CHEMISTRY

PROTEINS – WORKSHEET 2

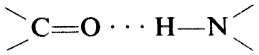
QUESTION 1
Which of the following bonding types is not responsible for maintaining the tertiary structure of a protein?

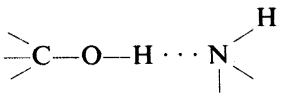
A Covalent bonding
B Hydrogen bonding
C Ionic bonding
D Dispersion forces

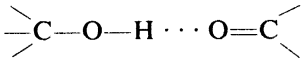
QUESTION 2
Which of the following protein structures would be affected if a protein was boiled in a hot concentrated solution of hydrochloric acid?

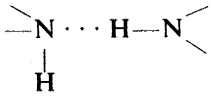
A Primary structure
B Secondary structure
C Tertiary structure
D All of the above

QUESTION 3
Some naturally occurring proteins exist in a spiral configuration known as an α helix.
The bond responsible for maintaining the structure of this helix is best represented by:

A. 

B. 

C. 

D. 

QUESTION 4
The helical shape of proteins is maintained by

A Disulfide bridges
B Ionic interactions between COO^- and NH_3^+ groups
C Hydrogen bonding
D Covalent bonds

QUESTION 5
Enkephalins are substances in the brain that can function as neurotransmitters. Leucine-enkephalin is one example which has the following sequence of amino acids:

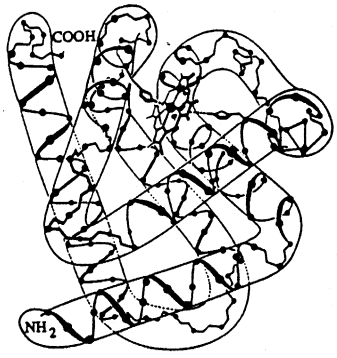
Tyr – Gly – Gly – Phe – Leu

(a) Enkephalins are members of what group of biochemicals?

(b) Draw the structural formula of the dipeptide formed when tyrosine and glycine react.

(c) Name the type of bond linking tyrosine and glycine.

(d) Below is a diagram of a molecule with a much longer sequence of amino acids, each represented by a black dot. Name one type of bonding, other than covalent bonding, invoved in holding this structure together.



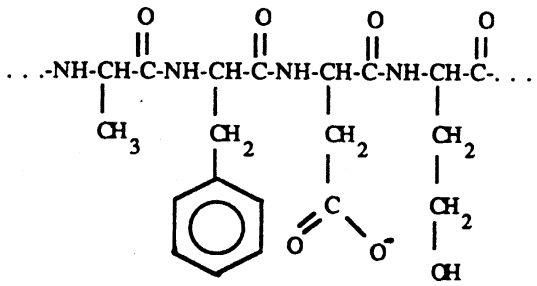
QUESTION 6
What is denaturation and how does it occur?

Solution

QUESTION 7
During denaturation, the secondary and tertiary structures are disrupted. Explain why this happens. In your answer, state why the primary structure is unaffected.

Solution

QUESTION 8
The following structure represents a segment of a protein.



(a) Give the general name of the four units in this protein segment and draw the structural formulae of each unit.

(b) How is the protein broken down to these units in the laboratory?

(c) Which one of the four units obtained by breaking the protein chain is least soluble in water? Give a reason for your answer.

(d) Give two examples of forces or bonding within a protein molecule which determine its three dimensional shape in solution.

(e) What happens when a solution of the protein is boiled?

QUESTION 9
One property which identifies enzymes as proteins is that they

A Contain nitrogen.
B Change the position of equilibrium in biological reactions.
C Are found only in animals.
D Contain many peptide links.

QUESTION 10
Why are most enzymes so specific that they will only accept one substrate?

Solution

QUESTION 11
Why does protein digestion commence in the stomach and not in the mouth?

Solution

QUESTION 12
Saliva contains a substance called amylase, which converts starch into the disaccharide maltose. Starch forms helical structures and cellulose forms linear chains of glucose units.

