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

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.

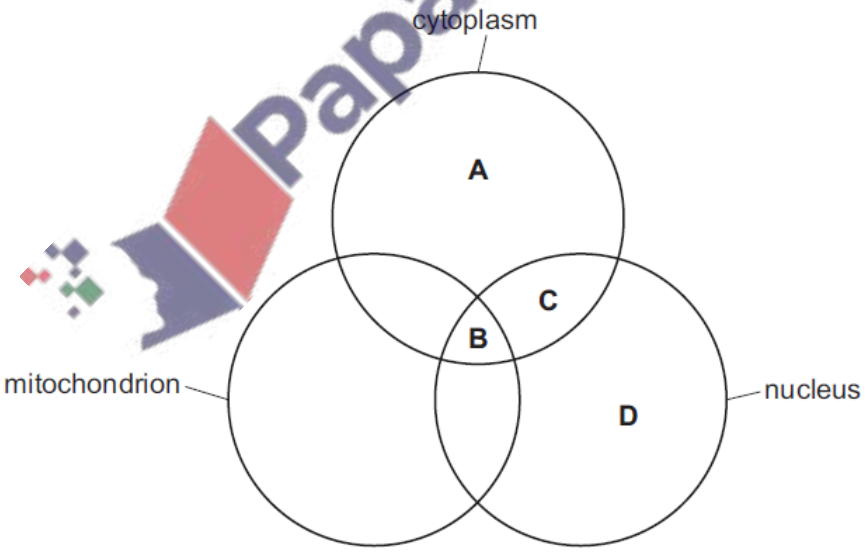
amino acid	anticodon
Val	C A A
Val	C A G
Val	C A C
Val	C A U

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

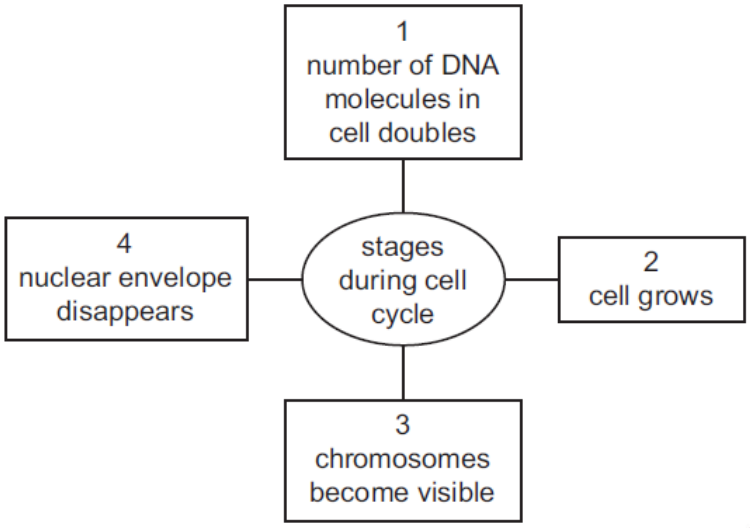
9. Nov/2022/Paper_13/No.3

Which letter represents cell structures where mRNA may be found?



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

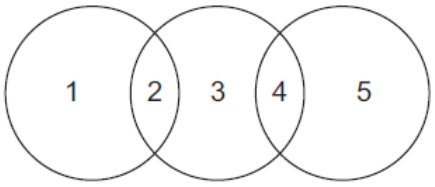
What does a nucleotide contain?

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

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.

