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VCE Biology ¾
Proteins, Protein Export & Enzymes [1.4]
Test Solutions

30 Marks. 1 Minute Reading. 16 Minutes Writing.

Results:

Test	_____ / 20
Extension	_____ / 10

Section A: Test Questions (20 Marks)

INSTRUCTION: 20 Marks. 1 Minute Reading. 16 Minutes Writing.

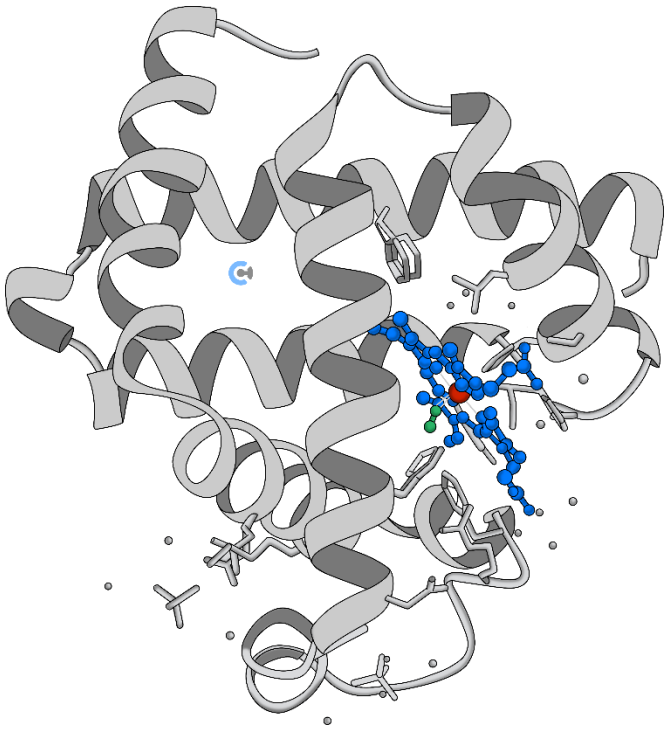
Question 1 (5 marks)

Tick whether the following statements are **true** or **false**.

	True	False
a. Proteins are made of nucleotides joined by condensation polymerisation.		✓
b. The primary structure of a protein refers to the linear sequence of amino acids.	✓	
c. Tertiary structure is determined by interactions between R groups in amino acids.	✓	
d. All proteins have a quaternary structure.		✓
e. The active site of an enzyme is complementary in shape to its substrate.	✓	
f. Non-competitive inhibitors bind to the active site of an enzyme, blocking the substrate.		✓
g. The proteome is the set of all proteins expressed by an organism at a given time.	✓	
h. Enzymes are consumed in the chemical reactions they catalyse.		✓
i. Beta-pleated sheets are a type of secondary protein structure.	✓	
j. The Golgi apparatus is involved in folding and modifying proteins after synthesis.	✓	

Question 2 (1 mark)

In the 1950s, scientist John Kendrew determined the structure of myoglobin. Myoglobin was found to be a single polypeptide chain with one heme group, as shown below.



The protein structure shown above would best be described as myoglobin's:

A. Primary structure.

B. Secondary structure.

C. Tertiary structure.

D. Quaternary structure.

Question 3 (1 mark)

Which one of the following statements about proteins is correct?

A. The activity of a protein may be affected by the temperature and pH of its environment.

B. The primary structure of a protein refers to its three-dimensional protein shape.

C. Proteins are not involved in the human immune response.

D. A protein with a quaternary structure will be an enzyme.

Question 4 (1 mark)

Acetylcholinesterase is an enzyme that catalyses the breakdown of the neurotransmitter acetylcholine into acetate and choline.

Some chemicals used to kill insects contain aldicarb.

