

DNA, the genetic code and gene expression: practice questions

8 questions • 27 marks • mark scheme at the back

For Pearson Edexcel International AS Biology XBI11 and International A Level Biology YBI11. **A Level only** is IA2 content (Units 4 to 6), not needed for the International AS.

Name

Total / 27

1 UNIT 1 STYLE [1 mark]

Which statement correctly describes the bonds in a DNA molecule?

- A. ☐ Phosphodiester bonds between bases on opposite strands; hydrogen bonds between nucleotides on the same strand
- B. ☐ Hydrogen bonds between bases on opposite strands; phosphodiester bonds between nucleotides on the same strand
- C. ☐ Peptide bonds between bases on opposite strands; hydrogen bonds between nucleotides on the same strand
- D. ☐ Hydrogen bonds between bases on opposite strands; peptide bonds between nucleotides on the same strand

2 UNIT 1 STYLE [4 marks]

Describe the structure of a DNA molecule.

3 UNIT 1 STYLE [5 marks]

Describe how DNA is replicated. Include the role of DNA polymerase.

In the Meselson and Stahl experiment, bacteria were grown for many generations in a medium containing heavy nitrogen (^{15}N) and then transferred to a medium containing light nitrogen (^{14}N). DNA was extracted from the bacteria at intervals and centrifuged. The table shows the bands of DNA seen. Explain how these results support the semi-conservative model of replication and show that the conservative model is incorrect.

Bands of DNA in the centrifuge tube	
Generations in ^{14}N	Bands seen
0	One heavy band
1	One band, intermediate density
2	One intermediate band and one light band, in equal amounts

5 UNIT 1 STYLE

[4 marks]

The table shows part of the genetic code, as mRNA codons. A section of the template strand of a gene has the base sequence TAC CTT TTT ACT. Deduce the sequence of amino acids coded for by this section.

mRNA codons and the amino acids they code for	
mRNA codon	Amino acid
AUG	Methionine (start)
GAA	Glutamic acid
AAA	Lysine
UGA	Stop
GAG	Glutamic acid

Answer = ...

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6 UNIT 1 STYLE

[1 mark]

The genetic code is described as degenerate. What does this mean?

- A. ☐ Each codon codes for more than one amino acid
- B. ☐ Each amino acid is coded for by more than one codon
- C. ☐ Each base is part of more than one codon
- D. ☐ Each codon consists of more than three bases

7 UNIT 1 STYLE

[4 marks]

A gene mutation can have different effects on the protein it codes for. Explain why a substitution of one base may have no effect on the protein, but a deletion of one base is likely to have a large effect.

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Compare and contrast the structure and function of mRNA and tRNA.

Mark scheme

One mark for each point unless a maximum is given. Words in brackets are not needed for the mark.

1. [1]

B B. Hydrogen bonds link complementary bases across the two strands; phosphodiester bonds link the sugar and phosphate of adjacent nucleotides along each strand.

2. [4]

- two polynucleotide strands wound in a double helix (1)
- each strand has a sugar-phosphate backbone, of deoxyribose and phosphate linked by phosphodiester bonds (1)
- bases A, T, C, G; A pairs with T, C pairs with G (complementary base pairing) (1)
- held by hydrogen bonds between the bases (1)
- strands are antiparallel (1)
- Max 4

3. [5]

- DNA unwinds / helicase breaks the hydrogen bonds between the strands (1)
- each strand acts as a template (1)
- free nucleotides pair with complementary bases on the template (A-T, C-G) (1)
- DNA polymerase joins the nucleotides (1)
- forming phosphodiester bonds (between adjacent nucleotides) (1)
- semi-conservative: each new molecule has one old strand and one new strand (1)
- Max 5

4. [5]

- after 1 generation, all DNA is intermediate density, so each molecule has one ^{15}N strand and one ^{14}N strand (1)
- conservative model predicts one heavy band and one light band after 1 generation, which was not seen, so it is refuted (1)
- after 2 generations, light DNA (both strands ^{14}N) and intermediate DNA (one strand ^{14}N and one ^{15}N) are present (1)
- semi-conservative model: the old strands (^{15}N) each pair with new ^{14}N strands, and the new strands then act as templates producing $^{14}\text{N}/^{14}\text{N}$ molecules (1)
- each original ^{15}N strand is conserved in a new molecule (1)
- Max 5

5. [4]

- mRNA is complementary to the template strand: first two codons AUG GAA (1)
- last two codons AAA UGA (1)
- methionine – glutamic acid – lysine (1)
- UGA is a stop codon, so there is no further amino acid (1)
- If mRNA is wrong, allow one mark for the correct sequence of amino acids from a wrong mRNA sequence (error carried forward).

6. [1]

B B. Degenerate means more than one codon can code for the same amino acid.

7. [4]

- genetic code is degenerate / the new codon may code for the same amino acid (1)
- so a substitution changes at most one codon / one amino acid (1)
- deletion shifts the reading frame / frameshift (1)
- all the codons after the deletion change, so many amino acids differ / the protein's primary and tertiary structure change (1)
- and so the protein may not function (1)
- Max 4

8. [3]

- both are single-stranded polynucleotides / contain ribose and uracil (1)
- mRNA is a long linear strand with codons; tRNA is a short folded molecule with an anticodon (1)
- mRNA carries the code from DNA to the ribosome; tRNA brings amino acids to the ribosome (1)
- tRNA has an amino acid binding site / has hydrogen-bonded base pairs within the molecule; mRNA does not (1)
- Max 3