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BIOLOGY

Class 9th (KPK)

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Chapter No.6
Enzymes

Q1: Define metabolism and its types?

Ans: Metabolism:

Meaning:

The word metabolism is derived from a Greek word meaning "Change"

History:

Concept of metabolism was first of all given by Ibn-e-Nafees.

Definition:

The sum of all Chemical reactions that takes place in living organisms is called Metabolism.

Types of Metabolism:

There are two types of metabolism.

i. Anabolism
ii. Catabolism

I. Anabolism:

It is a constructive process in which small molecules combine to form larger molecule is called anabolism. These types of reactions are called anabolic reactions.

Example:

Photosynthesis: $6\ CO_2 + 12\ H_2O \xrightarrow[\text{chlorophyll}]{\text{sun light}} C_6H_{12}O_6 + 6O_2 + 6\ H_2O$

II. Catabolism:

It is a destructive process in which larger molecules breakdown into smaller molecules is called catabolism. Such reactions are known as catabolic reaction.

Example:

Respiration. $C_6H_{12}O_6 + 6O_2 + 6\ H_2O \xrightarrow[\text{chlorophyll}]{\text{sun light}} 6\ CO_2 + 12\ H_2O + ATP$

Q2: Define activation energy? How enzymes lower the activation energy of substrate?

Ans: Activation energy:

The minimum amount of energy required to convert a reactant into product is called activation energy.

Methods of lowering activation energy:

Enzymes lower the activation energy in several ways. They do so by,

i. Altering the shape of the substrates and reducing the amount of energy required to complete the transition.
ii. Disrupting the charge distribution.
iii. Bringing substrates in the correct orientation to react.

Q3: Write the characteristics of enzymes.

Ans: Characteristics of enzymes:

i. Enzymes are globular proteins in nature and are secreted by cells.
ii. The enzymes functions as catalyst and increase the rate of chemical reaction.
iii. They lower the activation energy of reactions.
iv. Enzymes are usually very specific for the type of reaction and for the nature of their substrate.
v. A small amount of enzyme can bring change in a large amount of substrate.
vi. Enzymes are sensitive to change in pH of the substrate.
vii. Some enzymes work inside the cells called intracellular enzymes. Like mitochondrial enzymes while some enzymes like pepsin work in stomach.
viii. Enzymes activity can also be regulated by inhibitor and activators.

Q4: Define the following terms?

Ans: Activators:

Substances which enhance the enzymes activity are called activators.

Co-factors:

The non-protein molecules or ions required by enzymes for activity are called Co-factors. e.g. metallic ions and organic molecules.

Co-enzymes;

If the organic cofactor is loosely attached with the enzyme, they are called Co-enzymes mostly coenzymes are vitamins riboflavin, thiamine, folic acid.

Prosthetic group:

It is organic cofactor is tightly attached with enzyme they are called prosthetic groups.

Apo enzymes;

Enzyme without cofactor is called Apo enzymes.

Holoenzyme:

Enzyme with cofactor is called Holoenzyme. OR Complete enzyme is called Holoenzyme.

Substrate:

The substances on which enzyme act are called substrate.

Active site:

A region on an enzyme where substrate binds during reaction is called active site.

Activation energy:

The amount of energy required to start a biochemical reaction is called activation energy.

Q5: Why enzymes are specific in their function discuss?

Ans: Enzymes are very specific in their action because of their active site. An enzyme generally catalyzes only one kind or one type of chemical reaction. Therefore, they are specific for certain substrate. One particular enzyme cannot speed up many different types of reactions.

No reaction can occur in a cell unless its own specific enzyme is present.

Example:

Urea ---Urease--- → Ammonia

Starch ---Amylase--- → Glucose

Protein ---Proteas--- → Amino acid

Lipid ---Lipase--- → fatty acid

Cellulose ---Cellulase--- → Glucose

Q6: Describe the mechanism of enzyme action?

Ans: There is a small portion in the enzyme molecule that is actually involved in catalysis. This catalytic region is called active site.

When an enzyme joins its substrate, the complex is formed called enzyme substrate complex. As a result of interaction between an enzyme and its substrate product is formed.

$E + S \longrightarrow E S C \longrightarrow P + E$

E = enzyme S = Substrate P = Product

Mechanism:

Two models have been proposed to explain the mechanism of enzymes action. These are,

1. Lock and key model.
2. Induced fit mode.

1. Lock and key Model:

History:

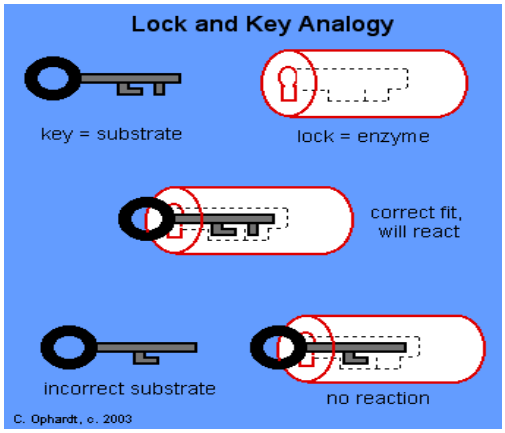
This model was proposed by a German biochemist Emil fisher in 1894.

