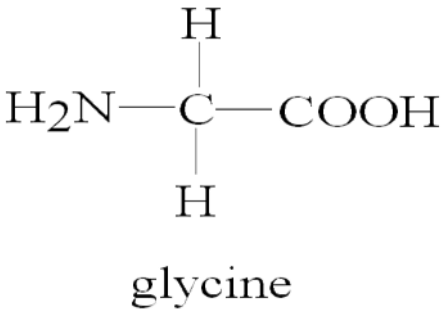
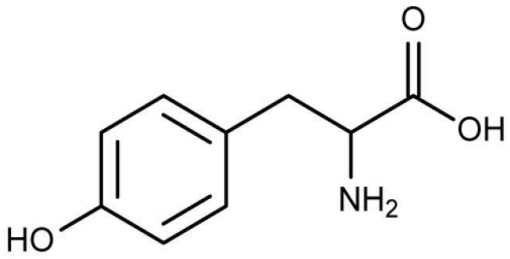
Subject Title: Biochemistry & Clinical Pathology **Subject Code:** 0808

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for anyequivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1		**Solve any Eight of the followings:**	**8×2=16M**
1	a)	**Give structure of (i) Glycine (ii) Tyrosine**  glycine  Tyrosine	**1M each**
	b)	**Define and classify vitamins.** The naturally occurring micronutrients present in food and are required for normal functioning and growth of the living organisms are called as a Vitamins. Classification • Fat soluble vitamins: these are soluble in fat and are stored in liver. e.g. Vitamin A, Vitamin D, Vitamin E and Vitamin K • Water soluble vitamins: These are soluble in water and are not stored in body. e.g. Water soluble vitamin includes B-complex group (B_1, B_2 , B_3, B_5, B_6,B_7,B_9,B_{12}) and Vit C	**1Mdef.** **1Mclassf.**

<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>c)</td><td>Define (i) Anabolism (ii)Catabolism
(i)Anabolism: It’s a biosynthetic phase, uses energy to construct components of cells such as proteins and nucleic acids.

(ii) Catabolism: It’s a process of degradation of complex matter into simple form the generating energy & metabolites that provide metabolic fuel & building block for the cell.</td><td>1M each</td></tr>
<tr><td></td><td>d)</td><td>Differentiate between fats and oil.
<table>
<tr><th>Fats</th><th>Oils</th></tr>
<tr><td>Fats are solids at room temp</td><td>These are liquid at room temp</td></tr>
<tr><td>Contain greater amounts of saturated fatty acids</td><td>Contain greater amounts of unsaturated fatty acids</td></tr>
<tr><td>Mainly originate from animal sources</td><td>Mainly originate from plant sources</td></tr>
<tr><td>e. g. Butter, cream</td><td>e. g. Castor oil ,Olive oil</td></tr>
</table></td><td>2M</td></tr>
<tr><td></td><td>e)</td><td>Define Biochemistry and state its importance.
Biochemistry -The study dealing with the chemistry of living organism in its different phases of activity is called as biochemistry.

Importance:

1) It deals with study of living system and its working.

2) Study of nature and working of biomolecules.

3) Diagnosis of various metabolic disorders.

4) Study of various deficiency diseases.</td><td>1Mdef.
1M imp. any two</td></tr>
<tr><td></td><td>f)</td><td>Explain in brief Benedict’s test.
Test: When sugar solution is heated with benedict’s reagent it gives red precipitate</td><td>2M</td></tr>
</table>

		Principle: Carbohydrate is heated with alkaline copper sulphate; copper ions get reduced and give red precipitate of cuprous oxide. All reducing sugars give this test positive, while sugars like sucrose do not give this test positive.	
	g)	**Give biological functions of calcium.** Calcium plays important role in: • Formation & development of bones &teeth • Muscle contraction • Blood clotting • Growth of children • Responsible for transmission of nerve impulse • Activation of enzymes • Regulation of permeability of membranes.	**2M any four**
	h)	**Define:** **i)Acid value:** It is number of milligram of KOH required to neutralize the free fatty acids present in 1gram of fat or oil. **ii)Iodine value:** It is the number of grams of iodine required to saturate or absorbed by 100gms of fat or oil.	**1M each**
	i)	**Define cell and give functions of Mitochondria.** Cell: It is defined as structural and functional unit of living organism and capable of carrying on processes of life independently. Mitochondria are engaged in oxidative metabolism, and are responsible for the transportation of chemical energy into biological energy, in the form of ATP .	**1M def.** **1M fun.**

		All enzymes involved in Krebs cycle are present in mitochondria.	
	j)	**Define essential fatty acids with examples.** The unsaturated fatty acids which are not synthesized in the body and are required to be supplied through diet for the normal growth of body are called as essential fatty acids. E.g. Arachidonic acid, linoleic acid, linolenic acid. Etc	**1M def.** **1M e.g. any two**
	k)	**Explain in short Iodine test** This test is used for identification of starch. Sample solution + Iodine give blue colour indicating the presence of starch.	**2M**
	l)	**What is active site of an enzyme?** • Portion of an enzyme to which the substrate binds & gets converted into the product. • In the active site, the amino acids are grouped together in such a manner so as to enable the enzymes to combine with substrate.	**2M**
2		**Solve any FOUR of the followings**	**4×3=12M**
2	**a)**	**Mention the names of water soluble vitamins and their respective co-enzymes.** **Water soluble vitamins: Coenzymes:** Vitamin B1- Thiamine — Thiamine pyrophosphate Vitamin B2- Riboflavin — FAM (Flavin adenine mononucleotide), FAD (Flavin adenine dinucleotide) Vitamin B3- Niacin — NAD(Nicotinamide adenine dinucleotide), NADP(Nicotinamide adenine dinucleotide phosphate) Vitamin B5- Pantothenic acid — Coenzyme-A Vitamin B6- Pyridoxine — Pyridoxal phosphate Vitamin B7- Biotin — Biotin Vitamin B9- Folic acid — Tetrahydrofolate Vitamin B12- Cyanocobalamin — Deoxyadenosine cobalamin Vitamin C (Ascorbic acid) — Ascorbic acid	**3M** **For any 6**
2	**b)**	**Explain water balance of normal individual**	**3M**

(Balance may be given for 2500ml/2800ml)

Water is very essential for living system. There is no life without water. Total body water accounts for 70%of body weight. However, a loss of 10% of water in our body is serious sand a loss of 20% is fatal.

Therefore, a balance should be maintained between water intake and output.

Water intake source -

1) Drinking water -1500ml

2) Solid food -1000ml

3) Oxidation of carbohydrates, fats and protein- 300ml

Water loss from body -

Water is lost continuously from the body in the following ways.

