCU	alanine
ACG, ACA, ACC, ACU	threonine
UGC, UGU	cysteine
UAC, UAU	tyrosine
CAG, CAA	glutamine
CGG, CGA, CGC, CGU	arginine

A DNA template strand has the base sequence shown.

ACAGTATTATTTGCAACG

What would the change in the amino acid be if the first base in the fifth DNA triplet was substituted for an A base?

A alanine to cysteine

B alanine to threonine

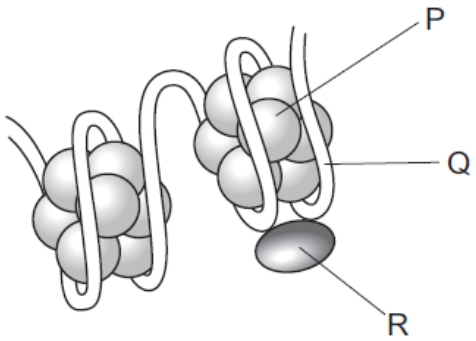
C arginine to cysteine

D arginine to threonine

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5. June/2023/Paper_9700/12/No.20

The diagram shows part of the organisation of a section of a DNA molecule and the associated histones, P and R, in prophase of mitosis.



Which statement about the features labelled P, Q and R during prophase of mitosis is correct?

A The coiled DNA molecule forms Q and wraps around histone R to form small clusters held in place by histone P.

B The groups of histones, P, and its associated DNA, Q, move closer together as the chromosome condenses around R.

C The histones P and R are made of protein around which the DNA molecule, Q, is wrapped so that the DNA molecule can fit inside the nucleus.

D The linked groups of histones P and R and the associated DNA, Q, form strands that fold and twist together to form a chromatid.

6. June/2023/Paper_9700/12/No.23

Which statement about mRNA is correct?

A It is a polymer made of nucleotides all joined with hydrogen bonds.

B Each nucleotide subunit contains the sugar ribose.

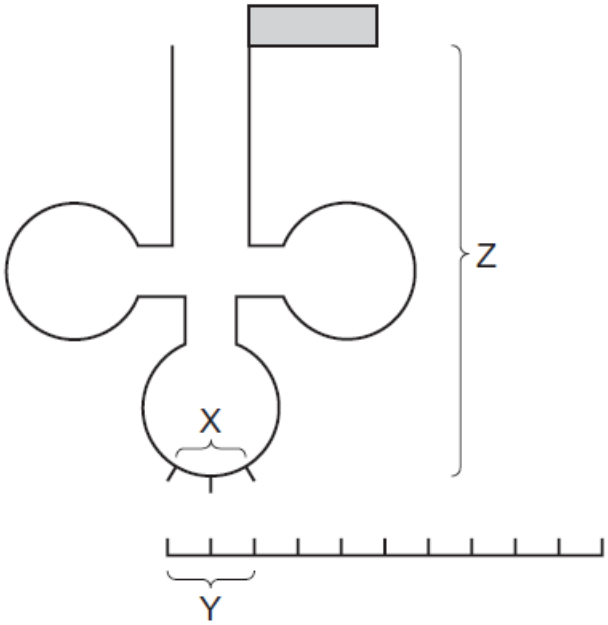
C It always has an equal proportion of adenine and uracil.

D The mRNA sequence is identical to the template strand of DNA.

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7. June/2023/Paper_9700/12/No.24

The diagram shows part of the process of translation.



What are the names of the structures labelled X, Y and Z?

	X	Y	Z
A	anticodon	codon	mRNA
B	anticodon	codon	tRNA
C	codon	anticodon	mRNA
D	codon	anticodon	tRNA

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8. June/2023/Paper_9700/12/No.25

The DNA triplets of genes are translated as amino acids or stop signals during protein synthesis. The table shows some of these triplets.

DNA triplet	name of amino acid
ATA	tyrosine
ATG	tyrosine
ACA	cysteine
ACG	cysteine
ATC	*stop signal*
ACC	tryptophan

What could be the effects of **one** substitution mutation in a triplet coding for tyrosine?

1 The triplet is translated as cysteine.

2 The triplet is translated as tryptophan.

3 The triplet is translated as tyrosine.

4 Translation stops at this triplet.

A 1, 2 and 3 **B** 1, 2 and 4 **C** 1, 3 and 4 **D** 2, 3 and 4

9. June/2023/Paper_9700/13/No.23

Which molecules make up the structure of ATP?