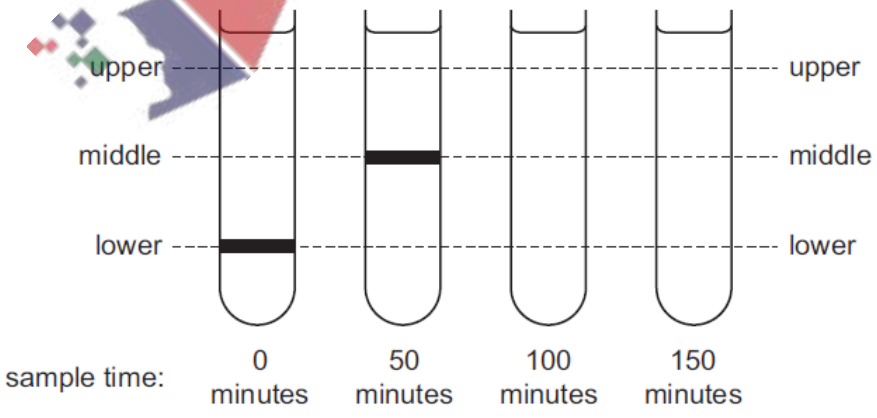
E. coli were grown on a medium containing only heavy nitrogen, ^{15}N, until all of the bacterial DNA contained heavy nitrogen.

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%

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.

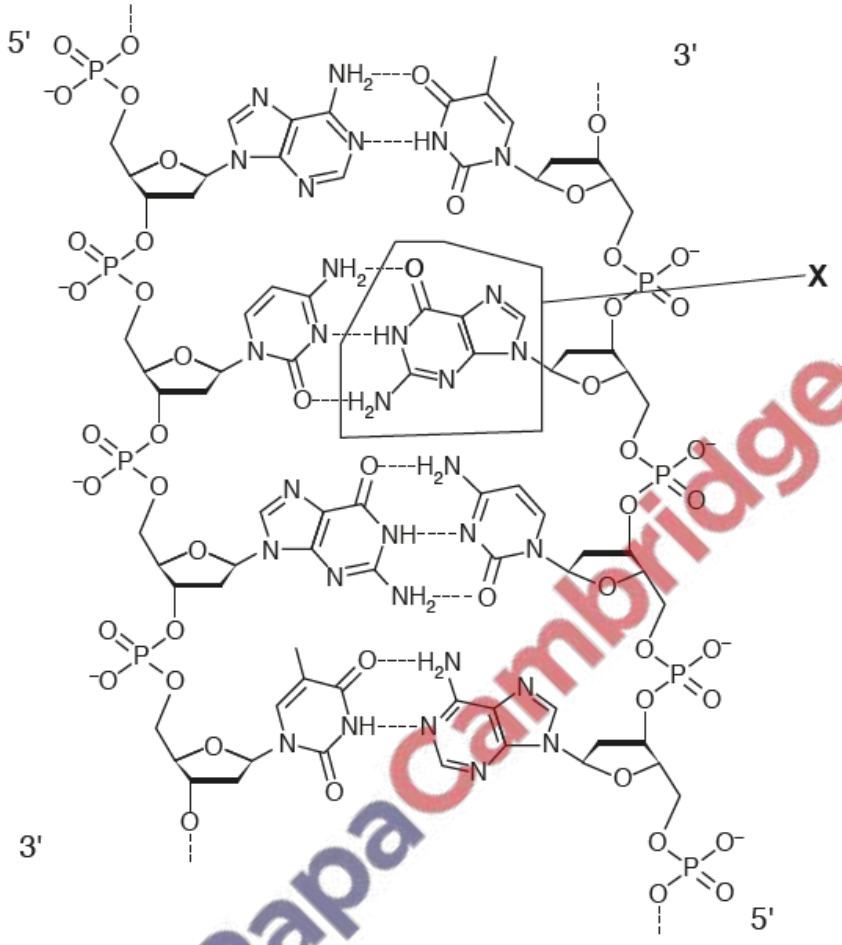


Fig. 3.1

(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]

(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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(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.

