

1 Haemoglobin is a protein found in red blood cells that helps transport oxygen in the blood.

In sickle cell anaemia, the presence of the allele (**a**) in place of the normal allele (**A**) results in a change of one amino acid in the haemoglobin molecule.

This mutation changes the properties of haemoglobin and can result in red blood cells becoming less flexible and blocking small blood vessels.

The frequency of the recessive allele (**a**) is much higher in populations in West Africa than in populations in Northern Europe.

People in West Africa have a much higher risk of being infected with malaria parasites and developing severe anaemia than people in Northern Europe.

People who are heterozygous for sickle cell anaemia have sufficient amounts of normal haemoglobin to prevent severe anaemia.

One theory suggests that the malaria parasite (*Plasmodium sp.*) causes red blood cells with any modified haemoglobin to rupture. This occurs before the parasite can reproduce.

\*(a) In West Africa, the average life expectancies of people with genotypes **AA**, **Aa** or **aa** are different.

(i) Using the information above, give an explanation for the difference in life expectancy of people who do not have the recessive allele.

(2)

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(ii) Using the information above, give an explanation for the difference in life expectancy of people in West Africa who have the genotype **Aa**.

(2)

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\*(b) Explain how a change of one amino acid can lead to a change in the structure and properties of the haemoglobin protein.

(4)

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**(Total for Question 1 = 8 marks)**

2 One gene can give rise to more than one protein.

(a) Give **three** differences between fibrous and globular proteins.

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**3** One role of the skin is to protect the body from infection.

(a) (i) Explain how skin flora protect the body from infection.

(2)

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(ii) The skin produces lipids that protect the body from infection.

Place a cross  in the box next to the correct explanation of how these lipids protect the body from infection.

(1)

- A** they are alkalis that kill bacteria
- B** they have antimicrobial properties that inhibit the growth of bacteria
- C** they are enzymes that destroy viruses
- D** they are water soluble and prevent viruses from replicating

(b) The skin contains a fibrous protein. This protein forms a barrier to the entry of microorganisms.

(i) Place a cross  in the box next to the name of this protein.

(1)

- A** cytokine
- B** interferon
- C** keratin
- D** lysozyme

- (ii) The primary structure of a protein is important in determining its final structure and properties.

Describe the structure and properties of fibrous proteins.

(4)

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- (iii) Describe the roles of the template (antisense) DNA strand and mRNA in determining the primary structure of a protein.

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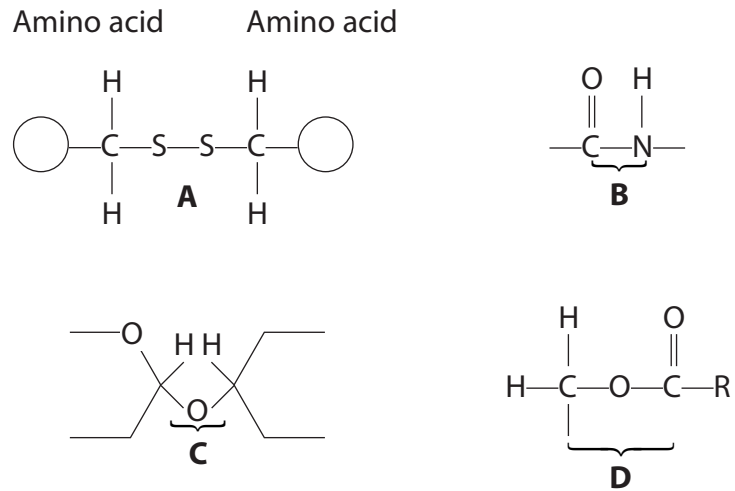
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- 4 (a) The diagrams below show four different bonds, A, B, C, and D, found in biological molecules.



Place a cross ☒ in the box to complete each of the following statements.

- (i) The bond which occurs in a triglyceride molecule is

(1)

- A**
- B**
- C**
- D**

- (ii) The bond which may occur in the tertiary, but not the primary, structure of a protein is

(1)

- A**
- B**
- C**
- D**

(iii) The peptide bond is

(1)

A

B

C

D

(iv) The ester bond is

(1)

