C. METABOLISM

3.7 ENZYMES

SYNOPSIS

- Biological catalysts of living organisms are the **enzymes**
- The biochemical reactions of the cell are catalysed by enzymes.
- Enzymes are synthesised by living organisms
- Enzymes are proteins which catalyse thermodynamically possible reactions.
- Enzyme is defined as "a protein with catalytic properties due to its power of specific activation" by Dixon and Web (1964)
- Enzymes are also called organic catalysts,bio catalysts or biological middle men.
  The term enzyme was coined by **Khune.**
- The fermentation of sugar to alcohol in yeast is catalysed by 'ferments' It was stated by **Louis Pasteur**
- 'Ferments' causing fermentation of the substance were called enzymes.
- Cell free enzyme such as **Zymase** of yeast is involved in the fermentation of sugar. It was stated by **Edward Buchner**.
- The protein nature of the enzyme was first established by **James Sumner**.
- The enzyme urease was isolated in a crystallised form from **seeds of Jack bean** by - **James Sumner.**
- All enzymes are proteins. It was postulated by James Sumner.
- Pepsin and Trypsin were isolated in a crystallised form by **John Northrop** and his associates.
- All enzymes were proved to be proteins by **John Northrop.**
- Basic information about the enzymes was published as a treatise by J.B.S. Haldane.
- The study of enzymes is called **enzymology**.
- Properties:- Enzymes in general have the following properties
- **1. Catalytic Property**
- An organic catalyst is enzyme.
- They only speed up the rate of a reaction and never change the equilibrium of a reaction.
- **2. Proteinaceous nature**
- All enzymes are chemically proteins.
- An enzyme made up of only proteins is called Simple enzymes.
  Example:-pepsin,trypsin
- An enzyme having a non - protein part along with the protein part is called **conjugated enzyme** or **Holoenzyme**.
- Protein part of holoenzyme is Apoenzyme.
- Non Protein part of Holoenzyme is co - factor

The co - factors are either metal ion - cofactor or organic co-factor.

Metal ion cofactors:-In some enzymes,metallic cations get tightly attached to the apoenzymes. such enzymes are called "**Metelloenzymes**". These enzymes cannot catalyse a biochemical reaction without the presence of these active-cofactors.

Ex:- Cu^{2+} → Cytochrome oxidase
Fe^{2+} → Catalase
Mg^{2+} → Hexokinase
Mn^{2+} → IAA oxidase
Mo^{2+} → Nitrate reductase
Zn^{2+} → Carbonic anhydrase

- Organic co-factors are two types.
- Small organic molecule which are loosely associated with enzyme protein is co-enzyme.
- These co-enzymes are derived from water soluble vitamins.

Ex:-**Co-enzymes**	**Source of vitamin**
1. TPP(Thiaminepyrophosphate)	VitaminB_1(Thiamine)
2. PP(Pyridoxal Phosphate)	VitaminB_6(Pyridoxine)
3. NAD^+(Nicotinamide adeninedinucleotide)	Nicotinic acid(Niacin)
4. Co-enzyme 'A' (Co-"A")	Pantothenic acid

- Cofactors which are tightly bound to the enzyme protein - prosthetic group.
- Heam moiety of peroxidase is a good example of prosthetic group.

3.Specificity

- It is an out standing property of the enzyme.
- An enzyme will act on specific substrate in a specific reaction for converting it in to product.
- Ex: Sucrase can act on sucrose and Maltase can act only on Maltose.

4.Active in Minute Quantity

- The enzymes are very active in extremely small quantities.
- The number of molecules of substrate converted into products by one molecule of an enzyme in one minute time is called TON (Turn Over Number)
- TON varies from enzyme to enzyme.

5.Reversibility

Most of the enzymes are reversible in their action. They can speed up a particular reaction either in forward or backward direction.

Ex:-The enzyme "aldolase" converts a hexose into to trioses and the same enzyme forms one hexose from two trioses.

Fructose1,6-bisphosphate→ glyseraldyhide3-phosphate+ dihydroxyeacetonephosphate

6.Thermolabile

- All enzymes are heat sensitive because they are Proteins.
- The enzymes are proteins and denatured by heat.
- The optimum temperature for most of the enzymes is 25_0 - 30_0 C
- Enzymes are inactive at lower temperatures.

