SUMMER– 2023 EXAMINATION

Model Answer – Only for the Use of RAC Assessors

Subject Title: BIOCHEMISTRY & CLINICAL PATHOLOGY **Subject Code**: **20223**

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 the 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, the 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 any equivalent 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.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

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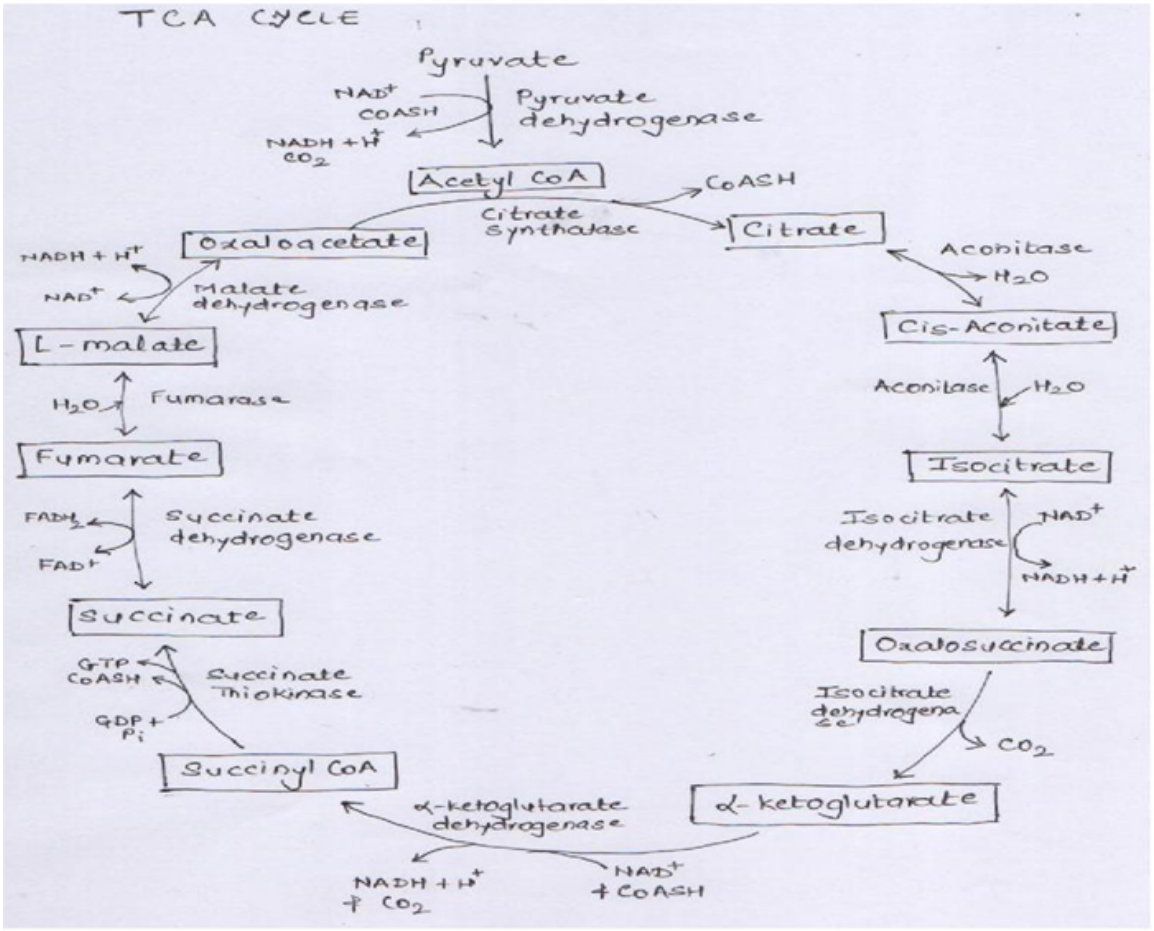
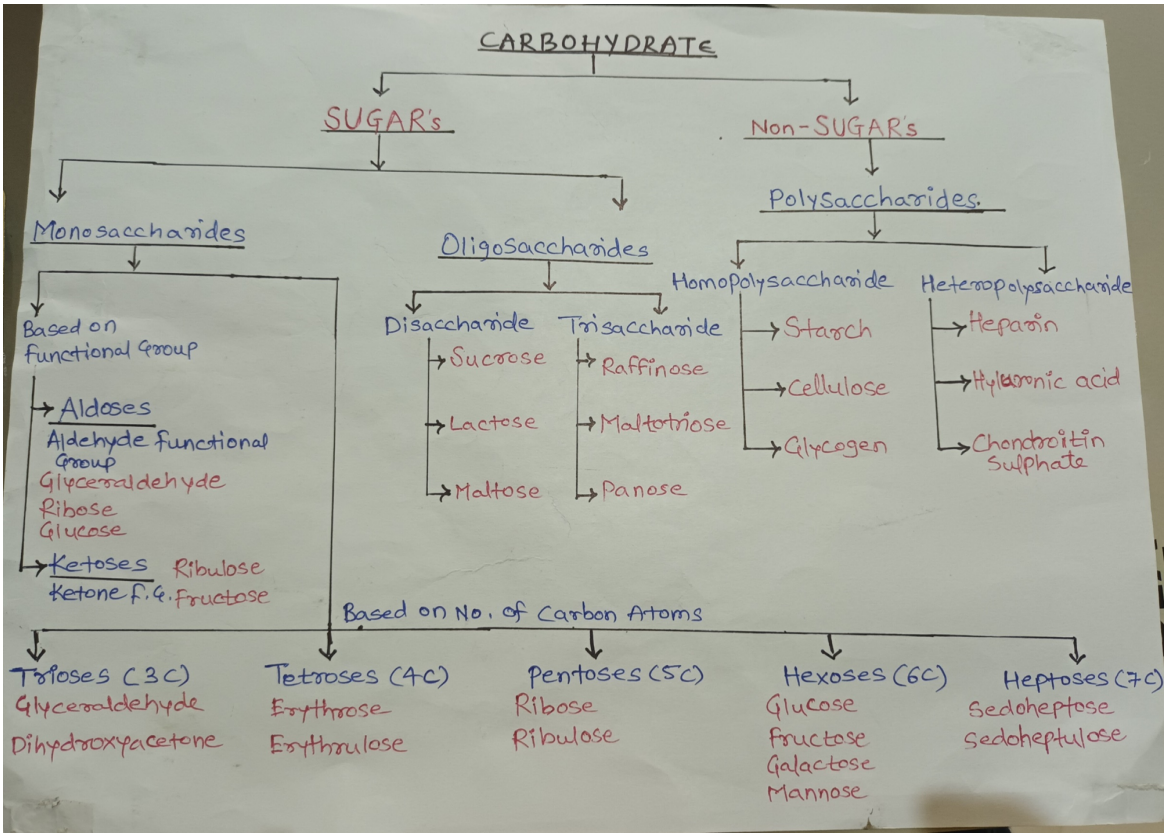
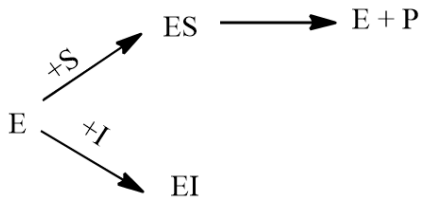
Q. No.	Sub No.	Answers	Marking Scheme
1		**Attempt any SIX of the following:**	**30M**
1	a	**Discuss TCA cycle along with its energetics.** **Marking Scheme: 4M for Cycle or detailed explanation , 1M Energetics** **Answer:**  **Tricarboxylic acid Cycle (TCA Cycle) / Kreb's Cycle:** It's a central pathway for release of energy from acetyl CoA which is produced from glycolysis, catabolism of fatty acids or amino acids. 1. Condensation of acetyl CoA obtained from pyruvic acid/pyruvate with oxaloacetate to form citric acid in presence of citrate synthase.	**5M**