1 adenine

2 thymine

3 deoxyribose

4 phosphate

5 ribose

A 1, 2 and 3 **B** 1, 3 and 4 **C** 1, 4 and 5 **D** 2, 4 and 5

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10. June/2023/Paper_9700/13/No.24

A short piece of DNA, 19 base pairs long, was analysed to find the number of nucleotide bases in each of the polynucleotide strands. Some of the results are shown.

	number of nucleotide bases			
	A	C	G	T
strand 1				4
strand 2		7		5

How many cytosines were in strand 1?

A 2 **B** 3 **C** 5 **D** 7

11. June/2023/Paper_9700/13/No.25

Which statement about the role of DNA polymerase in the process of semi-conservative replication of DNA is correct?

A DNA polymerase forms the hydrogen bonds between complementary base pairs.

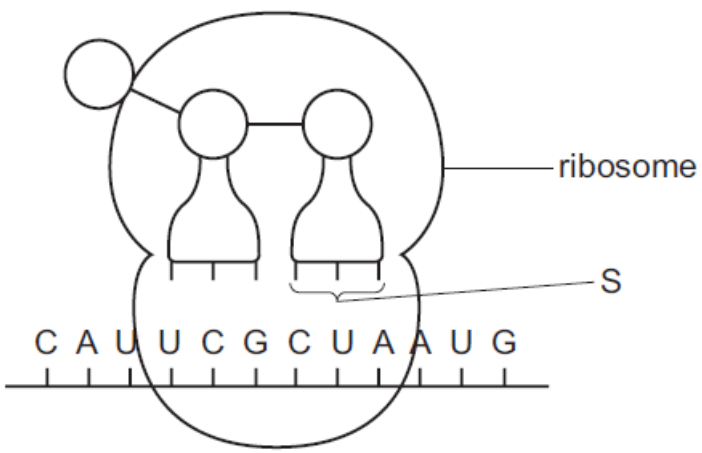
B DNA polymerase moves along the lagging strand in the 3′ to 5′ direction.

C DNA polymerase joins new bases to the leading strand only.

D DNA polymerase moves along leading and lagging strands in the 5′ to 3′ direction.

12. June/2023/Paper_9700/13/No.26

The diagram shows the process of translation occurring at a ribosome.



What is the base sequence at S?

A CUA **B** CAT **C** GAU **D** GAT

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13. June/2023/Paper_9700/21/No.4

The gene for the enzyme catalase is on chromosome 11 in humans.

(a) Explain the meaning of the term gene.

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..... [2]

(b) Two enzymes, DNA polymerase and DNA ligase, are involved in the replication of DNA.

Fig. 4.1 shows the replication of part of human chromosome 11 by DNA polymerase. The arrows show the direction of synthesis of the new polynucleotides by DNA polymerase.

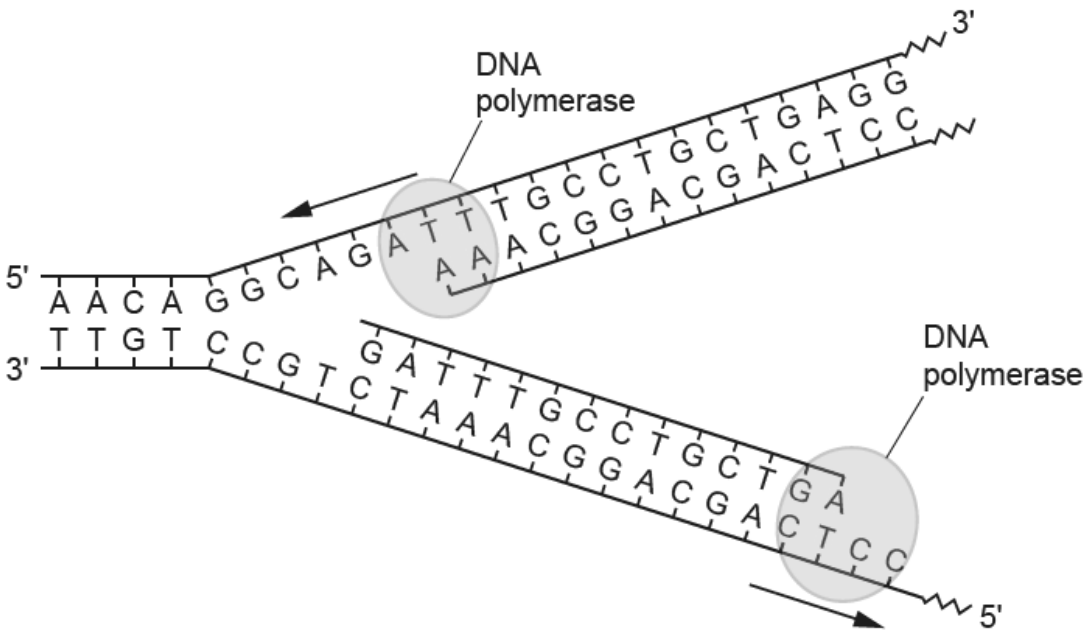


Fig. 4.1

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(i) Describe the roles of DNA polymerase and DNA ligase in the replication of DNA.