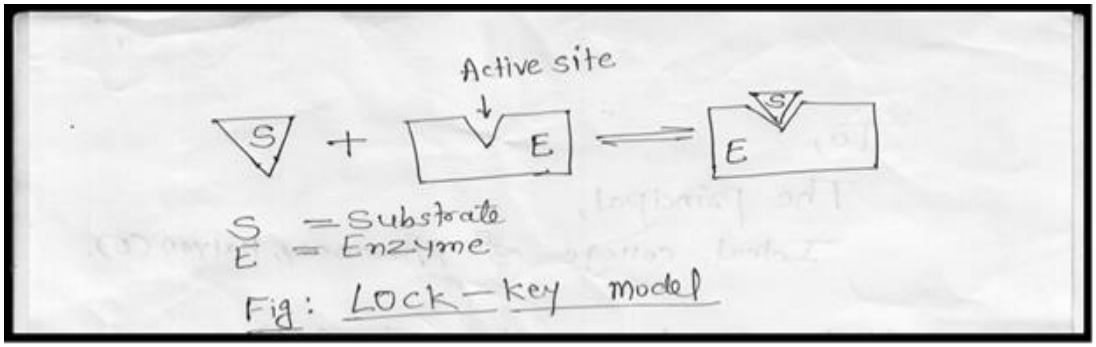
1) via kidney as urine -1500ml

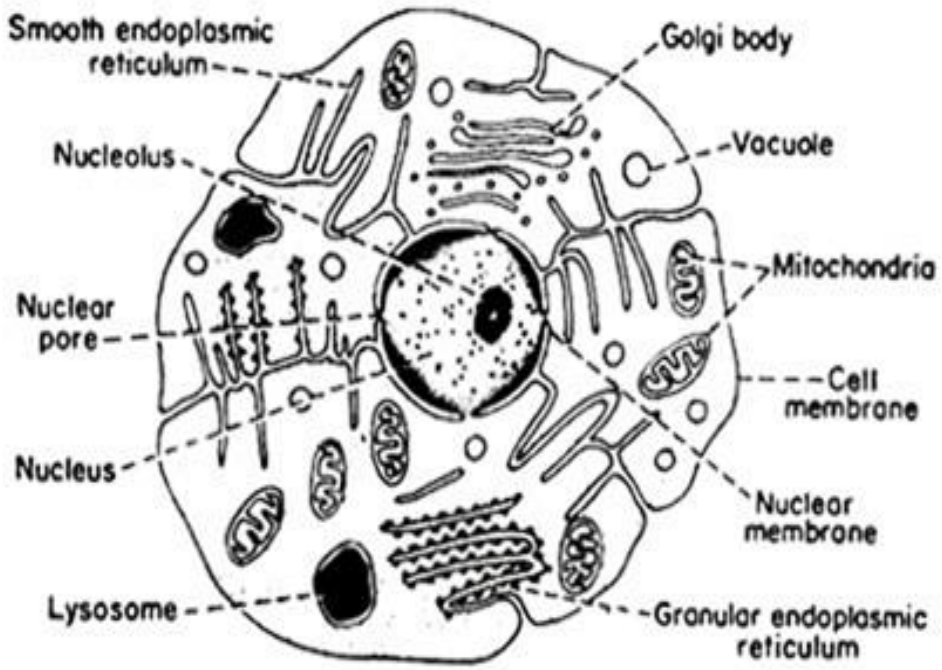
2) via skin -800ml

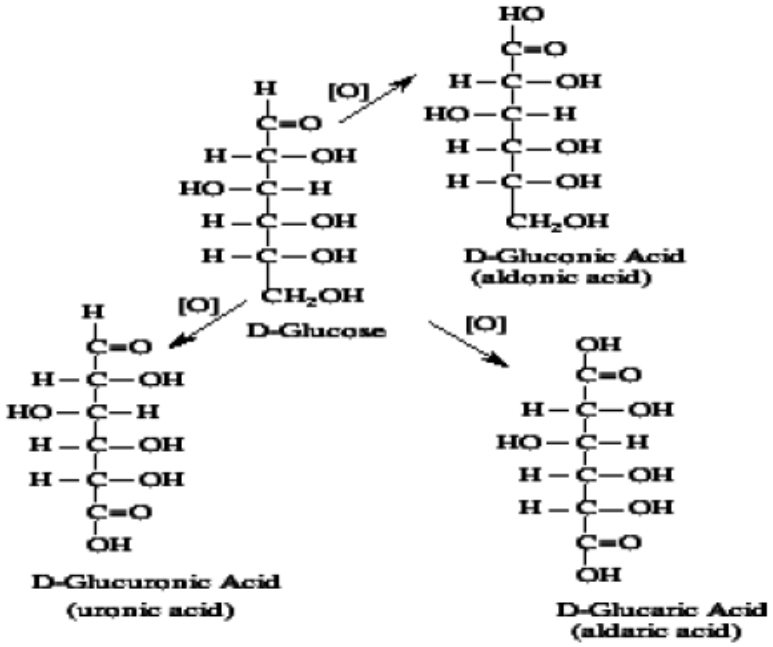
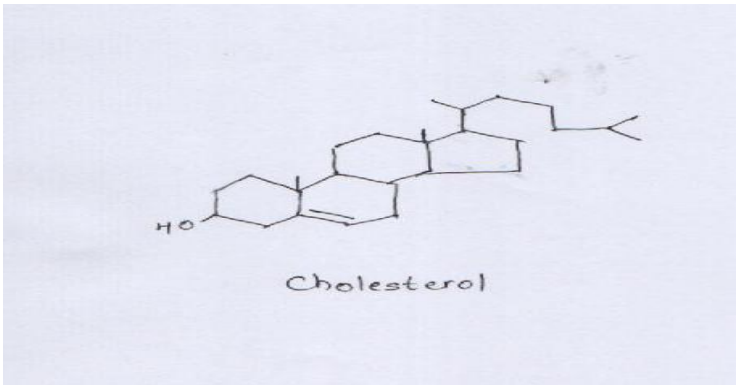
3) via lungs in expired air -400ml

4) via faeces -100 ml

Water intake	**Ml**	**Water loss**	**Ml**
Drinking water	1500ml	Urine	1500ml
Solid food	1000ml	Faeces	100ml
Oxidation of carbohydrates Fats, Proteins	300ml	Skin	800ml
-	-	Lungs	400ml
Total	2800ml	Total	2800ml

2	**c)**	**Give physiological role of Iodine & Iron:** **Iodine:** • Iodine is essential trace element required for the biosynthesis of thyroid hormones like thyroxine and triiodothyronine. • It is required for the normal growth and development of body. • Helps in treatment of Hypothyroidism. **Iron:** Iron is essential element required in different processes: • Formation of red blood cells • DNA synthesis • Formation of myoglobin • Involved with Oxidoreductase enzymes & electron carrier. • Associated with effective immunocompetence of the body. • Helps in treatment of iron deficiency anaemia	**1.5 M** **Any 3 fns.of each**
2	**d)**	**Explain Lock and Key Model of enzyme action.**  It is the first model proposed by" Emil Fisher" to explain enzyme action mechanism. It is like a Lock & Key. In this case the shape of active site of an enzyme and that of substrate is complementary to each other.	**1Mdig.** **2Mexpl.**

		The substrate molecule fits into the active site of enzyme just as key fits into a lock. Hence called Lock & Key model. The shape of active site is rigid and complementary to the shape of substrate complex.	
2	**e)**	**Draw a neat labelled diagram of typical animal cell.**  	**3M**
2	**f)**	**Explain Oxidation of D-Glucose.** • Glucose gives acid on oxidation. Different oxidising agents give different products. • with bromine gives Gluconic acid . • With platinum it gives Glucouronic acid. • With nitric acid it gives Glucosaccharic acid	**3M**

			
3		**Solve any FOUR of the followings**	**4×3=12M**
3	**a)**	**Give structure and colour reactions of cholesterol.**  **1) Liebermann-Burchard test:** When chloroform solution of cholesterol is treated with acetic anhydride & concentrated sulphuric acid, green colour is formed. **2) Salkowaski test:** When chloroform solution of cholesterol is treated with concentrated sulphuric acid, upper layer gives red colour and H_2SO_4 layer gives green colour. **3) Formaldehyde-H_2SO_4 Test:** To a solution of cholesterol in chloroform in dry test tube if formaldehyde -sulphuric acid solution is added, cherry colour develops.	**3M** **(Structure - 1 M, any 2 tests – 2M)**

<table>
<tr><td>3</td><td>b)</td><td>Define pathological urine. Name abnormal constituents of urine with diseases associated with them.

Pathological urine- Urine that contains substances essential to the body or tissues (like sugar, bile salts, albumin etc.), in addition to normal organic & inorganic substances, is called as pathological or abnormal urine. Such urine indicates some disease or disorder.

<table>
<tr><th>Abnormal constituents</th><th>Associated ailment</th></tr>
<tr><td>Sugar (glucose)</td><td>Glycosuria- Diabetes mellitus</td></tr>
<tr><td>Ketone bodies</td><td>Ketonuria- Diabetes mellitus, Pregnancy, Carbohydrate starvation</td></tr>
<tr><td>Albumin</td><td>Proteinuria- Pregnancy, severe exercise, high protein meal, Nephritis</td></tr>
<tr><td>Bile pigments / salts</td><td>Jaundice /Hepatitis</td></tr>
<tr><td>Blood</td><td>Haematuria- Acute inflammation of urinary organs, T.B., Cancer, Haemolytic jaundice etc.</td></tr>
<tr><td>Pus</td><td>Pyuria- Inflammation of urinary bladder, urethra, kidney</td></tr>
</table>
</td><td>3M

(Definition- 1M, Abn.consti. with diseases 2M for any 4)</td></tr>
<tr><td>3</td><td>c)</td><td>Define and Classify Lipids.