Statement:

According to this model active site of enzyme and substrate have specific geometric shape. The substances molecule exactly fits in the active site of enzyme just like a lock and a key. Enzyme is the lock and substrate are the key. This model suggests that the active site is a rigid and non-flexible structure.

Mechanism:

According to lock and key hypothesis the enzyme (key) combined with a specific substrate (lock) and chemically changing the substrate into a new product. No change occurs in the enzyme during or after the reaction.



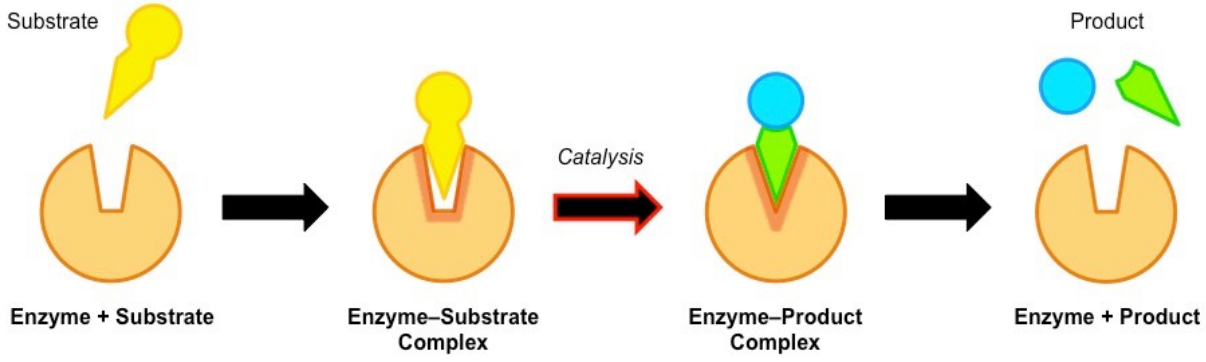
2. inducted fit model:

History:

This model was first proposed by American Biologist DanielKoshland in 1958. It is also called Hand and Glove model. According to this model active site of enzyme are flexible.

Mechanism:

Koshland suggested that when a substrate combines with an enzyme it induces changes in the enzyme structure. This change helps the enzyme to perform its catalytic activity more effectively. So, the active sites of the enzymes are not rigid and are flexible.



Q7: What is the effect of temperature, PH and substrate concentration on enzymes activity?

Ans: I. Effect of temperature:

Enzymes are very sensitive to the change in temperature. With increase in temperature the enzymes activity also increases but there is limit to the increase. This limit is called optimum temperature. The optimum temperature for human enzyme is between 35 – 40 C^o and the average temperature is 37C^o. When temperature is above 40C^o denaturing of enzyme quickly starts. At 0 C^o the enzyme becomes inactive and cannot perform their function.

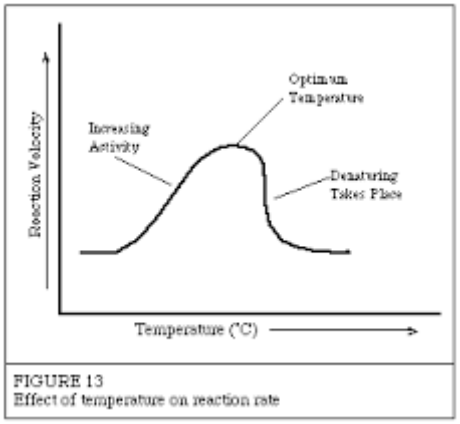


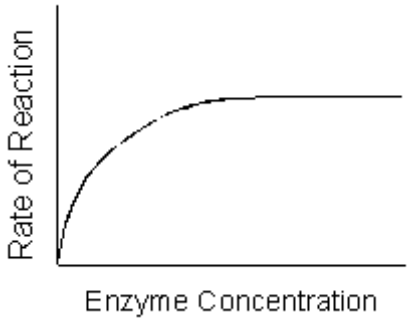
FIGURE 13
Effect of temperature on reaction rate

ii. Effect of pH:

The activity of enzymes varies with change in pH. The pH at which the activity of an enzyme is maximum called optimum pH. Optimum pH value for most enzymes is between 6-8. The activity of enzyme pepsin in stomach work best at a pH of 2 and trypsin at a pH 8. Change in pH can stop enzyme activity. Any change in Ph can lower the enzymatic activity. Extreme changes in the pH of solutions denture the enzymes.

iii. Effect of substrate concentration:

The rate of reaction of reaction increases with the increase in substrate concentration. When enzyme become saturated. At saturation point the reaction cannot increase further enzymes are said to be saturated when all of its active sites are occupied by the substrate.