Aldicarb is a reversible inhibitor of acetylcholinesterase that:

A. Permanently blocks the active site of acetylcholinesterase.

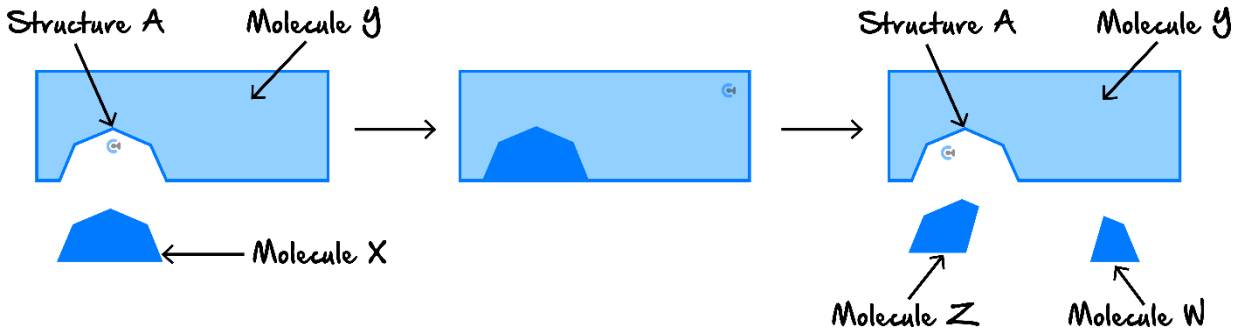
B. Acts by strongly binding to the active site of acetylcholinesterase.

C. Increases the rate at which acetylcholine is broken down into acetate and choline.

D. Reduces acetylcholinesterase activity by reducing the number of active sites for acetylcholine to bind to.

Question 5 (1 mark)

The diagram below represents a generalised biochemical process.



Which one of the following statements is correct?

A. Molecule *Y* represents the substrate.

B. Molecule *X* represents an enzyme.

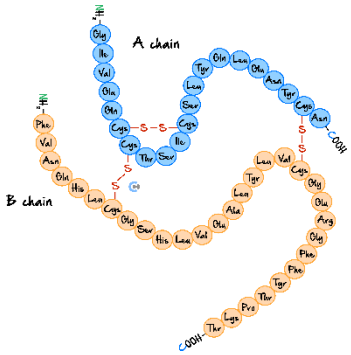
C. Structure *A* is an active site.

D. Molecule *Z* is a reactant.

Space for Personal Notes

Question 6 (1 mark)

The diagram below represents a functional insulin molecule, which is comprised of 2 polypeptide chains (*A* and *B*) connected by disulphide bonds.



The insulin protein is functional at the:

A. Primary level.

B. Secondary level.

C. Tertiary level.

D. Quaternary level.

The 4 levels of protein structure include the primary level (amino acid order), the secondary level (coiling within the polypeptide strand), the tertiary level (3D structure of the polypeptide) and the quaternary level (2 or more polypeptides making the functional protein). Insulin is functional at the quaternary level as there are 2 polypeptides linked together to make the functional protein.

Study Design Reference:

The functional importance of the four hierarchal levels of protein structure

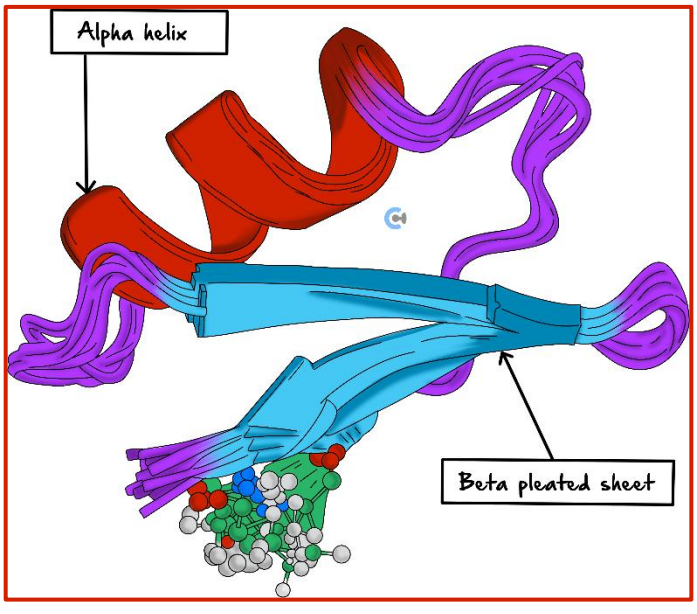
Web Link

https://biomedapps.curtin.edu.au/biochem/tutorials/prottute/hierarchy.htm

Question 7 (3 marks)