<table>
<tr><th>Q. No.</th><th>Sub No.</th><th>Answers</th><th>Marking Scheme</th></tr>
<tr><td></td><td></td><td>
2. Conversion of citric acid/citrate to cis aconitate in presence of aconitase & $Fe2^{+}$.Cis aconitic acid/aconitate accepts water to give isocitric acid/isocitrate in presence of aconitase & $Fe2^{+}$.
3. Isocitric acid/isocitrate undergoes oxidation in presence of isocitrate dehydrogenase & NAD^{+} to give Oxalosuccinic acid/oxalosuccinate.
5. Decarboxylation of oxalosuccinic acid/oxalosuccinate to alpha ketoglutaric acid/alpha ketoglutarate in presence of isocitric acid dehydrogenase, Mg/ Mn.
6. Oxidative decarboxylation of alpha ketoglutaric acid/alpha ketoglutarate to succinyl CoA in presence of alpha ketoglutarate dehydrogenase, CoA-SH, NAD^{+}, Mg.
7. Succinyl CoA gets converted to succinic acid/succinate in presence of succinate thiokinase/succinyl CoA synthetase, GDP, Mg.
8. Succinic acid/succinate undergoes dehydrogenation in presence of succcinate dehydrogenase, FAD^{+} to form fumaric acid/fumarate.
9. Fumaric acid/fumarate takes up water molecule in presence of fumarase to form maleic acid/malate.
10. Maleic acid/malate undergoes oxidation in presence of malate dehydrogenase, NAD^{+} to form oxaloacetic acid/oxaloacetate.
11. Cycle gets repeated again by the entrance of another molecule of Acetyl CoA.

