

# Nucleic acids and protein synthesis

## Question Paper 1

Level	International A Level
Subject	Biology
Exam Board	CIE
Topic	Nucleic acids and Protein synthesis
Sub Topic	
Booklet	Multiple Choice
Paper Type	Question Paper 1

Time Allowed : 48 minutes

Score : / 40

Percentage : /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 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
<b>A</b>	AU	2	CG	2
<b>B</b>	AU	2	Cg	3
<b>C</b>	AU	2	TU	2
<b>D</b>	AU	3	Cg	2

2 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
<b>A</b>	✓	✓	✓
<b>B</b>	✓	✓	x
<b>C</b>	✓	x	✓
<b>D</b>	x	✓	x

key

✓ = correct statement

x = incorrect statement

3 The protein p53 is produced in a cell in response to DNA damage.

A scientist exposed three groups of cells, X, Y and Z, to different conditions.

group of cells	conditions cells were exposed to
X	ionising radiation
Y	ultra-violet light
Z	nicotine

In which groups of cells would the scientist find large quantities of p53 mRNA?

**A** X, Y and Z    **B** X and Y only    **C** Y and Z only    **D** Y only

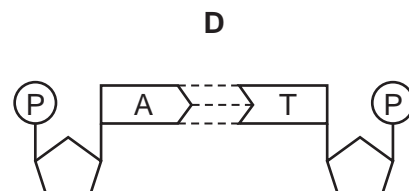
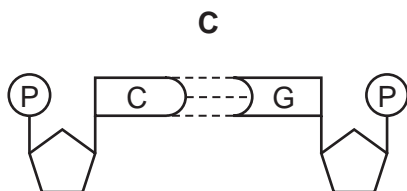
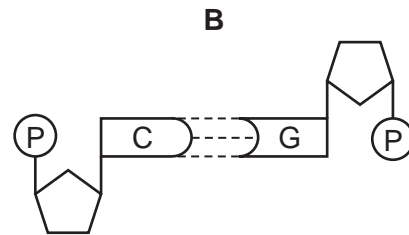
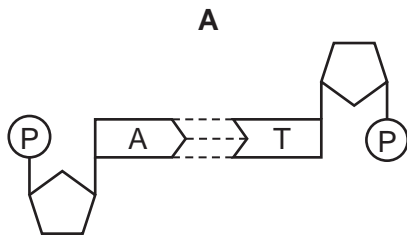
4 What is needed to transcribe DNA?

- A DNA ligase
- B DNA polymerase
- C ribosomes
- D RNA polymerase

5 Which row correctly describes adenine?

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

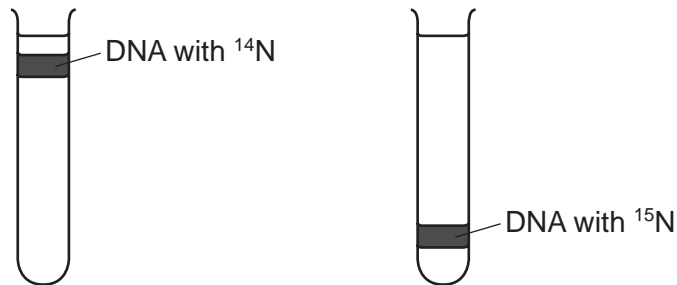
6 Which diagram represents a correct base pair of DNA?



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

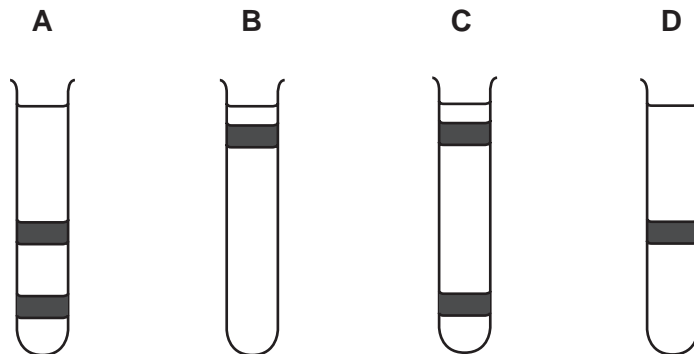
One set was grown in a medium containing the 'heavy' isotope of nitrogen,  $^{15}\text{N}$ , until all the DNA was labelled. The other set were grown in a medium containing the 'light' isotope of nitrogen,  $^{14}\text{N}$ , until all the DNA was labelled.