7.Sensitivity to pH

- The hydrogen ion concentration controls the enzymatic activity to a great extent.
- Most of the enzymes work best at neutral P^H
- Some enzymes work in acedic medium,while thers require an alkaline medium
- Some optimum pH values of various enzymes are;

Pepsin	-	2.0
Peroxidase	-	5.0
Amylase	-	7.0
Urease	-	7.0
Catalase	-	7.0
Trypsin	-	8.0

Nomenclature of enzyme

- Most of the enzymes are named by adding the suffix 'ase' to the name of the substrate

Egs.	Sucrase	Acts on Sucrose
	Maltase	Acts on Maltose
	Urease	Acts on Urea
	Cellulase	Acts on cellulose
	Nuclease	Acts on DNA orRNA (Nucleic acids)
	Lipase	Acts on lipids

- Type of reaction catalized by an enzyme.

Egs:- Carboxylase	Help in carboxilation.
Dehydrogenases	Help in dehydrogenation.
Isomarases	Help in Isomarisation.
Oxidases	Help in Oxidation.
Phosphorylases	Help in Phosphorylation.
Transaminase	Transfer of amino group.

- Some enzymes are named by adding the suffix 'ase' to the name of substrate and the type of reaction they catalyse

  Ex:- Pyruvic decarboxylase.

  Malate dehydrogenase.

  Help in malate dehydrogenation.

  Citrate synthetase - Help in synthesis of citric acid.
- Some valid enzyme names do not end up with the suffix 'ase'

  Ex: Pepsin, Trypsin, Renin and Caesin.

- Enzyme Classification (IUB-System) – The international union of Biochemistry (1964) proposed new system of enzyme classification.
- According to this classification, enzymes are divided into six major classes. Each major class of enzyme is further divided into sub classes and sub-sub classes on the basis of the nature of individual transformations involved.

1) Oxidoreductases

These enzymes catalyse oxidation and reduction of substrates usually involving hydrogen transfer. Oxidoreductases are again divided in to three sub classes.

a) **Dehydrogenases**: They transfer hydrogen atom from the substrate to NAD_+

e.g.: Malate + NAD_+ **Malate dehydrogenase** → Oxaloacetate + $NADH+H_+$

b) **Reductases**: They add hydrogen to substrate or remove oxygen.

e.g.: $NO_3 \xrightarrow{Nitrate\ reductase} NO_2^-$

c) Oxidases: They transfer hydrogen from the substrate to O_2

e.g.: Glycolic acid + O_2 $\frac{Glycolic\ acidoxidase}{Glyoxylic\ acid + H_2O}$

2) Transferases

These enzymes are involved in the transfer of a chemical group such as amino group or phosphate group from one molecule to another. Common examples are:

a) Transaminases: They transfer an amino group from one substrate to another.

e.g :Aspartic acid + ketoglutaric acid

Transaminase Oxaloactic acid + Glutamic acid

b) Kinases: They are involved in the transfer of phosphate form ATP to substrate.

e.g. Glucose + ATP $\xrightarrow{Hexokinase}$ Glocose - 6 - phosphate + ADP

3) Hydrolases

This group of enzymes are involved in the cleavage of bonds by the addition of water. Two sub-classes in this class are;

a) Phosphatases: They are involved in the removal of phosphate from the substrate.

e.g.: - Fructose - 1,6 – bisphosphate - $\xrightarrow{Fructose1,6-bisphosphatase}$ Fructose- 6-phosphate + Pi

b) Peptidases: These are involved in the cleavage of peptide bonds.

e.g.:- Hydrolysis of protein to peptides by proteolytic

enzymes like Pepsin and Trypsin.

4) Lyases

- Enzymes which split the substrates in the absence of H_20

e.g:- Arginosuccinic acid $\xrightarrow{Arginosuccinase}$ Argenine + Fumaric acid.

5) Isomerases Enzyme which are involved in the rearrangement of atoms of a molecule (intra molecules group transfer)

Eg: Ribose - 5 - phosphate $\xrightarrow{\text{Ribose-5 phospho isomerase}}$ Ribulose -5 - phosphate.

6) Ligases Enzymes which are assosiated in the formation of new bond by using energy from A T P hydrolysis.

These enzymes are also known as synthetases.