The lipids are a large and diverse group of naturally occurring organic compounds that are related by their solubility in nonpolar organic solvents (e.g. ether, chloroform, acetone & benzene) and general insolubility in water. They are esters of fatty acids.</td><td>3M

(Definition- 1M, Classification -2M.)</td></tr>
</table>

Classification:

Simple lipids: Esters of fatty acids with alcohol.

• Fats & oils : Castor oil

• Waxes : Bees wax

Compound Lipid

• Glycerophospholipids., Sphingophospholipids, Glycolipids

• Lipoproteins: Contain proteins

• Sulpholipids

• Aminolipids

• Lipoproteins: Contain proteins

• Sulpholipids:

• Aminolipids:

Derived Lipids:

• Eg: Alcohols, Glycerol, Fatty acids etc

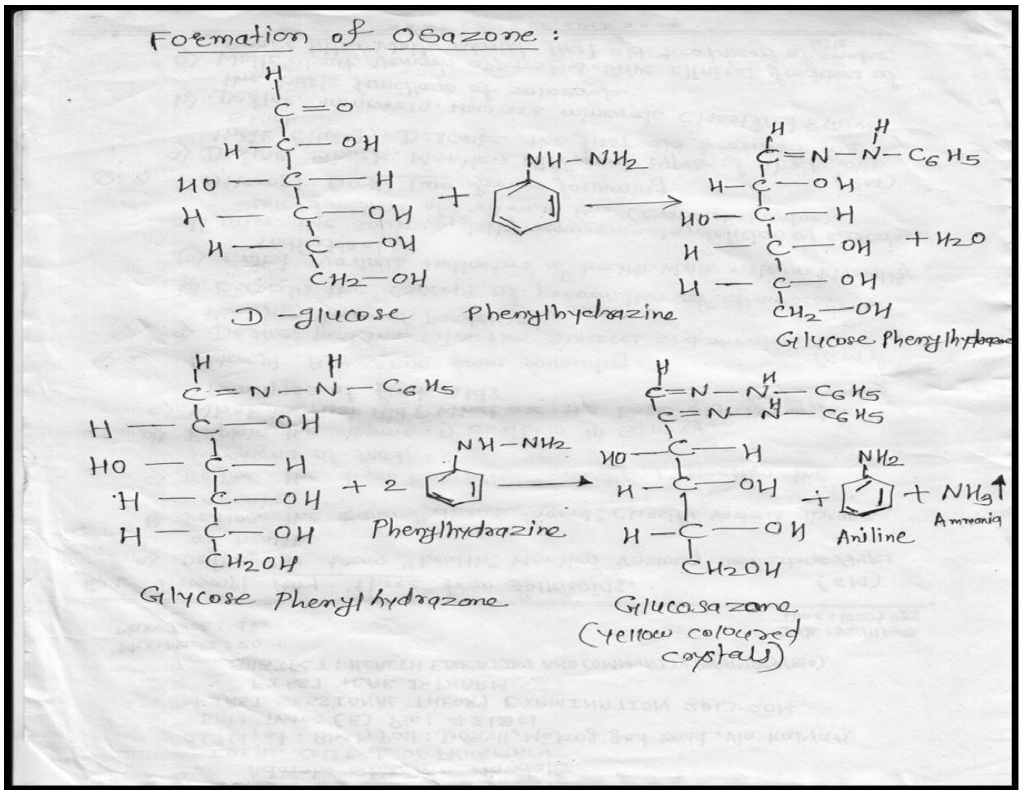
Miscellaneous Lipids:

• Eg : Carotenoids, Squalene.

Neutral Lipids:

• They are mono, di, triacyl glycerols, cholesterol, cholesteryl esters.

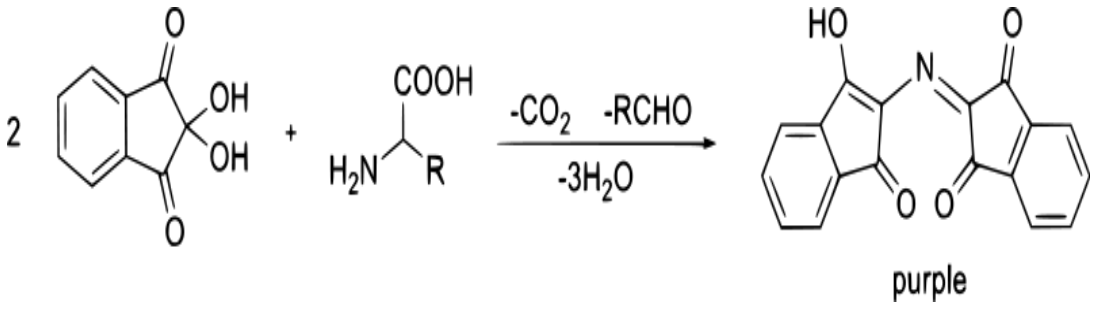
Schematic classification can be considered

3	**d)**	**Explain Osazone formation of D-Glucose.** i) When glucose (reducing sugar) is treated with phenyl hydrazine, it gives reaction product phenylhydrazone. ii) Two molecules of phenyl hydrazine are heated again with glucose phenylhydrazone, It gives products like ammonia, aniline and glucosazone.  	**3M**
3	**e)**	**Give functions of Vit.C.** Vitamin C plays important role in: • Collagen formation • Bone formation • Iron & haemoglobin metabolism • Tryptophan,Tyrosine , Folic acid metabolism • Synthesis of immunoglobulins (antibodies) • Synthesis of peptide hormone & corticosteroid hormones	**3M** **(Any 6 functions for 3 M)**

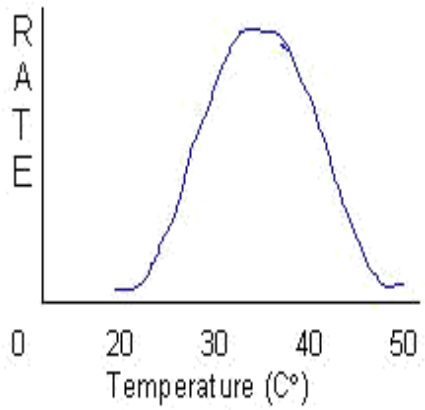
		• Reduces risk of cataract formation • As an antioxidant reduces risk of cancer, coronary heart disease.	
3	**f)**	**Define electrolytes. Write functions of electrolytes.** Electrolyte is a substance that ionizes when dissolved in suitable ionizing solvents such as water. Electrolytes affect the amount of water in your body. **Functions of electrolytes:** • Many of them are essential minerals e.g. sodium, potassium etc. They perform important role in our body. • Minerals maintain acid base balance, required for normal cellular activities. • Electrolytes control osmosis & hence volume of various body fluids. • They carry electrical current that allows production of action potential & gradient potential required for nerve impulse transmission.	**3M** **(Definition- 1 M, Functions- 2M)**
4		**Solve any FOUR of the followings**	**4×3=12M**
4	**a)**	**How will you detect (i) Sugar (ii) Ketone bodies from the given sample of urine?** **i) Sugar:** **Benedict's test:** 5ml urine+ 5ml Benedict's reagent, boil for 2 minutes &cool. Green/ yellow/ red ppt obtained indicates presence of sugar according to concentration. **OR** **Fehling's test:** 2ml Fehling's A+ 2ml Fehling's B, boil for few minutes, add 2-3 ml of urine, and boil again. Red/ yellow ppt obtained indicates presence of sugar. **ii) Ketone bodies :** **Rothera's test :** 5 ml urine sample +($NH_4)_2SO_4$ to saturate it completely + 2 drops of sodium nitroprusside solution + 2ml strong ammonia solution from side of test tube, wait for 10 min .permanganate colour develops, ketones like acetone present.	**3M** **(1.5 M each)**

