Chapter = 06

Biology 9th - Detailed Question Answers

➔ ENZYMES

Q.1: Define metabolic reactions and metabolism.

Ans: **Metabolic Reactions and Metabolism**: Life is another name of activity therefore thousands of chemical reactions take place in the body of an organism. These reactions of an organism are collectively called metabolic reactions and this phenomenon of chemical activity called metabolism.

Q.2: Briefly describe the types of metabolic activities.

Ans: **Types of Metabolic Activities**: The metabolic activities phenomenon of two types, either constructive or destructive.

Constructive Reactions: In constructive reactions large molecules are formed to form a structure of cell or body. These reactions are called anabolic reactions and this type of metabolism is called anabolism.

Destructive Reactions: On the contrary, the destructive reaction in which large molecules breakdown in small molecules to produce energy or to re-utilize further or to discard called catabolic reactions. The type of this metabolic activity is called catabolism.

Q.3: What is activation energy?

Ans: **Activation Energy**: The chemical reaction requires particular conditions to carry down at proper rate, temperature and pressure. The conditions of temperature and pressure inside cell or organism are generally found not suitable for chemical reaction e.g. inside human body normal temperature remain 37° and pressure is 120/80m.m of Hg. These conditions of temperature and pressure are not enough to perform any chemical reactions.

Now body requires some facilitators. These facilitators help to perform biochemical reactions at low energy. It is clear now that each reaction requires some amount of minimum energy to initiate a reaction. This minimum amount of energy is called activation energy. If this amount is high, the difficult will be the reaction or vice versa e.g. the activation energy needed to break a glucose molecule initially requires energy of 2 ATP molecules.

Q.4: What are enzymes?

Ans: **Enzymes**: The high amount of activator energy cannot be provided by organism itself therefore they require some facilitators to reduce this activation energy. These facilitators are special molecules made up of mostly protein called enzymes (En=inside, zyme=yeast). The name was coined due to observation when yeast was introduced in fruit sap which converted it into alcohol. Now the enzymes are defined as the biocatalysts which facilitate chemical reaction by lowering activation energy.

This action of enzyme allows biological reaction to proceed rapidly at relatively low temperature and pressure tolerable by living organism.

Q.5: Describe the characteristics of enzymes.

Ans: **Characteristics of Enzymes**:

(i) Enzymes are biocatalyst, made up of mostly proteins and therefore three dimensionally folded chains of amino acids with a specific shape. This shape is determined by the sequence of amino acids held together by bonds, for example Hydrogen bonds.

(ii) Enzymes speed up reactions by bringing reactants together and reducing the activation energy required starting the reaction (enzymatic reaction).

(iii) When an enzyme starts a chemical reaction, catalyzes the reaction hence does not utilized itself which means even a single or little amount of enzyme can start a reaction and catalyze fast.

(iv) Their presence does not affect the nature or properties of end products.

(v) They are very specific in their action; a single enzyme catalyzes only a single chemical reaction or a group of related reactions.

(vi) The shape of active site is complementary to shape of the substrate.

(vii) They are sensitive to even minor change in pH, temperature and substrate concentration.

(viii) Some enzymes require cofactor for their functioning.

(ix) Many enzymes work in a sequential manner to produce a specific product. This pathway is called metabolic pathway.

(x) Activity of enzymes can be enhanced by activator and can be decreased by inhibitors.

Q.6: Define: (i) substrate (ii) active site (iii) activator.

Ans: **Substrate**: Reactants of enzyme are called substrate.

Active Site: A small portion of enzyme where substrate attaches with enzyme is called active site.

Activator: Enzyme activators are molecules that can bind with an enzyme to increase its activity.

Q.7: Define and Explain cofactor.

Ans: **Cofactor**: A cofactor is a non-protein substance which may be organic or inorganic.

Zn^{+2} ,Mg^{+2} , Mn^{+2} ,Fe^{+2} ,Cu^{+2} ,K^{+1} and Na^{+1} are inorganic cofactors and NADP, NAD and FAD are organic cofactors.

Cofactor can be categorized into prosthetic group (if organic cofactors are tightly bound to an enzyme) and Coenzymes (if organic cofactors are loosely attached with an enzyme).

Q.8: What is an enzyme inhibitor?

Ans: **Enzyme Inhibitor**: An enzyme inhibitor is a molecule that binds to an enzyme and decreases its activity. Since blocking an enzyme's activity can kill a pathogen.