Eg :Glutamic acid + NH_3 + ATP $\xrightarrow{Glutaminesynthetase}$ Glutamine + ADP

- This classification scheme provides a method of identifying individual enzymes by a series of four numbers.
- The first number indicates the main class to which the enzyme belongs, the second and third denote the sub class and sub-sub class respectively.
- The fourth number is the serial number of the enzyme in its particular sub-sub class.

e.g.: Glucose 6 - phosphotransferase - E.C.2.7.1.2.

- In the above examples, the enzyme having systematic code number 2.7.1.2, the first digit '2' indicates the class to which the enzyme belongs. i.e. transferases; the second number '7' indicates the sub class i.e. transfer of phosphate group (phosphotransferase), the third one stands for sub-sub class i.e. the phosphate group is accepted by alcohol (alcohol of glucose) and the fourth '2' indicates the serial number of the enzyme. A compendium of the six major classes of enzymes.

Class	Type of reaction	Example
1. Oxidoreductases	Oxidation reduction	Malate dehydro-genase
2. Transferases	Group of transfer	Hexokinase
3. Hydrolases	Hydrolysis reactions (Transfer of functional group towater)	Pepsin and Trypsin.
4. Lyases	Addition or removal of groups to form double bonds	Fumarase
5. Isomerases	Isomerization (Intra molecular group transfer)	Riosephosphate isomerase
6. Ligases - Ligation of two - substratesat the expense of ATP	Amino acyle-tRNA- synthetase.	

Mechanism of Enzyme Action

- The kinetic energy required for a substrate to under go a chemical reaction isActivation energy or Gibb's free energyof activation
- Activation energy is available in different forms like heat, ATP etc.,
- Enzymes speed up the reaction by lowering theamount of activation energy.

Eg: Activation energy required for the conversion of H_2O_2 into H_2O and O_2 in the absence of enzyme is – 18,000 calories.

- Activation energy that is required for the same reaction in the presence of Catalase is 5,500 calories A calorie (cal):-is equivalent to the amount of heat required to raise the Temperature of 1gm of water by 1^0c at one atmospheric pressure.

Mechanism of Enzyme action

During the enzyme action, the enzyme combines with itsspecific substrate(S) to form enzyme substrate complex (ES).

Enzyme substrate complex is short lived.

- Activation energy of the E.S. Complex is low.
- Finally substrate converted into products (P) and dissociates from E.S.complex.
- Enzyme is retained back without any quantitative and qualitative changes.
- Lock and key hypothesis – proposed by Emil Fisher and elaborated by Paul Fields and Woods.
- This theory states that every enzymes possesses "ACTIVE SITES" OR "CATALYTIC SITES".
- The shape and size of active site closely resemble the shape of a substrate molecule.Thus a substrate whose shape is analogous to the shape of an active site can fit in, to form an enzyme substrate complex. This can be equated to a particular key ,opening a particular lock. This lock and key model accounts for "Enzyme specificity" the notched portion of the key represents the active sites at an enzyme.
- X-ray crystallography studies on enzymes have shown that active sites are three dimensional clefts and crevices that come from different parts of the amino acid sequence of that enzyme protien.

Enzyme Inhibition

- Any substance (other than substrate molecule) that can block the catalytic effect of enzyme is called – Enzyme inhibitor

Nature of Enzyme inhibitors – organic or inorganic.

- Types of Enzyme inhibitors
  1) Competitive inhibitors
  2) Non-competitive inhibitors
  3) Allosteric modulators
- Substances which are structurally similar to. substrate molecules and compete for the active sites of enzyme are – Competitive inhibitors.
- Competitive inhibitor for succinic dehydrogenase is – Malonic acid
- Competitive inhibitors are medicinally useful as drugs in the control of bacterial pathogens
- Competitive inhibitors are also used in treating certain forms of cancer
- Substances which are structurally do not resemble the substrate molecule are called – Non competitive inhibitors
  Eg: Salts of heavy metals and cyanides.
- Inhibition of first step of a series of reactions in metabolism by the end product is Allosteric modulation (Feed back inhibition).
- A compound (A) is converted by a series of enzymatic reactions via intermediates like (B) (C)(D) and (E) to an end product (F).This product (F) can some time reversibly combine with the first enzyme to inhibit its combination with (A).

