CHAPTER 3

Enzymes

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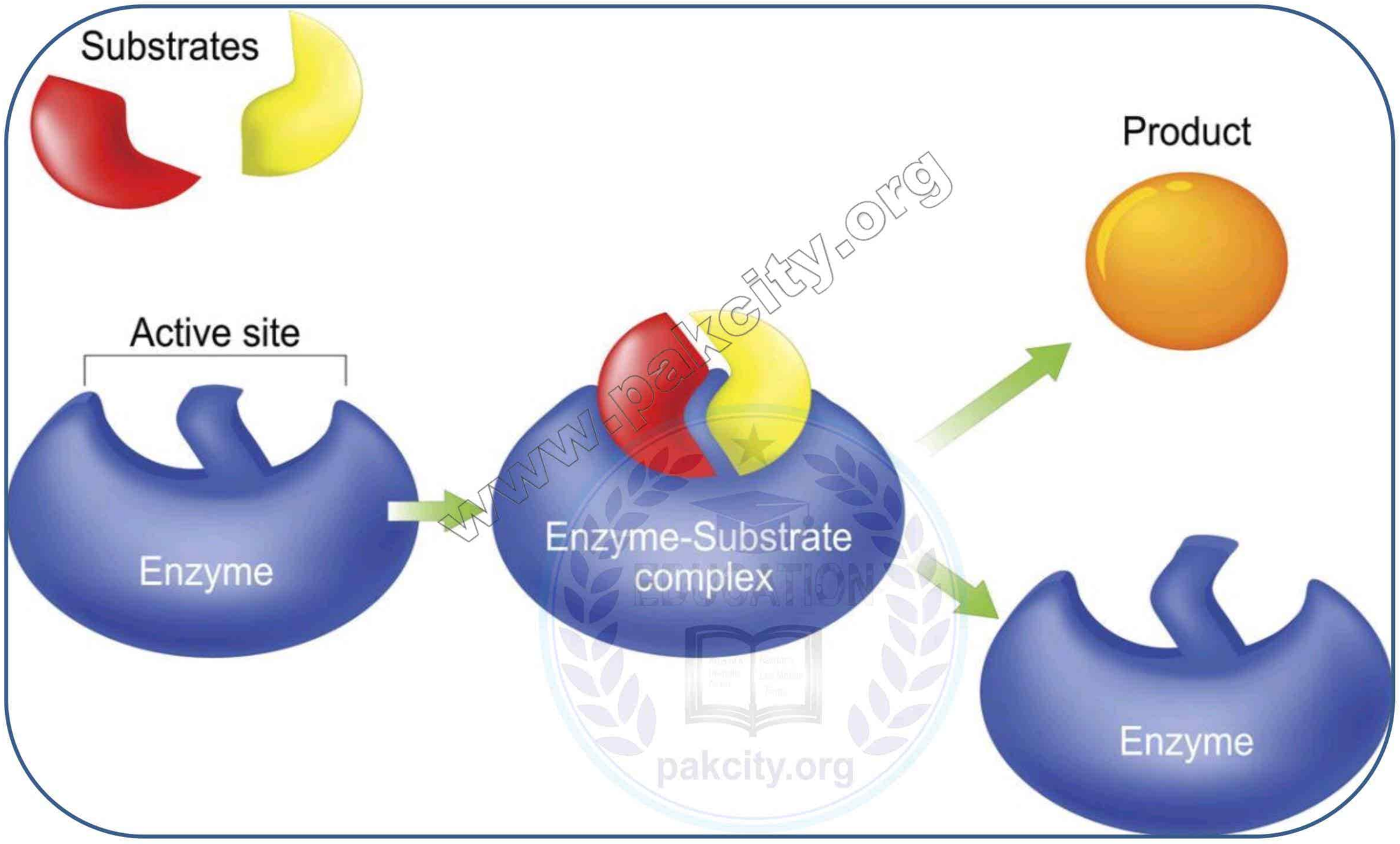


- **Exercise Short Answers**
- **Important Short answers**
- **Exercise MCQ's**
- **Important Additional MCQ's**
- **Past MDCAT MCQ's**

Exercise MCQ's

❖ **Encircle the correct answer from the multiple choices**.

1) **What if you add more substrate to already occurring enzymatic reaction and it has no effect on the rate of reaction? What is the term given for this situation?**
   a) Saturation b) Denaturation c) Composition d) Inhibition
2) **If more substrate to an already occurring enzymatic reaction is added, more enzyme activity is seen because:**
   a) There is probably more substrate present than there is enzyme
   b) There is probably more enzyme available than there is substrate
   c) There is probably more product present than their on either substrate or enzyme
   d) The enzyme substrate complex is probably failing to form during the reaction
3) **The rate of an enzyme catalyzed reaction:**
   a) Is constant under all conditions
   b) Decrease as substrate concentration increase
   c) Cannot be measured
   d) Can be reduced by inhibitors
4) **The active site of an enzyme:**
   a) Never change
   b) Forms no chemicals bond with substrate
   c) Determines, by its structure, the specificity of the enzyme
   d) Looks like a lump projecting from the surface of an enzyme
5) **Which statement about enzyme is not true?**
   a) They consist of proteins, with or without a non-protein part.
   b) They change the rate of catalyzed reaction
   c) They are sensitive to heat
   d) They are non-specific in their action