(a) What are the bonding forces between the cellulose chains?

(b) What are the bonding forces within a cellulose chain?

(c) Describe briefly how amylase reacts with starch, but cannot react with cellulose, even though both are polymers of glucose.

QUESTION 13
Gelatine is a protein obtained from animal by-products. It dissolves in hot water and sets or forms a gel on cooling.

(a) Explain why the gelatine solution sets.

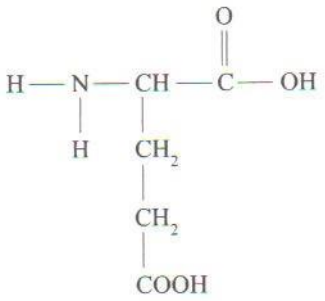
(b) Gelatine will sometimes not set when fruit acids are mixed with it. Give a reason for this observation.

Solution

QUESTION 14
Explain how changing one amino acid in a protein could completely destroy its activity.

Solution

QUESTION 15
One section of a protein chain is made from the glutamic acid monomer. The structural formula of the glutamic acid molecule is shown in the diagram below:



(a) Name the monomers that are used to make proteins.

(b) Draw the structural formula of a section of a protein chain that contains the glutamic acid unit.

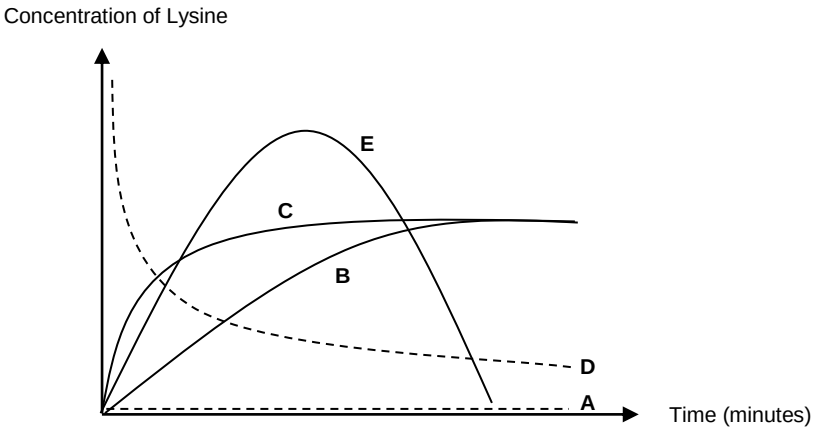
(c) When the glutamic acid unit is replaced with a valine unit, the biological function of this protein is changed. Explain why replacing the glutamic acid unit with a valine unit will change the biological function of this protein.

(d) Valine self-ionises in aqueous solution.

(i) Draw the structural formula of the ion formed after valine self-ionises.

(ii) Describe how this ion is formed.

QUESTION 16
A VCE student decided to investigate the catalytic activity of enzymes under varying conditions. During each experiment, she measured the amount of free lysine (an amino acid) in solution. The concentration of free lysine in solution is shown below.



In each experiment, the student takes a 20 mg sample of protein and measures the concentration of lysine at 2 minute intervals.

Which curve, A,B,C,D or E best describes the change in concentration when the sample of protein is treated with:

(a)	Amylase at pH 7	A	B	C	D	E
(b)	Protease at pH 7	A	B	C	D	E
(c)	Protease at pH 1.0	A	B	C	D	E
(d)	Protease at 100°C	A	B	C	D	E
(e)	Hot, concentrated HCl	A	B	C	D	E

In each case, circle the correct response.

QUESTION 17

(a) Glucose is the only product of the hydrolysis of the saccharide maltose, $C_{12}H_{22}O_{11}$. Write a balanced equation for the hydrolysis of maltose.

(b) An experiment to investigate the hydrolysis of maltose was conducted as follows:

Hypothesis

The rate of hydrolysis of maltose increases as the temperature increases.