  A→B→C→D→E→F

  '! ……."!
- Allosteric modulation can be observed during glycolysis of respeiration when the. accumulation of glucose-6-phosphate occurs, it in hibits the enzyme hexokinase.
- Non-competitive inhibitos occupy positions in the enzyme other than active sites.
- Lock and key model explains enzyme action. It was proposed byEmile Fisher.
- Salts of heavy metals and toxins are generally non-competitive inhibitors
- The term allosteric has been introduced by the nobel laureates Jacob and Monad to denote an enzyme site other than active site.
- The enzymes which posses allosteric sites are known as allosteric enzymes.
- The binding of substance to allosteric sites may stimulate or inhibit enzyme action.
- The substances that reduce the activity of an enzyme by binding at allosteric site are known as "allosteric inhibitors".

ENZYMES

LEVEL - I

129. Enzymes
  1) Increase the amount of activation energy of a chemical reaction
  2) Change rate of reaction
  3) Favour delay of equallibrium
  4) Change direction of reaction
130. An enzyme with 'Haem' part as prosthetic group
  1) Pyruvate kinase 2) PEP carboxylase
  3) Peroxidase 4) Phosphatase
131. The enzyme with code number 2.7.1.2 is the first enzyme of
  1) Krebs cycle 2) Calvin cycle
  3) Glycolysis 4) C_4cycle
132. All enzymes are made up of
  1) Carbohydrates 2) Lipids
  3) Aminoacids 4) Minerals
133. Co-factor of carbonic anhydrase is
  1) Fe^{-} 2) Mn^{2+} 3) K^{+} 4) Zn^{2+}
134. Mg^{2+} acts as a co-factor for the enzyme
  1) Hexokinase 2) PEP carboxy kinase
  3) Catalase 4) Pepsin
135. The enzyme code of glucose - 6 - phospho tranferase is
  1) 2.1.7.2 2) 2.1.7.3
  3) 2.2.1.7 4) 2.7.1.2.
136. Total number.of classes in IUB system of classification is
  1) 4 2) 5 3) 6 4) 7
137. Ligases are enzymes which are useful for
  1) Producing complex products by creating new bonds
  2) Rearranging atoms in a molecule
  3) Splitting complex molecules into simple compounds
  4) Hydrolysis
138. Metal Ion cofactor for Hexokinase is
  1) Fe^{2+} 2) Zn^{2+} 3) Mn^{2+} 4) Mg^{2+}
139. The protein part of a conjugated enzyme is
  1) Holo enzyme 2) Apoenzyme
  3) Co-enzyme 4) Co factor
140. At temperature below freezing point an enzyme is
  1) Slightly active 2) Killed
  3) Inactivated 4) Un affected
141. Which class of enzymes can split the substrates in the absence of H_2o
  1) Hydrolases 2) Transferases
  3) Ligases 4) Lyases

142. The Enzymes catalysing the splitting of a substrate with the addition of water are
1) Lyases 2) Hydrolases
3) Ligases 4) Oxidoreductases

143. The enzyme which plays a major role in the transfer of phosphate to a substrate is
1) Hexokinase 2) Transaminase
3) Oxidase 4) Dehydrogenase

144. Hexokinase belongs to the class
1) Transferases 2) Lyases
3) Oxidoreductases 4) Isomerases

145. Reductases are enzymes which are useful in
1) Reducing a substrate by adding OH group to it
2) Removing or seperating Oxygen from a substrate
3) Transfer hydrogen from substrate to NAD^+
4) Adding oxygen to the substrate

146. The conversion of nitrate to nitrite is carried out by
1) Reductases 2) Dehydrogenases
3) Oxidases 4) Transferases.

147. One of the following is the property of an enzyme
1) lowers activation energy
2) Increases Activation energy
3) Eliminate the need of Activation energy
4) Promoting growth in the body.

148. The catalytic property of an enzyme depends on
1) The quality of end product 2) The temperature
3) Size of cell 4) Its concentration

149. The IUB code of an enzyme is 2.7.1.2. The third digit '1' denotes
1) Sub class 2) Class
3) Serial number 4) Sub-Sub-class

150. Consider a metabolic sequence with the following reactions
A→B(Step-1), B→C(Step-2), C→D(Step-3), D→E(Step-4)
In allosteric modulation, enzyme action is inhibited at
1) Step-1 2) step-4
3) Step-1 and 4 4) Any step

151. Cyanides generally are
1) Competitive inhibitors
2) Non-competitive inhibitors
3) Allosteric modulators
4) All types of inhibitors