Q.9: Describe the uses of enzymes in industries.

Ans: **Uses of Enzymes**: Many enzymes are used commercially in industries. The most common industries are:

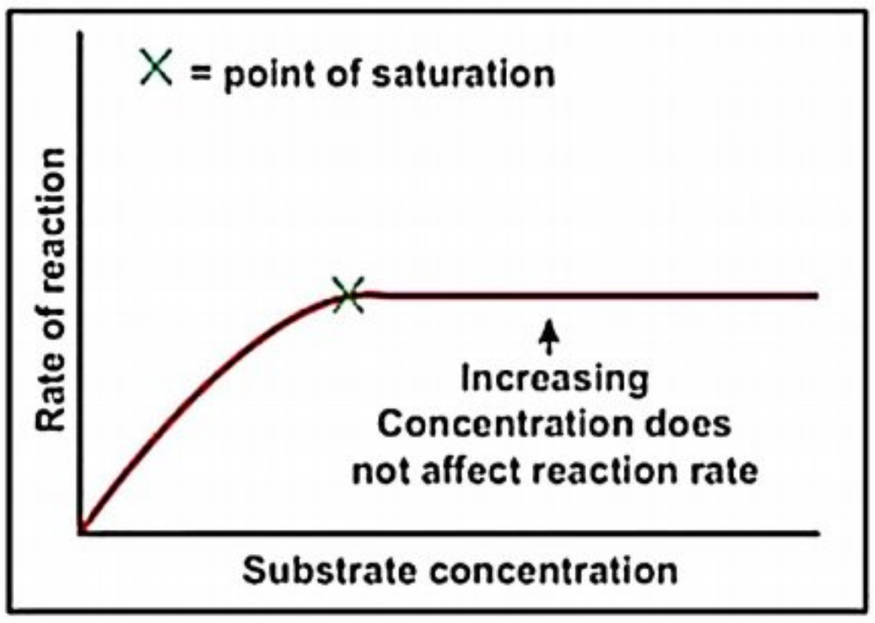
- Paper industry - To get cellulose for paper making.
- Food industry - For making bakery products and pizza
- Brewing industry - For conversion of sugar into alcohol
- Bio-detergents - Use to remove different type of stains

Q.10: Explain the factors affecting the activity of an enzyme.

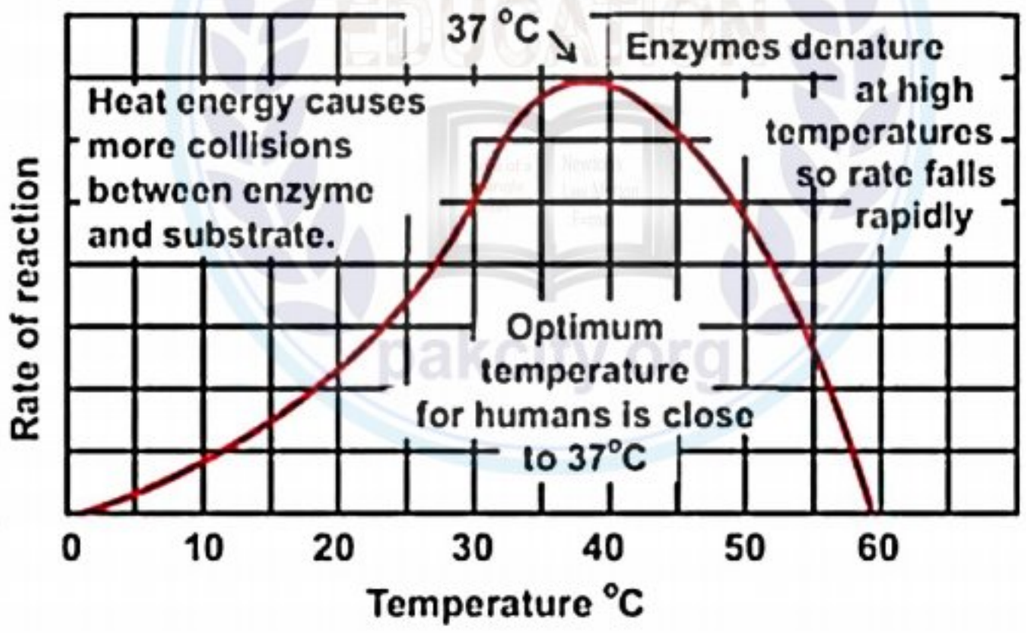
Ans: **Factors Affecting the Activity of an Enzyme**: In nature, organisms adjust the conditions of their enzymes to produce an optimum rate of reaction, where necessary, or they may have enzymes which are adopted to function well in extreme conditions where they live. The main factors which affecting the activity of an enzyme are as follows:

(i) **Substrate Concentration:** It has been shown experimentally that if the amount of the enzyme is kept constant and the substrate concentration is then gradually increased, the reaction velocity will increase until it reaches a maximum after which further increase in the substrate concentration produces no significant change in the reaction rate.