4	**b)**	**Write biological functions of lipids.** • Energy storage: Triacylglycerols, stored in adipose tissue, are a major form of energy storage. • Acting as structural components of cell membranes: The glycerophospholipids are the main structural component of biological membranes, • Dietary fats help to dissolve fat soluble vitamins: (A, D, E and K) • Lipids play diverse and important roles in nutrition and health. Many lipids are absolutely essential for life. • Humans have a requirement for certain essential fatty acids, such as linoleic acid, linolenic acid. These are provided by lipids. • Lipids provide excellent insulation as fat is bad conductor of heat. • Fats provide padding to protect internal organs. • Lipoproteins and glycolipids are essential for cellular integrity.	**3M** **(Any 6 functions for 3 M)**
4	**c)**	**State, what you mean by essential and non essential amino acids. Give examples.** **Essential amino acids:** Amino acids which cannot be synthesized by the body but which are required for normal functioning of body and supplied through diet. Eg. Valine, leuciene, Isoleucine, phenylalanine, tryptophan, lysine, arginine, histidine, methonine. (any 2) **Non essential amino acids:** Amino acids which are synthesized in the body. Eg. Glycine, alanine, tyrosine, aspargine, aspartic acid , glutamine, glutamic acid, cysteine, serine, proline (any 2)	**3M** **(1.5 M each)**
4	**d)**	**Classify proteins with examples.** **Based on chemical nature & solubility** • **Simple:** Composed of only amino acid residues. Ex. Protamines, Histones Albumins & globulins, Scleroproteins • **Conjugated:** Besides amino acid residues they contain nonprotein moiety known as prosthetic group or conjugating group. Ex. Nucleoproteins, Phosphoproteins, Glycoproteins, Lipoproteins	**3M**

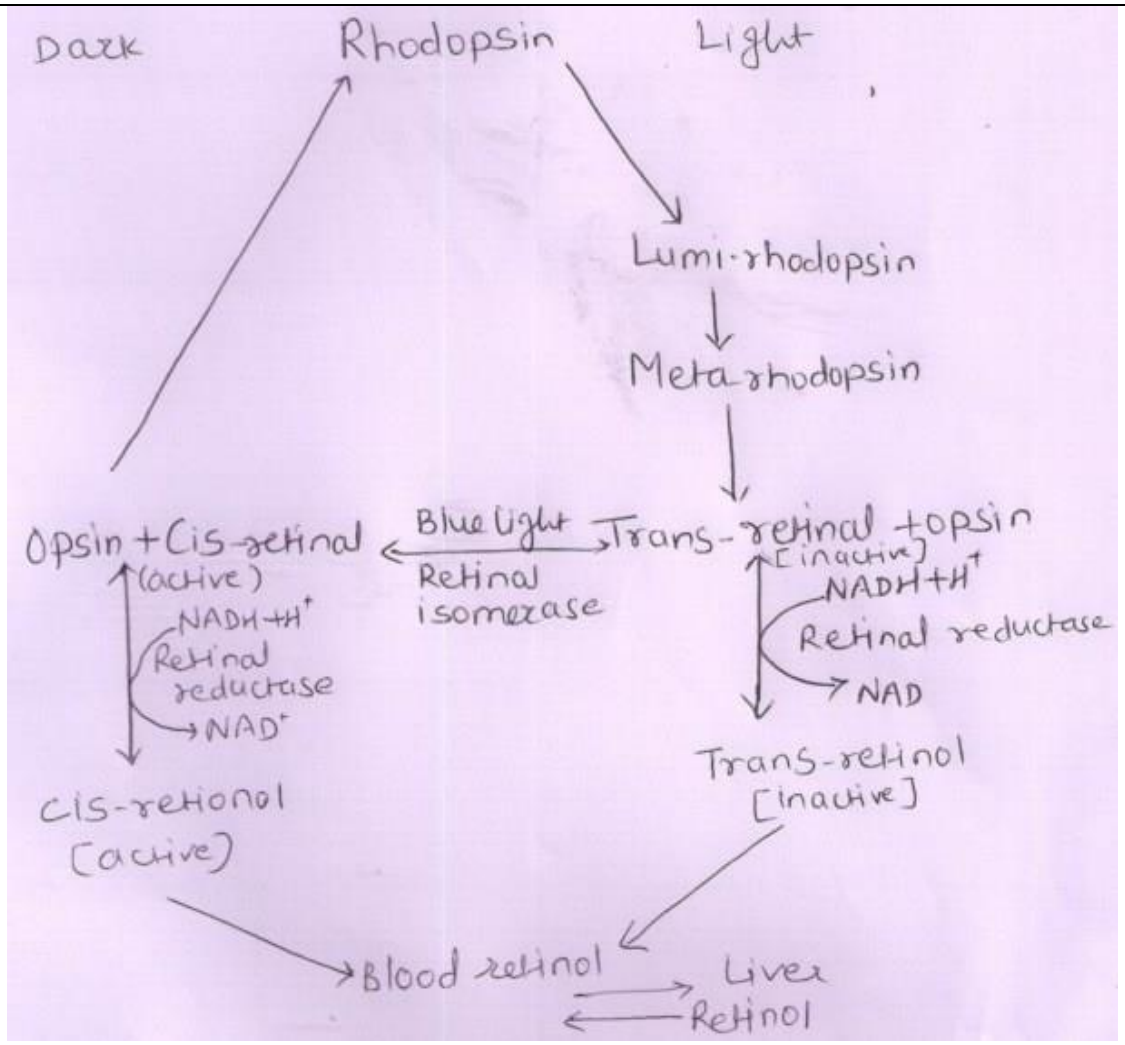
		• **Derived:** They are denatured or degraded products of simple or conjugated proteins. Ex. Peptones, peptides. **OR** **Proteins can also be classified on nutritional basis:** • **Complete proteins:** Contain all essential amino acids in required quantities eg. Milk protein, egg protein • **Partially incomplete proteins:** they partially lack in one or more essential amino acids. Eg. Wheat ,rice proteins • **Incomplete proteins:** Don't contain all essential amino acids. Eg.Gelatin, zein of maize. **OR** **Classification Based on the functions –(Any6)** • Structural Proteins: Keratin • Catalytic Proteins: Pepsin,Hexokinase • Transport Proteins: Haemoglobin, Serum albumin • Hormonal Proteins: Insulin, Growth hormone • Contractile Proteins :Myosin,Actin • Storage Proteins : Glutelin • Genetic Proteins : Nucleoproteins • Defence Proteins: Immunoglobulins • Receptor proteins: Hormones, Viruses	
4	**e)**	**Write pharmaceutical and therapeutic significance of enzymes.** **Pharmaceutical Significance of enzymes** • Renin is used for cheese preparation. • Glucose isomerase is used for production of syrup. • Alpha amylase is used in food industry to covert starch to glucose.	**3M** **(1.5 M Each)** **(Any 3 can be considered for 1.5 M)**

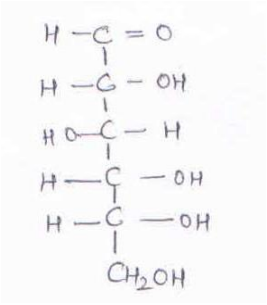
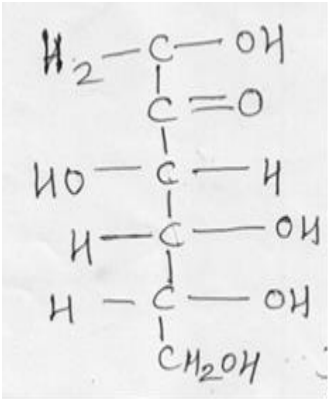
		• Penicillin acylase is used for production of 6- amino Penicillanic acid. • Papain, pepsin and trypsin are used in preparation of digestants. **Therapeutic Significance of enzymes** • Trypsin: Purified enzyme is used orally or parenterally or intramuscularly in treatment of acute thrombophlebitis • Streptokinase: Bacterial enzyme causes fibrinolysis & dissolution of clot. • Pepsin is used in treatment of gastric achylia • Lysoenzyme useful in treatment of eye infection • Galactosidase useful in treatment of lactose intolerance. • Sulphanilamide because of its similarity with PABA competes with it & inhibits enzyme folic acid synthatase& selectively kills pathogenic organisms. • Allopurinol acts as competitive inhibitor of xanthin& reduces its conversion to uric acid **Other correct related examples can be considered.**	
4	**f)**	**Explain in brief:** **(i) Ninhydrin test:** In acidic condition amino acid reacts with ninhydrin to give blue to violet colour, at 60-70 ^{0}C. (Reaction is optional)  A deep blue or purple colour known as Ruhemann's purple is evolved. It's an identification test for amino acids.	**3M** **(1.5 M each)**