152. Malonic acid is a competitive inhibitor in Kreb's cycle for
1) Citric acid 2) OAA,
3) Fumaric acid 4) Succinic acid

153. Malonic acid inhibits the catalytic activity of
1) Fumarase 2) Citrate synthetase
3) Succinic dehydrogenase
4) Oxalosuccinic decarboxylase

154. According to Jacob and Monad the term Allosteric refers to this Part of enzyme.
1) Active site 2) Protein part 3) Cofactor
4) Enzyme site other than active site

155. Salts of heavy metals are
1) Non-competitive inhibitors
2) Competitive inhibitors
3) Allosteric modulators
4) Feed back inhibitors

156. In Glycolysis the activity of hexokinase is inhibited by
1) Depletion of Glucose-6- Phosphate
2) Excess of Fructose-6- Phosphate
3) Excess of Glucose-6- Phosphate
4) Depletion of fructose 6- Phosphate

157. The central idea in the formation of E-S complex in lock and key hypothesis is
1)Ability of substrate to combine with the enzyme at any place.
2) Similarity of the shape of active site and the structure of substrate Molecule.
3) Availability of high amount of activation energy
4) Highly reactive natureof the co-factor intheenzyme

158. Paul Fields and D.D.Woods are associated with
1) Classification of enzymes
2) Nomenclature of enzymes
3) Nature of enzyme action
4) Discovery of enzymes

159. A competitive inhibitor prevents enzyme action by
1) Combining with the substrate
2) Lowering the activation energy
3) Changing the active site
4) Combining with the enzyme at the active site

160. Arginosuccinase will split Arginosuccinic acid into argenine and
1) Succinic acid 2) OAA
3) Malic acid 4) Fumaric acid

161. The co enzyme for malate dehydrogenase is
1)NAD^+ 2) $NADP^+$ 3) FAD 4) Co-A

162. When Glycolic acid is oxidized in presence of Oxygen by the enzyme Glycoic acid oxidase, the products are Glyoxylic acid and
1) CO_2 2) H_2O_2
3) H_2O 4) $CO_2 + H_2O$

163. This enzyme will not show optimum activity at neutral pH
1) Amylase 2)Catalase 3)Urease 4)Peroxidase

164. The enzyme isolated from jack beans by Sumner is
1) Urease, 2) Zymase, 3) Pepsin, 4) Trypsin

165. According to Louis Pasteur the conversion of grape juice into alcohol is helped by
1) Urease, 2) Sucrase,
3) Ferments, 4) Catalase

166.

Table-1 (Holoenzyme)	**Table-2 (Cofactor)**
I) Catalase	A) Copper
II) Cytochrome oxidase	B) Iron
III) Carbonic anhydrase	C) Magnesium
IV) Hexokinase	D) Zinc

The correct match is

	I	II	III	IV
1)	D	A	B	C
2)	B	A	D	C
3)	A	C	D	B
4)	D	B	A	C

167.

List - I	List - II
A. Haldane	I. Zymase
B. Louis Pasteur	II. Pepsin and Trypsin
C. John Northrop	III.Treatise
D. Edward Buchner	IV. Hens egg white
	V. Ferments

The correct match

	A	B	C	D
1.	IV	II	III	I
2.	III	V	II	I
3.	I	II	III	IV
4.	II	I	IV	III

168. Match the following

Enzyme	**pH Value**
A Trypsin	i. 5.0
B Amylase	ii. 2.0
C Pepsin	iii. 7.0
D Peroxidase	iv. 8.0
	v. 6.0

The correct match

	A	B	C	D
1.	II	I	III	IV
2.	IV	III	II	I
3.	I	II	III	IV
4.	II	I	IV	III

169.

Table-1 (Holoenzyme)	**Table-2 (Cofactor)**
I) Pyruvic decarboxylase	A) Copper
II) Cytochrome oxidase	B) TPP
III) Carbonic anhydrase	C) Mn
IV) OEC	D) Zinc

The correct match is

	I	II	III	IV
1)	D	A	B	C
2)	B	A	D	C
3)	A	C	D	B
4)	D	B	A	C

170. Three column match

Column -1 (Enzyme)	**Column -2 (Reaction)**	**Column -3 (Example)**
A) Isomerase	Intra molecular Shift	Triose phosphate Isomerase
B) Transferase	Oxidation	Hexokinase
C) Oxido-reducates	Reduction/ Oxidation	Malate dehydrogenase
D) Ligase	Hydrolysis	Fumarase

The correct combination is
1) A, B & C 2) A & C
3) B & C 4) A & D

171.