In other words, the enzyme molecules are saturated with substrate. The excess substrate molecules cannot react until the substrate already bond to the enzymes has reacted and been released (or been released without reacting).

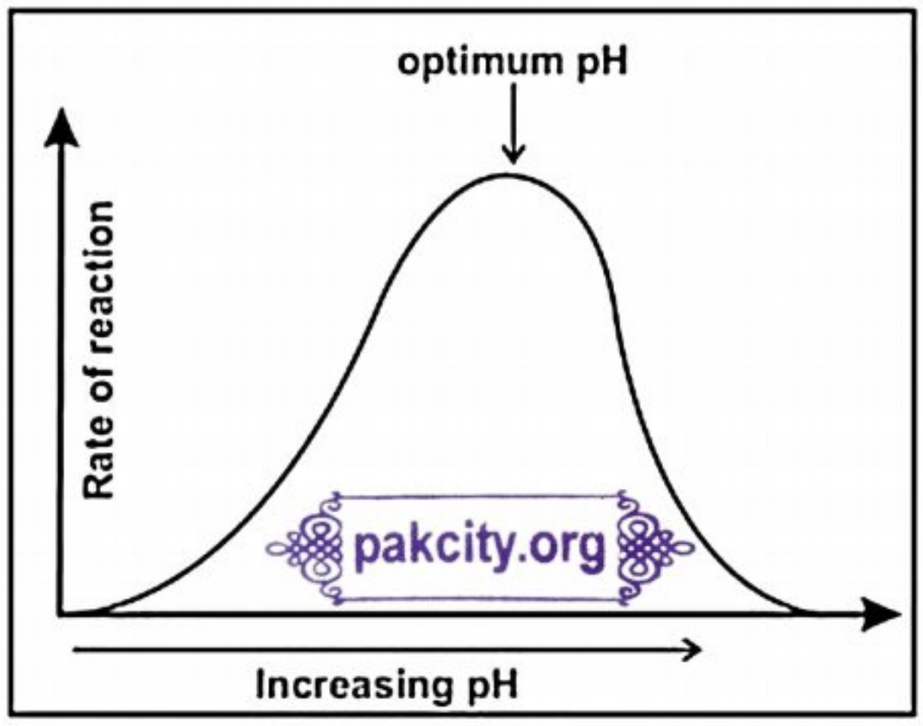


(ii) **Temperature**: The protein nature of the enzymes makes them extremely sensitive to thermal changes. Enzyme activity occurs within a narrow range of temperatures compared to ordinary chemical reactions. Enzymes catalyzes by randomly colliding with substrate molecules, increasing temperature and increase collision which also increases are rate of reaction, forming more product. However, increasing temperature also increases the vibrations and structure of enzymes is lost i.e. denature enzyme. These changes decrease the rate of enzyme action or it may seized completely.



In summary, as temperature increases, initially the rate of reaction will increase, because of increased kinetic energy. However, the effect of bond breaking will become greater and greater, and the rate of reaction will begin to decrease as shown in given diagram.

(iii) **pH**: Enzymes are also sensitive to pH due to their protein nature. All enzymes work at their maximum rate at narrow range of pH. The point where the enzyme is most active is known as optimum pH. For example, pepsin works at a low pH i.e. it is highly acidic; while trypsin works at a high pH i.e. it is basic.

