

# 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 : 36 minutes

Score : / 30

Percentage : /100

Grade Boundaries:

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

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

- A disulfide
- B hydrogen
- C ionic
- D peptide

2 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

3 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
<b>A</b>	AT	2	TU	2
<b>B</b>	AU	2	AT	2
<b>C</b>	AU	2	GC	3
<b>D</b>	AU	3	GC	3

4 Sickle cell anaemia is caused by a mutation in an allele of the gene that codes for the  $\beta$ -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)  $\beta$ -globin alleles.

HbA CTGACTCCTGAGGAGAAGTCT

HbS CTGACTCCTGTGGAGAAGTCT

How will the mutation in the HbS allele result in the production of an altered version of the  $\beta$ -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.

5 Which level of organisation of a haemoglobin molecule is coded by a DNA molecule?

- A primary structure
- B secondary structure
- C tertiary structure
- D quaternary structure

6 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 shown below.

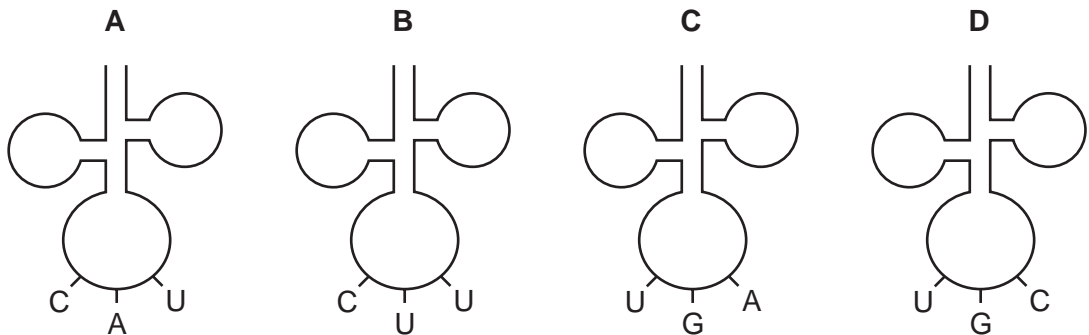
glutamine (glu) GAA GAG

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?



7 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

8 The statements are about genes and proteins involved in breast cancer.

- The protein coded by the *BRAC1* gene inhibits the growth of breast cancer cells.
- The protein coded by the *RAD51* gene is required for the repair of damaged DNA.

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

	gene	
	<i>BRAC1</i>	<i>RAD51</i>
<b>A</b>	✓	✓
<b>B</b>	x	✓
<b>C</b>	✓	x
<b>D</b>	x	x

key

✓ = normal active gene

x = mutated gene

9 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

10 Which type of molecule is always the end product of transcription?

- A** amino acid
- B** functional protein
- C** mRNA
- D** polypeptide

11 The table gives tRNA anticodons for four amino acids.

amino acid	tRNA anticodon
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 complementary to the mRNA from which this polypeptide was formed?

- A CTTTTATGGGGA
- B CUUUUAUGGGGA
- C GAAAATACCCCT
- D GAAAUAACCCCU

12 A polypeptide molecule contains the amino acid sequence:

glycine – leucine – lysine – valine.

The table shows DNA codes for these amino acids.

glycine	leucine	lysine	valine
CCC	GAA	TTT	CAA

Which tRNA 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

13 Which plant cells do **not** contain a nucleus?

- 1 companion cells
- 2 sieve tube elements
- 3 xylem vessel elements

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

14 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		
	<i>BRCA1</i> or <i>BRCA2</i>	<i>p53</i>	<i>RAD51</i>
<b>A</b>	✓	✓	✓
<b>B</b>	✓	✓	x
<b>C</b>	✓	x	✓
<b>D</b>	x	x	x

key

✓ = gene produces normal protein

x = gene produces abnormal protein

or no protein

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

- A** amino acid
- B** DNA
- C** nucleotide
- D** polypeptide

- 16 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
- 17 Which statement describes a process that occurs during protein synthesis?
- A** Transcription is the linking together of a tRNA molecule and a specific amino acid.
- B** Transcription is the linking together of free DNA nucleotides.
- C** Translation is the linking together of amino acids coded for by mRNA.
- D** Translation is the synthesis of an mRNA molecule by base pairing of nucleotides with DNA.
- 18 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

**19** What does the process of transcription require?

- A** ATP, DNA and free nucleotide bases
- B** DNA, mRNA and RNA polymerase
- C** mRNA, ribosomes and RNA polymerase
- D** ribosomes, tRNA and ATP

**20** A peptide consists of ten amino acids of four different kinds.

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

- A** 4                      **B** 10                      **C** 12                      **D** 30

**21** Which statements about tRNA structure are correct?

- 1 There is a binding site for the attachment of a specific amino acid, as well as a different binding site for the attachment to the ribosome, in order to allow translation to occur.
- 2 There is a ribose-phosphate backbone with strong covalent phosphodiester bonds and areas within the polynucleotide chain where base-pairing by hydrogen bonding occurs.
- 3 There is a section known as 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 only
- B** 1 and 2 only
- C** 2 and 3 only
- D** 1,2, and 3 only



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 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

23 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

24 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

25 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?

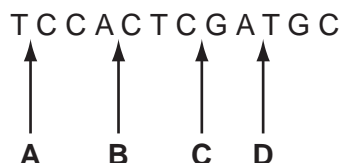
- A** AGU
- B** GAU
- C** TCA
- D** UCA

26 Which statements are correct about DNA transcription and translation?

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

27 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?



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

normal haemoglobin

thr-pro-glu-glu

sickle cell haemoglobin

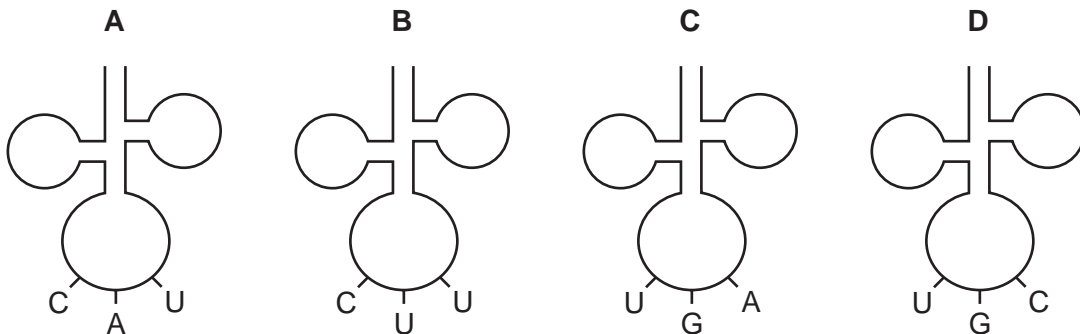
thr-pro-val-glu

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?



29 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

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