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  $^{15}\text{N}$  labelled DNA were transferred to a medium containing  $^{14}\text{N}$  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?



- 8 Which nucleic acid bases are pyrimidines?

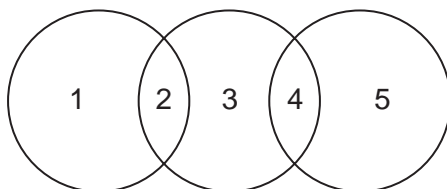
- A adenine and guanine
- B adenine, cytosine and thymine
- C cytosine, thymine and uracil
- D guanine, cytosine and uracil

- 9 A short piece of DNA fifteen 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 adenine (A) were present in strand 2?

- A 2                      B 3                      C 4                      D 6
- 10 The diagram shows some relationships between different nucleic acid bases.



Which row is correct?

	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

- 11 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

- 12 Which type of molecule is the end product of translation?
- A amino acid
  - B mRNA
  - C polypeptide
  - D tRNA
- 13 What is the **minimum** number of hydrogen bonds in a length of DNA containing 700 nucleotides?
- A 350                      B 700                      C 1050                      D 1400
- 14 During semi-conservative replication of DNA in eukaryotic cells, the following processes occur.
- 1 Free nucleotides are hydrogen bonded to those on the exposed strand.
  - 2 Hydrogen bonds are broken between the complementary base pairs.
  - 3 The cell receives the signal to begin to divide.
  - 4 Covalent bonds form between adjacent nucleotides on the same strand.
  - 5 The DNA double helix is unwound.

Which shows the correct order of some of the processes?

- A 3 → 1 → 2 → 4
- B 3 → 2 → 4 → 5
- C 5 → 2 → 1 → 4
- D 5 → 2 → 3 → 1

15 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.

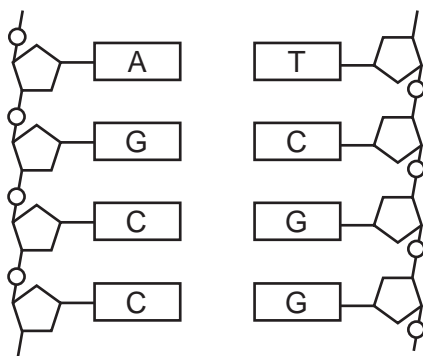
Which row correctly matches a drug to an explanation of the mechanism of action?

	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
<b>A</b>	aphidicholine	epirubicin	cytarabine	hydroxycarbamide
<b>B</b>	epirubicin	cytarabine	hydroxycarbamide	aphidicholine
<b>C</b>	hydroxycarbamide	aphidicholine	epirubicin	cytarabine
<b>D</b>	hydroxycarbamide	epirubicin	cytarabine	aphidicholine

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

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

17 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

18 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



19 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  $^{15}\text{N}$  DNA.
- Q All bacteria contain hybrid DNA ( $^{15}\text{N}$  DNA and  $^{14}\text{N}$  DNA).
- R Bacteria contain either all  $^{14}\text{N}$  DNA or hybrid DNA.
- S Bacteria grown in a  $^{15}\text{N}$  medium for many generations.
- T Bacteria transferred to a  $^{14}\text{N}$  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

