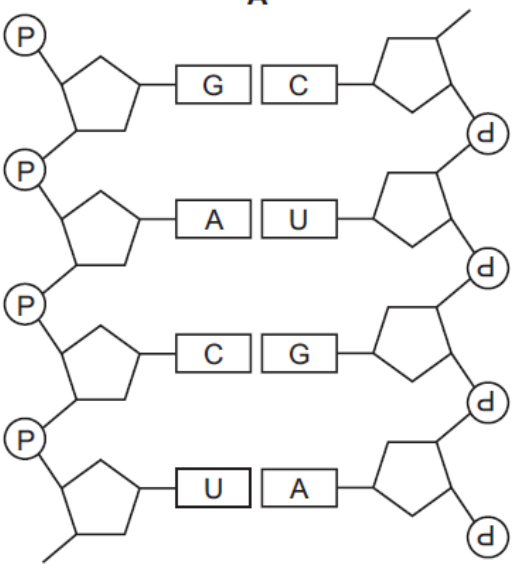
Nucleic acids and protein synthesis – AS 9700 November 2023

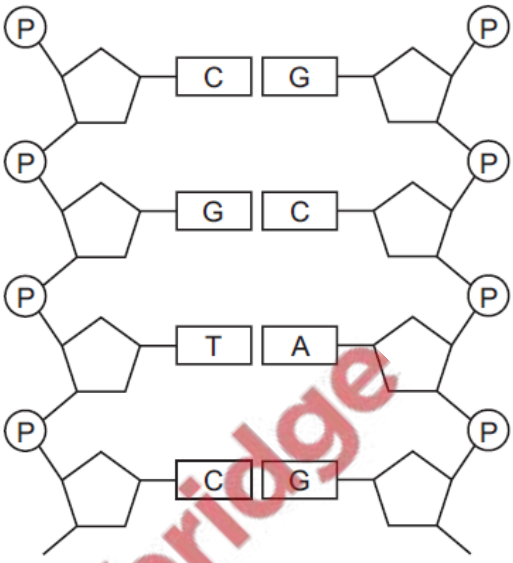
1. Nov/2023/Paper_ 9700/11/No.22

Which diagram correctly shows the structure of a piece of DNA?

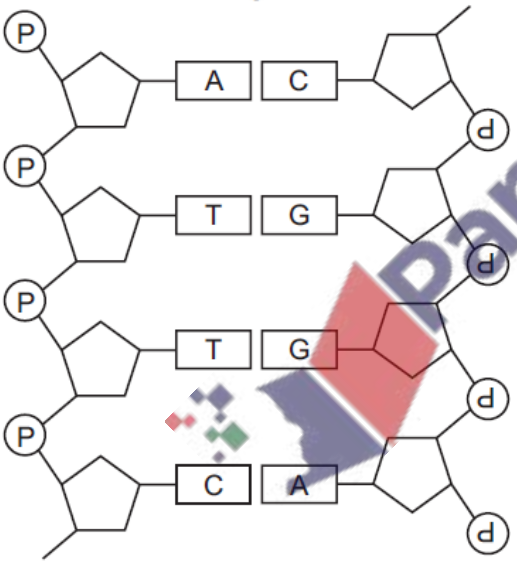
A



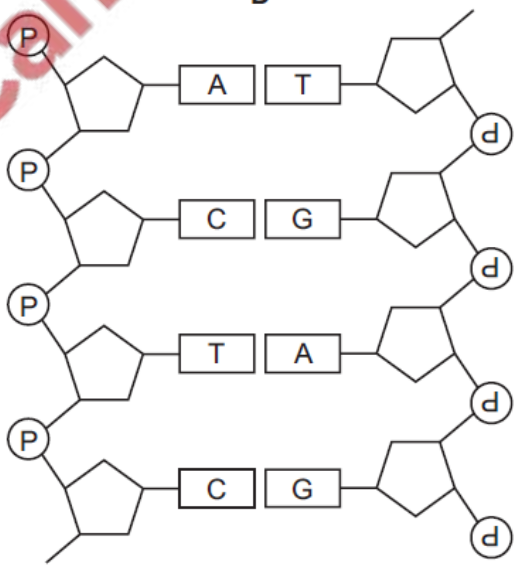
B



C



D



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.

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.