<u>Energetics of TCA cycle:</u>
<table>
<tr><th>Reactions</th><th>No. of ATP formed</th></tr>
<tr><td>Isocitrate to oxalosuccinate</td><td>3</td></tr>
<tr><td>Alpha ketoglutarate to succinyl Co-A</td><td>3</td></tr>
<tr><td>Succinyl Co-A to Succinate</td><td>1</td></tr>
<tr><td>Succinate to Fumarate</td><td>2</td></tr>
<tr><td>Malate to oxaloacetate</td><td>3</td></tr>
<tr><td>Total</td><td>12 ATP</td></tr>
</table>
</td><td></td></tr>
<tr><td>1</td><td>b</td><td>What are carbohydrates? Classify them with suitable examples.
Marking Scheme: 1.5 M explanation , 3.5 M Classification with examples</td><td>5M</td></tr>
</table>

Q. No.	Sub No.	Answers	Marking Scheme
		Answer: Carbohydrates may be defined as polyhydroxy aldehydes or ketones or compounds which produce them on hydrolysis. Carbohydrates are essential biomolecules consisting of carbon, hydrogen & oxygen & are known as hydrates of carbon. Chemically, they are polyhydroxy alcohols with aldehyde or ketone as functional groups. Carbohydrates are broadly classified into; A) Sugars & B) Non-Sugars Sugar type of Carbohydrates are further classified as mentioned below- **I) Monosaccharides** are the simplest group of carbohydrates and are often referred to as simple sugars. •They have general formula CnH2nOn and they cannot be further hydrolysed. •They are further classified as- **A) On basis of functional groups:** **i) Aldoses:** when the functional group of monosaccharides is an aldehyde they are known as aldoses. E.g. Glyceraldehyde, glucose. **ii) Ketoses**: when the functional group of monosaccharides is a ketone they are known as ketoses eg. Fructose **B) On basis of number of carbon atoms-** •**Trioses** -three carbon atoms e.g.- glyceraldehyde •**Tetroses**- four carbon atoms e.g. Erythrose, erythrulose. •**Pentoses**- five carbon atoms e.g. Ribose, ribulose. •**Hexoses**- six carbon atoms e.g. Glucose, fructose, galactose, mannose, etc. •**Heptoses**- seven carbon atoms e.g. Sedoheptose, sedoheptulose. **II) Oligosaccharides** contain two to ten monosaccharide molecules. Based on the number of monosaccharide units present, the oligosaccharides are further subdivided into: **i. Disaccharide**- class of oligosaccharide consisting of two monosaccharide units. eg. ***Sucrose*** (glucose+ fructose), ***lactose*** (galactose + glucose) , ***maltose*** (glucose + glucose).	

Q. No.	Sub No.	Answers	Marking Scheme
		ii. Trisaccharide- class of oligosaccharide consisting of three monosaccharide units. E.g. ***Raffinose*** (three galactose sugar units), ***maltotriose*** (three glucose sugar units). **III) Non sugars (Polysaccharides)** are the polymers of monosaccharide units with higher molecular weight held together by glycosidic bonds. Polysaccharides are of two types: ***i) Homopolysaccharide*** - these on hydrolysis yield only a single type of monosaccharide unit. E.g.- ***Starch, cellulose, glycogen etc*** ***ii) Heteropolysaccharide*** - these on hydrolysis yield a mixture of few monosaccharides or their derivatives unit. E.g.- Hyaluronic acid, heparin, chondroitin sulphate etc. OR **Schematic classification of Carbohydrates can be considered**  	
1	**c**	**What is enzyme inhibition? Explain competitive and Non-competitive inhibition.**	**5M**

Q. No.	Sub No.	Answers	Marking Scheme
		Marking Scheme: 1M definition, 2M competitive inhibition & 2M Non-competitive inhibition **Answer:** •Enzyme inhibition is defined as a process wherein a substance binds with the enzyme and brings about a decrease in catalytic activity of that enzyme. The inhibitor binds noncovalently with the enzyme and the enzyme inhibition can be reversed if the inhibitor is removed. There are 3 broad categories of enzyme inhibition- •Reversible inhibition(Competitive & non-competitive) •Irreversible inhibition •Allosteric inhibition The reversible inhibition is further subdivided into; I. Competitive inhibition II. Non-competitive inhibition **<u>Competitive Inhibition:</u>** •The inhibitor (I) which closely resembles the real substrate (S) is regarded as a substrate analogue. •The inhibitor competes with substrate and binds at the active site of the enzyme but does not undergo any catalysis. •As long as the competitive inhibitor holds the active site, the enzyme is not available for the substrate to bind. •During the reaction, ES and EI complexes are formed as shown below;  •The relative concentration of the substrate and inhibitor and their respective affinity with the enzyme determines the degree of competitive inhibition. •The inhibition could be overcome by a high substrate concentration.	

Q. No.	Sub No.	Answers	Marking Scheme

Enzyme	Substrate	Inhibitor	Significance
Monoamine oxidase	Catecholamines	Ephedrine, Amphetamine	Elevates catecholamine level
Dihydrofolate reductase	Dihydrofolic acid	Methotrexate	Treatment of cancers
Acetylcholine esterase	Acetylcholine	Succinylcholine	Muscle relaxant in surgery
HMG CoA reductase	HMG CoA	lovastatin	inhibit cholesterol synthesis

Non-competitive Inhibition:

•The inhibitor binds at a site other than the active site on the enzyme surface. This binding impairs the enzyme function.

•The inhibitor has no structural resemblance with the substrate.

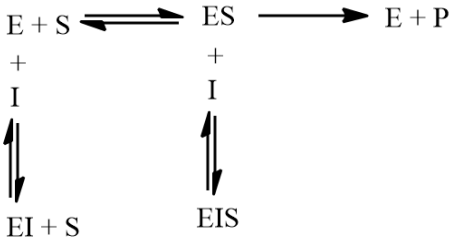
•However, there usually exists a strong affinity for the inhibitor to bind at the second site.