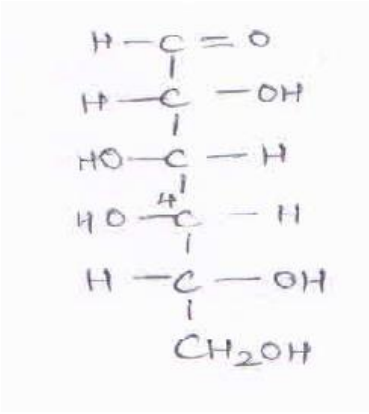
		(ii) Biuret test : **Principle –**This test is positive for all compounds containing more than one peptide linkage. The peptide linkage of protein reacts with copper ions to form a complex of violet colour. **Procedure :** General test for proteins: 3 ml of protein solution + 3 ml of 5% Sodium hydroxide + 3 to 4 drops of 1% Copper sulphate : Purple or pinkish purple colour is developed. Proteins are present. (i.e. presence of peptide bond)	
5		**Solve any FOUR of the followings**	**4×3=12M**
5	**a)**	**Explain in brief:** **i) Kwashiorkar** **ii) Marasmus** **Kwashiorkar**-It is predominantly found in children between 1to5 yrs. It is due to insufficient intake of proteins as the diet of a weaning child consists of carbohydrate. Symptoms: Stunted growth, Edema on legs & hands, Diarrhoea, Discoloration of hair skin, Anemia , Apathy, Moon face, Decreased plasma albumin concentration. Treatment: Protein rich food. **Marasmus**- Occurs in children below 1 yr age. Symptoms: Growth retardation, Muscle wasting, Anaemia , Weakness, No edema ,No decreased concentration of plasma albumin Treatment: Mother's milk.	**Each explanation-1.5M**
5	**b)**	**Enlist the factors affecting enzyme activity. Explain the effect of temperature.** **Factors that affect the enzyme activity are-** • Hydrogen ion concentration • Concentration of enzymes • Concentration of substrate • Temperature	**3M (Factors -1M Explanation-1.5 M and diagram -0.5M)**

		• Time • Effect of Product concentration • Effect of light & other physical factors • Allosteric factors • Effect of hormones & other biochemical agents. **Effect of temperature:** • Optimum temperature is usually reached at around 37°C—45°C for animal enzymes. • Velocity of reaction is increased from 1.1 to 3 times for every 10° rise in temperature. • Above the optimum temperature, rate decreases. • The enzyme gets denatured at a rate faster than the increase in reaction. • Most of the enzymes get denatured above 60°C. • The time of exposure is also important factor. An enzyme may withstand higher temperatures for short periods of time. • Optimum temperature has meaning only if the time of reaction is also stipulated. Enzyme activity is maximum at optimum temperature.  	

5	**c)**	**Describe "Role of Vit A in vision"** The retina of the eye contains two types of receptor cells, Rod cells which are responsible for dim light vision & the cones, responsible for bright light vision. Cones are also responsible for colour perception. The deficiency of cone pigments makes the individual colour blind. In retinal pigments, the rod cells contain rhodopsin. Under the influence of light, rhodopsin is converted to lumirhodopsin which is further converted into metarhodopsin. Then hydrolysed to protein opsin & trans retinal. Trans-Retinal (trans- retinene) is inactive in the synthesis of rhodopsin, it must be coverted to the active cis- isomer. In the eye, the trans-retinal is reduced to trans-retinol by the enzyme retinal reductase & NADH. The trans retinol which is too inactive in rhodopsin synthesis is passed into blood stream, then carried to liver. It is then converted to cis -isomer. In dim light active cis-retinol from the blood enters the retina where it is oxidized to cis-retinal by reverse action of retinal reductase in the presence of NAD^+. Finally, the cis-retinal combines with protein opsin to give back rhodopsin and thus cycle is repeated.	**3M (Explanation -1.5 M and diagram-1.5 M)**

		 The individual having vitamin A deficiency is unable to resynthesize rhodopsin and thus unable to see in the dim light and the condition is called night blindness.	
5	**d)**	**Define and classify carbohydrates with examples.** **Define-** Carbohydrates- It may be defined as polyhydroxy aldehydes or ketones or compounds derived from their hydrolysis. **Classification-** **1) Sugars (saccharides)-** **a) Monosaccharides** (depending upon number of carbon atom, it is subdivided in following types)	**3M** **(Define- 0.5M Classification - 1.5 M and examples-**

		i)Trioses-e.g. D-Glycerose ii) Tetroses-e.g. D-Erythrose iii) Pentoses-e.g. D-Ribose iv) Hexoses- e.g. Glucose, Fructose Depending on functional group i) Aldoses : Glucose ii) ketoses : Fructose **b) Disaccharides-** e.g. Lactose, Maltose, Sucrose. **c) Oligosaccharides**- e.g. Raffinose, Maltotriose. **2) Non sugars (poly saccharides)** **a) Homopolysaccharides**-e.g. Starch, Cellulose. b) **Heteropolysaccharide**s e. g. Hyaluronic acid **Schematic representation can also be considered.**	**1M)**
5	**e)**	**Give the structure of-** **i) D-Glucose**  **ii) D-Fructose:** 	**3M (Each structure 1M)**

		iii) D-Galactose 	
5	**f)**	**Expalin "Mutarotation" of D-Glucose** Definition: Change in specific rotation on standing of aqueous solution of sugar is known as **Mutarotation**. When monosaccharide glucose is dissolved in water ,its optical rotation gradually changes until it reaches a constant value. Freshly prepared solution of alpha D-glucose has a specific rotation of $+112^0$ and on standing specific rotation falls to $+52.5^0$ and remains constant at this value. This final stage can be obtained more quickly either by heating or by adding some catalyst like acid or alkali. This change in specific rotation is called as mutarotation. Fresh solution of beta D-glucose has rotation value of $+19^0$ which on standing also changes to 52.5^0 It can be represented as follows- α—D—Glucose → D—Glucose ← β—D—Glucose. ($+112^0$) ($+52.5^0$) ($+19^0$)	**(Defination-1M and Explanation 2M)**
6		**Solve any FOUR of the followings**	**4×4=16**
6	**a)**	**Explain in brief reactions of "Glycolysis"** **(Detailed diagrammatic representation can be considered for full marks)** It's a main pathway for glucose oxidation	**4M**

1. Phosphorylation of glucose to glucose 6 phosphate in presence of enzyme hexokinase & ATP & Mg

2. Isomerisation of Glucose 6 phosphate to fructose 6 phosphate in presence of phosphohexo isomerase

3. Phosphorylation of fructose 6 phosphate to fructose 1,6 diphosphate in presence of phosphofructokinase,ATP& Mg

4. Cleavage of fructose 1,6 diphosphate to dihydroxy acetone phosphate & glyceraldehyde 3 phosphate in presence of aldolase. These 2 products are interconvertible in presence of triose phosphate isomerase

5. Glyceraldehyde 3 phosphate further undergoes oxidation to 1,3 diphosphoglycerate in presence of glyceraldehyde 3 phosphate dehydrogenase & NAD+

6. Transformation of 1,3 diphosphoglycerate to 3- phosphoglycerate in presence of phosphoglycerate kinase, Mg & ADP

7. 3- phosphoglycerate changes to 2-phosphoglycerate in presence of phosphoglycerate mutase

8. Loss of water molecule from 2-phosphoglycerate results into formation of phosphoenol pyruvic acid in presence of enolase

9. Loss of phosphate from phosphoenol pyruvic acid results into formation of Enol pyruvic acid in presence of pyruvate kinase, Mg & ADP

