MISSION M.B.BS

Date: 11/07/2022

Subject: ZOOLOGY

Topic : BIOMOLECULES - L7

Class: Standard

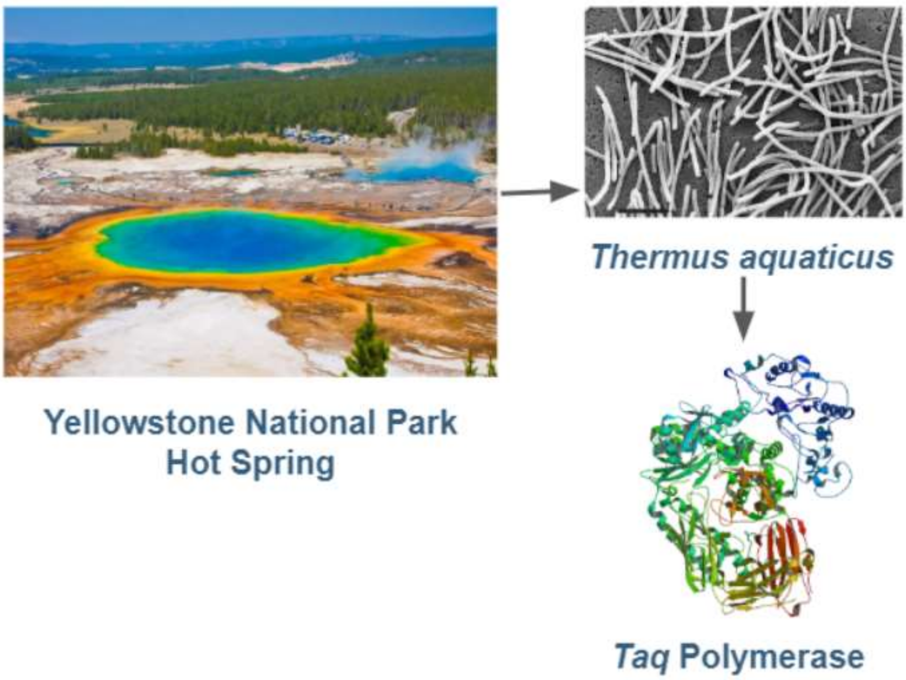
Instructions:

A

1. Which of the following statements is incorrect?

   - ✗ **A.** Enzymes are denatured at high temperature but in certain exceptional organisms they are effective even at 80-90 degree celsius
   - ✗ **B.** Enzymes require optimum pH for maximal activity
   - ✓ **C.** All enzymes are exclusively proteinaceous
   - ✗ **D.** Enzymes are highly specific

Generally, enzymes are proteinaceous in nature but certain enzymes such as ribozymes are exceptions to proteinaceous enzymes. They are made u of nucleic acids. Ribozymes are RNA molecules capable of catalysing a biochemical reaction.
Enzymes are the catalysts in the living system. Being proteinaceous, the enzymes are generally thermolabile (temperature-sensitive) in nature. They generally work over a narrow range of temperature, usually corresponding to the body temperature of the organism. However, certain enzymes that a isolated from organisms who normally live under extremely high temperatures (up to 80-90 degree celsius) are stable and retain their catalytic power even at high temperatures.



Each enzyme has a characteristic optimum pH at which its activity is maximal. A deviation or change to more alkaline or acidic pH can cause a drop the activity of enzymes. Most enzymes have an optimum pH in a range of 4-9.
Enzymes are highly specific in nature. It binds to a particular substrate as it fits into its active site. It means that an enzyme that catalyses one reactio may not catalyse another.

2. Name the type of enzyme involved in the following reaction:
S-G + S' → S + S'-G

A. Isomerase

B. Transferase

C. Hydrolase

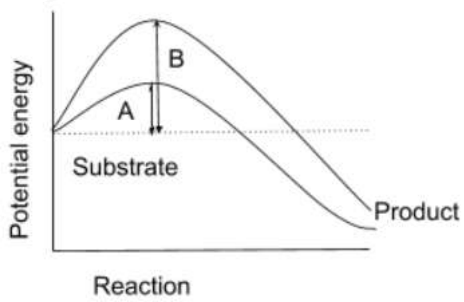
D. Lyase

As shown in the reaction, there is a transfer of a functional group from one substrate to another. The chemical substituent G gets transferred from Substrate S to substrate S'. This transfer is facilitated by a transferase enzyme.

The enzymes are classified into six major classes. A brief about each class has been summarised in the following table.