•In fact, the inhibitor does not interfere with the enzyme-substrate binding.

•But the catalysis is prevented, possibly due to a distortion in the enzyme conformation.

•The inhibitor generally binds with the enzyme as well as the ES complex.

•The overall relation in non-competitive inhibition is represented below;



Drug	Enzyme inhibited	Significance
Disulfiram	Alcohol dehydrogenase	treats chronic alcoholism
Isocarboxazid	Monoamine oxidase	treats depression
Digoxin	Na+/K+ ATPase	cardiotonic

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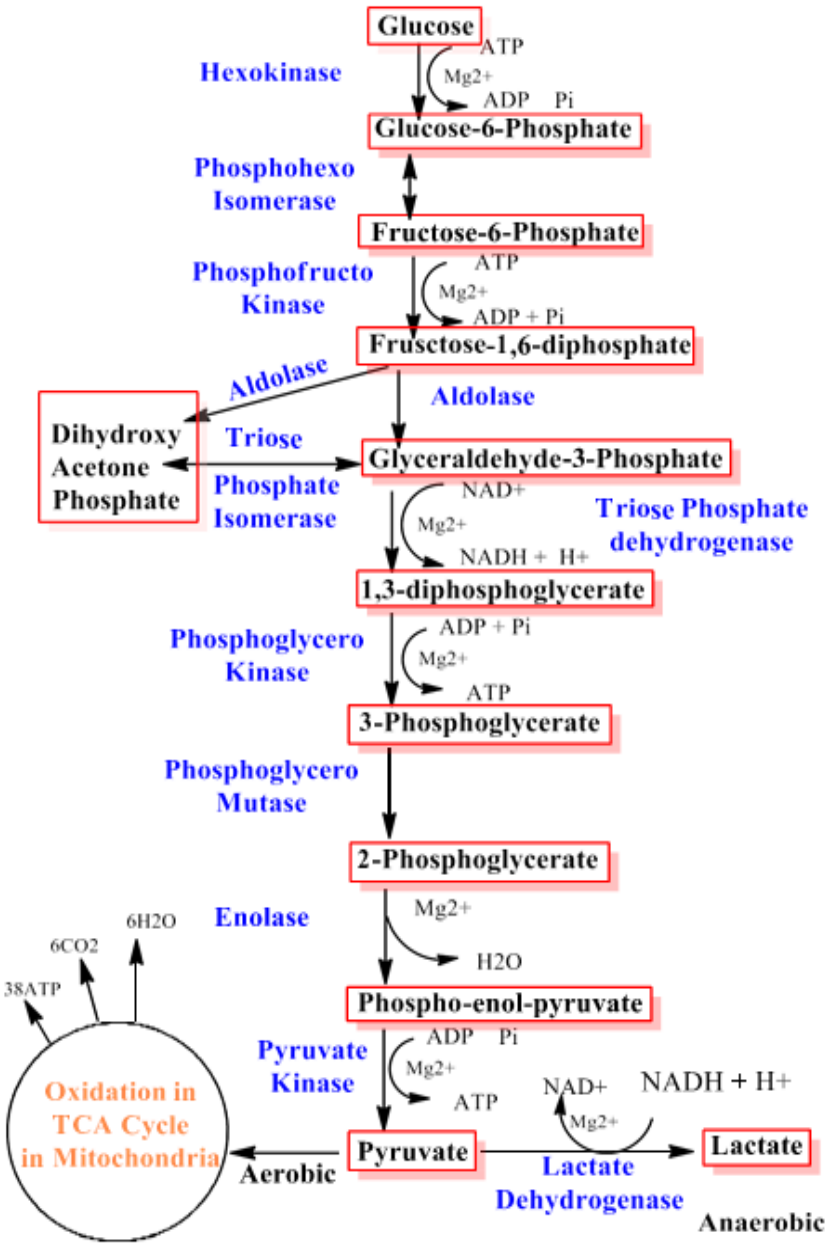
Q. No.	Sub No.	Answers	Marking Scheme
1	d	**What is the Embden-Meyerhof pathway? Discuss various stages of the pathway.** **Marking Scheme: 1M explanation, 4M stages of pathway OR Detailed diagrammatic representation can be considered** **Answer:** **Glycolysis** or **Embden-Meyerhof pathway** is the sequence of reactions converting glucose (or glycogen) to pyruvate or lactate, with the production of ATP. It takes place in all cells of the body. **the various stages of the pathway are-** 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 phosphohexose 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 dihydroxyacetone 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 in the formation of phosphoenol pyruvic acid in presence of enolase. 9. Loss of phosphate from phosphoenol pyruvic acid results in 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.	5M

Q. No.	Sub No.	Answers	Marking Scheme
		11. Keto pyruvic acid under aerobic conditions enters the TCA cycle in mitochondria. Pyruvic acid forms the main end product of glycolysis in those tissues which are supplied with sufficient Oxygen. 12. But in tissues where oxygen is not supplied, lactic acid is formed as an end product of glycolysis by reduction in presence of lactate dehydrogenase & NADH.	