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..... [5]

(ii) State the name of the stage of interphase in the cell cycle when DNA replication occurs.

..... [1]

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(c) Fig. 4.2 is a diagram of chromosome 11 at metaphase of mitosis.

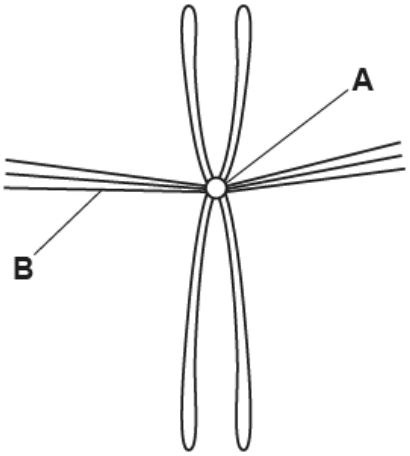


Fig. 4.2

(i) State the names **and** functions of structures **A** and **B**.

structure **A** .....

function .....

.....

structure **B** .....

function .....

.....

[2]

(ii) Complete Fig. 4.3 to show what happens to chromosome 11 in anaphase, so that the daughter nuclei are genetically identical.

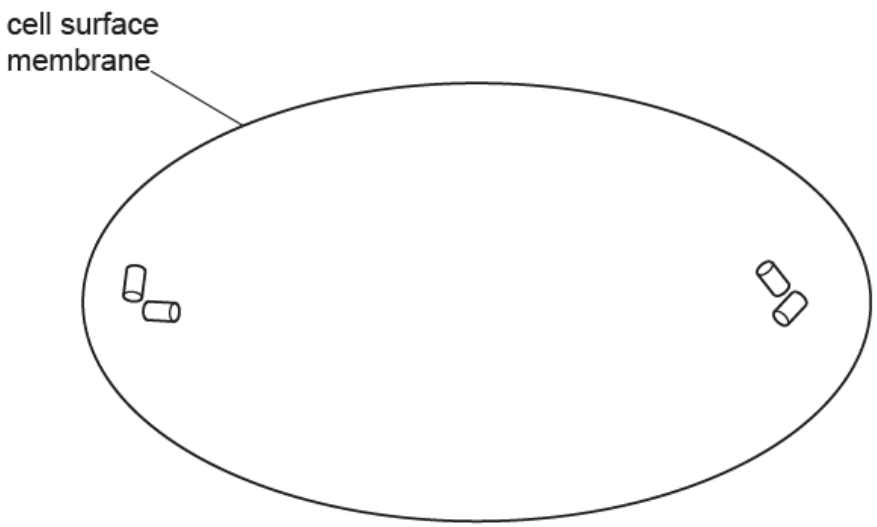


Fig. 4.3 [3]

[Total: 13]

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14. June/2023/Paper_9700/22/No.5

Nucleotide and nucleoside analogues are therapeutic drugs that have a similar structure to nucleotides or nucleosides of RNA and DNA.

A nucleoside is composed of a nitrogenous organic base (base) and a pentose sugar.

(a) The names of the bases present in RNA and DNA nucleotides can be abbreviated using a single letter. These are shown in Table 5.1.

Complete Table. 5.1 by stating:

- the name of each base
- whether the base is a purine **or** pyrimidine
- whether the base is present
  - **only** in an RNA molecule (write **RNA** in the table)
  - **only** in a DNA molecule (write **DNA** in the table)
  - in RNA **and** in DNA molecules (write the word **both** in the table).

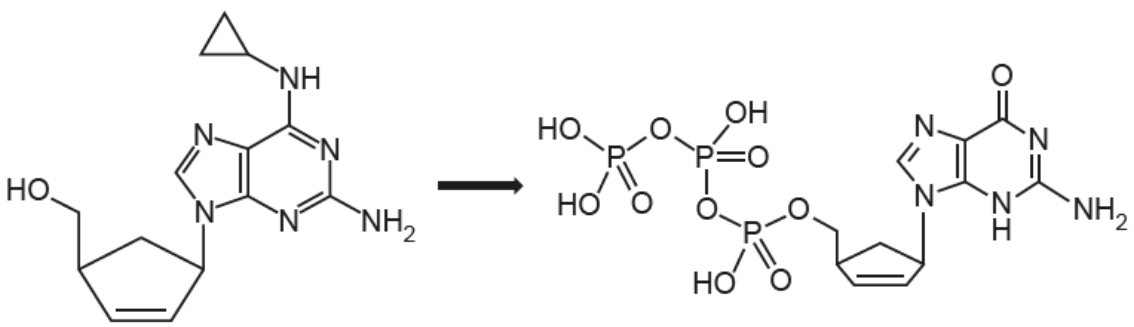
Table 5.1

base	name of base	purine or pyrimidine	present in RNA, DNA, or both
A			
C			
G			
T			
U			

[4]

(b) Abacavir is an analogue drug used in the treatment of some viral diseases. It enters a cell infected by a virus and is metabolised to the analogue carbovir triphosphate.