Sl.No.	Class	Function
1	Oxidoreductase	This class of enzymes catalyses reactions that involve electron transfer
2	Transferase	Enzymes that catalyse reactions which involve the transfer of groups of atoms are a member of this class
3	Hydrolase	Enzymes that catalyse the hydrolysis reaction are a member of this class
4	Lyase	Enzymes that catalyse the removal of groups from substrates by mechanisms other than hydrolysis leaving double bonds
5	Isomerase	This class of enzymes are involved in reactions that convert a substance into its isomer
6	Ligase	Ligases are enzymes that catalyse reactions which involve the formation of bonds/linking together of two compounds

3. Which of the following describes the given graph correctly?



A. Endothermic reaction with energy A in absence of enzyme and B in the presence of an enzyme

B. Exothermic reaction with energy A in absence of enzyme and B in the presence of an enzyme

C. Endothermic reaction with energy A in presence of enzyme and B in the absence of an enzyme

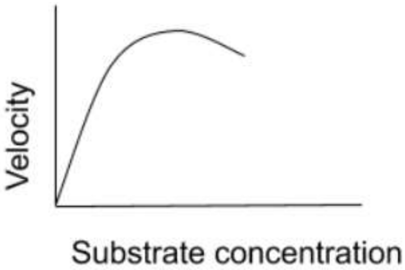
D. Exothermic reaction with energy A in presence of enzyme and B in the absence of an enzyme

In enzymatically catalysed reactions, enzymes lower the amount of activation energy required to start the reaction. Activation energy is defined as the minimum amount of extra energy required by reacting molecules to get converted into the product(s).

Exothermic reactions are those that release energy, usually in the form of heat while endothermic reactions are those that require energy usually in th form of heat to proceed.

As shown in the graph, the energy of the product formed is lower than that of the substrate molecules. It means that during the course of the reaction energy is released. Hence, the reaction represented by both the curve is that of an exothermic process. Also, we see that curve A has a peak lower t that of the curve B. This peak refers to the transition state of the substrate being converted into the product(s). The difference in the energy level of th substrate and transition state is the activation energy required to start the reaction. We observe that this difference is the least in curve A, implying th the activation energy is also reduced. Hence, it can be said that curve A represents reaction in the presence of an enzyme.

4. The given graph shows the effect of substrate concentration on the rate of reaction of the enzyme green-gram-phosphatase. What does the graph indicate?



A. The rate of the enzyme reaction is directly proportional to the substrate concentration

B. Presence of an enzyme inhibitor in the reaction mixture

C. Formation of an enzyme-substrate complex

D. At higher substrate concentration the pH increases

The graph given shows the relationship of rate or velocity of the reaction with respect to substrate concentration.

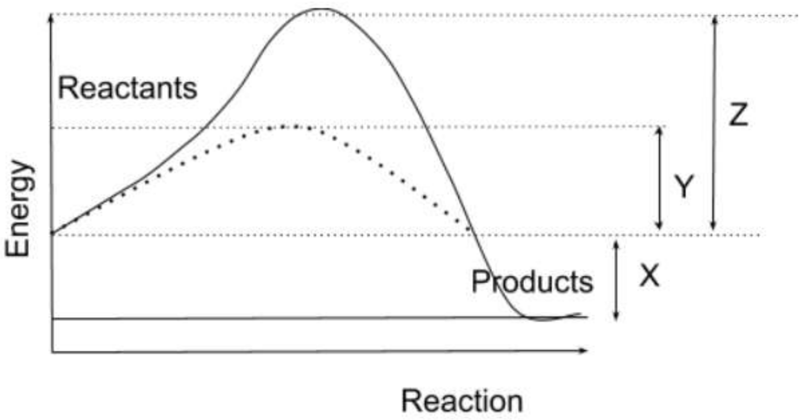
Option(a) is true only till the point where velocity reaches the maximum. After that, as the substrate concentration is increased, it is seen in the graph that the velocity decreases. As this decrease in the velocity of the reaction upon further addition of substrate is not explained by option (a), hence it is incorrect.

After the reaction reaches V_{max}, further addition of substrate causes a decline in the rate of reaction, indicating the presence of inhibitor molecules in reaction mixture. The reaction mixture includes the enzyme, substrate, product and the inhibitor in this case. Hence, option (b) is correct.

Formation of the enzyme-substrate complex may or may not take place after the addition of inhibitors as the inhibitor may be competitive or non-competitive. The enzyme-substrate complex is formed only till the velocity of the reaction reaches its peak. Beyond that it is decreasing in the graph a this is not explained in option (c). Hence, the option (c) is incorrect.

The given graph is the velocity of reaction vs substrate concentration graph. The relation between pH and substrate concentration for this particular reaction cannot be deduced by this graph.

5. The diagram illustrates energy changes in an enzyme controlled reaction.



Which of the following represents the lowering of the activation energy?