Answer key:

1	A	**2**	B	**3**	d	**4**	c	**5**	d

Most Important MCQ's

❖ **Encircle the correct answer from the multiple choices.**

Enzyme Characteristics

1. **Biochemically enzymes are:**
   a) Carbohydrates b) Hormones c) Fatty acids d) Proteins
2. **Biological molecules (proteins) which catalyze a biochemical reaction and remain unchanged after completion of reaction are called:**
   a) Cofactor b) Coenzymes c) Activator d) Enzymes
3. **Which statement about enzyme is incorrect:**
   a) Some of them consist solely of protein with no non protein part.
   b) They catalyze a chemical reaction without being utilized.
   c) All enzymes are fibrous Proteins.
   d) They without their cofactor are called apoenzyme.
4. **All enzyme are globular:**
   a) Carbohydrates b) Lipid c) Nucleic acid d) Protein
5. **All enzyme are proteins:**
   a) Fibrous b) Globular c) Non enzymatic d) None
6. **Three dimensional globular protein is:**
   a) Starch b) Glucose c) Antibiotics d) Enzyme
7. **Which of the following is not a globular protein?**
   a) Myosin b) Hemoglobin c) Antibodies d) Hormones
8. **The presence of enzymes:**
   a) Slow down the rate of reaction
   b) Increase the rate of reaction
   c) Does not show any change
   d) Completely stops the reaction
9. **The functional specificity of every enzyme is the consequences of its specific:**
   a) Chemistry b) Configuration c) Concentration d) Both a & b
10. **Enzymes involved in cellular respiration are found in:**
    a) Cytoplasm b) Endoplasmic Reticulum c) Mitochondria d) Ribosomes
11. **Which of the following is example/s of enzymes attached to membranes system inside the cell in specific and ordinary arrangement:**
    a) Mitochondria b) Chloroplast c) Both a & b d) None

Cofactors

12. **The non-protein part of enzyme is known as:**
    a) Polypeptides b) Co-enzyme c) Co-factor d) Activator
13. **The detachable cofactor of an enzyme is known as:**
    a) Activator b) Prosthetic group c) Coenzyme d) Apoenzyme
14. **An activated enzyme consisting of polypeptide chain and a cofactor is called:**
    a) Apoenzyme b) Holoenzyme c) Activated enzyme d) Both b and c
15. **If detachable cofactor is an inorganic ion then it is designed as:**
    a) Coenzyme b) Enzyme c) Prosthetic group d) Activator
16. **If non-protein part is loosely attached to the protein part, it is known as:**
    a) Co-factor b) Prosthetic group c) Holoenzyme d) Coenzyme
17. **Coenzyme is closely related to:**
    a) Vitamins b) Minerals c) Water d) Lipid
18. **Which one is essential raw material for coenzymes?**
    a) Proteins b) Vitamins c) Carbohydrates d) Lipids
19. **Vitamins are the essential raw materials for the synthesis of:**
    a) Coenzyme b) Prosthetic group c) Activator d) Apoenzyme
20. **If non-protein part is covalently bonded to enzyme it is called as:**
    a) Coenzyme b) Prosthetic group c) Activator d) Apoenzyme
21. **The inactive form of enzyme pepsin is:**
    a) Holoenzyme b) Pepsinogen c) Apoenzyme d) None
22. **Pepsin is a powerful protein digesting enzyme and is produced in inactive form known as:**
    a) Pepsin b) Pepsinogen c) Ptyalin d) Pentenol
23. **Some enzyme are potentially damaging if they are manufactured in their active form known as:**
    a) Trypsinogen b) Pepsin c) Pepsinogen d) Amylase

Mechanism of Enzymes Action

24. **An enzyme and substrate react through definite charge bearing sites:**
    a) Locus b) Centromere c) Active sites d) None

b)

25. The active site of an enzyme:

a) Never changes
b) Form no chemical bond with substrate
c) Determine by its structure, the specificity of enzyme
d) Look like a lump projecting from

26. Enzymes _____ the activation energy of a chemical reaction:

a) Increases
b) Decreases
c) Does not effect
d) Increases or decreases depending upon individual enzyme

27. The specificity of an enzyme is due to its:

a) Hydrogen bond
b) High molecular weight
c) Configuration
d) pH sensitivity

28. Lock and key model was proposed by:

a) Koshland b) Emil Fischer c) Fleming d) Watson

29. A lock and key model to visualize substrate & enzyme interaction was proposed by:

a) Rudolph Virchow b) Emil Fischer c) Lorenz Oken d) Koshland

30. According to law and key model, the active site is:

a) Attractive structure (Liquid)
b) Flexible structure (Enzyme)
c) Soft structure
d) Rigid structure