Fig. 5.1 shows the molecular structure of abacavir and carbovir triphosphate.



abacavir

carbovir triphosphate

Fig. 5.1

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Carbovir triphosphate can be inserted into an elongating polynucleotide chain instead of a nucleotide. This interferes with the action of DNA polymerase during the synthesis of viral DNA.

(i) With reference to Fig. 5.1, explain whether carbovir triphosphate will replace a purine or a pyrimidine nucleotide in the elongating polynucleotide chain.

.....

.....

..... [1]

(ii) With reference to Fig. 5.1 **and** the action of DNA polymerase, suggest why the conversion of abacavir to carbovir triphosphate increases the chance of the analogue being added to the viral polynucleotide chain.

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..... [2]

(iii) Suggest **and** explain how carbovir triphosphate interferes with the action of DNA polymerase **and** how this may prevent the synthesis of viral DNA.

.....

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.....

.....

..... [4]

[Total: 11]

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15. March/2023/Paper_9700/12/No.37

What defines infectious diseases?

A Symptoms are caused by a bacterium that passes from contaminated air, soil or water to a host.

B Symptoms are caused by a pathogen that is transmitted from one host to another.

C Symptoms are caused by a microorganism that is carried by a vector.

D Symptoms are caused by a virus that mutates to infect a new species.

16. March/2023/Paper_9700/12/No.38

A hurricane destroys a large town on an island. People move away from the town and set up tents, where sanitation is poor.

Which disease is most likely to spread within a week of the change in living conditions?

A cholera

B HIV

C malaria

D TB

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17. March/2023/Paper_9700/22/No.4

Tuberculosis (TB), influenza and polio are examples of infectious diseases.

(a) **(i)** Explain what is meant by an infectious disease.

.....

.....

.....

.....

..... [2]

(ii) Name a species of organism that causes TB.

..... [1]

(b) Immunity can be described as artificial or natural **and** passive or active.

Name the type of immunity that a mother gives to her baby through breast milk.

..... [1]

(c) The influenza virus can mutate frequently to produce different strains of the virus. A new vaccine is often necessary to stimulate the production of new antibodies to these new strains.

Explain why different antibodies need to be produced to give immunity to these new strains.

.....

.....

.....

.....

.....

.....

..... [3]

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(d) Polio is a serious viral disease affecting young children. In 1996, polio caused paralysis in more than 75 000 children across Africa. A long-term vaccination programme allowed the World Health Organization (WHO) to declare that Africa was largely free of polio in 2020.

(i) Explain how vaccination programmes can help to control the spread of infectious diseases, such as polio.

.....

.....

.....

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.....

.....

..... [3]

(ii) Antibiotics, such as penicillin, do **not** help to prevent the spread of viral diseases, such as polio.

Explain why penicillin is **not** effective against viruses.

.....

.....

..... [1]

[Total: 11]

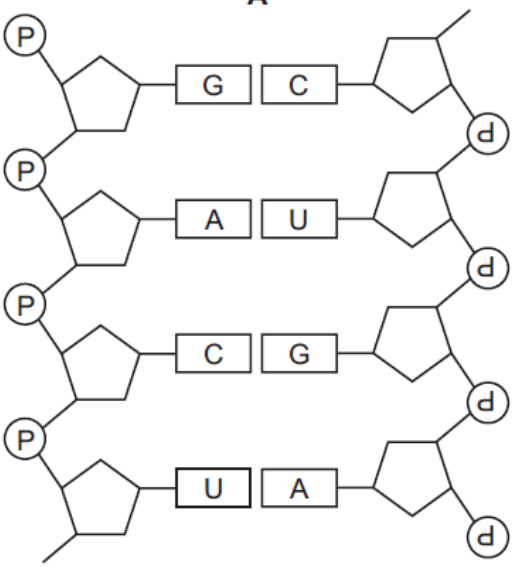
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Nucleic acids and protein synthesis – AS 9700 November 2023