A. X

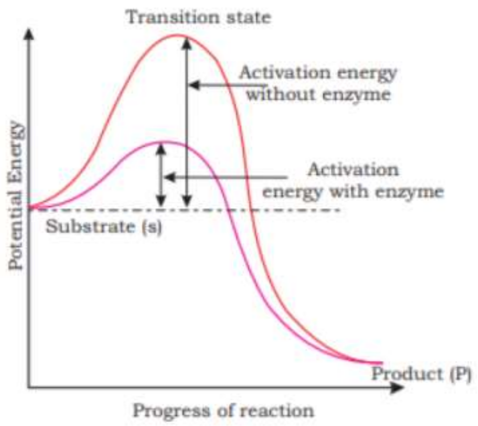
B. Y

C. Z

D. Z - Y

In enzymatically catalysed reactions, enzymes lower the amount of activation energy required to start the reaction. Activation energy is defined as the minimum amount of extra energy required by reacting molecules to get converted into the product(s).
The peaks of the curves refer to the transition state of the substrate being converted into the product(s). The difference in the energy level of the substrate and transition state is the activation energy required to start the reaction.

In the given graph, the addition of an enzyme has lowered the transition state that is represented by the peak of the curve Y. The difference in the transition state of curve Z and curve Y represents how much activation energy has been lowered due to the addition of enzymes. The lowering of the activation energy can be calculated by computing the difference between Z and Y transition states (Z-Y). Hence, the correct option is (d).



6. The catalytic efficiency of two different enzymes can effectively be compared by the

- ✔ **A.** K_m value
- ✖ **B.** pH optimum value
- ✖ **C.** molecular size of the enzyme
- ✖ **D.** temperature optimum value

The catalytic efficiency of two different enzymes can be compared by their K_m values. The K_m or the Michaelis-Menten constant refers to the concentration of substrate at which the reaction reaches half its maximum velocity. K_m indicates the affinity of the enzyme for its substrate.
A high K_m value indicates low affinity while low K_m value indicates a high affinity for the substrate.
A higher affinity for the substrate corresponds to higher efficiency of enzymes, since high affinity ensures greater amount of substrate-enzyme bindin and product formation. Small
K_m also suggests that an enzyme is able to tightly bind with the substrate.

Different enzymes have different pH optima. pH alone cannot be used to compare the efficiency of two enzymes. Some enzymes function in acidic environments while others in an alkaline environment.

Molecular size of the enzyme generally has got little to do with its efficiency.
Same is the case with temperature. Being proteinaceous, the enzymes are generally thermolabile (temperature-sensitive) in nature. They generally v over a narrow range of temperature. At lower temperatures, enzymes become inactivated and at higher temperatures, they may get denatured. However, certain enzymes are very resistant to high temperatures. For example, *Taq* polymerase obtained from *Thermus aquaticus* has its temperat optima at 72-degree celsius. Temperatures optima can vary between enzymes and cannot be used as a sole criterion for comparing the efficiency of enzymes.

7. Enzymes catalysing the breakdown of larger molecules into smaller molecules are

- ✔ **A.** hydrolases
- ✖ **B.** isomerases
- ✖ **C.** ligases
- ✖ **D.** both (a) and (c)

Hydrolases are enzymes that catalyse the hydrolysis of their substrates by adding constituents of water (hydrogen and hydroxyl groups). Digestive enzymes belong to this group. For example - lactase, maltase, amylase, protease, etc.

Isomerases are the enzyme that catalyses the reaction in which substrate is converted into its positional or optical isomer by intramolecular rearrangement.

Ligases are the enzymes that catalyze the linking together of compounds utilising energy from ATP.