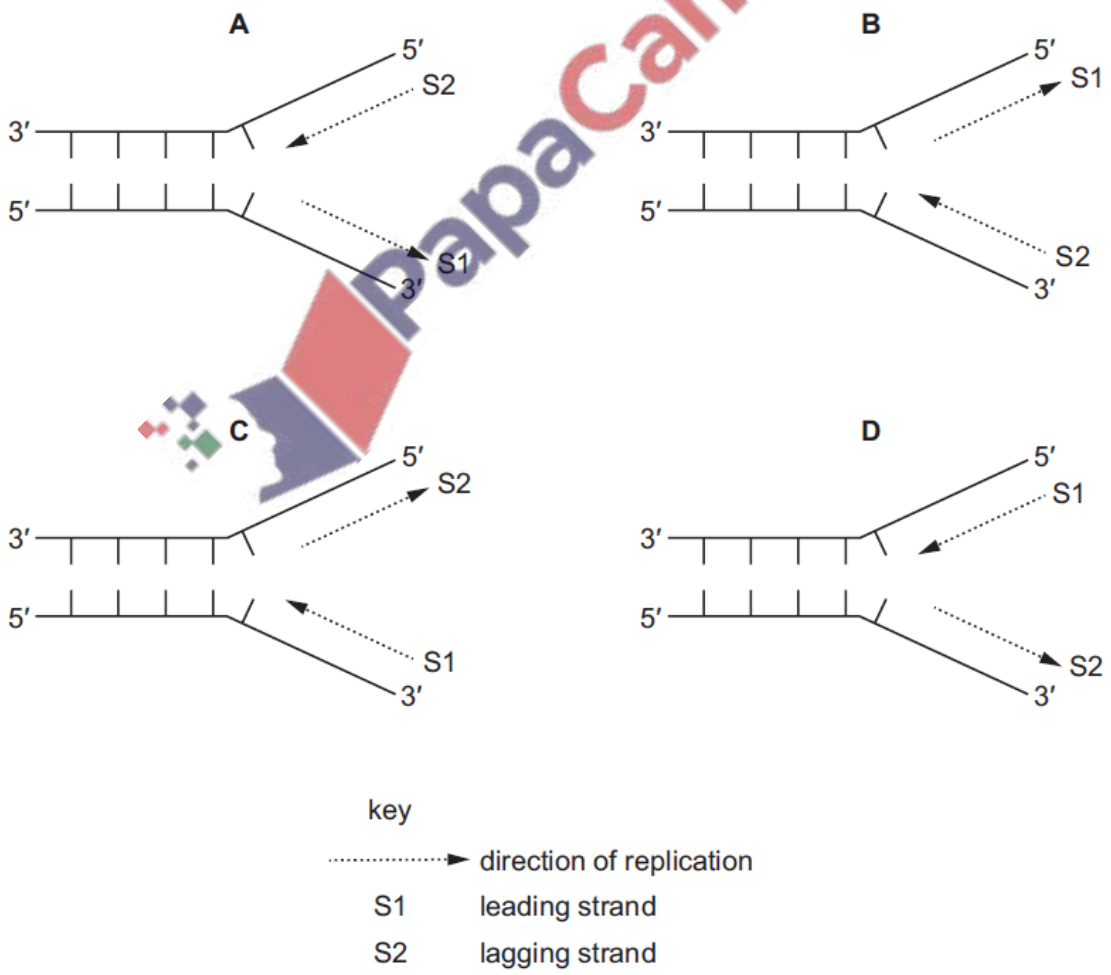
B It has complementary bases all held together by three hydrogen bonds.

C It has phosphodiester bonds that are formed using DNA ligase.

D It has a backbone of phosphate molecules and nucleotides.

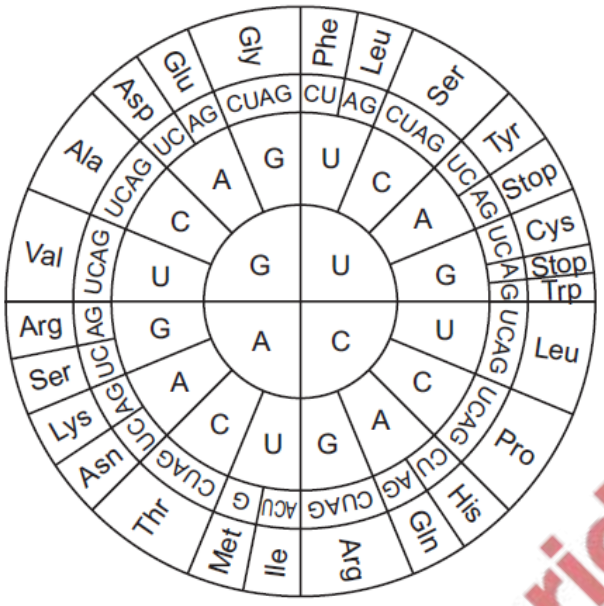
6. Nov/2023/Paper_ 9700/12/No.22

Which diagram correctly shows the replication of DNA?



