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

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

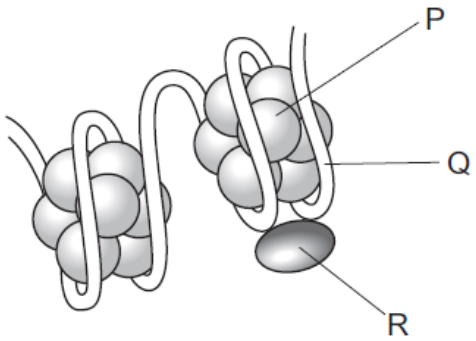
B alanine to threonine

C arginine to cysteine

D arginine to threonine

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.

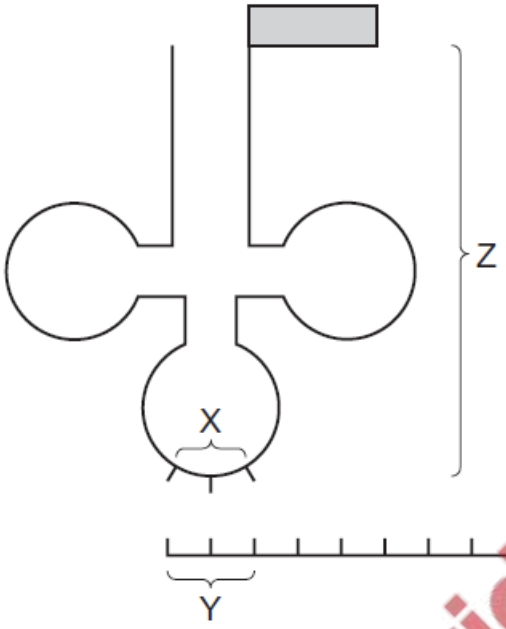
B Each nucleotide subunit contains the sugar ribose.

C It always has an equal proportion of adenine and uracil.

D The mRNA sequence is identical to the template strand of DNA.

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

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

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.

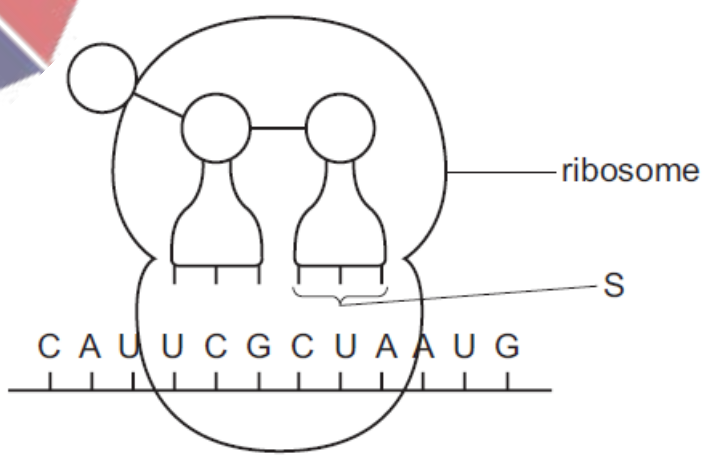
B DNA polymerase moves along the lagging strand in the 3′ to 5′ direction.

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

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.

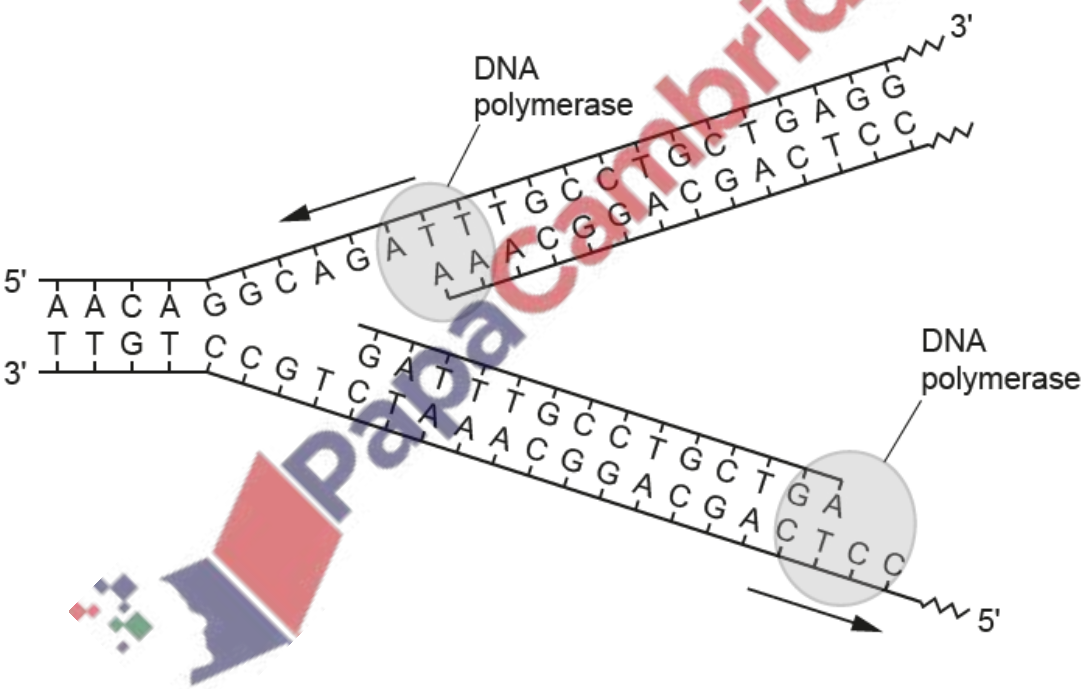

Fig. 4.1

(i) Describe the roles of DNA polymerase and DNA ligase in the replication of DNA.