31. Which statement is incorrect about Lock and Key Model?

a) Specific enzyme can transform only a specific substrate
b) Active site of an enzyme is a non-flexible structure
c) Active site does not change before during or even after the reaction
d) t explains the mechanism of every chemical reaction

32. Induced fit model was proposed by:

a) Heterotrophs b) Decomposers c) Green plants d) Consumers

33. The active site of an enzyme:

a) Never changes
b) Forms no chemical bond with substrate
c) Determined by structure and the specificity of the enzyme
d) They are non-specific in their action

Factor affecting the Enzyme Activities

34. The rate of enzyme controlled reaction increases rapidly if the amount of enzyme is doubled in the presence of an unlimited substrate concentration. This is due to:

a) Number of active sites increase
b) Energy of activation lowers
c) Kinetic energy of molecules increase
d) Enzymes does not denature

35. Which step causes activation of catalytic site of an enzyme?

a) Change in pH of the surroundings
b) Formation of Enzyme Substrate complex
c) Change in the charge of the active site
d) Change in temperature

36. If more substrate to already occurring enzymatic reaction is added more enzyme activity is seen because:

a) There is probably more substrate present than there is enzyme
b) There is probably more enzyme available than there is substrate
c) There is probably more product present than there is either substrate or enzyme
d) The enzyme substrate complex is probably failing to form during the reaction.

37. The optimum temperature for enzyme to work at maximum rate in human is:

a) 35ºC b) 37ºC c) 40ºC d) 30ºC

38. Enzyme lower down the energy of:

a) Kinetics b) Potential c) Ionic d) Activation

39. The activation energy of the reactions is lowered by:

a) Coenzyme b) Enzyme c) Substrate d) Product

40. Optimum pH for Pepsin is:

a) 2.00 b) 4.50 c) 5.50 d) 6.80

41. 4.50 is the optimum pH value for the enzyme:

a) Chymotrypsin b) Sucrase c) Enterokinase d) Arginase

42. Optimum pH for Sucrase is:

a) 3.50 b) 4.50 c) 5.50 d) 6.50

43. Optimum pH for Enterokinase enzyme is:

a) 2.00 b) 4.50 c) 5.50 d) 6.80

44. Salivary amylase acts best at pH:

a) 4.50 b) 6.8 c) 7.2 d) 8.5

45. The enzyme with optimum pH= 7.60 is:

a) Arginase b) Enterokinase c) Catalase d) Sucrase

46. The optimum pH of pancreatic lipase is:

a) 6.0 b) 7.0 c) 8.0 d) 9.0

47. The optimum pH of enzyme Arginase is:

a) 2.00 b) 9.50 c) 7.60 d) 9.70

48. The optimum pH of enzyme Catalase is:

a) 2.00 b) 9.50 c) 7.60 d) 9.70

49. A little change in pH may lead to:

a) Ionization of active site of an enzyme
b) Ionization of substrate
c) Retard or even block enzyme activity
d) Effects enzyme only in high concentration

50. Extreme changes in pH cause the bonds in the enzyme to break, resulting in the enzyme:

a) Denaturation b) Saturation c) Competition d) Inhibition

51. Excessive increase in temperature of medium causes the enzyme molecule to:

a) Activate b) Unaffected c) Denatured d) None of these

Enzymes Inhibitors

52. Poison, like cyanide, antibiotics and some drugs are examples of:

a) Enzymes b) Co-enzymes c) Inhibitors d) Co-factor

53. The competitive inhibitor of succinic acid is:

b) Malate b) Citrate c) Malonic acid d) Fumarate

54. The inhibitors that bind tightly and permanently to enzymes and destroy their globular structure stopping their catalytic:

a) Reversible Inhibitors
b) Competitive Inhibitors
c) Irreversible Inhibitors
d) Non-Competitive Inhibitors

55. The type of inhibition in which inhibitor has no structural similarity to substrate and combines with enzyme at other than the active site is called:

a) Irreversible inhibition
b) Competitive inhibitors
c) Non-competitive and reversible inhibition
d) Reversible inhibition

56. Malonic acid is an example of:

a) Irreversible inhibitor
b) Reversible inhibitor
c) Competitive inhibitor
d) Non-competitive inhibitor

57. Enzyme succinate dehydrogenase converts succinate into:

a) Malate b) Citrate c) Malonic acid d) Fumarate

58. If enzyme concentration is low than substrate pH and temperature values are equal to requirement then which of the following will increase rate of reaction:

a) Increase in concentration of enzyme
b) Increase in concentration of substrate
c) Increase in pH
d) Increase in temperature

Answer key:

1	d	**2**	d	**3**	c	**4**	D	**5**	b	**6**	d	**7**	a	**8**	b	**9**	d	**10**	c
11	c	**12**	c	**13**	a	**14**	B	**15**	d	**16**	d	**17**	a	**18**	b	**19**	a	**20**	b
21	b	**22**	b	**23**	c	**24**	C	**25**	c	**26**	b	**27**	c	**28**	b	**29**	b	**30**	d
31	d	**32**	c	**33**	c	**34**	A	**35**	b	**36**	b	**37**	b	**38**	d	**39**	b	**40**	a
41	b	**42**	b	**43**	c	**44**	B	**45**	c	**46**	d	**47**	d	**48**	c	**49**	a	**50**	a
51	c	**52**	c	**53**	c	**54**	C	**55**	c	**56**	c	**57**	d	**58**	a				

Past MDCAT MCQ's

2008

1. **The optimum temperature for enzymes of human body is**
   a) 32 ºF b) 313 K. c) 46 ºC d) 37 ºC

2009

2. **Pepsin enzyme is produced in an inactive form and is activated in situation when it is required because:**
   a) Not produced in complete form
   b) It does not work efficiently at that time
   c) Quite capable of destroying cells internal structure
   d) None of the above
3. **Enzyme after catalysis detaches itself from the product:**
   a) Completely b) Changed c) Incompletely d) Unchanged

2010

4. **An activated enzyme consisting of polypeptide and a cofactor is known as:**
   a) Amylase b) Haloenzyme c) Apoenzyme d) Coenzyme
5. **_____ forms weak linkages with enzymes and their effect can be neutralized completely or partly by an increase in the concentration of the substrate.**
   a) Only competitive Inhibitors
   b) Irreversible inhibitors
   c) Reversible inhibitors
   d) Both reversible and irreversible inhibitors

2011

6. **An enzyme and substrate reacts through a special feature or site present in enzyme:**
   a) Building Site b) Catalyst Site c) Active Site d) Inhibition Site
7. **The non-protein part of enzyme which is covalently and permanently bonded is called:**
   a) Prosthetic Group b) Co-Enzyme c) Co-Factor d) Activator
8. **Enzymes increase the rate of reaction by:**
   a) Increasing Temperature
   b) Decreasing Activation Energy
   c) Decreasing pH
   d) Increasing Activation Energy

2012

9. **The type of inhibition in which inhibitor has no structural similarity to substrate and combines with enzyme at other than the active site is called:**
   a) Irreversible inhibition
   b) Non-competitive and reversible inhibition
   c) Competitive inhibition
   d) Reversible inhibition
10. **The inhibitors that bind tightly and permanently to enzymes and destroy their globular structure and catalytic activity are:**
    a) Reversible inhibitors
    b) Competitive inhibitors
    c) Irreversible inhibitors
    d) Non-competitive inhibitors
11. **Enzyme succinate dehydrogenase converts succinate into:**
    a) Malate b) Citrate c) Malonic acid d) Fumarate
12. **If the detachable co-factor is an inorganic ion then it is designated as:**
    a) Coenzyme b) Holoenzyme c) Prosthetic group d) Activator

2013

13. **If the co-factor is covalently or tightly and permanently bonded to enzyme then it will be called:**
    a) Coenzyme b) Activator c) Prosthetic group d) Apoenzyme
14. **Optimum pH value for the working of pancreatic lipase is:**
    a) 4.50 b) 2.00 c) 7.60 d) 9.00

15. The view that active site of an enzyme is flexible and when a substrate combines with it, cause changes in enzyme structure is known as:

a) Lock & key model
b) Sliding filament model
c) Induce fit model
d) Specificity model

16. All coenzymes are derived from:

a) Proteins b) Carbohydrate c) Nucleic acids d) Vitamins

2014

17. All co-enzymes are derived from:

a) Proteins b) Metal ions c) Carbohydrates d) Vitamins

18. The competitive inhibitors have structural similarity with:

a) Active site b) Substrate c) Binding site d) Co-enzyme

19. Which one of the following is the optimum pH of pancreatic lipase enzyme?

a) 7.60 b) 9.00 c) 8.00 d) 9.70

20. A co-factor tightly bound to the enzyme on the permanent basis is called:

a) Activator b) Prosthetic group c) Co-enzyme d) Apo-enzyme

2015

21. Some enzymes require helper which is non-protein part for its efficient functioning that is called:

a) Accelerator b) Prosthetic group c) Cofactor d) Apoenzyme

22. Pepsin, protein digesting enzymes, sets best pH:

a) 3.00 b) 2.00 c) 4.50 d) 6.00

23. Which one of the following is an example of competitive inhibitor?

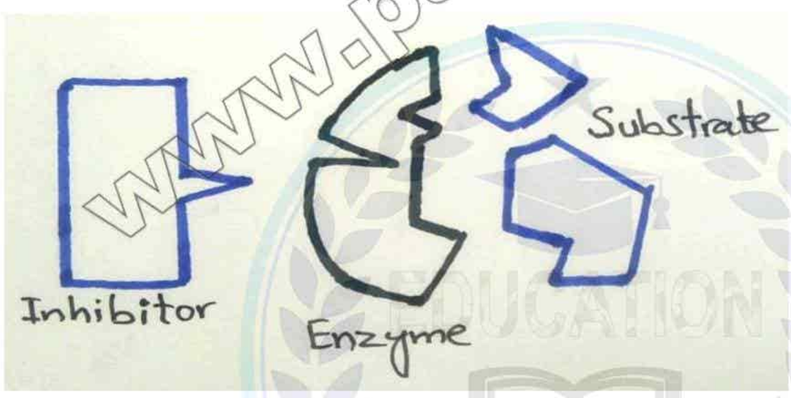
a) Glucose b) Succinic Acid c) Fumarate d) Melonate