20 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

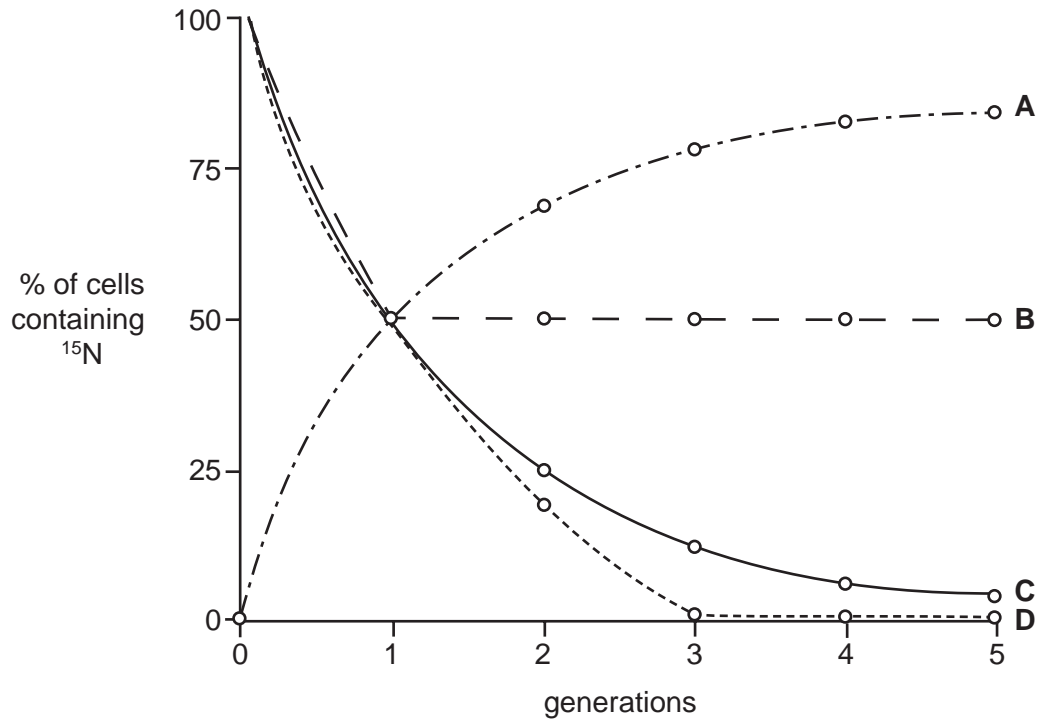
21 In the DNA sequence for sickle cell anaemia, adenine replaces thymine in a CTT triplet, forming the triplet CAT. During synthesis of the sickle cell haemoglobin molecule, the amino acid valine is incorporated instead of glutamic acid.

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

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

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

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

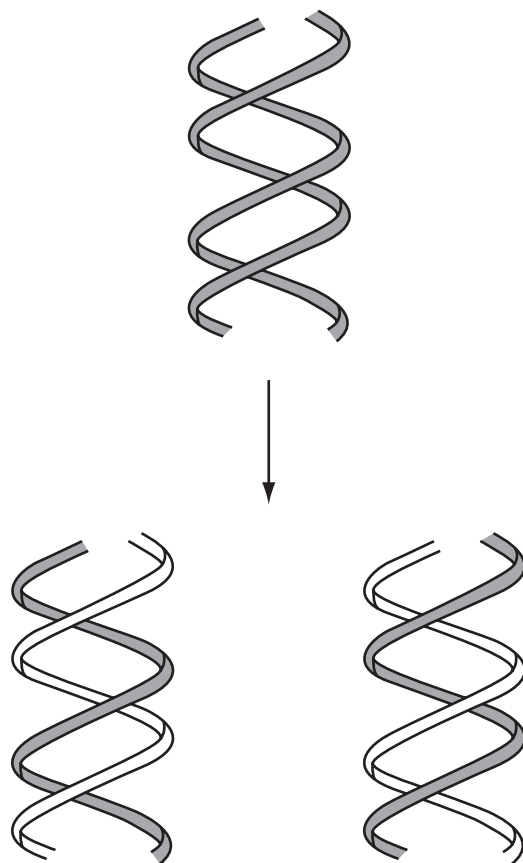


- 23 The table shows the sugars and some bases found in RNA and DNA.

Which is correct?

	RNA	DNA
<b>A</b>	ribose	thymine
<b>B</b>	ribose	uracil
<b>C</b>	thymine	deoxyribose
<b>D</b>	uracil	ribose

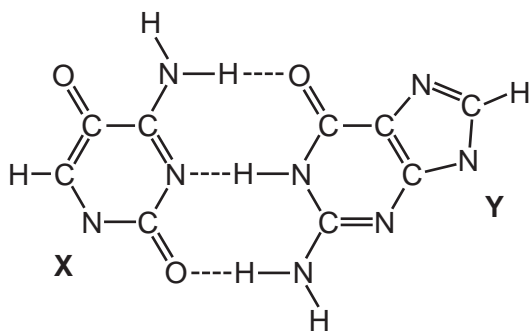
24 The diagram shows a process involving DNA.



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

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



What are the correct bases?

