2.1 DNA, protein synthesis and evidence

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

KEY WORDS transcription • translation

Objective

DNA, protein synthesis and evidence. Original classroom practice for IB HL; not an official IB paper.

1 Key knowledge and worked examples

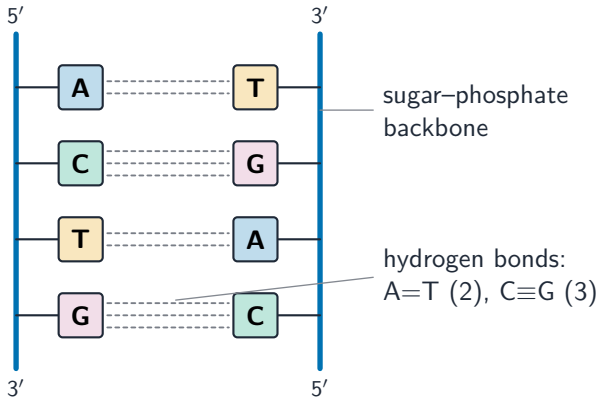
What would explain this observation?

- A change in DNA can affect a protein, but not every DNA change changes the amino-acid sequence. The effect depends on the sequence and how it is used.

Build the model

- DNA stores information in a base sequence.
- Complementary base pairing supports copying.
- During gene expression, **transcription** makes RNA and **translation** uses codons to assemble an amino-acid sequence.
- transcription: Formation of RNA using a DNA template.
- translation: Formation of a polypeptide using an mRNA sequence.

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the two strands run in opposite directions (antiparallel)

Choose evidence that can test it

- A codon comprises three bases.
- The genetic code is degenerate: more than one codon can specify the same amino acid.
- A substitution can therefore be silent, while insertions or deletions can shift the reading frame.

In the lab: Keep DNA template, coding DNA and mRNA distinct. State the strand used and write sequences in the required direction. Use a codon table for mRNA, not an unexplained DNA triplet.

Work from known quantities

- Known: an mRNA coding region contains 90 bases, including one stop codon.
- Codons = bases/3 = 90/3 = 30.
- A stop codon does not encode an amino acid, so the peptide contains 29 amino acids under this stated model.

Your turn: A coding mRNA segment has 63 bases including a stop codon. Find peptide length.

Check the conclusion and its limits

- The number of bases is not automatically the number of amino acids.
- Real genes include regulatory regions and, in eukaryotes, often introns; a whole gene length is not a peptide-length calculation.

Not true: Each DNA base encodes one complete amino acid. Amino acids are encoded by triplets of bases (codons), not by single bases. Three bases specify one amino acid, and a stop codon specifies none.

Key:

- DNA stores information in a base sequence.
- A codon comprises three bases.
- Watch for: the number of bases is not automatically the number of amino acids.

■ **Write from a peptide of 23 amino acids**

- An mRNA coding region has 72 bases, including one stop codon.
- Find the number of amino acids. A substitution can be silent.

2 Practice

2.1 Which change can leave the amino-acid sequence unchanged? Choose one answer.

- **A** A substitution producing a synonymous codon
- **B** Every deletion of one base
- **C** Every insertion of one base [1]

2.2 A coding mRNA segment has 63 bases including a stop codon. Find peptide length. Show the relation, substitution and units. [2]

2.3 Decide whether this claim is true and justify: Each DNA base encodes one complete amino acid. [2]

2.4 Formation of RNA using a DNA template: write the technical term. [1]

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3 Exam-style questions

3.1 An mRNA coding region has 126 bases including one stop. A substitution turns codon 11 into a stop. Compare peptide lengths, assuming translation starts at the same codon. [4]

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Solutions

2.1 A The genetic code is degenerate: several codons can specify the same amino acid, so a substitution that produces a synonymous codon leaves the sequence unchanged. Deleting or inserting one base shifts the reading frame and changes every downstream codon.

2.2 63/3=21 codons including one stop. Peptide length=21−1=20 amino acids.

2.3 False. Amino acids are encoded by triplets of bases (codons), not by single bases. Three bases specify one amino acid, and a stop codon specifies none.

2.4 transcription. transcription means Formation of RNA using a DNA template.

3.1 Original 126/3−1=41 amino acids. New codon 11 is not translated into an amino acid: 10 residues. The model excludes altered initiation, splicing and readthrough.

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