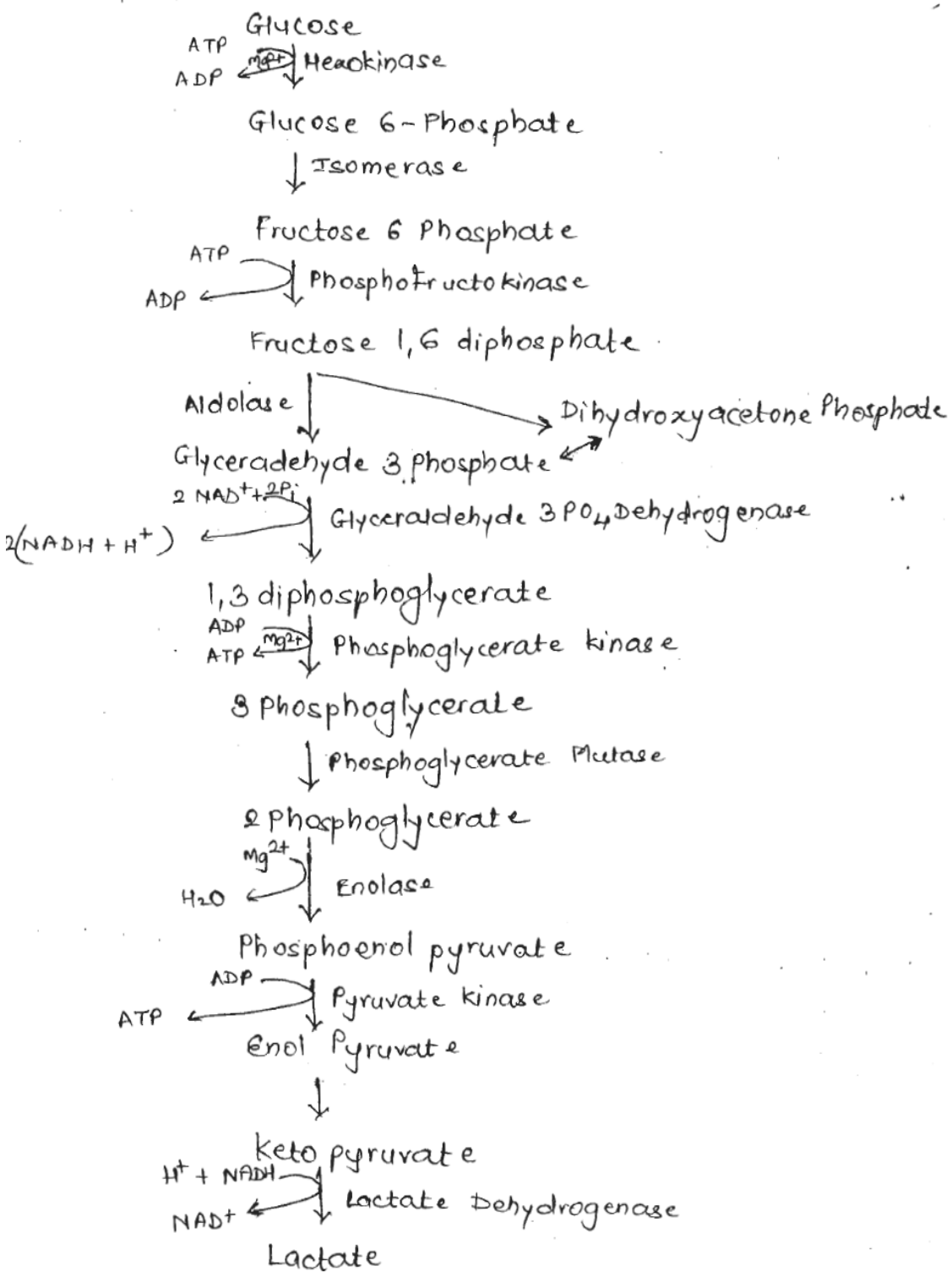
10. Enol pyruvic acid gets converted to keto form of pyruvic acid in presence of pyruvate kinase

11. Keto pyruvic acid under aerobic conditions enter TCA cycle in mitochondria. Pyruvic acid forms main end product of glycolysis in those tissues which are supplied with sufficient Oxygen.

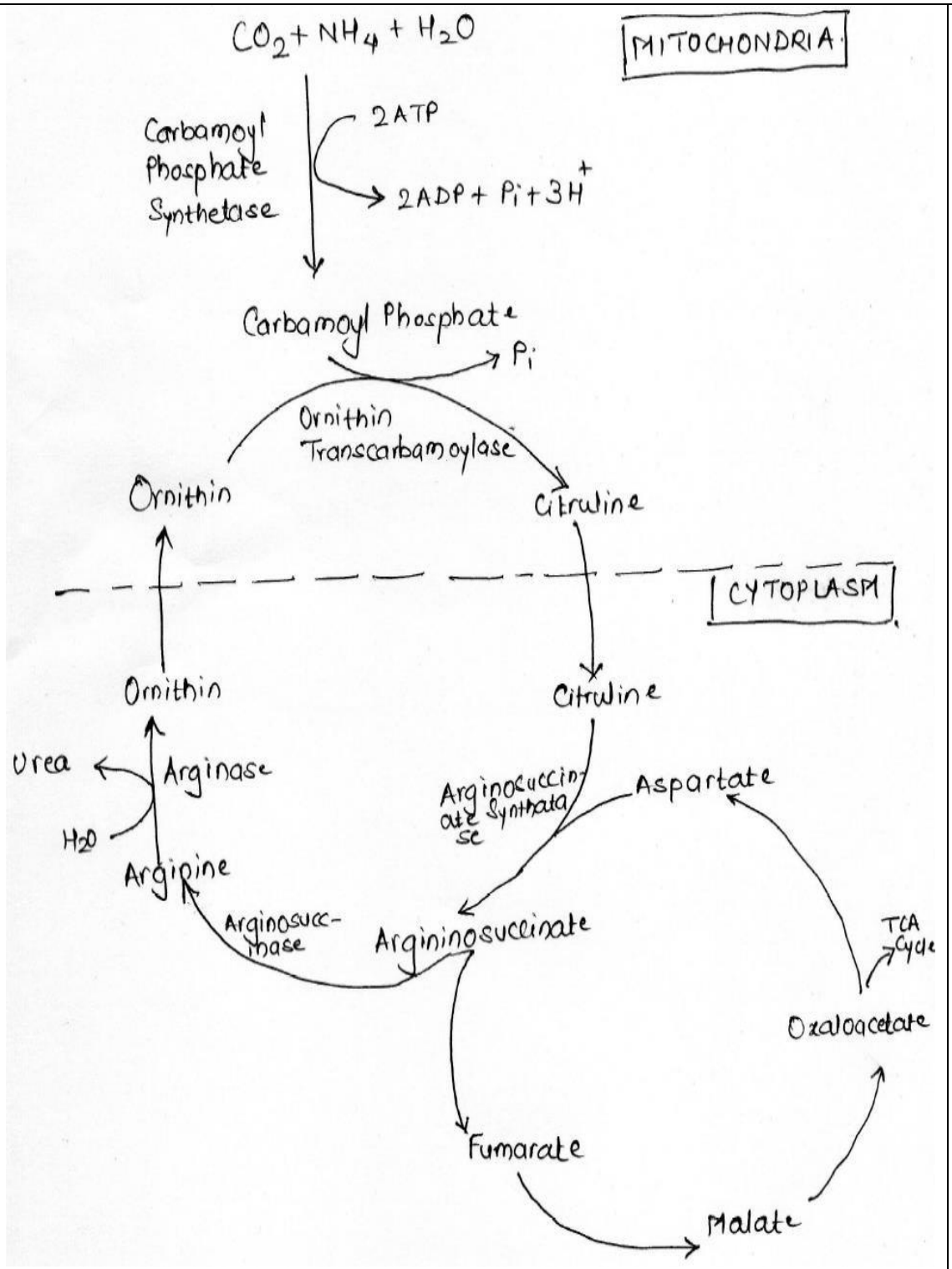
12. But tissues where oxygen is not supplied ,lactic acid is formed as an end product of glycolysis by reduction in presence of lactate dehydrogenase & NADH.