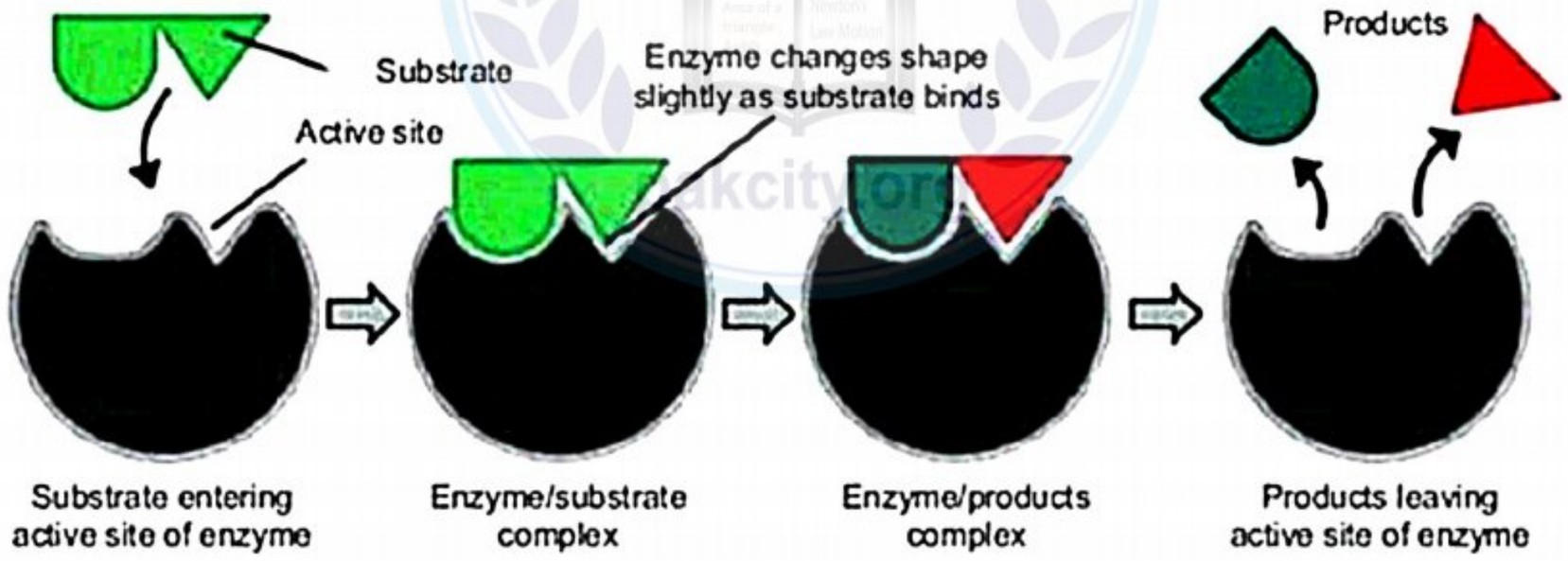


Effect of PH on enzyme activity

Most enzymes work at neutral pH 7.4. Small changes in pH above or below the optimum do not cause a permanent change to the enzyme, since the bonds can be reformed. However, extreme changes in pH can cause enzymes to denature and permanently lose their function.

Q.11: Describe the models explaining mechanism of enzyme action.

Ans: **Mechanism of Enzyme Action**: Enzyme catalyzes the reaction by attaching to substrate which ends to the product which ends to the product formation. Enzyme exposes its active site to attract specific substrate, makes enzyme substrate complex (ESC) after which the product is formed and enzyme is detached from it and used again for the same reaction.