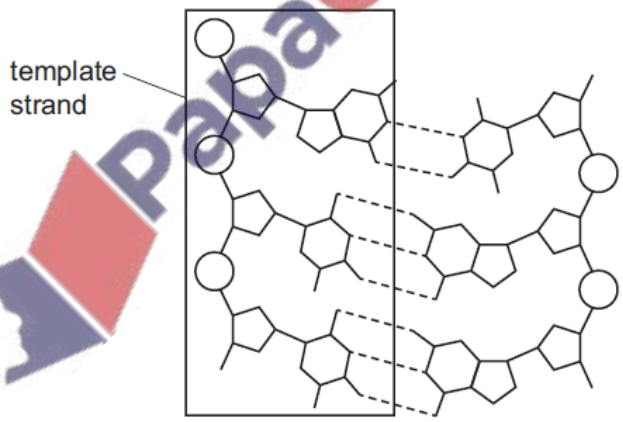
7. Nov/2023/Paper_ 9700/12/No.23

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

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%

11. Nov/2023/Paper_ 9700/21/No.6

(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.

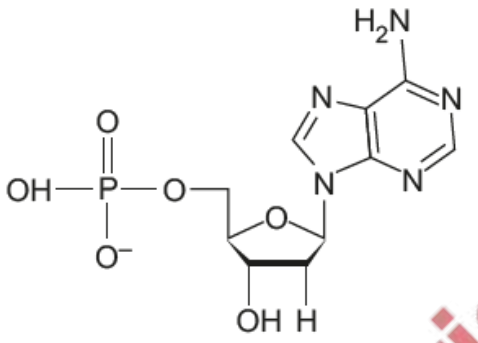


Fig. 6.1

Fig. 6.2 shows the structure of a modified nucleotide.

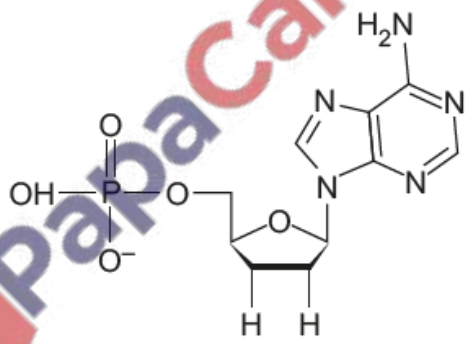


Fig. 6.2

Suggest how the structure of the modified nucleotide prevents DNA polymerase joining it to another nucleotide.

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..... [2]

(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.

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..... [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.

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..... [3]

[Total: 8]

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.

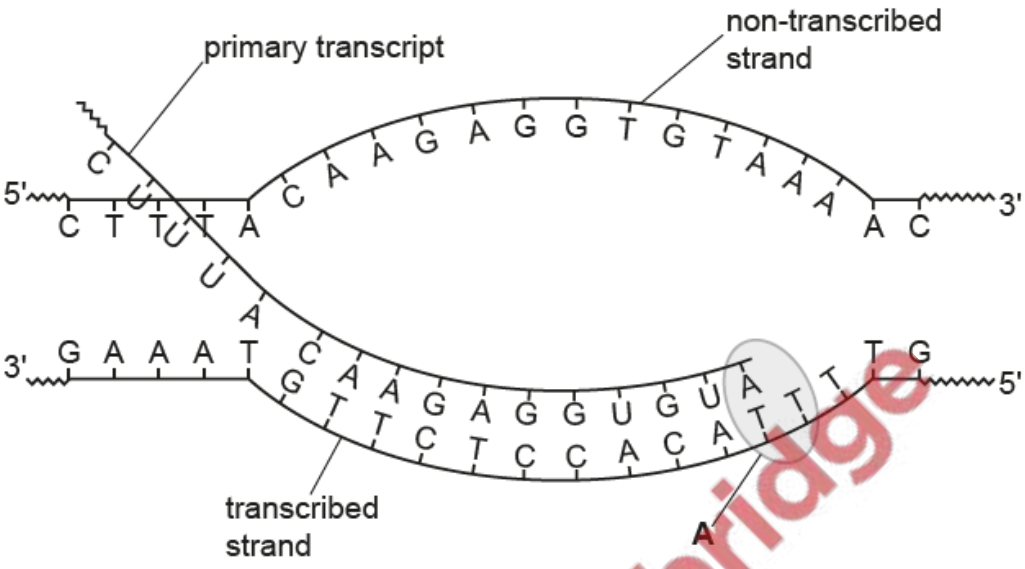

Fig. 4.1

(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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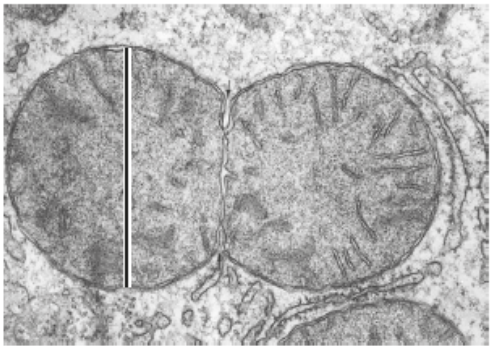
.....[2]

(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.

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..... [3]

[Total: 11]