Net reaction for glycolysis is:

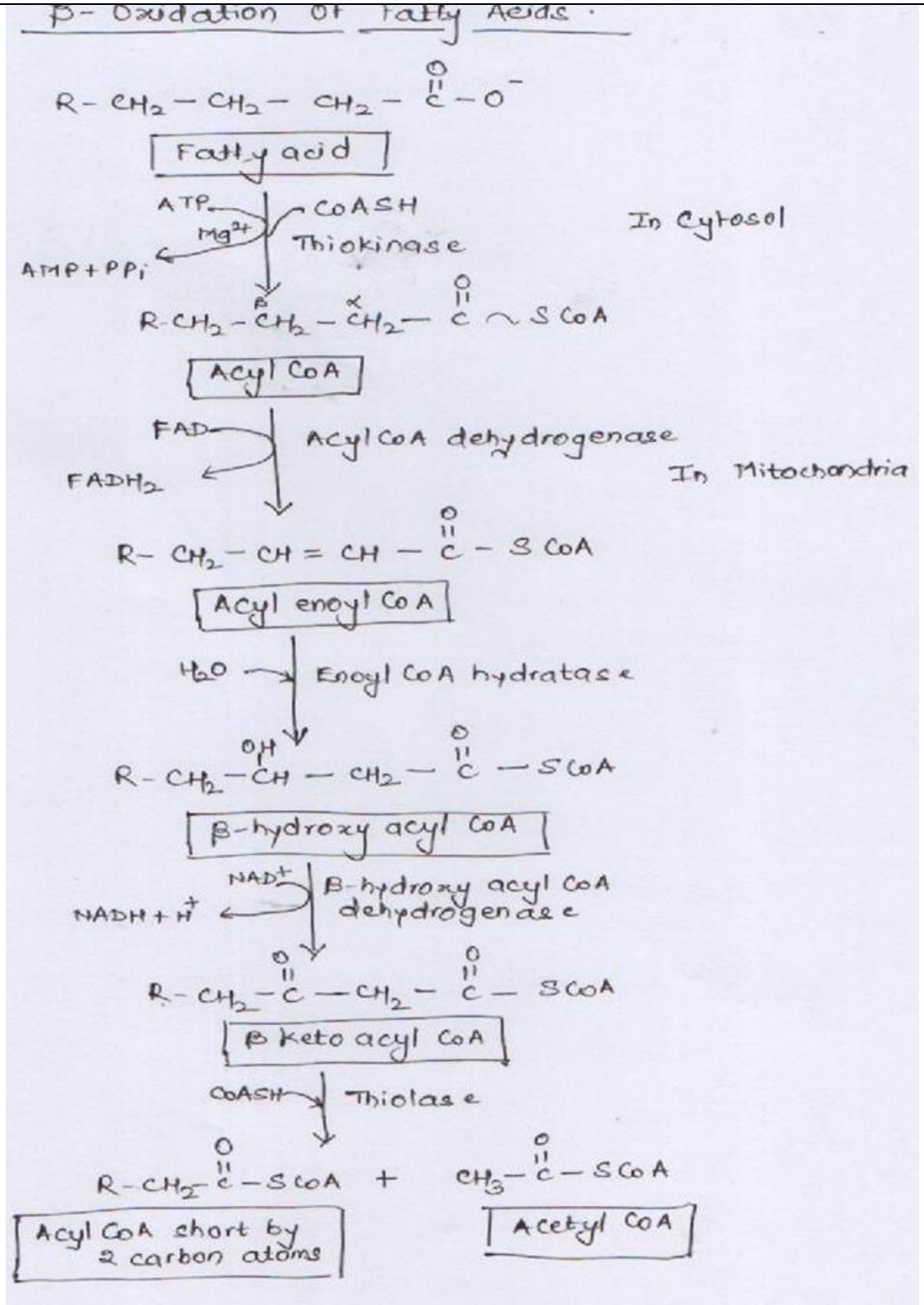
$$\text{Glucose} + 2\text{NAD}^+ + 2\ \text{ADP} + 2\ \text{Pi} \rightarrow 2\ \text{Pyruvate} + 2\ \text{ATP} + 2\ \text{NADH} + 2\ H_2O.$$


Glucose
ATP
ADP
Mg2+
Hexokinase
Glucose 6-Phosphate
Isomerase
Fructose 6 Phosphate
ATP
ADP
Phosphofructokinase
Fructose 1,6 diphosphate
Aldolase
Dihydroxyacetone Phosphate
Glyceradehyde 3 phosphate
2 NAD+ + 2Pi
2(NADH + H+)
Glyceraldehyde 3PO4 Dehydrogenase
1,3 diphosphoglycerate
ADP
ATP
Mg2+
Phosphoglycerate kinase
3 Phosphoglycerate
Phosphoglycerate Mutase
2 Phosphoglycerate
Mg2+
H2O
Enolase
Phosphoenol pyruvate
ADP
ATP
Pyruvate kinase
Enol Pyruvate
Keto pyruvate
H+ + NADH
NAD+
Lactate Dehydrogenase
Lactate

6	**b)**	**Explain the "Formation of Urea" in the body** **(Detailed diagrammatic representation can be considered for full marks)** 1) Molecule of ammonia, CO2 & phosphate are condensed to form 'Carbamoyl phosphate' in presence of enzyme 'carbamoyl-phosphate synthetase. 2) Carbamoyl phosphate transferred to ornithine forms citrulline in presence of an enzyme ornithine transcarboxylase. This reaction takes place in mitochondria. The citrulline formed in this reaction enters in cytoplasm & the next reactions take place in cytoplasm 3) Citrulline condenses with Aspartate to form argininosuccinate. The reaction is catalysed by an enzyme Arginosuccinatesynthetase. 4) Arginosuccinate is now cleaved into 'arginine' & 'fumarate' by the enzyme 'arginosuccinase'. Fumarate formed may be converted to oxaloacetate via the actions of enzymes 'fumerase'& malate dehydrogenase & then transmitted to regenerate aspartate. 5) Finally arginine is cleaved into ornithine & urea by the enzyme arginase. With this reaction cycle is completed & ornithine molecule accepts molecule of carbamoyl phosphate to repeat the cycle. the overall equation of the urea cycle is: NH3 + CO2 + aspartate + 3 ATP + 2 H2O → urea + fumarate + 2 ADP + 2 Pi + AMP + PPi	**4M**