The structure of a scorpion venom toxin molecule is shown below. The arrows are pointing to two different secondary structures.

a. Name these secondary structures in the boxes provided. (2 marks)



b. The molecule can be described as having a tertiary structure. Define the tertiary structure of a protein. (1 mark)

3D folded structure, containing one polypeptide chain consisting of secondary structures.

Question 8 (7 marks)

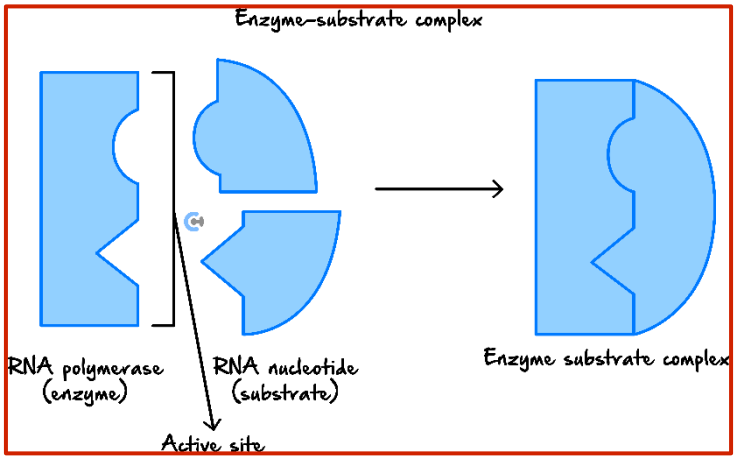
RNA polymerase is an enzyme essential for protein synthesis, and its role in ageing is being investigated. In past studies, the inhibition of RNA polymerase III is linked to a 10% extension in lifespan in flies and worms. As RNA polymerase has the same structure and role in other organisms, its inhibition is thought to increase lifespans in mammals, including humans.

a. Describe how enzymes facilitate biological reactions. (2 marks)

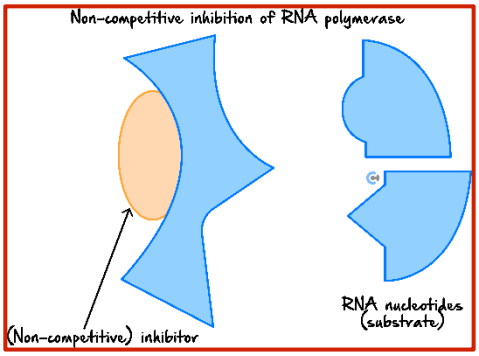
Enzymes collide/bind to briefly with the substrate (1). *This means that less energy is needed for bonds to form/break OR the reaction can occur faster* (1).
1 mark for the enzyme and substrate coming into contact.
1 mark for either speeding up or lowing the activation energy required.

b. In the boxes below, draw and label diagrams to show the following reactions of RNA polymerase: (2 marks)

Enzyme-substrate complex:



Non-competitive inhibition of RNA polymerase:



1 mark for correct labelling of enzyme and substrate, showing complementary shape.

1 mark for showing inhibition that prevents binding of substrate.

c. Describe a condensation reaction that is facilitated by RNA polymerase. Include the role of RNA polymerase in your response. (3 marks)

RNA polymerase joins RNA nucleotides (1).
A water molecule is released (1).
Energy is required/energy is an input/reaction is endergonic (1).