Table-1 (Coenzyme)	**Table-2 (Vitamin)**
I) TPP	a) Pantothenic acid
II) PP	b) B_1
III) NAD^+	c) B_6
IV) Co-enzyme "A"	d) Niacin

The correct match is

	I	II	III	IV
1)	d	a	b	c
2)	a	c	d	b
3)	b	c	d	a
4)	b	c	a	d

172. Write in descending order basing on the optimum pH value for enzyme activity of the following enzymes

i) Trypsin ii) Urease iii) Pepsin iv) Peroxidase
1) iv,ii,iii,i 2) i,ii,iv,iii
3) i,ii,iii,iv 4) ii,iv,i,iii

173. Which of the following is not correct.
A. All enzymes are organic substances
B. All proteins are enzymes
C. All enzymes are proteins
D. All enzymes are thermolabile
1) A and B 2) B and D
3) B only 4) A and C

174. Which statement is correct regarding nomenclature of enzyme.
A. Based on Substrate name
B. First substrate name and then reaction name
C. Only product name
D. First product name and then substrate name
1) A and B only 2) B and C only
3) D only 4) A only

LEVEL - II

175. Assertion (A) : Proteinaceous nature of enzymes was first suggested by Northrop and his associates.
Reason (R): All enzymes are proteins but all proteins are not enzymes.

176. Assertion (A) : An enzyme with ambiguous nomenclature is catalase
Reason (R): Transferases are the enzymes which transfer groups other than hydrogen atoms from substrate to substrate.

177. Assertion (A) : Fourth number in enzyme code does not specify any information regarding catalytic nature of the enzyme.
Reason (R):Enzyme code of glucose 6-phospho transferase is 2:1:7:2.

178. Assertion (A) : Turn over number of enzyme is the indication of its efficiency
Reason (R): Enzymes remain unchanged even after the biochemical reactions

179. Assertion (A) : Prosthetic group is an organic substrance which is tightly bound to Apoenzyme.
Reason (R): Apoenzyme alone can carryout biochemical reaction in the absence of co-factor.

180. Assertion (A) : Ligases can not carry out biochemical reactions in the absence of ATP
Reason (R): Ligases create new bonds between substrate molecules by using energy from ATP hydrolysis

181. Assertion (A) : Apoenzyme and co factor are collectively called as Holoenzyme
Reason (R): Holoenzyme is tightly bound to the proteins.

182. Assertion (A) Enzymes are denatured at high temperature
Reason (R): Enzymes are proteins

183. Assertion (A) Trypsin shows optimum catalytic activity in slightly alkaline medium
Reason (R): The pH of Trypsin is 8.0

184. Assertion (A): The cofactor for IAA oxidase is Mg^{2+}
Reason (R): IAA oxidase is a metalloenzyme

185. Assertion (A) Transaminase belongs to the 2^{nd} class in IUB system.
Reason (R): Transaminases are useful in amino acid synthesis

186. Assertion (A) : Enzymes are sensitive to temperature
Reason (R) : Enzymes have high molecular weight

187. Assertion (A): Third digit in enzyme code of Glucose–6–phosphotransferase is sub - sub class
Reason (R): Glucose – 6 – phosphotransferase transfers phosphate group.

188. Assertion(A):Fructose1-6–bisphosphatase is placed in 2^{nd} class of IUB classification.
Reason (R): Fructose 1 – 6 bisphosphatase removes the phosphate from substrate by adding water.

189. Assertion (A): Enzymes are denatured by heat.
Reason (R): Enzymes are micro molecules having fatty acids which are destroyed by heat.

190. Assertion (A) : Co.enzymes are the organic co-factors of holoenzymes
Reason (R) : Heam moiety of peroxidase is a good example of an aponezyme

191. Assertion (A): TON of an enzyme indicates the efficiency of enzyme
Reason (R) : Prosthetic group is an organic cofactor, which is tightly bound to apoenzyme

LEVEL - III

192. Enzymes placed in third class of IUB are mainly present in
I. Suicidal bag of cell II. Starch factory of cell
III. Cell brain IV. Protein factory of cell
1) I and II 2) II and III
3) I and III 4) III and IV