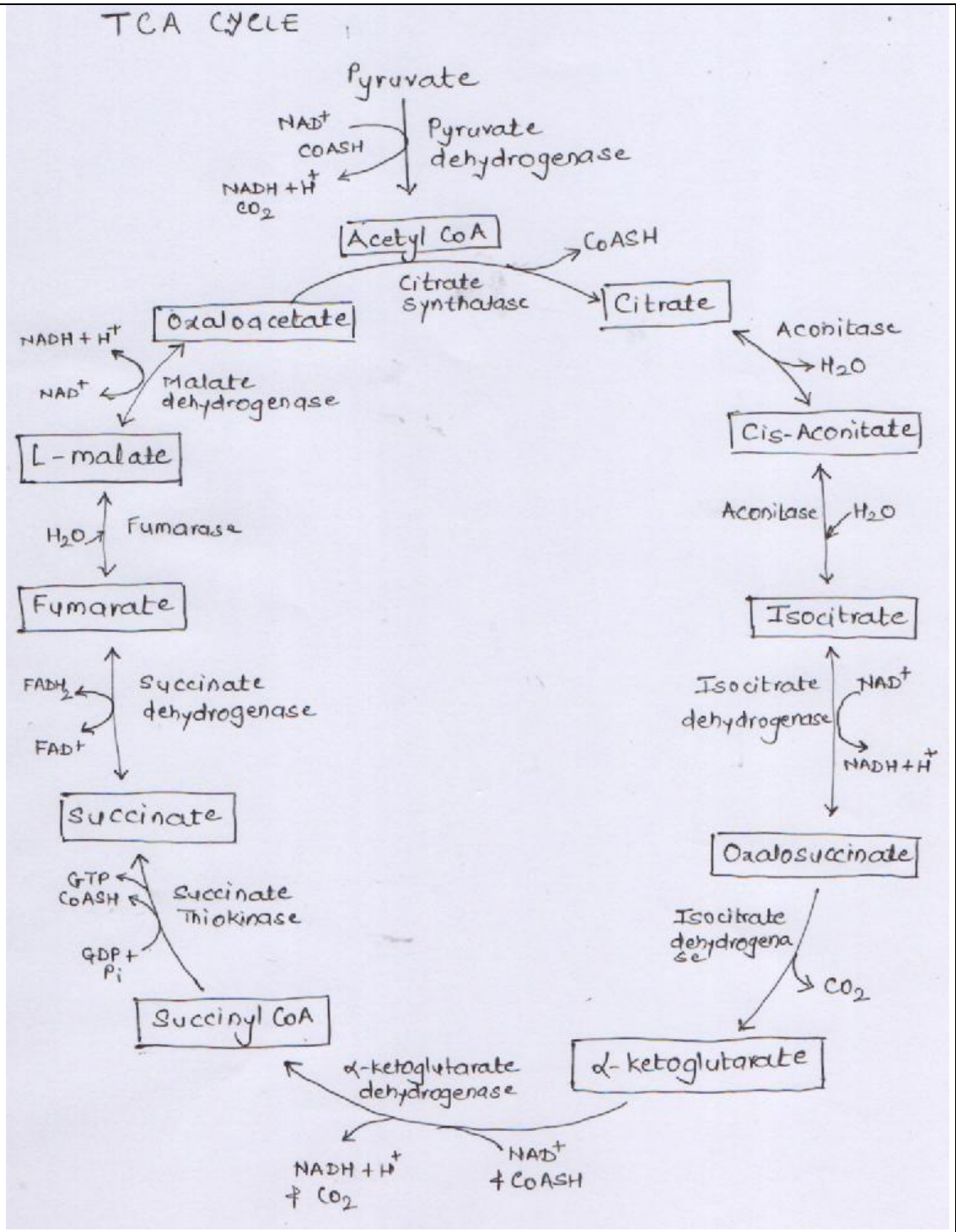

$CO_2 + NH_4 + H_2O$
MITOCHONDRIA
Carbamoyl Phosphate Synthetase
2ATP
2ADP + Pi + 3H+
Carbamoyl Phosphate
Pi
Ornithin Transcarbamoylase
Ornithin
Citrulline
CYTOPLASM
Ornithin
Citrulline
Urea
Arginase
H2O
Arginine
Argininosuccinate Synthetase
Aspartate
Arginosuccinase
Argininosuccinate
TCA Cycle
Oxaloacetate
Fumarate
Malate

6	**c)**	**Explain in brief reactions involved in "β-oxidation of fatty acids".** **(Detailed diagrammatic representation can be considered for full marks)** Beta oxidation is the main pathway used to liberate energy by oxidation of fatty acid It takes place in the beta carbon of fatty acid with removal of 2 carbons at a time from the carboxyl end of the molecule. The process repeats itself until the fatty acid with even number of carbon is completely converted to acetate molecules. Fatty acid containing even & odd number of carbon atoms as well as unsaturated fatty acids are oxidised by beta oxidation. It takes place in 5 steps in mitochondria of liver. 1. Activation of fatty acid. Long chain fatty acid gets activated to fatty acyl CoA in presence of CoASH, thiokinase&ATP 2. Fatty acylCoA undergoes dehydrogenation in presence of acyl CoA dehydrogenase &FAD to give alpha,beta unsaturated fatty acyl CoA 3. Addition of water molecule across the double bond results into formation of Beta hydroxy acyl CoA in presence of Enoyl CoA dehydratase 4. Hydroxyl group of Beta hydroxy acyl CoA gets oxidised to keto group forming Beta keto acyl CoA in presence of Beta hydroxy acyl CoA dehydrogenase & NAD+ 5. Thiolytic cleavage of acyl CoA takes place in presence of Beta keto acyl CoA Thiolase&CoASH. Acyl CoA thus formed contains 2 Carbons less than original acyl CoA which undergoes further oxidation by Beta-oxidation. Acetyl CoA is also formed which enters TCA cycle.	**4M**


β- Oxidation of Fatty Acids :
R- CH2 - CH2 - CH2 - C(=O) - O⁻
Fatty acid
ATP
Mg2+
CoASH
Thiokinase
In Cytosol
AMP + PPi
R-CH2 - CH2 - CH2 - C(=O) ~ S CoA
Acyl CoA
FAD
Acyl CoA dehydrogenase
In Mitochondria
FADH2
R- CH2 - CH = CH - C(=O) - S CoA
Acyl enoyl CoA
H2O
Enoyl CoA hydratase
R- CH2 - CH(OH) - CH2 - C(=O) - S CoA
β-hydroxy acyl CoA
NAD+
β-hydroxy acyl CoA dehydrogenase
NADH + H+
R- CH2 - C(=O) - CH2 - C(=O) - S CoA
β Keto acyl CoA
CoASH
Thiolase
R- CH2 - C(=O) - S CoA + CH3 - C(=O) - S CoA
Acyl CoA short by 2 carbon atoms
Acetyl CoA

6	**d)**	**Explain "Denaturation of Proteins"** Denaturation: • The phenomenon of disorganization of native protein structure is known as denaturation. • It results in loss of secondary, tertiary & quaternary structure of proteins. • This involves change in physical ,chemical& biological properties of protein molecules. Agents of denaturation: • Physical: Heat, violent shaking, X-rays, UV radiation. • Chemical: acids, alkalis, organic solvents, heavy metal salts etc. Characteristics of denaturation: • Helical structure is lost • Primary structure with peptide linkages remains intact.(Peptide bonds are not hydrolyzed) • Biological activity of protein is lost • Denatured protein is insoluble	**4M (Definition-1M and Explanation-3M)**
6	**e)**	**Explain in detail "Kreb's Cycle"** **(Detailed diagrammatic representation can be considered for full marks)** Kreb's cycle: It's a central pathway for release of energy from acetyl CoA whch is produced from glycolysis, catabolism of fatty acids or amino acids 1. Condensation of acetylCoA obtained from pyruvic acid with oxaloacetate to form citric acid in presence of citrate synthatase	**4M**

		2. Conversion of citric acid to cis aconitate in presence of aconitase&fe2+ 3. Cis acotinic acid accepts water to give isocitric acid in presence of acotinase& Fe2 4. Isocitric acid undergoes oxidation in presence of isocitric dehydrogenase & NAD+ to give Oxalosuccinic acid 5. Decarboxylation of oxalosucccinic acid to alpha ketoglutaric acid in presence of isocitri dehydrogenase, Mg/ Mn 6. Oxidative decarboxylation of alpha ketoglutaric acid to succinyl CoA in presence of alpha ketoglutarate dehydrogenase, CoA-SH, NAD+, Mg 7. SuccinylCoa gets converted to succinic acid in presence of succinate thiokinase, GDP, Mg 8. Succinic acid undergoes dehydrogenation in presence of succcinate dehydrogenase, FAD+ to form fumaric acid 9. Fumaric acid takes up water molecule in presence of fumarase to form maleic acid 10. Maleic acid undergoes oxidation in presence of malate dehydrogenase, NAD+ to form oxaloacetic acid. 11. Cycle gets repeated again by entrance of another molecule of Acetyl CoA8.	


TCA CYCLE
Pyruvate
NAD+
COASH
NADH + H+
CO2
Pyruvate dehydrogenase
Acetyl CoA
CoASH
Citrate synthatase
Citrate
Oxaloacetate
NADH + H+
NAD+
Malate dehydrogenase
Aconitase
H2O
Cis-Aconitate
L-malate
Aconitase
H2O
H2O
Fumarase
Fumarate
Isocitrate
FADH2
FAD+
Succinate dehydrogenase
Isocitrate dehydrogenase
NAD+
NADH + H+
Succinate
Oxalosuccinate
GTP
COASH
GDP + Pi
Succinate Thiokinase
Isocitrate dehydrogenase
CO2
Succinyl CoA
α-ketoglutarate
α-ketoglutarate dehydrogenase
NADH + H+
+ CO2
NAD+
+ COASH

6	**f)**	**Define enzymes. Classify them on the basis of type of reaction catalyzed by them.** **Definition:** Highly specific proteinous substances that are synthesized in a living cell &catalyze or speed up the thermodynamically possible reactions necessary for their existence. **Classification:** • Oxidoreductases : They bring about biological oxidation & reduction between two substrates. e.g ; Dehydrogenases, Oxidases, Hydroperoxidases, Oxygenases, Hydroxylases • Transferases : Catalyse transfer of some group or radical from one molecule to another. E.g.Transaminases, Transphosphorylases, Transglycosidases • Hydrolases: Bring about hydrolysis or condensation of substrate by addition or removal of water. Eg.Esterases, Peptidases • Lysases: Catalyse removal of groups from larger substrates by mechanisms other than hydrolysis, leaving double bonds. e.g. Carboxylysases, Aldehydelysases	**4M (Definition-1M and Classification -1,5M and Examples 1.5M)**

		• Isomerases: Catalyze interconversion of isomers. eg. Dextrose isomerase. • Ligases/ Synthatases: Catalyse the linking or synthesizing together of 2 compounds.Forming C-S bonds, C-N bonds, C-C bonds. E.g: Lysases, Isomerases, Ligases / Synthatases.	