2016

24. An enzyme required Mg++ to catalyze the substrate. The Mg++ is best identified as:

a) Prosthetic group b) Co-enzyme c) Activator d) Inhibitor

25. This figure represents _____ inhibitor.

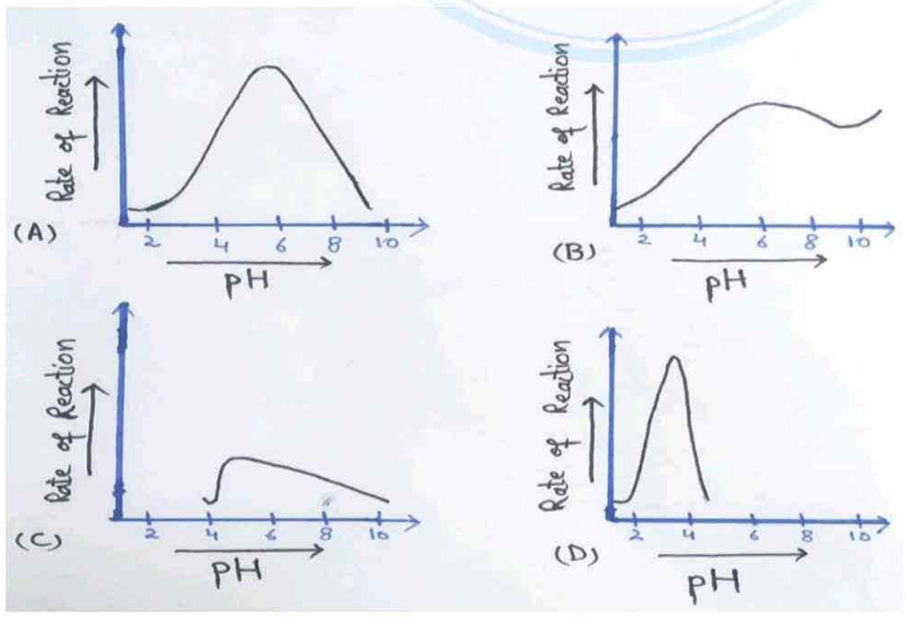


a) Non-competitive b) Irreversible c) Competitive d) Isosteric

26. According to _____ model the active site of enzyme is modified as the substrate interacts with enzyme:

a) Induced fit b) Emil Fischer c) Lock and Key d) Fluid Mosaic

27. Which one of the following graphs shows how the rate of reaction of pepsin is affected by pH?



2017

Answer Key

28. All enzymes are_____:

a) Fibrous proteins
b) Lipoproteins
c) Low molecular weight proteins
d) Globular proteins

1	d	**2**	c	**3**	A	**4**	b	**5**	c
6	c	**7**	a	**8**	B	**9**	b	**10**	c
11	d	**12**	d	**13**	C	**14**	d	**15**	c
16	d	**17**	d	**18**	B	**19**	b	**20**	b
21	c	**22**	b	**23**	D	**24**	c	**25**	a
26	a	**27**	d	**28**	D				

Exercise Short Answers

Q1(a) List two conditions that destroy enzymatic activity by disrupting bonds between the atoms in an enzyme.

Ans: There are following conditions:

a) **Temperature:** Increase of temperature from the optimum increases the vibration of atoms of enzymes molecules and denatured enzymes.
b) **pH value:** Extreme change in pH cause the bonds in the enzyme to break, resulting in the enzyme denaturation.

Q1(b) How do low and high temperature, affect an enzyme activity?

Ans: Enzymes work maximum at optimum temperature. For example, 37C is optimum temperature for enzyme of human body.

a) **High temperature:** But increase of temperature from the optimum increases the vibration of atoms of enzymes molecules and denatured enzymes.
b) **Low temperature:** Low temperature deprive of kinetic energy of reactant and enzymes molecules which slow down the reaction.

Q1 (c) What is prosthetic group?

Ans: Prosthetic group:

If the non-protein part is covalently bonded, it is known as prosthetic group.

Example: Haeme is an iron containing prosthetic group which acts as an electron carrier in cytochrome and oxygen carrier in hemoglobin and myoglobin.

Q1 (d) Define inhibitors of enzyme.

Ans: An inhibitor is a chemical substance that can react (in place of substrate) with the enzyme but it is not transformed into products and thus blocks the active site temporarily or permanently.