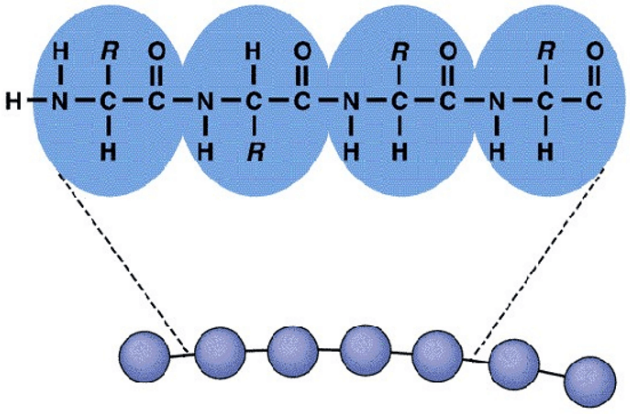
1	e	**Explain Primary and Secondary structure of protein.** **Marking Scheme: 2M Primary structure , 3M Secondary structure.** **Answer:**	**5M**

Primary structure of proteins:

- The primary structure of protein is referred mainly to the number, nature and the sequence of amino acids along the polypeptide chains.
- This sequence determines the further levels of organization of the protein molecule.
- The linear sequence of amino acid residue in a polypeptide chain is called the Primary structure of protein.
- While representing the primary structure;

a) The N-terminal amino acid i.e. the amino acid with either free amino group, is always on the left end of the polypeptide chain and

b) The C-terminal amino acid i.e. amino acid with free –COOH group, at the right end of the chain.



Secondary structure of proteins:

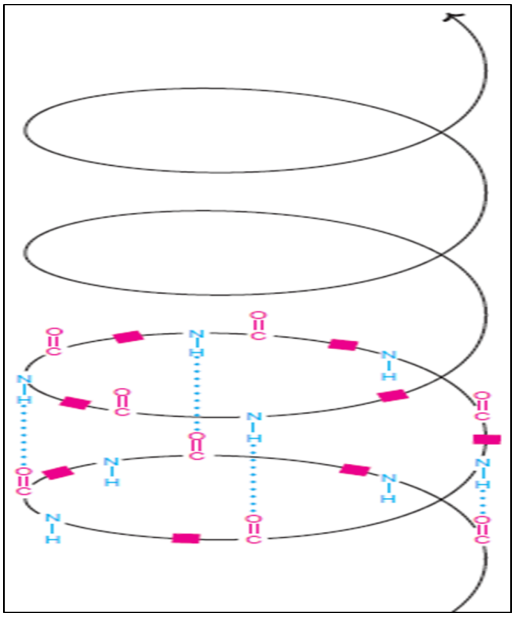
- The conformation of polypeptide chain by twisting or folding is referred to as Secondary structure of protein:
- The folding of the chain is mainly due to the presence of hydrogen bonds between amino groups and carboxyl groups of the peptide bond.
- Two types of secondary structure are likely: **(i) α- helix (ii) β-pleated sheet**

i) α- helix (α- helical)

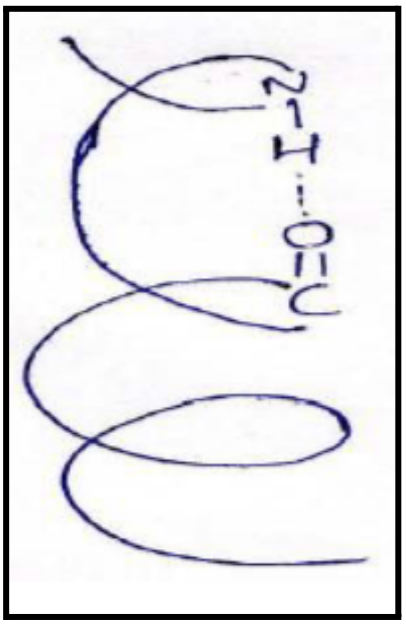
- The α helical is the most common spiral structure of protein.
- It has a rigid arrangement of polypeptide chains.

Q. No.	Sub No.	Answers	Marking Scheme

- The α - helical structure depends on the intramolecular hydrogen bonding between **NH** and **C=O** group of peptide bonds.
- In the α - helix the polypeptide is folded in such a way that the C=O of each amino acid residue is hydrogen bonded to the NH of 4th amino acid residue along the chain.



OR



(ii) β-pleated sheet: It is another form of secondary structure, this result from hydrogen bonding between two peptide chains. It may occur in two types

a) Parallel pleated sheet:

- In this type of structure the polypeptide chain is side by side and in the same direction so that N-terminal residues are on the same end.
- This pleated sheet conformation is stabilized by hydrogen bonding, here bonds are formed between the NH group of a peptide in one chain and C=O group of a neighboring chain.

b) Anti- parallel pleated sheet:

- In this type of structure the polypeptide chain lies in opposite directions so that the N-terminal end of one and the C- terminal of the other, face each other.
- In this structure the polypeptide chains are held together by hydrogen bonds, so as to give a sheet like structure and hence are called as β – pleated sheet conformation.

