

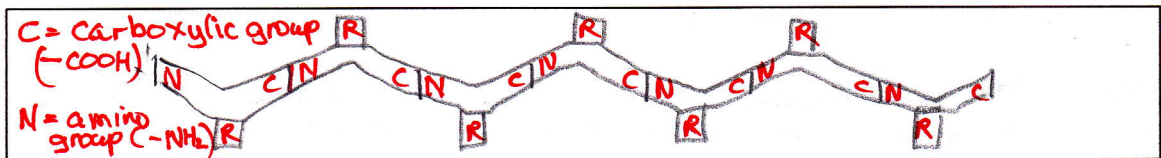
ENZYMES – FAST AND FLEXIBLE – WORKSHEET FOR ARTICLE

Read the article 'Enzymes – Fast and Flexible' and then answer the following questions.

- 1 By how much can enzymes speed up chemical reactions? (parag. 1) $\times 10^6$ to $\times 10^{12}$ (1)
- 2 What is meant by the term 'high catabolic efficiency'? (parag. 1) can speed up chemical reactions to an enormous extent even at low temperatures. More efficient than industrial catalysts. (1)
- 3 What does the 'R' of R-groups stand for in the context of amino acids in a protein chain and how do these 'R' groups affect the structure of the protein? (parags 2 + 3)

R stands for 'radical' - a side chain on amino acids which sticks out from the backbone of the amino acid chain. They affect the structure of the protein by the fact that weak bonds form between R groups which stabilise the globular folded shape of the protein, giving it its unique 3-D shape & to types of R groups in the chain.

- 4 Draw a simplified diagram of part of a protein molecule showing the positions of R groups, amino groups, carboxylic acid groups and the backbone of the chain.



- 5 The word **CONFORMATION** is highlighted in paragraph 3. Read the paragraph thoroughly and then explain what is meant by this word.

conformation = shape of protein molecule held by weak bonds between R groups.

- 6 Which regions of a protein are generally towards the middle of the molecule?

hydrophobic regions

- 7 What is meant by the term 'catalytic amino acids', and explain where they are found structurally in the molecule. (parag 4)

The few amino acids in the chain of an enzyme that are involved in catalysis - not necessarily adjacent to each other, but brought into proximity by the folding into the 3-D conformation, at the active site region.

8 Molecules only react when they collide with one another, but the collisions have to be 'right' in certain ways for the reaction to take place. Suggest 2 important ways that collisions must be 'right'. (parag 5)

right order

right speed

or right alignment (parag 6)

(2)

9 What is meant by the term 'transition state' of a reaction? (parag 7) an unstable

arrangement of atoms which is between reactant and products and having some features of each. (2)

10 What type of energy is needed to get the reaction to go and to form the transition state? (parag 7)

activation energy

(1)

11 Which is generally smaller in size, substrate or enzyme? (parag 9) substrate

(1)

12 Explain why the strength of charged groups of the substrate is less in the cytoplasm than in the environment of the active site. (parag 10)

The +ve and -ve groups on the substrate are surrounded by a shell of water molecules in the cytoplasm, which decreases the strength of attraction between them.

(2)

13 The word 'allosteric' is used in parag 11. The A-Z Biology Handbook (a biological dictionary by Bill Inge defines allosteric as:

'allosteric: refers to a molecule whose shape can be altered by something in its environment.'

Explain how the fact that enzymes are allosteric supports the Induced Fit model of enzyme action rather than the Lock and Key model. (parag. 11)

The fact that certain molecules such as ATP can bind to an enzyme at sites other than the active site and alter its activity. If (2)

enzymes were rigid, a molecule binding to one part of it would not affect other parts.

14 What are the two possible interchangeable conformations of a flexible enzyme molecule? (parag. 12)

binding conformation and a catalytically active conformation (2)

15 How is activation energy lowered? (parag. 12) The substrate causes the enzyme to

alter shape and this in turn disturbs the substrate molecule, stretching bonds which lowers the activation energy. (2)

16 Explain how the theories of induced fit and flexible protein models could explain the activities of other types of proteins. (parag. 13)

- protein carriers + channels, (2)

hormone binding, neurotransmitters could all have allosteric conformations that enable them to react with what they are transporting in such a way that their shape changing affects the bonds in their substrates as they distort these substrates.