Example: For example poisons, like cyanide, antibiotics, anti-metabolites and some drugs.

Q1 (e) How does an enzyme accelerate a metabolic reaction?

Ans: Enzymes accelerate a metabolic reaction by following ways:

- Enzymes accelerate a metabolic reaction by decreasing the activation energy of reaction.
- In the absence of enzymes the reaction would proceed at very slow speed making life impossible.
- Small amount of an enzyme can accelerate chemical reactions.
- They increase the rate of reaction without themselves being used up. They are used again and again.

Important Short Answers

Q:1 Differentiate between Enzyme and Coenzyme.

Enzyme	Coenzyme
• Enzymes are biologically active proteins and are called biological catalysts (biocatalysts) i.e.; they speed up a chemical reaction without being consumed during the reactions.	• Coenzyme is an non-protein part is loosely attached to protein part known as a co-factor.
• It catalysis a chemical reaction.	• It cannot catalysis a chemical reaction.
• Some, but not all, enzymes require coenzymes for their activity and become inactive without these.	• It always assists a specific enzyme for its activity and is loosely attached with it.
• Its molecule has no vitamin.	• It often has a vitamin as building unit.
• **Example**: Pepsin, Sucrase, Arginase etc.	• **Example:** NAD, FAD,ATP etc.

Q:2 Differentiate between Apoenzyme and Holoenzyme.

Apoenzyme	Holoenzyme
• An enzyme with its coenzyme or prosthetic group is removed designed as apoenzyme.	• An activated enzyme consisting of polypeptide chain and a cofactor is called holoenzyme.
• It consists of protein or polypeptide only.	• It consists of protein or polypeptide and non-protein part as well.
• It cannot perform a chemical reaction.	• It can perform a chemical reaction.
• It is inactive usually.	• It is active.
• **Example:** 1) Pepsinogen is inactive form of protein digesting enzyme. 2) DNA polymerase, RNA polymerase, Catalase (without Mg^{++}).	• **Example:** 1) Pepsin is active form of protein digesting enzyme. 2) DNA polymerase, RNA polymerase, Catalase (all need Mg++ as cofactor).

Q:3 Write down four characteristics of enzymes.

Ans: Characteristics of enzymes:

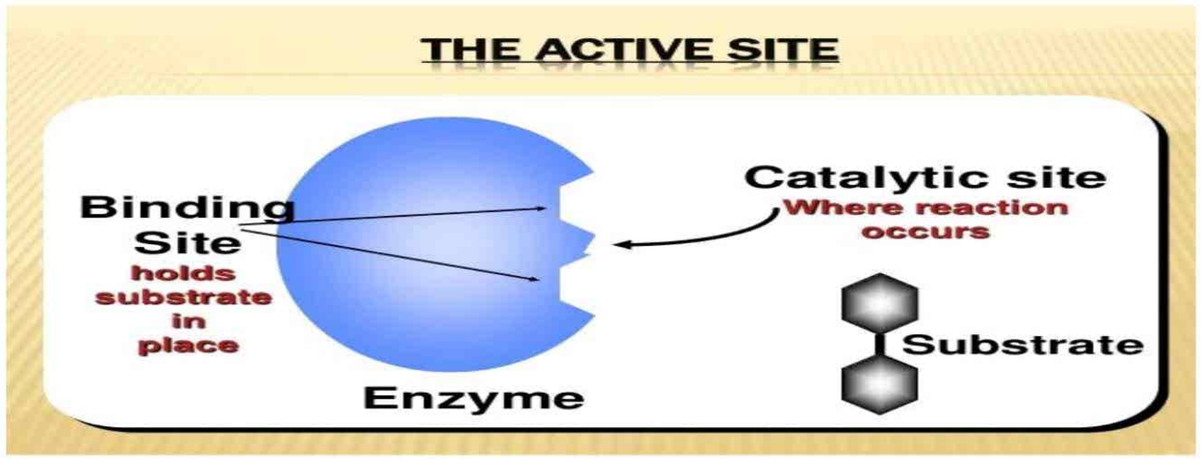
1) An enzyme is a biological catalyst which greatly increases the speed of a chemical reaction without being used up.
2) An enzyme works by lowering the activation energy, the kinetic energy necessary to get a reaction going.
3) Enzymes are highly specific in their action; a single chemical reaction catalyzes only a single chemical reaction or group of closely related chemical reactions.
4) All enzymes are globular proteins.

Q:4 What is active site of enzyme? Differentiate between binding site and catalytic site.

Ans: Active site of enzyme:

These are the charge bearing sites, three dimensional cavity, composed of a few amino acids which perform catalytic activity for enzymes. So active site is involves in catalytic activity of an enzyme. The reactant/ substances which attach on the active sites of enzymes are called substrate.

Binding site	Catalytic site
• Binding site helps in recognition and binding of correct substrate to active site.	• Catalytic site transforms substrate into product.
• It activates the catalytic site of enzyme.	• Activated catalytic form a product.