SUMMER– 2023 EXAMINATION

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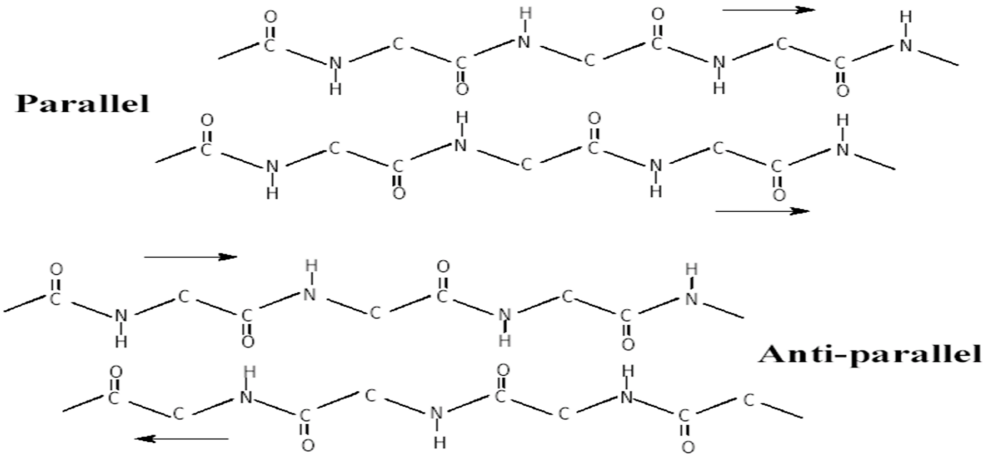
Q. No.	Sub No.	Answers	Marking Scheme
		 ***Other correct representations can also be considered.***	
1	f	**Explain routinely performed tests to assess the functions of the kidney.** **Marking Scheme: 1M enlist, 4M detailed explanation** **Answer:** •The kidney function tests may be divided into four groups. **1. Glomerular function tests :** •All the clearance tests (inulin, creatinine, urea) are included in this group. **2. Tubular function tests :** •Urine concentration or dilution test, urine acidification test. **3. Analysis of blood/serum :** •Estimation of blood urea, serum creatinine, protein and electrolyte are often useful to assess renal function. **4. Urine examination :** •Simple routine examination of urine for volume, pH, specific gravity, osmolality and presence of certain abnormal constituents (proteins, blood, ketone bodies, glucose etc.) also helps to assess kidney functioning.	**5M**

Q. No.	Sub No.	Answers	Marking Scheme
		A) The clearance tests •The clearance tests, measuring the glomerular filtration rate (GFR) are the most useful in assessing the renal function. •Clearance, in general, is defined as the volume of plasma that would be completely cleared of a substance per minute. •**Creatinine Clearance test:** •Creatinine is an excretory product derived from creatine phosphate (largely present in muscle). •Creatinine clearance may be defined as the volume (ml) of plasma that would be completely cleared of creatinine per minute. •Creatinine concentration in urine and plasma should be expressed in the units as mg/dl or mmol/l. •**Reference values :**The normal range of creatinine clearance is around **120-145 ml/min**. These values are slightly lower in women. •**Diagnostic importance :** •A decrease in creatinine clearance value (< 75% normal) serves as a sensitive indicator of a decreased GFR, due to renal damage. •This test is useful for an early detection of impairment in kidney function, often before the clinical manifestations are seen. •**Urea Clearance test:** •Urea is the end product of protein metabolism. •After being filtered by the glomeruli, it is partially reabsorbed by the renal tubules. •Hence, urea clearance is less than the GFR and, further, it is influenced by the protein content of the diet. •For these reasons, urea clearance is not as sensitive as creatinine clearance for assessing renal function. **Diagnostic importance :**	

Q. No.	Sub No.	Answers	Marking Scheme
		•A urea clearance value below 75% of the normal is viewed seriously, since it is an indicator of renal damage. •Blood urea level as such is found to increase only when the clearance falls below 50% normal. **B) Urine concentration test:** •This is a test to assess the renal tubular function. •It is a simple test and involves the accurate measurement of specific gravity which depends on the concentration of solutes in urine. •A specific gravity of 1.020 in the early morning urine sample is considered to be normal. •Several measures are employed to concentrate urine and measure the specific gravity. •These include overnight water deprivation and administration of antidiuretic hormone. •If the specific gravity of urine is above 1.020 for at least one of the samples collected, the tubular function is considered to be normal. **C) Analysis of Blood or Serum:** •Estimation of serum creatinine and blood urea are often used to assess the overall kidney function, although these tests are less sensitive than the clearance tests. •Serum creatinine is a better indicator than urea in this regard. **D) Urine examination:** •The routine urine examination is a guiding factor for renal function. •The volume of urine excreted, its pH, specific gravity, osmolality, the concentration of abnormal constituents (such as proteins, ketone bodies, glucose and blood) may help to have some preliminary knowledge of kidney function.	

