

DNA & Protein Synthesis

Question Paper 4

Level	A Level
Subject	Biology
Exam Board	Edexcel
Topic	Biological Molecules
Sub Topic	DNA & Protein Synthesis
Booklet	Question Paper 4

Time Allowed: 52 minutes

Score: /43

Percentage: /100

Grade Boundaries:

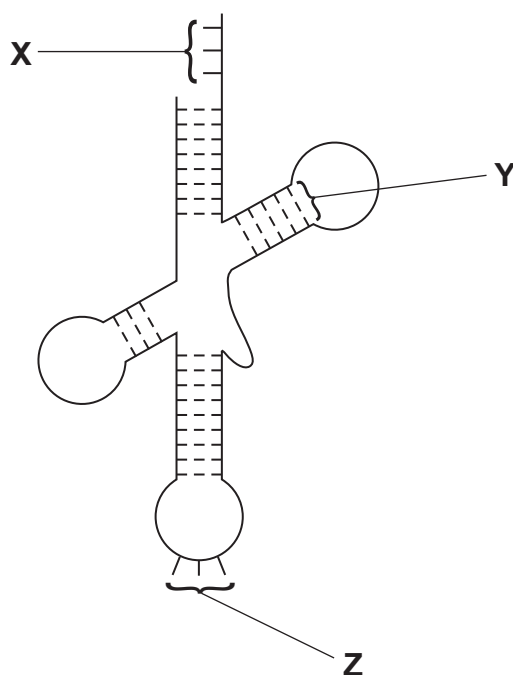
A*	A	B	C	D	E	U
>85%	77.5%	70%	62.5%	57.5%	45%	<45%

(a) Describe how a molecule of mRNA is made during transcription.

(4)

[illegible]

(b) The diagram below represents a tRNA molecule.



For each of the statements below, put a cross (☒) in the box that corresponds to the correct statement.

(i) Part **X** binds to

(1)

- ☐ **A** an amino acid for transcription
- ☐ **B** an amino acid for translation
- ☐ **C** mRNA for transcription
- ☐ **D** mRNA for translation

(ii) Part **Y** is a

(1)

- ☐ **A** glycosidic bond
- ☐ **B** hydrogen bond
- ☐ **C** peptide bond
- ☐ **D** phosphodiester bond

(iii) Part **Z** binds to

(1)

- ☐ **A** an amino acid during transcription
- ☐ **B** an amino acid during translation
- ☐ **C** mRNA during transcription
- ☐ **D** mRNA during translation

(c) Using the information shown in the diagram, describe **two** ways in which the structure of a tRNA molecule differs from the structure of a mRNA molecule.

(2)

1

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2

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(Total for Question 1 = 9 marks)

- 2** Nucleic acids, DNA and RNA, are very important molecules in living organisms. Messenger RNA (mRNA) and transfer RNA (tRNA) are involved in the synthesis of proteins.

For each of the statements (a) to (f), put a cross ☒ in the box that corresponds to the correct statement.

- (a) DNA and RNA are polynucleotides composed of mononucleotides joined by (1)

- ☐ **A** catabolic reactions
- ☐ **B** condensation reactions
- ☐ **C** hydrolysis reactions
- ☐ **D** redox reactions

- (b) The mononucleotides of RNA consist of a phosphate joined to the sugar (1)

- ☐ **A** deoxyribose
- ☐ **B** dextrose
- ☐ **C** ribose
- ☐ **D** ribulose

- (c) The mononucleotides in mRNA are joined together by (1)

- ☐ **A** disulphide bridges
- ☐ **B** glycosidic bonds
- ☐ **C** hydrogen bonds
- ☐ **D** phosphodiester bonds

(d) The bases in RNA are

(1)

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

(e) DNA is a double stranded molecule twisted into

(1)

- ☐ **A** a beta-pleated sheet
- ☐ **B** a double helix
- ☐ **C** a triple helix
- ☐ **D** an alpha helix

(f) The two DNA strands are held together by

(1)

- ☐ **A** disulphide bridges
- ☐ **B** glycosidic links
- ☐ **C** hydrogen bonds
- ☐ **D** phosphodiester bonds

(g) Describe the role of each of the following in protein synthesis. (4)

mRNA
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tRNA
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(Total for Question 2 = 10 marks)

- 3** DNA is found in chromosomes and consists of double-stranded polynucleotide molecules. The sequence of bases in DNA forms the basis of what is known as the genetic code.

(a) Explain why a molecule of DNA can be described as a **double-stranded polynucleotide**.

(3)

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(5)

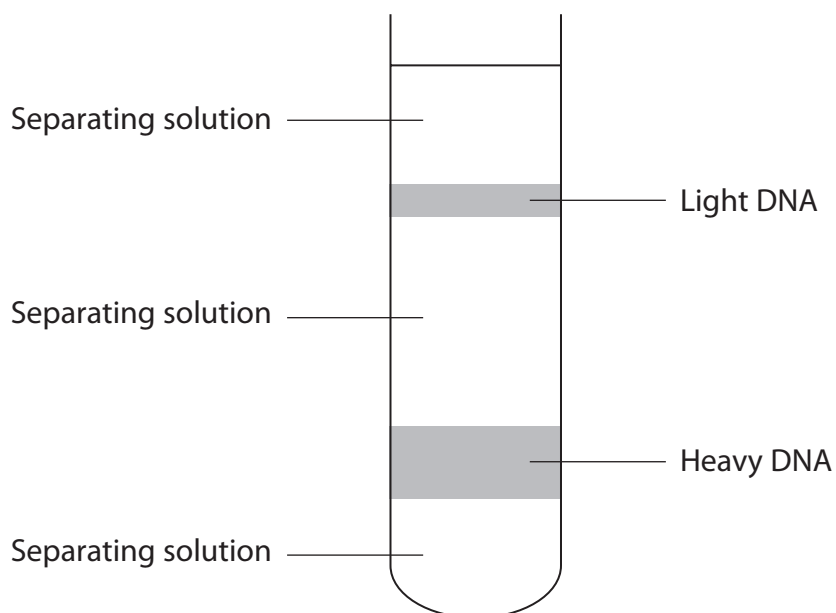
(Total for Question 3 = 8 marks)