Method

- Maltose solution was placed in five test-tubes.
- The test-tubes were agitated in water baths at different temperatures.
- A suitable indicator, to show the presence of glucose, was added to each test-tube.
- A suitable enzyme was added to each test-tube.
- The time taken for the formation of glucose, as shown by a colour change in the indicator, was recorded.

Results

Test-tube	Temperature (^{0}C)	Time (s)
1	10	No reaction by 120 s
2	20	35
3	30	10
4	40	5
5	60	No reaction by 120 s

(i) Identify *two* quantities that should be held at the same value in all test-tubes in this experiment.

(ii) State whether the results in test-tubes 1 to 4 support the hypothesis. Give a reason for your answer.

(iii) Explain why the reaction was faster at 30^0C than at 20^0C.

(c) Enzymes are protein molecules.

Explain the effect of the 60^0C temperature on the structure and function of the enzyme.

(d) Tick the appropriate box to indicate *one* random error that could affect the results of this experiment.

- ☐ The measuring cylinder for the maltose solution was incorrectly calibrated.
- ☐ The heating element in one water bath caused fluctuations in temperature.
- ☐ The enzyme had lost some of its activity as a result of long storage time.
- ☐ No indicator was added to test-tube 1.

(e) State *one* improvement that could be made to the design of this experiment.

(f) Glucose molecules occur in a ring form and a chain form, as shown in the equilibrium equation below:

$$\textbf{ring} \rightleftharpoons \textbf{chain}$$

$$K_c = \frac{[\text{chain}]}{[\text{ring}]} = 0.0002.$$

100 ml of glucose solution contains 0.01 mol of glucose molecules in the ring form. Calculate the concentration, in mol L^{-1}, of glucose molecules in the chain form in this solution.

(g) A small animal warms its body by using the heat released from the respiration of glucose. Assume that all this heat goes into the animal's body water, which has a mass of 200.0 g.

The combustion of 1.00 mol of glucose produces 2840 kJ of heat.

Calculate the increase in the temperature of the animal's body water as a result of the heat released when 0.00100 mol of glucose is used in respiration.
[4.2 J of heat warms 1.00 g of water by 1.0^0C]

SOLUTIONS

QUESTION 1 **Answer is D**

QUESTION 2 **Answer is D**

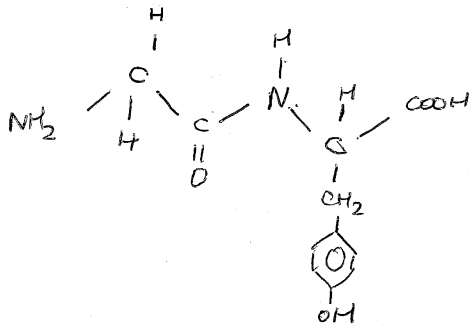
QUESTION 3 **Answer is A**

QUESTION 4 **Answer is C**

QUESTION 5

(a) Amino acids

(b)



(c) Peptide linkage

(d) Hydrogen bonding
Disulfide bridges

QUESTION 6

Denaturation is any process that alters the 2° or 3° structure of a protein + ∴ alters its activity.

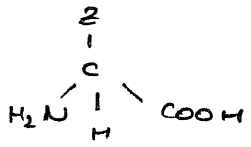
QUESTION 7

2° ⇒ H bonding 3° ⇒ disulfide links are disrupted by many conditions eg temp, pH extremes. The 1° structure is unaffected as the bonds holding amino acids together are strong covalent links. There is not enough energy available in most denaturation processes to disrupt these bonds. However – if we use EXTREME conditions eg conc. HCl + high temp we can hydrolyse proteins to form amino acids. In such conditions the 1° structure IS affected.

QUESTION 8

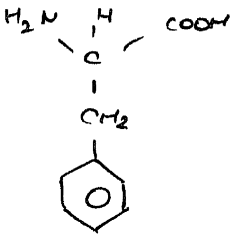
(a)

amino acids



(b) By boiling in hot concentrated HCl.