1	g	**Discuss in brief about B-oxidation of fatty acids.** **Marking Scheme: 5M stages of pathway OR Detailed diagrammatic representation can be considered for full marks** **Answer:** • 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 an even number of carbon is completely converted to acetate molecules. •Fatty acids 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 the mitochondria of the liver. ***1. Activation of fatty acid:*** •Long chain fatty acid gets activated to fatty acyl CoA in presence of CoASH, thiokinase & ATP ***2. Desaturation:*** •Fatty acyl CoA undergoes dehydrogenation in presence of acyl CoA dehydrogenase & FAD to give alpha, beta unsaturated fatty acyl CoA ***3. Hydration:*** •Addition of water molecule across the double bond results into formation of Beta hydroxy acyl CoA in presence of Enoyl CoA hydratase ***4. Oxidation:*** •Hydroxyl group of Beta hydroxy acyl CoA gets oxidised to keto group forming Beta ketoacyl CoA in presence of Beta hydroxy acyl CoA dehydrogenase & NAD^+ ***5. Thiolytic cleavage:*** •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 the TCA cycle.	**5M**

SUMMER– 2023 EXAMINATION

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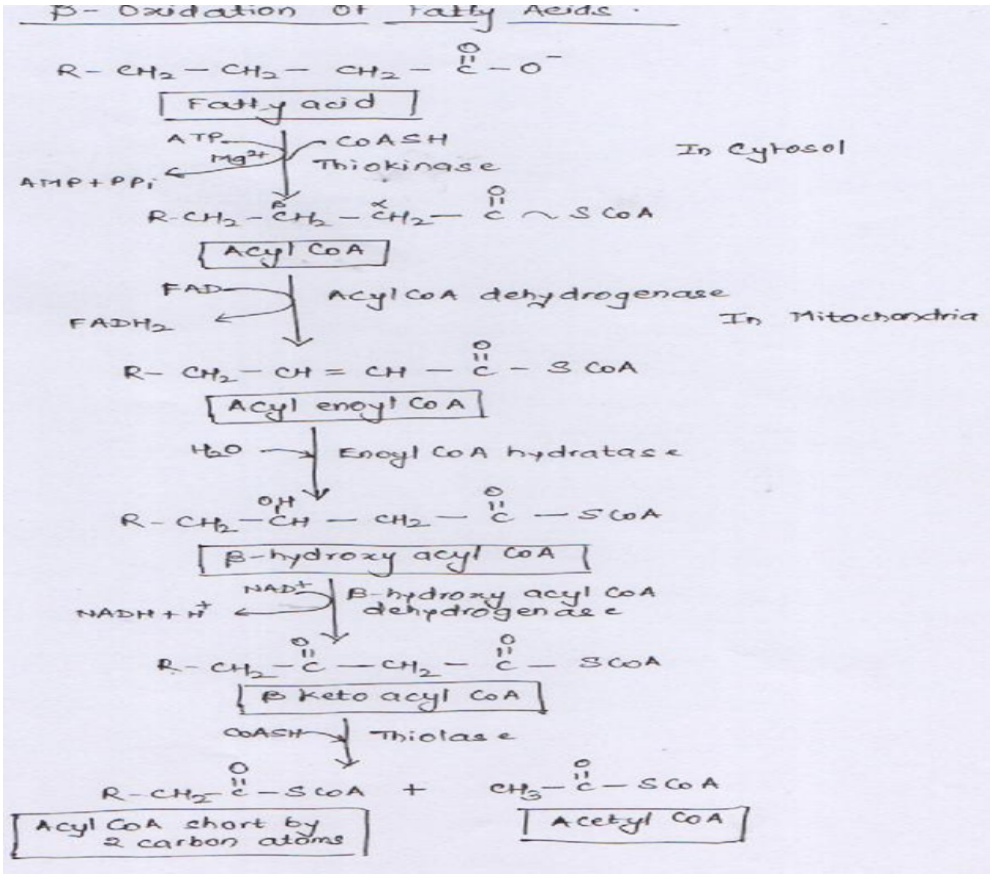
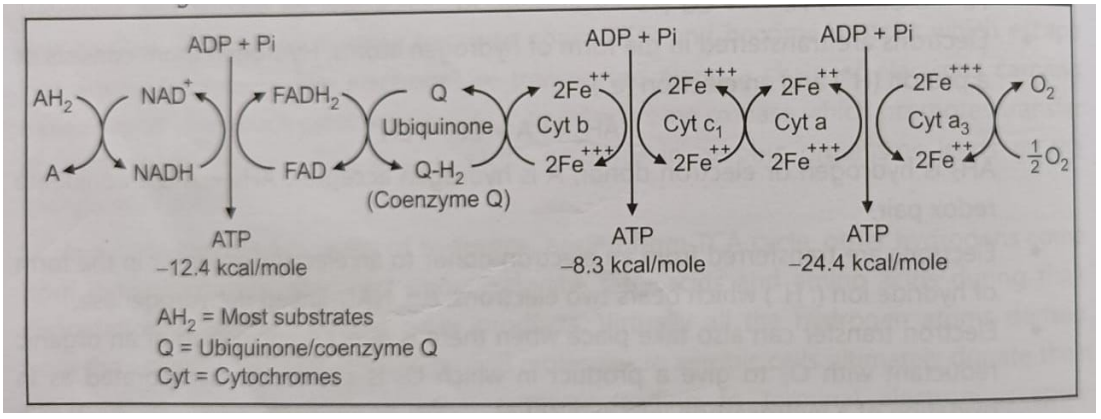
		 ***Any other representations can be considered***	
2		**Attempt any TEN of the following**	**30 M**
2	**a**	**Write biological role, deficiency condition and symptoms of vitamin C.** **Marking Scheme: Biological role any two (1M), deficiency condition (1M) and symptoms any two (1M).** **Answer:** **Biological role of Vitamin C:(any 2 for 1 mark)** 1. It is involved in the oxidation-reduction reactions of the cells, since it undergoes reversible oxidation. 2. It is involved in the conversion of folic acid to folinic acid. 3. It is also involved in the hydroxylation of steroids in the adrenal cortex. 4. It is required in the metabolism of tyrosine , phenylalanine and tryptophan..	**3M**