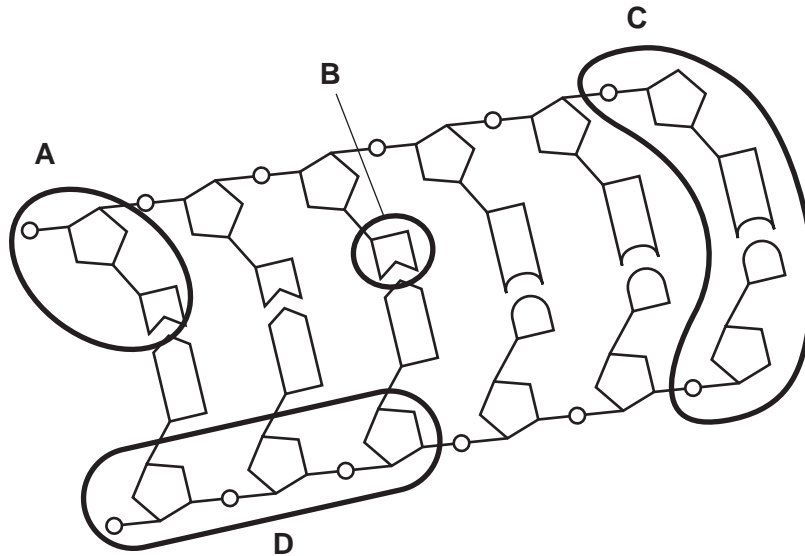
	<b>X</b>	<b>Y</b>
<b>A</b>	adenine	cytosine
<b>B</b>	adenine	uracil
<b>C</b>	cytosine	guanine
<b>D</b>	cytosine	thymine

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

	type of sugar	bonds linking complementary bases
<b>A</b>	hexose	hydrogen
<b>B</b>	hexose	peptide
<b>C</b>	pentose	hydrogen
<b>D</b>	pentose	peptide

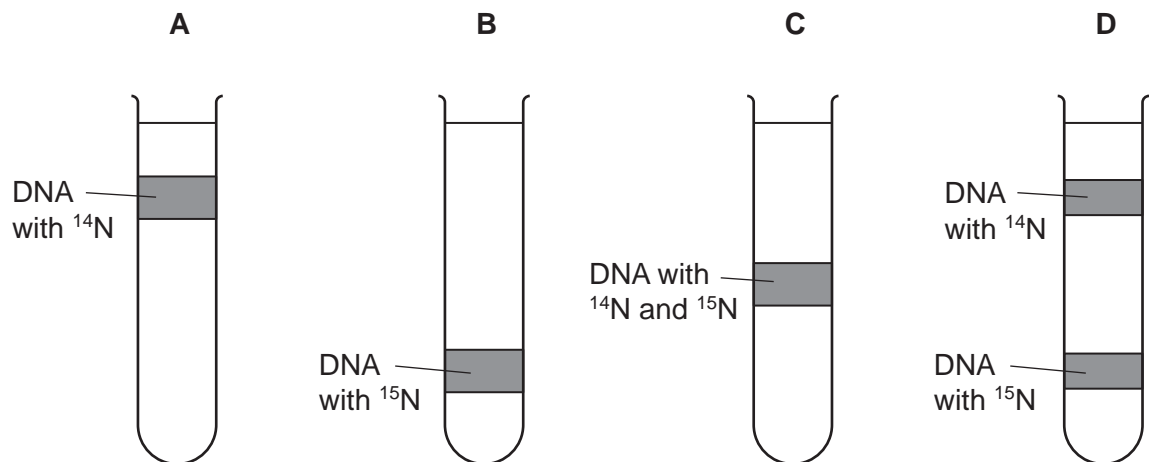
27 The diagram shows part of a DNA molecule.

Which part is a nucleotide?



28 Bacteria were grown for many generations in a medium containing a heavy isotope of nitrogen,  $^{15}\text{N}$ . They were then transferred to a medium containing the light isotope of nitrogen  $^{14}\text{N}$ . 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  $^{15}\text{N}$  settled at a lower depth than the DNA with the  $^{14}\text{N}$ .

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



29 The diagram shows the chromosomes of one cell which has been squashed during mitosis.



Which stage of mitosis is shown and what is the haploid chromosome number in this species?

	stage of mitosis	haploid chromosome number
<b>A</b>	anaphase	5
<b>B</b>	anaphase	10
<b>C</b>	metaphase	5
<b>D</b>	metaphase	10

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

source of 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	28.7	22.2	27.2	22.0
rat bone marrow	28.6	21.4	28.4	21.5
yeast	31.3	18.7	32.9	17.1

What is a valid deduction from these data?