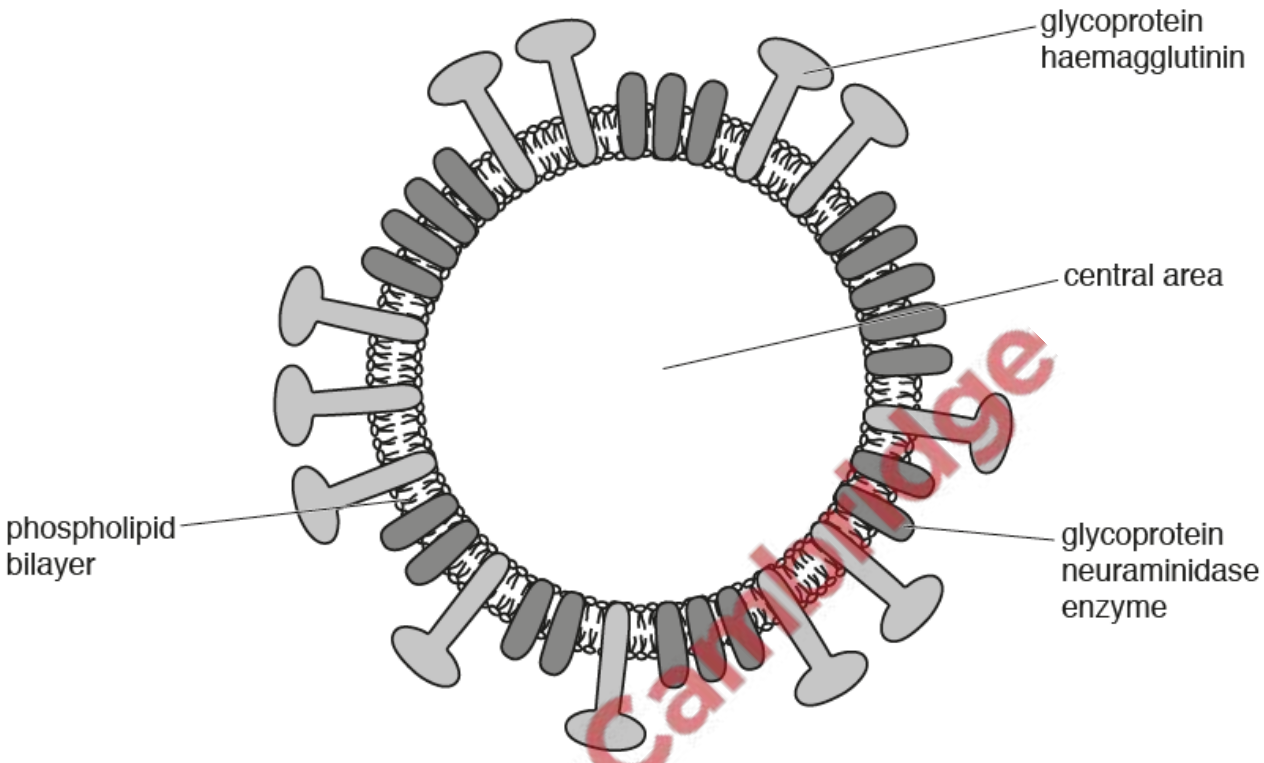

Fig. 4.1

(i) State the differences between the structure of a virosome and a virus.

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(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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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.

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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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(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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(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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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.

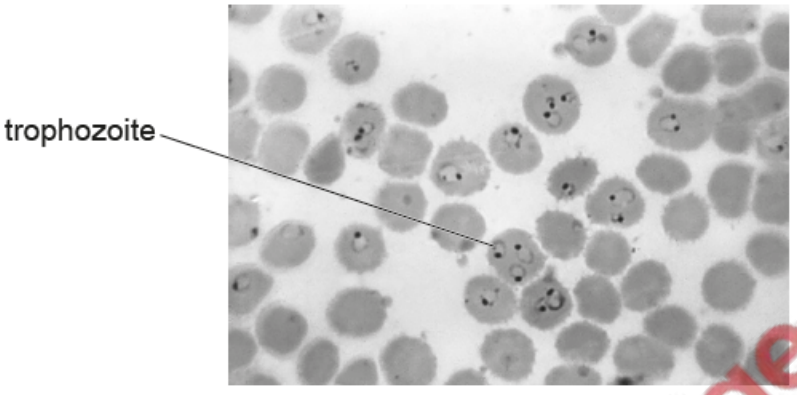

Fig. 3.1

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)

(i) Using gene *kelch13* and mutation F446I as examples, explain the difference between a gene and a gene mutation.

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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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(d) Use Table 5.2 to explain why some mutations have no effect on the primary structure of a protein.

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