A

B

C

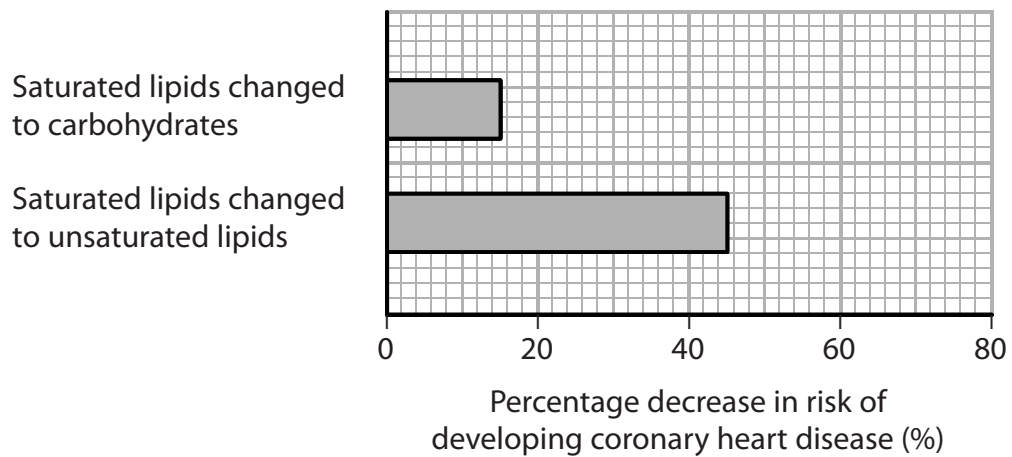
D



- (b) Adult volunteers took part in an investigation to find out the effect of dietary changes on their risk of developing coronary heart disease.

In this investigation, 5% of the volunteers' energy intake was changed from one food source to another. The volunteers' total energy intake remained constant.

The graph below shows the results of this investigation.



- (i) Suggest why it was necessary to ensure that their total energy intake remained constant.

(2)

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(ii) Using the information in the graph and your own knowledge, suggest an explanation for the results of this investigation.

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**(Total for Question 4 = 9 marks)**

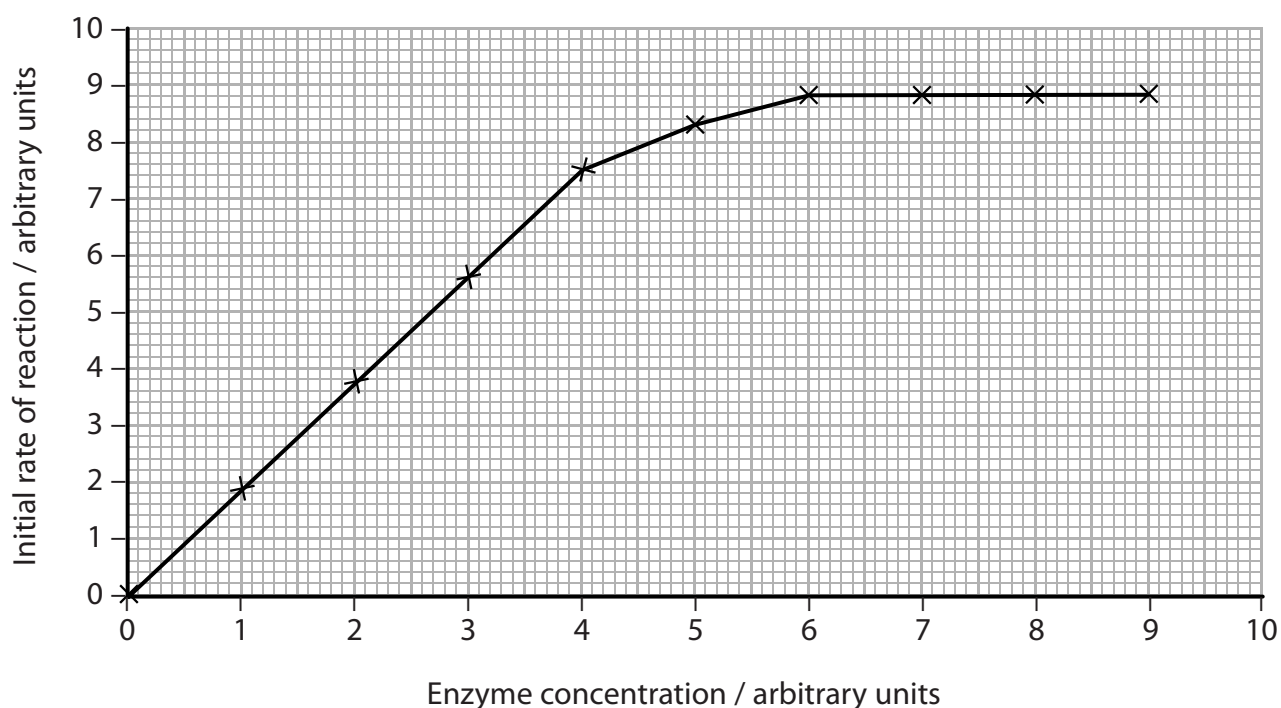
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5 Enzymes are biological catalysts made of protein.

(a) Proteins are chains of amino acids. In the space below draw the structure of **one** amino acid.

(3)

(b) The graph below shows the effect of changing the enzyme concentration on the initial rate of a reaction.



(i) Explain the effect of changing enzyme concentration on the initial rate of reaction.

(3)

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