SHORT QUESTIONS

C. Write short Answer of the following Questions.

Q1: Differentiate between lock and key model and the induced-fit model?
Ans Difference between lock and key model and the induced-fit model:

Characters	Lock & Key Model	Induced Fit model
History	This model was proposed by a German biochemist Emil Fischer in 1894.	This model was first proposed by American Biologist Daniel Koshland in 1958.
Statement	According to this model active site of enzyme are rigid.	According to this model active site of enzyme are flexible.
Geometry	No change occurs in the enzyme during or after the reaction.	The geometry of enzymes changes during reaction.

Binding	Enzyme can only bind with a single substrate	In the induced-Fit model, multiple substrates can bind with an enzyme.
Active site	Active site does not change its shape.	Active site changes their shape slightly.

Q2: In what way does an enzyme affect the chemical affect the chemical reactions its catalysis?
Ans: Enzymes are biological catalysts. They speed up the chemical reaction by lowering the activation energy needed for the reaction.
Enzymes lower the activation energy by several ways.

- Altering the shape of substrate
- Disrupting the charge distribution
- Bringing substrates in correct orientation to react.

Q3: What will be the effect on digestion of we take some digestive enzymes from outsides?
Ans; If we take some digestive enzymes from outside the digestion will efficiently and effectively occur. It is very important that we preserve the body's ability to make enzymes. If supplemental plant digestive enzymes are taken with a meal, these digestive enzymes begin their work immediately. The supplemental digestive enzymes will break down the food, thus saving the body from having to release as many of its own enzyme.

Q4: What is meant by denaturation of enzymes?
Ans: The change in structure of enzymes resulting from the breakdown of the weak ionic and hydrogen bonding in enzymes is called denaturation of enzymes.

Q5: How are enzymes specific for the substrate?
Ans: Enzyme are very specific in their action, An enzyme catalysis only one specific reaction. Enzyme due to its specific chemical nature and structure can react with a specific substrate. That's why one particular enzyme cannot speed up different types of reactions. Proteases convert only protein into amino acid and lipase convert lipids into fatty acid.

Q6: What is the term used to describe the temperature and pH at which enzymes can work most effectively in a reaction?
Ans: All enzyme work at specific temperature, increase or decrease in specific temperature effect the rate of enzymes action. The temperature at which the enzymes works best is called optimum temperature.
Example:
Optimum temperature for human enzymes is between 35-40 C^{o}. Most enzymes work best at a pH between 6-8 which is called optimum pH. So, the term which used to describe the temperature and pH on which the enzymes work properly is called optimum temperature.

Long Question

C. Give detailed Answers to the following Question.

Q1: Describe the factors which affect the enzymes activities?
Ans: See Q No. 7

Q2; Explain the mode of action of an enzyme in a reaction?
Ans: See Q No. 6

Q3: what are the various properties of enzymes?
Ans: See Q No. 3

Q4: The diagram below shows the relationship between an enzyme, a substrate and the products of an enzyme catalyzed reaction?

a): What is represented by the parts labelled A,B and C in the diagram?
Ans: The parts labeled "A" shows a substrate, "B" shows an enzymes and "C" shows the products.

b) Name two properties of enzymes, that are represented in this diagram, what will happen to the chemical reaction if the enzyme is removed?
Ans: The enzyme in this diagram shows the active site, enzyme-substrate complex and the enzyme remain unchanged after reaction is completed.
When enzyme is removed the chemical reaction slows down or even stops.

c) What will happen to the rate of reaction if the reaction temperature is raised steadily?
i. From 25 C^o to 35 C^o and ii. From 40 C^o to 60 C^o
Ans: If the reaction temperature is changed from 25C^o to 35C^o, the rate of reaction will increase. But if the temperature of reaction is from 40C^o to 60C^o the reaction will stop.

d) What term is used to describe the condition of the enzyme when it is heated to a temperature of 60$C^o$and above?
Ans: The term used to describe the condition of the enzyme when it is heated to a temperature of 60C^o and above is denaturation.

Q No. 5: The graph below shows the rate of an enzymatic reaction?
a) According to graph A, at which temperature the enzyme activity is highest? When temperature increase above this point, what will happen to the enzyme?
Ans: According to graph A, the enzyme activity is maximum at 40 C^o. When temperature increase above this point, the enzymes becomes denature and decrease in the rate of reaction occurs sharply.
b) According to graph B, what is the optimum pH for i) pepsin and ii) lipase? As pH moves away from the optimum value, what will happen to the enzyme activity?

Ans: According to graph B, the optimum pH for pepsin is 2, and pH for lipase is 8. As pH moves away from the optimum value, the enzyme activity decrease and hence the rate of reaction decrease.