- A** DNA occurs in about the same amounts in all cells from the same species.
- B** Minute differences in DNA from different cells have large effects.
- C** The four bases show complementary base pairing.
- D** The structure of DNA is similar in both yeast and animal cells.

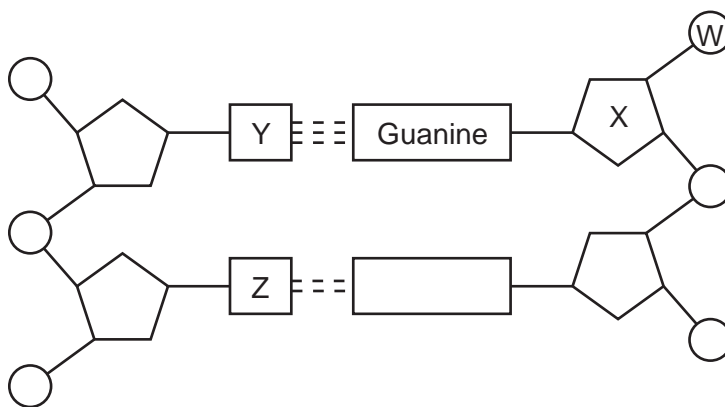
31 Which statement correctly describes the transcription of DNA?

- 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.

32 Which statement about the strands of a newly replicated DNA molecule is correct?

- A Both strands are made up of newly assembled nucleotides.
- B Both strands contain some nucleotides from the original molecule.
- C One strand is new and the other is part of the original molecule.
- D The sugar-phosphate chains are conserved and new bases are inserted between them.

33 The diagram shows part of a DNA molecule.

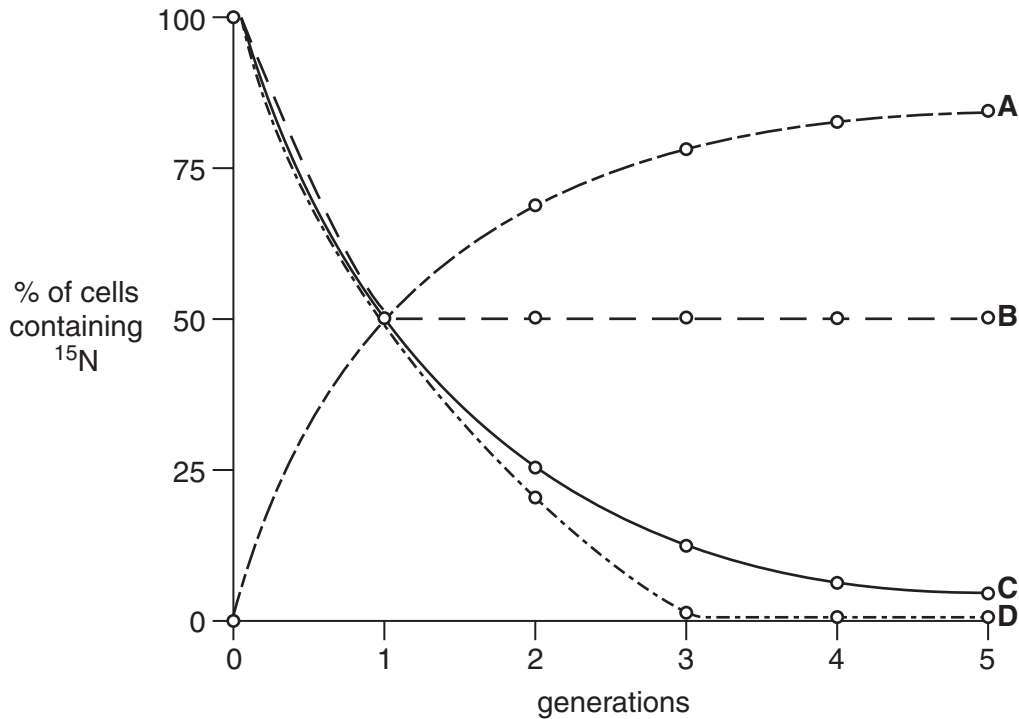


Which letters indicate cytosine, deoxyribose, phosphate and thymine?

	cytosine	deoxyribose	phosphate	thymine
<b>A</b>	W	X	Y	Z
<b>B</b>	Y	X	W	Z
<b>C</b>	Z	W	X	Y
<b>D</b>	Y	Z	X	W