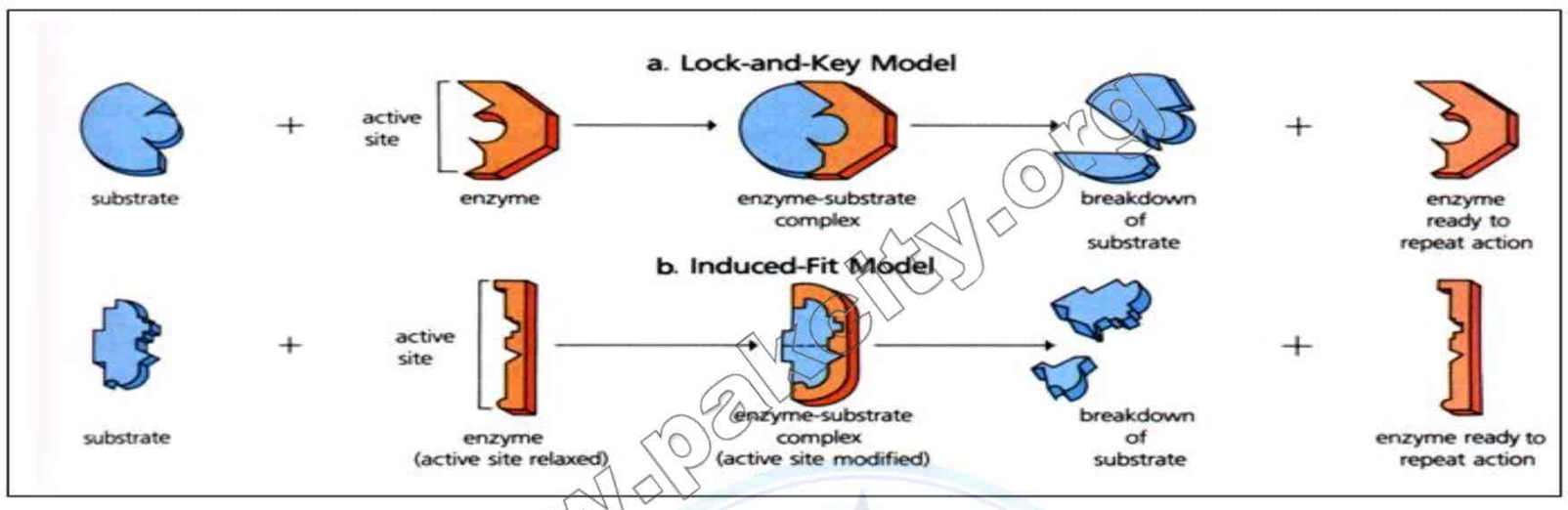


Q:5 Differentiate between Pepsin and Pepsinogen.

Pepsin	Pepsinogen
• Pepsin is powerful protein digesting enzyme.	• Pepsinogen is proenzyme.
• It is active form and digests protein.	• It is inactive form and not digests protein.
• It is activated by acidic pH or already activated pepsin in medium.	• It is converted into pepsin at acidic pH of medium.
• It is only stable at narrow pH nearly 2.	• It is stable at wider range of pH.

Q:6 Differentiate between Lock and Key model and Induced Fit model.

Lock and Key model	Induced Fit model
• According to this model, one specific key can open only a specific lock. Similarly, a specific enzyme can transform only specific substrate into products.	• According to this when a substrate combines with an enzyme, he active site of enzyme undergoes a slight change in shape.
• It is used only as a template.	• The change in structure enables the enzyme to perform its catalytic activity more effectively.
• It was proposed by Emil Fischer in 1890.	• It was proposed by Koshland in 1959.
• Later studies did not support this model in all directions.	• This is the most accepted model.



Q:7 Define the term Activator.

Ans. Activator:

The detachable cofactor is known as an activator if it is an inorganic ion.

- It increases activity of an enzyme.
- Some enzymes use metal ions as detachable cofactor like Mg^{2+}, Fe^{2+}, Cu^{2+}, Zn^{2+} etc.
- **Example:** Magnesium (Mg^{+2}) is an inorganic activator for enzyme phosphatase. OR Zinc ion (Zn^{-2}) is an activator for enzyme carbonic anhydrase.

Q:8 How does enzyme concentration affect the rate of reaction?

Ans: **Effect of Enzyme concentration the rate of reaction:**

The rate of reaction depends directly on the concentration of enzyme. By increasing the enzyme molecules, an increase in the number of active sites takes place and products are formed. After a certain limiting concentration, the rate of reaction will no longer depend upon this increase.