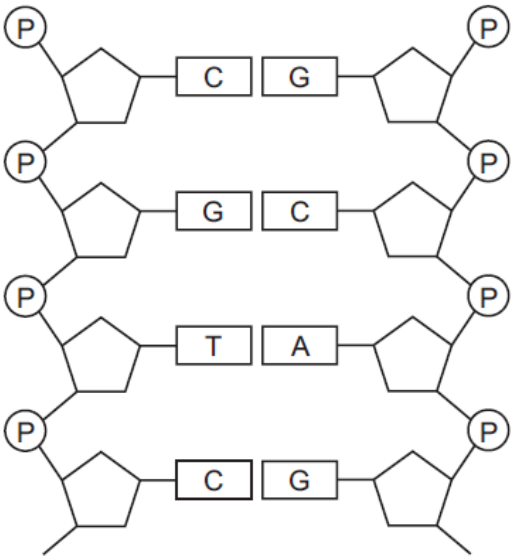
1. Nov/2023/Paper_ 9700/11/No.22

Which diagram correctly shows the structure of a piece of DNA?

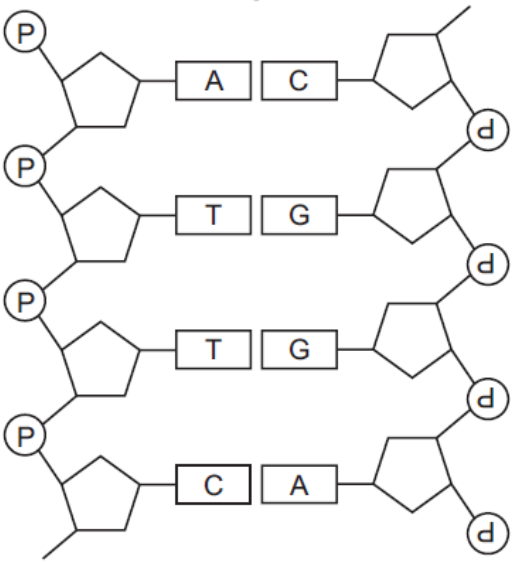
A



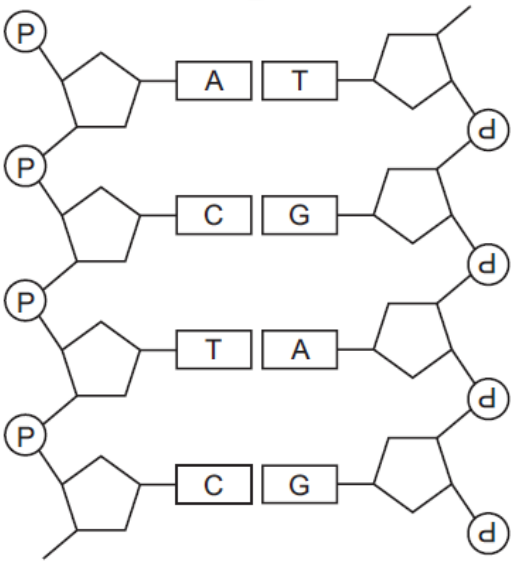
B



C



D



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2. Nov/2023/Paper_ 9700/11/No.23

Bacteria were grown in a medium containing ^{15}N. After several generations, all of the bacterial DNA contained ^{15}N. Some of these bacteria were transferred to a medium containing the common isotope of nitrogen, ^{14}N. The bacteria were allowed to divide once. The DNA of some of these bacteria was extracted and analysed. This DNA was all hybrid DNA containing equal amounts of ^{14}N and ^{15}N.

The remaining bacteria were left in the medium with ^{14}N and allowed to divide one more time. The DNA of some of these bacteria was extracted and analysed.

What is the percentage of hybrid DNA?

A 25% hybrid DNA

B 50% hybrid DNA

C 75% hybrid DNA

D 100% hybrid DNA

3. Nov/2023/Paper_ 9700/11/No.24

Which statements correctly describe the process of transcription?

1 mRNA is decoded by a ribosome to produce a specific amino acid chain.

2 A section of DNA is converted to RNA by RNA polymerase.

3 tRNA transfers amino acids to the ribosome.

A 1 and 3 **B** 1 only **C** 2 and 3 **D** 2 only

4. Nov/2023/Paper_ 9700/11/No.25

Sickle cell anaemia is caused by a mutation in an allele of the gene that codes for the β-globin polypeptide of haemoglobin.

The diagram shows the sequence of bases in a small section of the template strand of DNA for both the Hb^A (normal) and Hb^S (sickle cell) β-globin alleles.

Hb^A CTGACTCCTGAGGAGAAGTCT

Hb^S CTGACTCCTGTGGAGAAGTCT

Both the polypeptides for Hb^A and Hb^S are the same length.

How will the mutation in the allele result in the production of an altered version of the β-globin polypeptide?

A A tRNA molecule with the anticodon GUG will form hydrogen bonds with the altered codon on mRNA.