193. How many of the following enzymes come under I class of IUB that concerned with light reaction of photosynthesis ?
I. G-3-P dehydrogenase
II. Fd - NADP oxidoreductase
III. RUBISCO
IV. Nitrate reductase
1) II only 2) I and II
3) I, II and III 4) I, III and IV

194. Turn over number of one enzyme is 20. How many substrate molecules are converted into products after 8 minutes by five molecules of enzymes ?
1) 160 2) 800 3) 100 4) 268

195. 10 molecules of an enzyme convert 2400molecules of substrate into products in 10 minutes. What is its TON ?
1) 15 2) 16 3) 24 4) 240

196. TON of an enzyme is 12. Five molecules of enzymes act on 1000 substrate molecules for 12 minutes. What is the ratio of left out substrates and enzymes
1) 1 : 12 2) 36 : 12 3) 56 : 1 4) 1 : 1

197. Find the true match

List – I	List – II
1. II class of IUB	A. Nitrate reductase
2. IV class of IUB	B.Hexokinase
3. I class of IUB	C. Arginosuccinase
4. VI class of IUB	D. DNA ligase
5. III class of IUB	E. Ribose 5 (P) isomerase
6. V class of IUB	F. Trypsin

	1	2	3	4	5	6
1)	A	B	C	D	E	F
2)	B	C	A	D	F	E
3)	C	B	A	D	F	E
4)	B	C	A	F	D	E

198. TON of an enzyme is 16. Fourteen enzymes act on 784 substrates. What will be the ratio of substrates unconverted into products and enzymes after 180 seconds?
1) 1 : 6 2) 1 : 7 3) 8:1 4) 8 : 13

199. How many are true statement
I. Prosthetic group is an organic cofactor that is loosely attached with apoenzyme.
II. Zn^{++} is required for the activity of catalase
III. TON indicates enzymes concentration
IV.Conversion of malate into oxaloacetate is oxidation
1) I, II, III, IV 2) II, III, IV 3) III, IV 4) IV only

200. Study the following list

List - I	List - II
A)Oxido reductases	I)Hydrolysis of ATP
B)Transferases	II)Dehydrogenases
C)Hydrolases	III)Hexokinases
D)Ligases	IV)Phosphotases
	V)Arginosuccinase

	A	B	C	D
1)	V	II	III	I
2)	II	III	IV	I
3)	III	I	II	V
4)	I	IV	III	II

201. One of the following statements is wrong regarding enzymes
1) Enzymes act on specific substrates
2) Holoenzyme consists of apoenzyme and co-factor
3) The TON is same for all enzymes
4) Enzymes are very active in extermely small quantities

202. Tightly bound co- factors to apoenzyme of holoenzymes are
I) TPP II) Mg^{2+} III) Heam moiety IV) Zn^{2+}
1) I, II, III 2) I, III, IV
3) II, III,IV 4) I.II.IV

3.8 PHOTOSYNTHESIS

SYNOPSIS

- Photosynthesis is the most important physico-biochemical process on which the existence of life on earth depends.
- Photosyntheis is an "**Anabolic**" and an "**endergonic**" process
- It uses the light energy in order to reduce CO_2 into the carbohydrates
- Oxygen is the bye–product of this process.
- A simplified equation of this process is
$6CO_2 + 12H_2O \xrightarrow{light}_{chl} C_6H_{12}O_6 + 6H_2O + 6O_2$
- The carbohydrates produced during photosynthesis are converted into many organic molecules like proteins, lipids etc.
- Green plants use only 1% of the total radiant energy to fix two billion tonnes of CO_2 annually.
- 90% of global photosynthesis is performed in the oceans by algae.

PHOTO SYNTHETIC PIGMENTS

- Chloroplast is the cell organelle which contains all the photosynethetic pigments.
- Chloroplasts are regarded as food production centres.
- Leaves are the main site of photosynthesis
- Chloroplast is one of the largest cell organelle of a mesophyll.
- The chloroplast is surrounded by double and differentially permeable membranes, with a peri–plastidial space.
- The matrix of the chloroplast is called "stroma"
- It is enzyme rich and involved with dark reaction of photosynthesis.
- Stroma consists of Thylakoids.
- The stacks of thylakoids are called "**Grana**"
- The region where one thylakoid is in contact with the other is called 'Appressed region'.
- All the grana are linked by 'Fret membranes' or 'stroma lamellae'.
- Stroma thylalkoids,end branches of grana and grana margins which are exposed to stroma are called "non appressed regions".