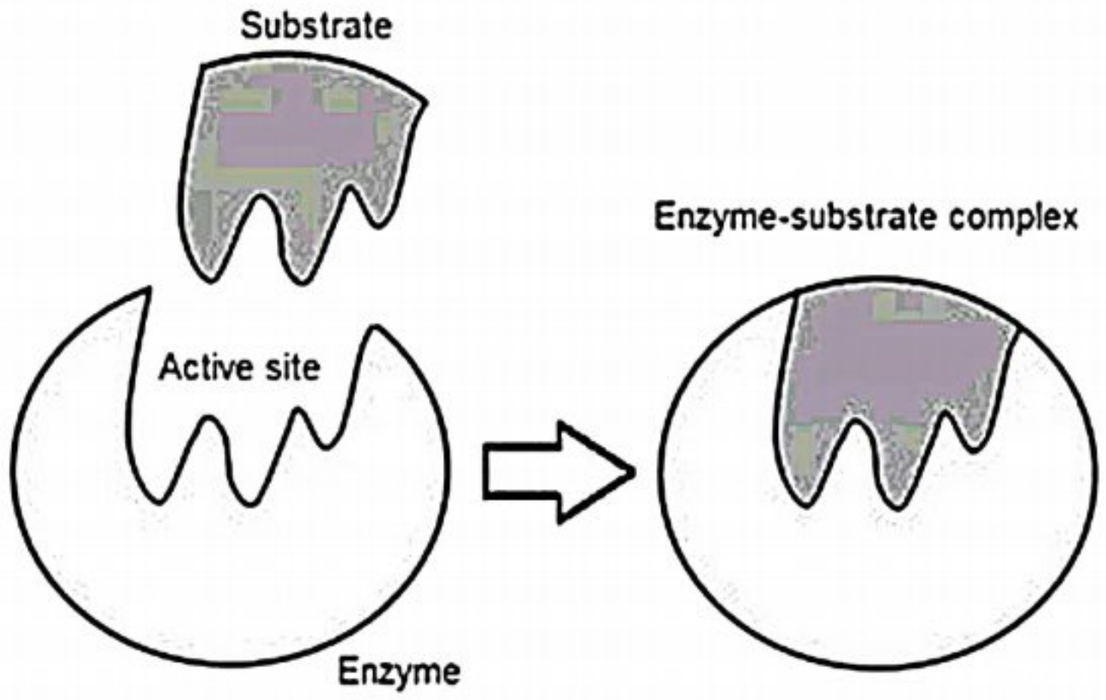


Action of Enzyme: In order to understand the mechanism of enzyme action two theories are proposed:

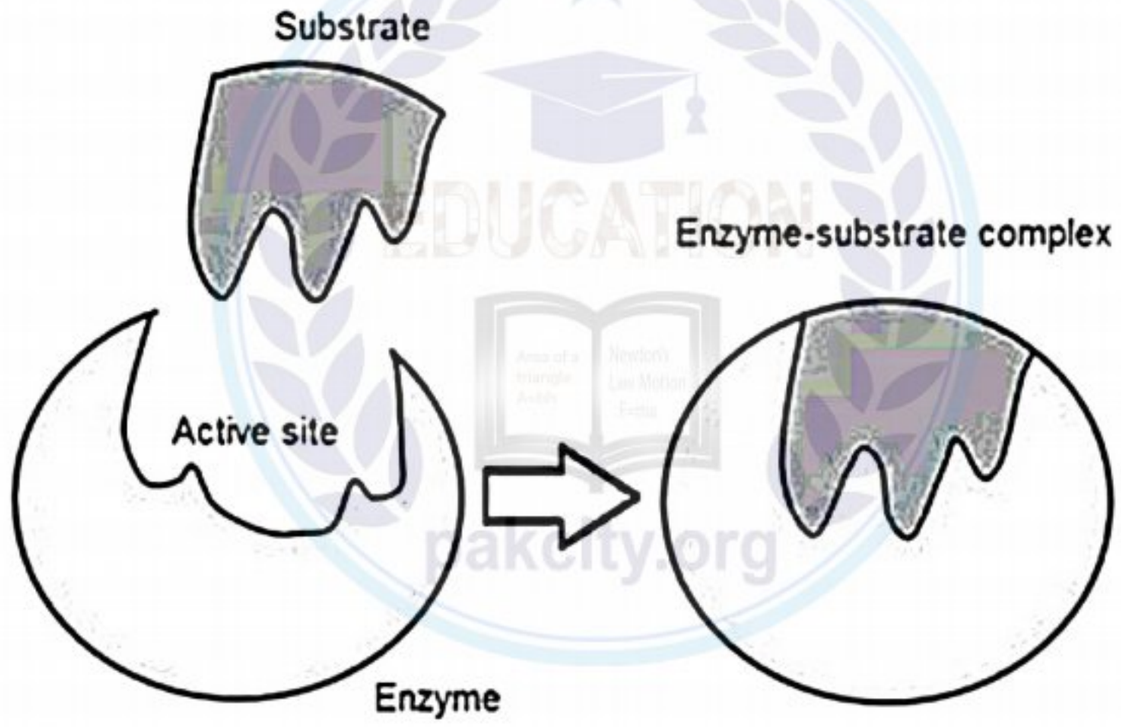
(i) Lock and key model (ii) Induced fit model.

(i) **The Lock and Key Model**: This theory was first postulated by Emil Fischer in 1894 shows the high specificity of enzymes. This theory explain that the enzyme and the substrate possess specific complementary geometric shapes that fit exactly into one another like a key into a lock/ only the correct size and shape of the substrate (the key)

would fit into active site (the key hole) of the enzyme (the lock). However/ it does not explain the stabilization of the transition state that the enzyme achieves. For example Lipase fits together with lipids to break them down.