B All the amino acids coded for after the mutation will differ from those in the Hb^A protein.

C mRNA transcribed from the Hb^S allele will contain the codon CAC instead of the codon CTC.

D The ribosome will be unable to continue translation of the Hb^S mRNA after the altered codon.

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5. Nov/2023/Paper_ 9700/12/No.21

Which statement correctly describes a feature of a DNA molecule?

A It has two parallel strands twisted into a double helix.

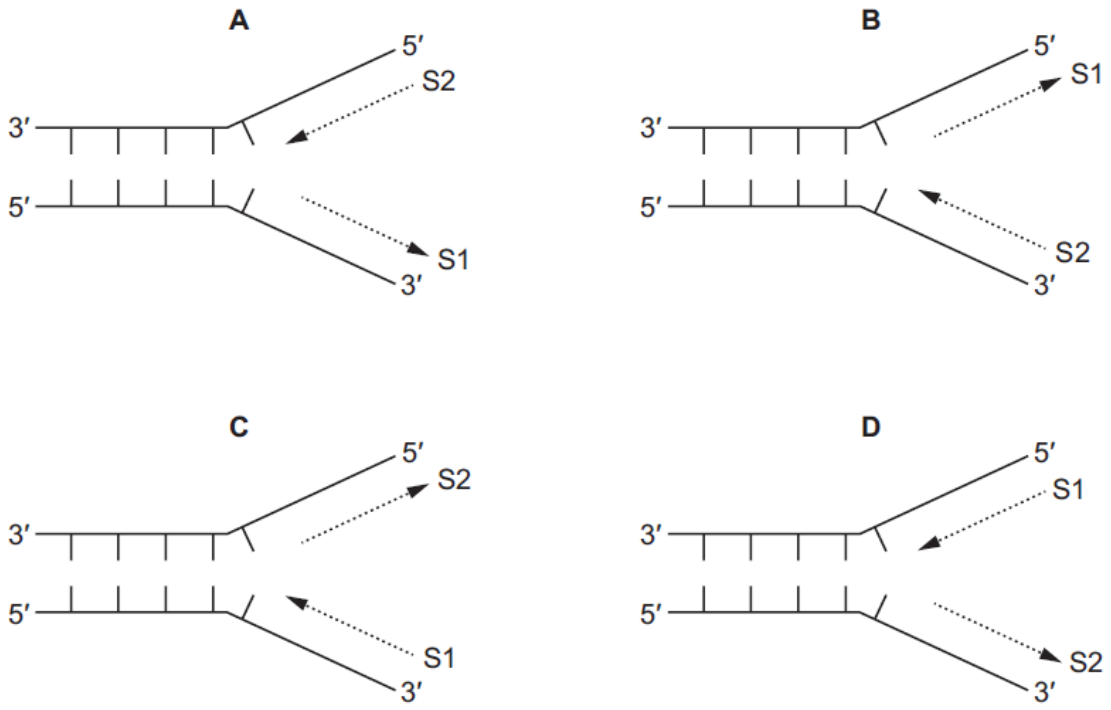
B It has complementary bases all held together by three hydrogen bonds.

C It has phosphodiester bonds that are formed using DNA ligase.

D It has a backbone of phosphate molecules and nucleotides.

6. Nov/2023/Paper_ 9700/12/No.22

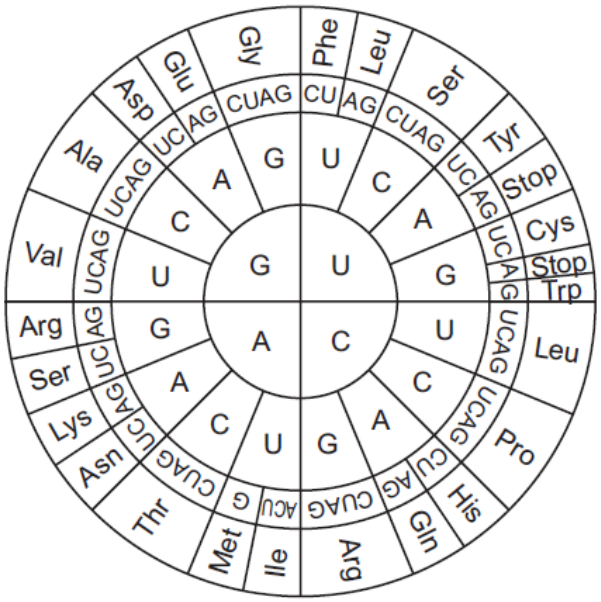
Which diagram correctly shows the replication of DNA?