8. The K_m value of the enzyme is the value of the substrate concentration at which the reaction reaches to

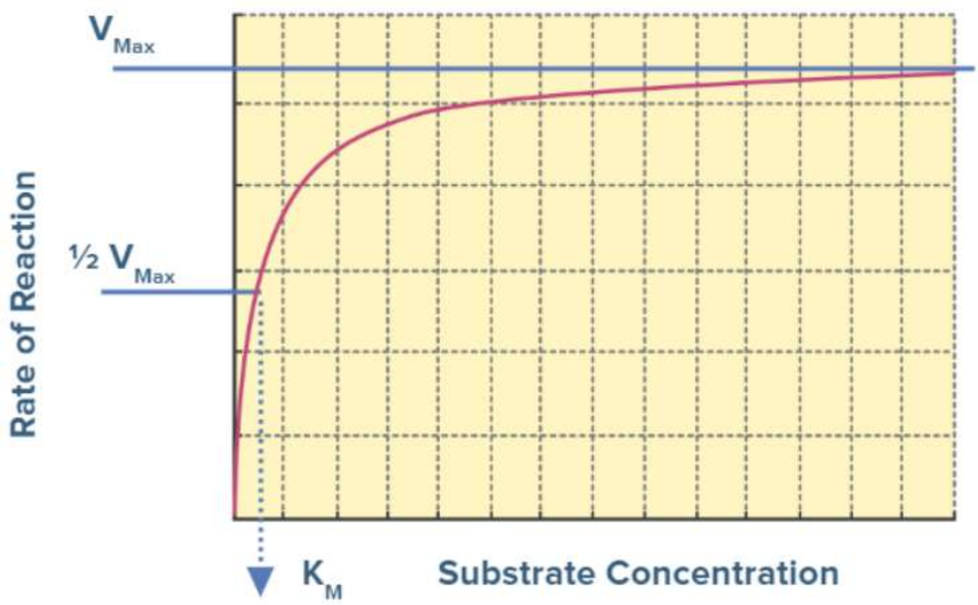
A. zero

B. $2\ V_{max}$

C. $\frac{1}{2}V_{max}$

D. $\frac{1}{2}V_{max}$

K_m or the Michaelis- Menten constant refers to the concentration of substrate at which the reaction reaches half its maximum velocity. The constant w given by Leonor Michaelis and Man Menten in 1913. It tells about the affinity of the substrate to the enzyme and the catalytic activity of the enzyme.



9. What would happen to V_{max}, in the presence of a non-competitive inhibitor?

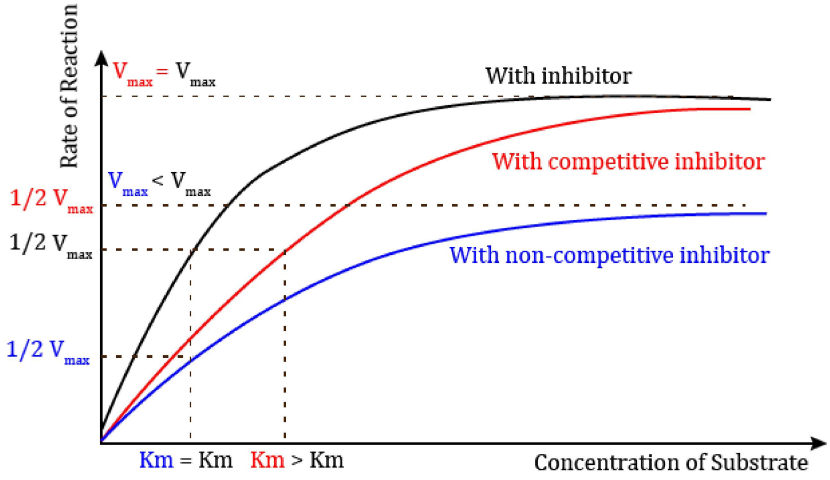
A. It decreases

B. It increases

C. Remains the same

D. First increase then decrease

In non-competitive inhibition, the inhibitor molecules do not compete with the substrates for active sites on the enzyme surface, but some other site o the enzyme. This results in a decrease in the enzyme molecules that can catalyse the reaction. Hence, V_{max} is lowered. As a result, the non-competitive inhibitors cannot be completely overcome by the addition of more substrate. This leads to a decreas in V_{max} of the reaction.



10. Which one of the following statements is incorrect?

- A. The competitive inhibitor does not affect the rate of breakdown of the enzyme-substrate complex
- B. The presence of the competitive inhibitor decreases the K_m of the enzyme for the substrate
- C. A competitive inhibitor reacts reversibly with the enzyme to form an enzyme-inhibitor complex
- D. In competitive inhibition, the inhibitor molecule is not chemically changed by the enzyme

Competitive inhibitors are structural analogues (having similar structure) of a substrate molecule. They compete for the same site(s) on the enzyme molecule that are normally occupied by the substrate molecules.
In the presence of inhibitors, the substrate molecules are not able to bind at the active sites of the enzymes. The inhibitors, in turn, bind reversibly wit those active sites forming an enzyme-inhibitor complex. The complex formed is inactive as it cannot form product(s). If the enzyme-substrate is alrea formed, the competitive inhibitor cannot affect the rate of breakdown of the enzyme-substrate complex. That is why it is recommended to add more substrate molecules for overcoming competitive inhibition.

K_m or the Michaelis-Menten constant refers to the concentration of substrate at which the reaction reaches half its maximum velocity. Due to the presence of competitive inhibitors, fewer substrate molecules are available to reach half of the maximum velocity of the reaction. In order to reach ha the maximum velocity, more substrate molecules will be needed thereby increasing K_m for the reaction.
Thus, the presence of competitive inhibitors will increase the K_m of a reaction. The competitive inhibitors are not changed chemically by the enzyme during reversible interactions.