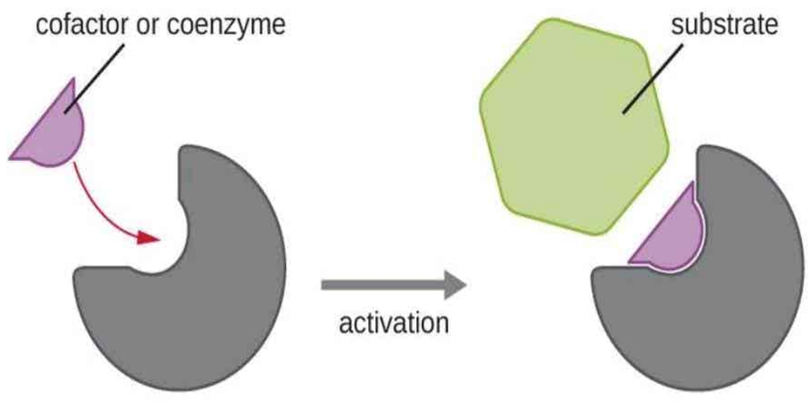
Q:9 What is cofactor? Also give its significance.

Ans: Co-factor:

Cofactors are non-protein part of some enzymes which are essential for the proper functioning of enzymes.

Significance of Cofactor:

- They usually act as bridge between enzymes and their substrate.
- Cofactor often contributes directly to the chemical reactions and brings about catalysis.
- Sometimes cofactor provide a source of chemical energy,, helping to drive reactions which would otherwise be difficult or impossible.



Q:10 differentiate between Irreversible inhibiter and reversible inhibitor.

Irreversible inhibiter	Reversible inhibitor
• They check the reaction by occupying or destroying the active site of globular structure.	• They do not destroy the active site.
• They form covalent bond with active site.	• They form weak linkage.
• Their effect cannot be neutralized.	• Their effect is partially or completely neutralized the by increasing the concentration of substrate.
• They are not further divided.	• They are further divided into two major types: Competitive and non-competitive inhibitor.

Q:11 Differentiate between Competitive and Non-Competitive Inhibitor.

Competitive Inhibitor	Competitive Inhibitor
• They have structurally similarity with substrate.	• They have not structurally similarity with substrate.
• They may be selected by binding site but are not able to activate the catalytic site.	• They form enzyme inhibitor complex other than active site.
• They inactivate enzyme by blocking active site.	• They inactivate enzyme by altering its globular structure.
• **Example:** Malonic acid is competitive inhibitor of succinic acid.	• **Example:** ATP is non-competitive inhibitor of phophofructokinase.

Q:12 What do you mean by optimum pH for enzyme? Also give examples.

Ans: Optimum pH:

An optimum pH is a narrow range of pH in which enzyme function effectively.

Examples:

- Pepsin: 2
- Sucrase:4.50
- Enterokinase:5.50

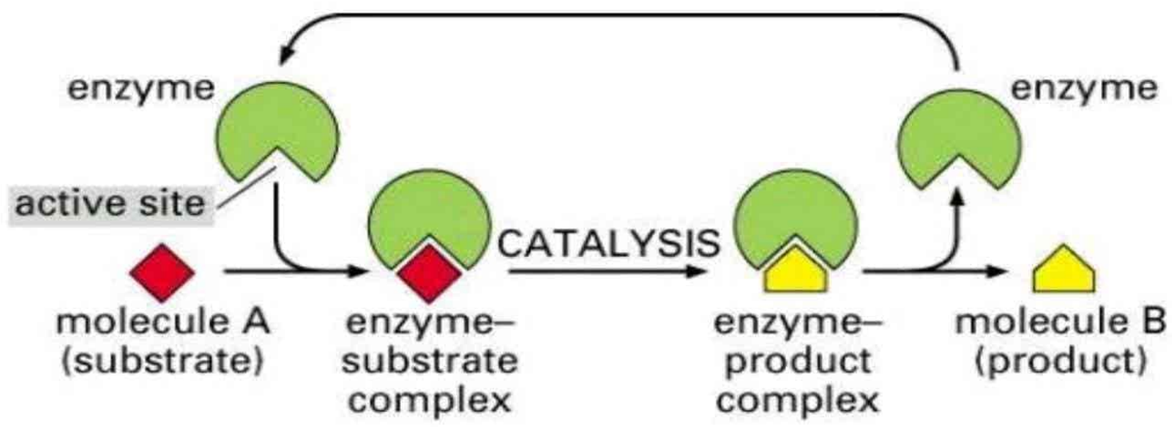
Q:13 Differentiate between Substrate and Active site.

Substrate	Active site
• The reactant upon which enzymes acts is called substrate.	• The catalytic activity of enzyme is restricted to small portion of the enzyme is called active site.
• Substrate is converted into product.	• Active site converts substrate into product.
• Substrate varies in chemical nature.	• Active site consists of only few amino acids.

Q:14 How enzymes catalyze series of chemical reaction?

Ans: Enzymes catalyzing series of chemical reactions:

In some cases, enzymes catalyze in series or chains. These enzymes are present in a specific order. Each enzyme controls a specific reaction. One enzyme hands over the substrate to another enzyme, forming an enzyme to enzyme chain. The product formed by on enzyme is transferred to the next enzyme. Finally the end product is formed.



Enzyme to enzyme chain is found in respiration and photosynthesis.