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

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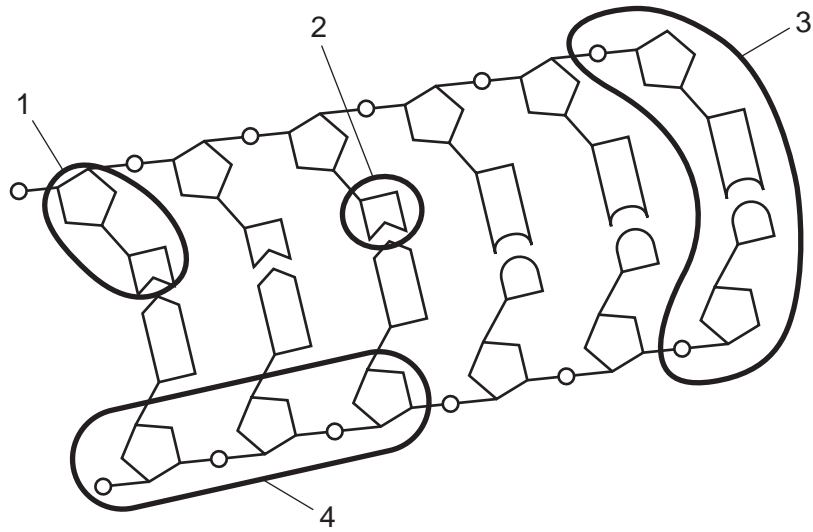
- 35** RNA is extracted from  $\beta$  cells in the pancreas. It is used to make DNA coding for human insulin.

Which enzyme is used to make the DNA?

- A** DNA ligase
- B** restriction enzyme
- C** reverse transcriptase
- D** RNA polymerase



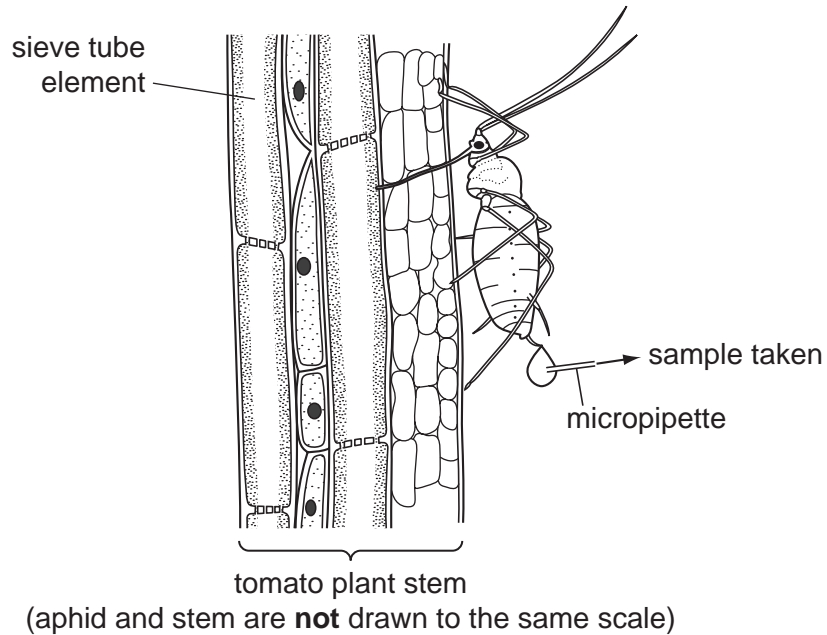
36 The diagram shows part of a DNA molecule.



Which regions contain phosphate groups?

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

- 37 A large number of aphids were used to collect samples of the contents of the sieve tube elements of a tomato plant.



Different samples of the sieve tube solution were tested.

Which was the correct result?

	Benedict's test		iodine solution
	before hydrolysis	after hydrolysis	
<b>A</b>	blue	blue	blue-black
<b>B</b>	blue	red	orange
<b>C</b>	red	blue	blue-black
<b>D</b>	red	red	orange

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

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

39 Which nucleic acid bases are purines?

- A** adenine and cytosine
- B** cytosine and thymine
- C** guanine and adenine
- D** uracil and cytosine

40 Which structural feature of the DNA molecule varies?

- A** the arrangement of the sugar-phosphate groups
- B** the double helical arrangement
- C** the number of hydrogen bonds between base pairs
- D** the pairing of the purines with pyrimidines