

# GCSE Biology (9 – 1)

## Protein Synthesis

Name: .....

Group: .....

### Instructions

- Read each question carefully before you begin to answer it.
- Use black ink or black ball-point pen for your answers.
- Fill in the boxes at the top of this page with your name and group.
- Attempt to answer every question in the booklet.
- Answer the questions in the spaces provided – there may be more space than you need in some answer spaces.
- Calculators may be used for this booklet.
- For any calculations, you **must** show all your working.
- Any and all drawings or graphs should be completed in pencil.



| For markers use |      |
|-----------------|------|
| Question        | Mark |
| 1               | /5   |
| 2               | /8   |
| 3               | /8   |
| 4               | /6   |
| 5               | /8   |
| 6               | /4   |
| Total           | /39  |
| %               |      |
| Grade           |      |

### Information

- The maximum mark for this paper is 39 marks.
- The marks for each question are shown in brackets.
- Please be aware that good English and clear presentation are required in your answers.



1. Protein synthesis is the process within cells of converting the DNA within a gene into a functional protein, using mRNA and ribosomes. Circle the letter of the correct answer for each.

a) The genetic code in a DNA molecule is a sequence of bases. What does a sequence of three bases, a triplet or codon, directly code for?

**A**

A specific protein

**B**

A specific amino acid

**C**

A specific ribosome

**D**

A specific sugar molecule

**(1 mark)**

b) DNA is found in the nucleus, but proteins are assembled in the cytoplasm.

Which molecule is responsible for carrying the genetic code from the nucleus to the ribosome?

**A** tRNA (transfer RNA).

**B** A copy of the entire DNA molecule.

**C** mRNA (messenger RNA).

**D** An enzyme.

**(1 mark)**

c) The first stage of protein synthesis involves making a copy of a gene.

What is this process called and where does it occur?

**A** Translation, in the nucleus.

**B** Transcription, in the cytoplasm.

**C** Replication, on the ribosome.

**D** Transcription, in the nucleus.

**(1 mark)**

d) During the second stage of protein synthesis, the protein chain is assembled.

What is the role of tRNA (transfer RNA) in this process?

**A** It carries a copy of the gene to the ribosome.

**B** It binds to the ribosome and reads the genetic code.

**C** It brings the correct amino acids to the ribosome.

**D** It unwinds the DNA double helix in the nucleus.

**(1 mark)**

e) RNA is a different type of nucleic acid to DNA. Which of the following is a key difference in the bases found in RNA compared to DNA?

**A** RNA contains Uracil (U) instead of Thymine (T).

**B** RNA contains Guanine (G) instead of Cytosine (C).

**C** RNA contains Thymine (T) instead of Uracil (U).

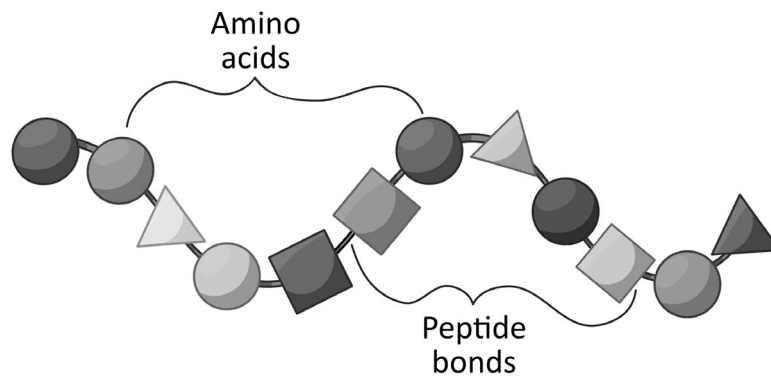
**D** RNA contains no Adenine (A).

**(1 mark)**

(Total for Question 1 is 5 marks)

2. The enzyme lysozyme is found in human tears and saliva.  
It consists of a single polypeptide chain made of 130 amino acids.

The figure below shows a section of the polypeptide chain that makes up lysozyme.



- a) Describe the role of mRNA in the production of lysozyme.

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(3 marks)

- b) A ribosome can join amino acids together at a rate of 15 amino acids per second.  
Calculate the **minimum time** required for a ribosome to synthesise one molecule of lysozyme.  
Give your answer to two significant figures.

Minimum time = .....

(2 marks)

- c) The time calculated in part (b) is the time for translation only.  
Explain why the total time taken from reading the DNA code to producing a functional lysozyme enzyme is longer than your calculated value.

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**(3 marks)**

(Total for Question 2 is 8 marks)

3. A specific human protein is made from a chain of 50 amino acids.

a) Calculate the minimum number of bases on the mRNA strand needed to code for this protein.

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**(2 marks)**

b) Describe how the mRNA code is used to assemble a protein at the ribosome.

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**(3 marks)**

c) A mutation occurs which changes a single base in the DNA sequence that codes for this protein. Explain how this one change could result in a non-functional protein.

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**(3 marks)**

(Total for Question 3 is 8 marks)



5. Ricin is a highly toxic protein found in the seeds of the castor oil plant. A single molecule of ricin can kill a cell by inactivating its ribosomes.

a) Describe the function of a ribosome in a healthy cell.

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**(2 marks)**

b) Using your knowledge of protein synthesis, explain why the inactivation of ribosomes by ricin is lethal to a cell.

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**(4 marks)**

c) Ricin itself is a protein. Suggest why heating castor oil seeds to a very high temperature makes them safe to eat, even though the ricin protein is still present.

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**(2 marks)**

(Total for Question 5 is 8 marks)

6. During protein synthesis, two types of RNA molecule, messenger RNA (mRNA) and transfer RNA (tRNA), work together at the ribosome.

Explain how mRNA and tRNA molecules interact at the ribosome to ensure a protein is assembled with the correct sequence of amino acids.

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**(4 marks)**

(Total for Question 6 is 4 marks)