(ii) **Induced Fit Model:** The induced fit model suggested by Daniel Koshland in 1958. It explains that active site continuously changes it shape until the substrate bind to it. It also says that active site of enzyme is flexible (lock and key theory does not explain it).



Q.12: What do you know about specificity of enzyme?

Ans: **Specificity of Enzyme**: In the human body there are more than 1000 known enzymes and all work with their own substrates. We know that enzymes are specific in nature therefore a particular enzyme can only bind to its specific substrate and it's all due to its active site. Active site of the enzyme possesses some geometric shape and as the enzymes are made up of proteins and proteins contain different type of amino acids which carry different charges / nature like acidic, basic, hydrophilic etc. hence active site is highly specific to its substrate. Some of the enzymes catalyze the reaction by recognizing the bond formed between the molecules, the functional group present in the molecules or the geometric shape of the molecules.

For example: proteases are the enzymes which catalyze the proteins only and lipase acts on lipids only. It means the enzymes are bond specific, so lipase can act an ester bond in lipids/fats substances.

Q.13: Briefly describe the categories of enzymes.

Ans: There are two categories of enzymes:

(i) Intracellular (ii) Extracellular

Intracellular enzymes work inside the cell such as ATPase, cytochrome C reductase etc. and **extracellular enzymes** work outside the cells such as pepsin, lipase etc.

Q.14: Why enzymes are specific in nature?

Ans: A few enzymes exhibit absolute specificity; that is, they will catalyze only one particular reaction. Other enzymes will be specific for a particular type of chemical bond or functional group. In general, there are four distinct types of specificity: Absolute specificity – the enzyme will catalyze only one reaction.

The reactants used in a reaction are also known as substrates. These substrates require enzymes to be specific so that enzymes act on the correct substrate or bond to catalyze the desired reaction. More precisely, the specificity of an enzyme is due to the precise interaction of the substrate with the enzyme.

Substrates are responsible for enzyme specificity. The molecular structure of a substrate connects to the enzyme so that the substrate can fit into the enzyme molecule.

For a substrate to bind to the active site of an enzyme it must fit in the active site and be chemically attracted to it.

Q.15: How enzyme reduces the amount of activation energy?

Ans: Enzymes can lower the activation energy of a chemical reaction in three ways. A ways the activation energy is lowered is having the enzyme bind two of the substrate molecules and orient them in a precise manner to encourage a reaction. This can be thought of as lining the binding pockets up for the substrates so that it is not left to random chance that they will collide and be oriented in this way. Another way enzyme can lower the activation energy by rearranging the electrons in the substrate so that there are areas that carry partial positive and partial negative charges which favor a reaction to occur. Lastly, the enzyme can strain the bound substrate which forces it to a transition state that favors a reaction. By manipulating the substrates of the reaction, the enzyme can lower the necessary energy needed to make the reaction occur.

Q.16: Why presence of enzymes does not effect on the nature and properties of end product?

Ans: The enzyme itself is not a component of the chemical reaction and is the same molecule at the beginning of the reaction as it is at the end. That is why their presence does not affect the nature or properties of end products.

Q.17: Distinguish between the following in tabulated form:

(i) Activator and Inhibitor (ii) Anabolism and Catabolism

Ans: **Difference between Activator and Inhibitor**

S No	Activator	Inhibitor
1.	Enzyme activators are molecules that can bind with an enzyme to increase its activity.	Enzyme inhibitors are molecules that can bind with an enzyme to decrease its activity
2.	They can be either proteins, peptides, lipids, small organic molecules or ions.	Two main types of inhibitors are reversible and irreversible inhibitors.

Difference between Anabolism and Catabolism

S No	Anabolism	Catabolism
1.	It is a metabolic chemical process used to build molecules required for the energy to do different activities by the body.	It is a metabolic chemical process used for breakdown of complex molecules to simple small molecules.
2.	In this state body requires energy to keep body in anabolic state. Nutrition is the main source.	In this state body releases energy in different activities.
3.	In anabolism state, energy is converted from kinetic energy to potential energy.	In catabolism state, energy is converted from potential energy to kinetic energy.
4.	Anabolism helps in furnishing and preserving tissues and results in muscle growth.	Catabolism helps in burning fats and calories.
5.	Anabolism requires less oxygen compared to catabolism.	Catabolism uses oxygen.
6.	Anabolism is in function during rest or sleep.	Catabolism is in function during activities.
7.	The main role is construction in metabolism.	The main role is destruction in metabolism.

Chapter =06

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