(c)



Due to hydrophobic benzene ring

(d) Hydrogen bonding, ionic interactions.
(e) Denaturation occurs.

QUESTION 9 **Answer is D**

QUESTION 10

Bic each type of enzyme has a particular active site which has specific 3-D arrangement. This means that the substrate that will fit into the active site is also specific.

QUESTION 11

The enzymes specific for protein digestion require acidic pHs such as those in the stomach for their activity.

QUESTION 12

(a) Hydrogen bonding, dispersion forces

(b) Covalent bonding

(c) (Proteins) enzymes possess a specific active site that is selective for the reactant that can be catalysed. ('Lock + Key') mechanism. The enzyme can attack to starch but not cellulose.

QUESTION 13

(a)

The hot water denatures the protein and upon cooling, the gel sets (as protein structure is deformed + coagulation has occured.

(b) Fruit acids hydrolyse proteins - ie break them down to amino acids which will not coagulate ∴ setting will not occur.

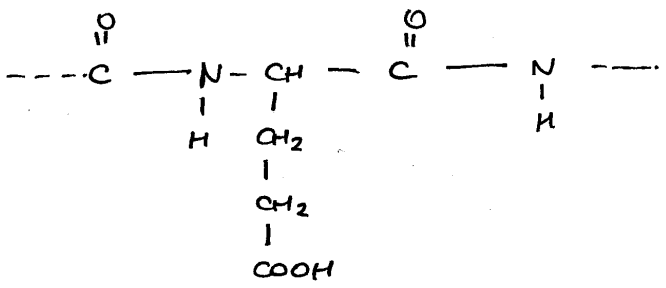
QUESTION 14

If the amino acid is located in a critical region eg. an area which determines the active site, changing the acid could alter the active site or 3-D shape and ∴ affect the protein's activity.

QUESTION 15

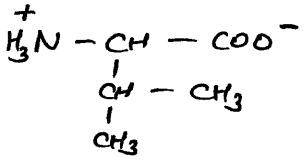
(a) Amino acids

(b)



(c)

Replacement with another amino acid will alter secondary and tertiary interactions, hence the active site and biological activity of the protein.

(d) (i) 

(ii)

In aqueous solutions - carboxy group functions as an acid, donating a proton to the amino group (which functions as a base).

QUESTION 16

(a)	Amylase at pH 7	**A**	B	C	D	E
(b)	Protease at pH 7	A	**B**	**C**	D	E
(c)	Protease at pH 1.0	A	B	**C**	D	E
(d)	Protease at 100°C	**A**	B	C	D	E
(e)	Hot, concentrated HCl	A	B	**C**	D	E

QUESTION 17

(a) $C_{12}H_{22}O_{11}(aq) + H_2O(l) \rightarrow 2C_6H_{12}O_6(aq)$

(b) (i)

Concentration and volume of maltose.
Concentration and volume of enzyme.

(ii) Yes. The results show that the enzyme hydrolyses maltose and that the rate of hydrolysis increases as the temp increases.

(iii)

As temp increases, kinetic energy of system increases and hence there is an associated increased proportion of effective collisions.

(c)

At higher temp, enzymes denature i.e. loss of 3-D shape and activity due to weakening/ breaking of the bonds that maintain the 3-D shape of the enzyme.

(d)

The heating element in one water bath caused fluctuations in temperature.

(e)

Use a greater range of temperaturer.

Note: Random errors are not related to incorrect procedures.

(f)

Ring form: $c = \frac{n}{V} = \frac{0.01}{0.1} = 0.1\ m$

$[chain] = 0.0002 \times [ring]$

$= 0.0002 \times 0.1$

$= 2 \times 10^{-5}\ m$

(g) $1\ mol \rightarrow 2840\ kJ$

$0.001\ mol \rightarrow x\ kJ$

$x \rightarrow 2.840\ kJ$

$E(J) = cm\Delta T$

$\Delta T = \frac{E(J)}{cm} = \frac{2840}{4.2 \times 200} = 3.38\ ^\circ C$