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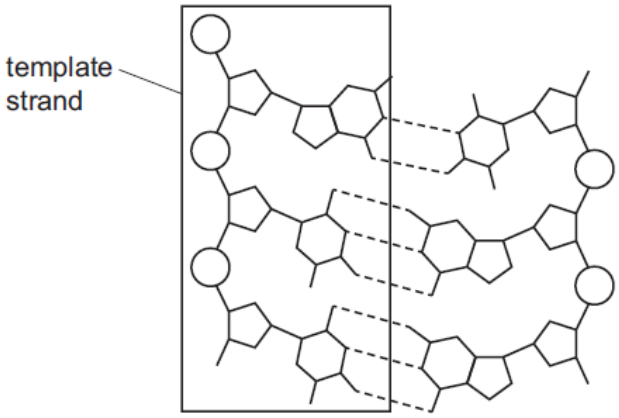
7. Nov/2023/Paper_ 9700/12/No.23

The RNA codon wheel is a tool used to find which amino acid would be translated from an mRNA sequence.



Codon position 1 is in the centre of the wheel, codon position 2 is in the middle of the wheel and codon position 3 is near the edge of the wheel. The three letters on the outside edge of the wheel identify the amino acid.

The diagram shows a section of DNA coding for one amino acid. The template strand is outlined in a box and the DNA base sequence is read in the 5′ to 3′ direction.



Which amino acid is coded for by this section of DNA?

A Gly **B** Pro **C** Trp **D** Thr

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8. Nov/2023/Paper_ 9700/13/No.22

During lagging strand replication, short fragments of DNA are produced. The fragments are joined together by DNA ligase.

Which row correctly describes the structure of these short fragments of DNA?

	have base sequences that are complementary to the newly synthesised leading DNA strand	consists of one polynucleotide strand	contains only carbon, hydrogen, oxygen and nitrogen
A	✗	✗	✓
B	✗	✓	✗
C	✓	✗	✓
D	✓	✓	✗

key

✓ = correct

✗ = not correct

9. Nov/2023/Paper_ 9700/13/No.23

The genome of the bacterium *Escherichia coli* has been altered to enable it to code for an amino acid that is not found in nature. All the ATC DNA stop triplets on the strand of DNA that is transcribed have been substituted to ATT. The ATC triplet can then be inserted to code for the new amino acid. A new tRNA can then be constructed to carry the new amino acid.

What is the anticodon of this new tRNA?

A ATC **B** AUC **C** TAG **D** UAG

10. Nov/2023/Paper_ 9700/13/No.24

40% of the bases in a section of a non-transcribed strand of DNA are purine molecules.

What will be the total percentage of cytosine **and** uracil bases in the primary transcript that is transcribed from the other strand of the DNA?

A 20% **B** 30% **C** 40% **D** 60%

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(a) (i) State the name of the phase of the mitotic cell cycle during which DNA replication occurs.

..... [1]

(ii) During research, scientists can use modified nucleotides to prevent elongation of a polynucleotide chain during DNA replication.

Fig. 6.1 shows the structure of a DNA nucleotide found in the nucleus of a cell.

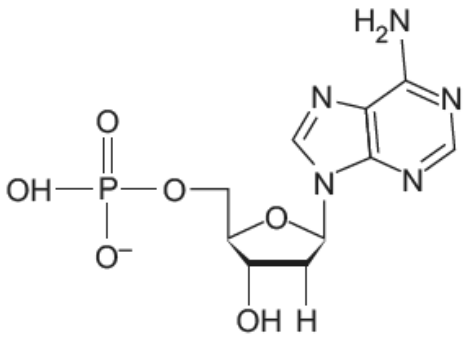


Fig. 6.1

Fig. 6.2 shows the structure of a modified nucleotide.

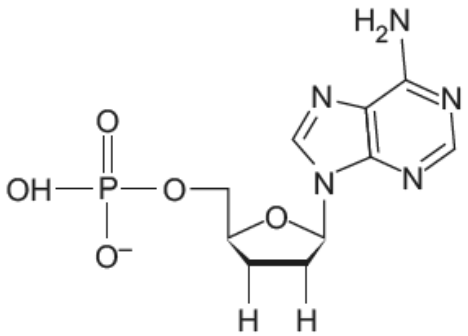


Fig. 6.2

Suggest how the structure of the modified nucleotide prevents DNA polymerase joining it to another nucleotide.

.....

.....

.....

.....

..... [2]

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(b) RNA aptamers are short, single-stranded RNA molecules that can be used to study some infectious diseases.

Scientists studying an infectious disease in animals investigated the effect of RNA aptamers on the activity of RNA polymerase that is produced by the pathogen.

The aptamers bind to a specific region of the RNA polymerase.