- 4** In the late 1950s, Meselson and Stahl performed some important experiments. These experiments provided evidence to support the idea that new DNA was synthesised by semi-conservative replication.

(a) Name an enzyme involved in DNA replication.

(1)

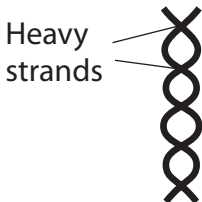
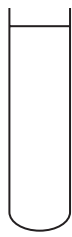
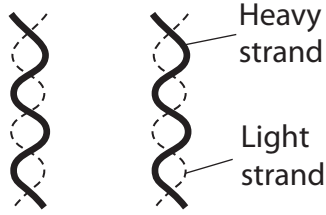
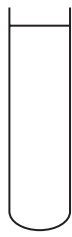
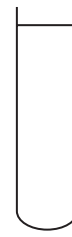
- (b) Meselson and Stahl's experiments involved growing bacteria in culture media containing either heavy nitrogen (^{15}N) or light nitrogen (^{14}N). The DNA was then extracted from the bacteria. The DNA was analysed as shown in the diagram below.



The table below summarises the three stages of Meselson and Stahl's experiment and their results.

Complete the table by drawing, in the appropriate boxes, diagrams of the DNA molecules and mark the position and size of the DNA bands in the tubes.

(6)

Experimental stage	Diagram to show the strands in the DNA molecules of the bacteria	Position and size of DNA bands in the tube of separating solution
Stage 1 Bacteria grown for several generations in culture medium containing heavy nitrogen		
Stage 2 The bacteria from the end of stage 1 were grown for another generation in culture medium containing light nitrogen		
Stage 3 The bacteria from the end of stage 2 were grown for one more generation in culture medium containing light nitrogen		

(Total for Question 4 = 7 marks)

(a) Describe the structure of an amino acid.

(4)

[illegible]

(c) The table below shows the amino acids coded for by the codons on **mRNA**.

Three-letter codons of mRNA and the amino acids specified by the codons

AAU } Asparagine	CAU } Histidine	GAU } Asparatic acid	UAU } Tyrosine
AAC } Asparagine	CAC } Histidine	GAC } Asparatic acid	UAC } Tyrosine
AAA } Lysine	CAA } Glutamine	GAA } Glutamate	UAA } Stop
AAG } Lysine	CAG } Glutamine	GAG } Glutamate	UAG } Stop
ACU } Threonine	CCU } Proline	GCU } Alanine	UCU } Serine
ACC } Threonine	CCC } Proline	GCC } Alanine	UCC } Serine
ACA } Threonine	CCA } Proline	GCA } Alanine	UCA } Serine
ACG } Threonine	CCG } Proline	GCG } Alanine	UCG } Serine
AGU } Serine	CGU } Arginine	GGU } Glycine	UGU } Cysteine
AGC } Serine	CGC } Arginine	GGC } Glycine	UGC } Cysteine
AGA } Arginine	CGA } Arginine	GGA } Glycine	UGA } Stop
AGG } Arginine	CGG } Arginine	GGG } Glycine	UGG } Tryptophan
AUU } Isoleucine	CUU } Leucine	GUU } Valine	UUU } Phenylalanine
AUC } Isoleucine	CUC } Leucine	GUC } Valine	UUC } Phenylalanine
AUA } Isoleucine	CUA } Leucine	GUA } Valine	UUA } Leucine
AUG } Methionine	CUG } Leucine	GUG } Valine	UUG } Leucine

The diagram below shows part of a messenger RNA molecule.



- (i) Place a cross ☒ in the box next to the complementary sequence of bases found on the strand of the **DNA** molecule, from which part of this mRNA molecule was synthesised.

(1)

- ☐ **A** G G T A A G C G C C T T
- ☐ **B** G G U A A C G C G G A A
- ☐ **C** A A C G G A U A U U G G
- ☐ **D** A A C G G A T A T T G G

- (ii) Place a cross ☒ in the box next to the sequence of amino acids found in the polypeptide chain that is coded for by this part of the **mRNA** molecule.

(1)

- ☐ **A** proline lysine alanine valine
- ☐ **B** proline phenylalanine alanine valine
- ☐ **C** glycine lysine arginine glutamine
- ☐ **D** proline lysine alanine glutamine

- (iii) Place a cross ☒ in the box next to the final codon on this **mRNA** molecule if GUU is the last codon for an amino acid.

(1)

- ☐ **A** AGU
- ☐ **B** ACU
- ☐ **C** UCA
- ☐ **D** UGA

(Total for Question 5 = 9 marks)