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(ii) State the name of the stage of interphase in the cell cycle when DNA replication occurs.

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(c) Fig. 4.2 is a diagram of chromosome 11 at metaphase of mitosis.

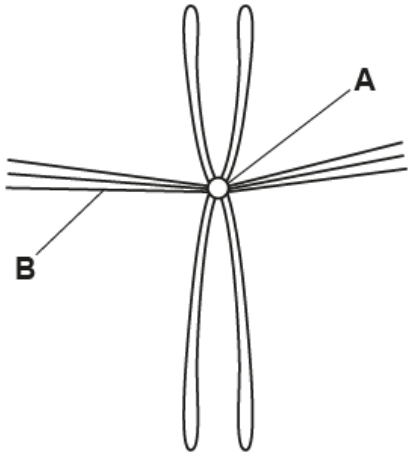

Fig. 4.2

(i) State the names **and** functions of structures **A** and **B**.

structure **A** .....

function .....

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structure **B** .....

function .....

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[2]

(ii) Complete Fig. 4.3 to show what happens to chromosome 11 in anaphase, so that the daughter nuclei are genetically identical.

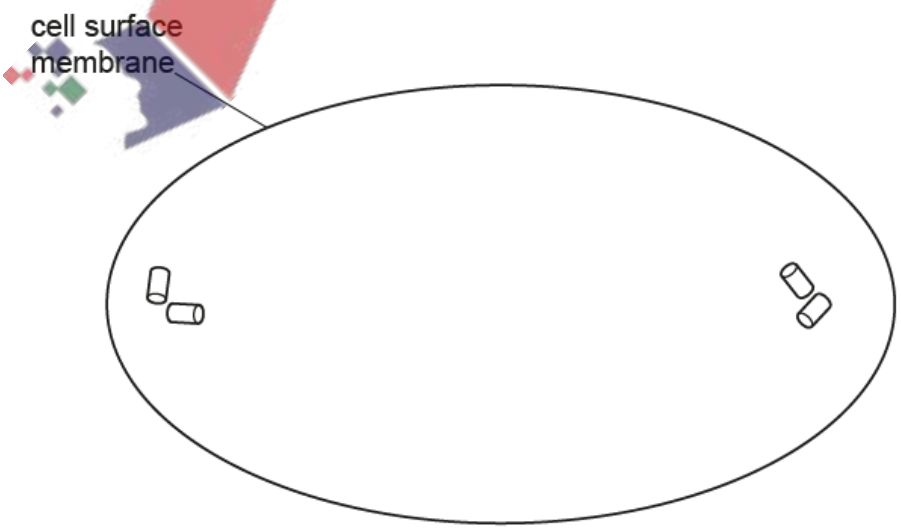


Fig. 4.3 [3]

[Total: 13]

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).

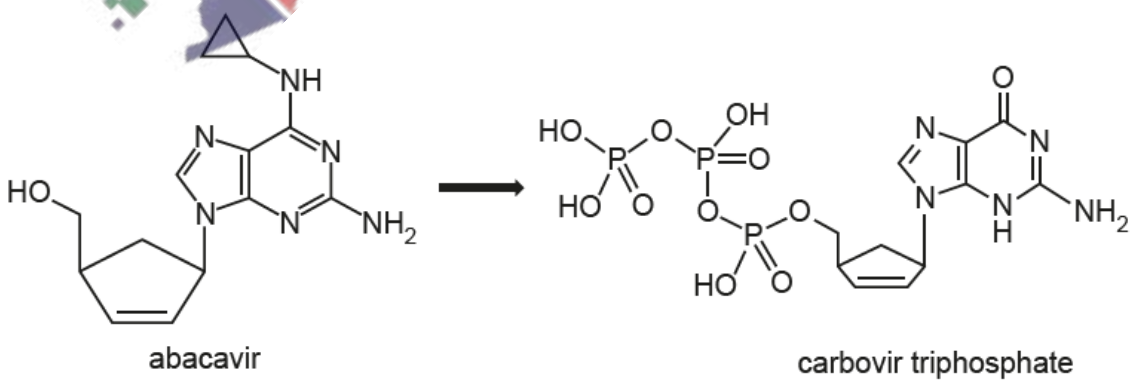
Table 5.1

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

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.

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(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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(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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[Total: 11]

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

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.

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(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.

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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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(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.

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[Total: 11]