Section B: Extension (10 Marks)

Question 9 (10 marks)

Amylase is an enzyme that breaks down starch to maltose. A student investigated the effect of pH on the activity of amylase. The activity of the enzyme was measured by testing for the presence of starch at short intervals. The following results were obtained.

pH	4.0	5.0	6.0	7.0	8.0	9.0
Mean amylase activity (% maximum)	22	65	97	100	54	27

a. Outline the steps that would be taken by the student for this investigation and what conditions would be required. (4 marks)

Multiple test tubes containing the same concentrations of starch and amylase would be set up (1). A range of pH buffer solutions (1). The test tubes would be incubated at the same temperature – ideally the optimum temperature for the amylase enzyme (1)
A short amount of solution would be taken from each test tube at regular intervals (such as 20 seconds) and tested for the presence of starch or rate of maltose production (1).

b. Suggest **two** reasons why the activity of amylase is so low at pH 4.0 and pH 9.0. (2 marks)

(Any 2 of the following for 1 mark each)
- *At low or high pH the enzyme could be denatured (1).*
- *The tertiary structure of the enzyme and the shape of the active site has changed so that the substrate no longer fits (1).*
- *High concentration of H^+ ions or OH^- ions interfere with the reaction by disrupting bonds (1).*

The student concluded that the optimum pH for the amylase activity was exactly 7.0. It was suggested by another student that the optimum pH may be slightly different to this value.

c. How might the first student improve this experiment in order to satisfy the possibility of another optimum pH? (1 mark)

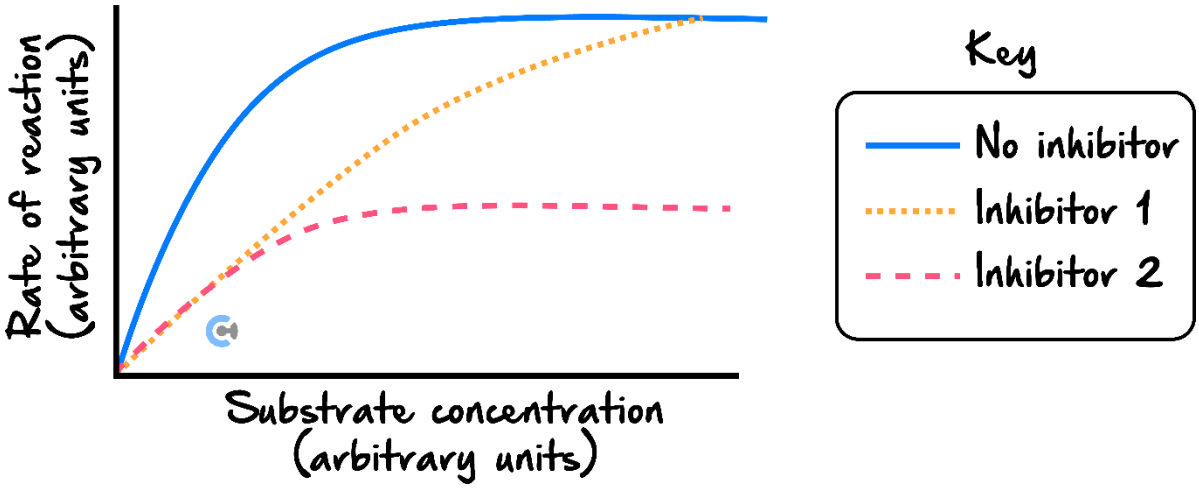
Repeat the experiment with pH values close to pH 7 such as 6.5 and 7.5.

An investigation was carried out on the effect of two different inhibitors of amylase. One was a competitive inhibitor and the other was a non-competitive inhibitor.

d. How do the actions of a competitive and a non-competitive inhibitor differ? (1 mark)

A non-competitive inhibitor prevents the enzyme from working by attaching to a site other than the active site whereas a competitive inhibitor binds to the active site and prevents the substrate from attaching.

The following graph shows the results of the reaction rate without an inhibitor and the reaction rates with the two different inhibitors described above.



e. State which lines on the graph refer to each type of inhibitor and give a reason for your answers. (2 marks)

inhibitor 1 is the competitive inhibitor & inhibitor 2 is the non-competitive inhibitor (1). Reasoning: As the concentration of substrate increases the substrate molecules outnumber the competitive inhibitor and so the reaction rate can reach a maximum. The action of the non-competitive inhibitor is not affected by an increase in substrate concentration therefore does not reach a maximum rate (1).

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