Table 6.1 shows the effect of two aptamers, F47 and F52, on the activity of RNA polymerase produced by the pathogen.

Table 6.1

aptamer present	V_{max} of RNA polymerase / arbitrary units	K_m of RNA polymerase / arbitrary units
none	1664	346
F47	1072	508
F52	1467	523

(i) With reference to Table 6.1, compare the effect of the aptamers on the affinity of RNA polymerase for its substrate.

.....

.....

.....

..... [2]

(ii) With reference to Table 6.1, suggest explanations for the effect of the presence of an aptamer on the rate of transcription catalysed by the RNA polymerase.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 8]

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12. Nov/2023/Paper_ 9700/23/No.4

Fig. 4.1 is a diagram showing the transcription of part of the *COL1A2* gene that codes for a collagen polypeptide. The part of the *COL1A2* gene shown is a section of exon. Structure **A** represents an enzyme involved in transcription.

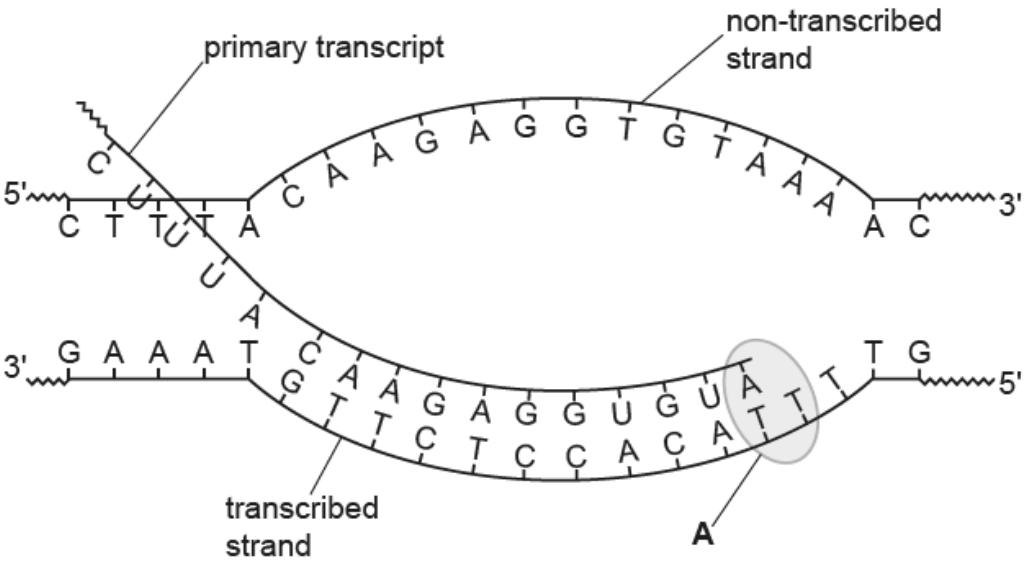


Fig. 4.1

(a) (i) Name the enzyme labelled **A** in Fig. 4.1.

..... [1]

(ii) Name the bond that forms between the nucleotides in the primary transcript.

..... [1]

(b) (i) State the number of amino acids that are coded for by the sequence of nucleotides on the primary transcript shown in Fig. 4.1.

..... [1]

(ii) Use the information in Fig. 4.1 to explain why one of the strands of DNA is **not** transcribed.

.....

.....

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.....

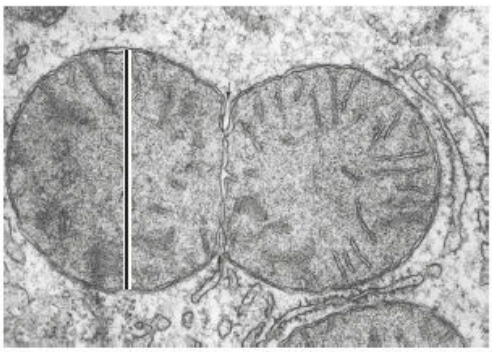
.....

..... [2]

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(c) New mitochondria are formed when a mitochondrion divides into two.

Fig. 4.2 is a transmission electron micrograph of a mitochondrion that is dividing.



magnification ×50 000

Fig. 4.2

(i) State **two** features of mitochondria that are **visible** in Fig. 4.2.

1 .....

2 .....

[2]

(ii) The line on Fig. 4.2 shows the diameter of one of the mitochondria.

Calculate the actual diameter of the mitochondrion.

Give your answer to one significant figure.

answer = ... μm [1]

(d) Mitochondrial DNA codes for some polypeptides of proteins used within the mitochondrion. Some of the proteins allow movement of ions into and out of the mitochondria.

Outline the ways in which ions can move into mitochondria.

.....

.....

.....

.....

.....

..... [3]

[Total: 11]

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