Q. No.	Sub No.	Answers	Marking Scheme
		5. It is required for the absorption of iron and incorporation of plasma iron in ferritin. 6. It is involved in the formation of nor-epinephrine. 7. It requires in the normal regulation of the colloidal conditions of fibrils and collagen of connective tissues, osteoid tissues, dentine. etc. 8. It is required for the hydroxylation of proline and hydroxyproline. **Deficiency condition of Vitamin C:** Scurvy. **Deficiency conditions symptoms of Vitamin C:** 1. Weakness, fatigue, restlessness, shortness of breath, anemia and susceptibility to infection. 2. Pain in the bones, joints, muscles of the extremities, swelling of long bones. 3. Loosening of the teeth, gums become swollen, blue red, spongy, bleeding from gums. 4. Poor healing of wounds, internal haemorrhage; etc.	
2	**b**	**Explain the process of ETC.** **Marking Scheme: Explanation of process of ETC (3M).** **Answer:** The respiration chain or electron transport chain (ETC): 1. During biological oxidation of substances, like carbohydrates, fatty acids and amino acids, most of the energy is evolved which is trapped in the form of ATP. Thus, ETC principally takes place in biological oxidation and oxidative phosphorylation. 2. The sequence of enzymes and carriers responsible for the transport of reducing equivalents from substrate to molecular oxygen is described as the respiratory chain. 3. It takes place in mitochondria and the energy formed is also stored there itself in the form of ATP. 4. The mitochondria contain a series of catalysts which are concerned with transport of reducing equivalents i.e. hydrogen and electrons and with their final reaction with oxygen to form water.	**3M**

Q. No.	Sub No.	Answers	Marking Scheme

5. In the respiratory chain the electrons flow from more electronegative components to more electropositive oxygen. Thus, the redox potential of a component of a chain gives the information regarding position in the chain.
6. The respiratory chain in the mitochondria starts from the NAD-linked dehydrogenase system on one side through flavoproteins and cytochromes to molecular oxygen on the other side. The reducing equivalents are either as H^+ or covalent hydrogen.
7. One additional carrier is present in between flavoproteins and cytochrome b which is called cytochrome-b is said to be 'ubiquinone' or 'Co-Q' . Among the various cytochromes, Cytochrome b has the lowest redox potential.
8. The cytochromes are arranged in order of increasing redox potential. The terminal cytochrome a_3 is responsible for the final combination of reducing equivalent with molecular oxygen to form water.
9. At the electronegative end of the chain, dehydrogenase enzymes catalyze the transfer of electrons from the substrate to NAD of the chain. The reduced NAD is oxidized by the metallo flavoprotein enzyme - NADH dehydrogenase, with FMN as 'prosthetic group'.

The major components of respiratory chain are arranged in order of increasing redox potential as shown below:



2	C	**What are abnormalities of red cells? Explain.** **Marking Scheme: Enlist (1M), Explanation (2M for any four)** **Answer:** **(1) Anaemia:** **1.1. Pernicious anaemia.** **1.2. Sickle cell anaemia.** **1.3. Megaloblastic anemia.** **1.4. Iron-deficiency anemia.** **1.5. Aplastic anemia.** **1.6. Haemorrhagic anaemia.** **1.7. Hemolytic anemia.** **(2) Polycythemia:** **(1) Anaemia:** Anaemia is a condition in which the oxygen-carrying capacity of blood is reduced. Anaemia is characterized by decreased number of RBCs or decreased concentration of haemoglobin. Loss of haemoglobin or RBCs or both causes anemia. The symptoms are fatigue intolerance to cold, breathlessness, loss of appetite, pale skin. **Types of anaemia:** **(1.1) Pernicious anaemia:** Inability of the stomach to produce intrinsic factor which is required for absorption of vitamin B_{12} in the small intestine leads to insufficient hemopoiesis and this condition is called pernicious anaemia. **(1.2) Sickle cell anaemia:** It is also called sickle cell disease or haemoglobinopathic haemolytic anaemia. In this disease, the bone marrow produces an abnormal type of haemoglobin i.e., "S " type and forms sickle or crescent shaped cells (i.e., C shaped) when subjected to lowered oxygen concentrations. The sickle cells do not pass through the small blood capillaries readily and may block the blood supply to vital organs. Patients with sickle cell disease show a marked susceptibility to infections. **(1.3) Megaloblastic anaemia:** It is caused due to inadequate intake of vitamin B_{12} or folic acid. The red bone marrow produces large, abnormal red blood cells called megaloblasts. It may be caused due to some drugs which are used in the treatment of cancer.	**3M**

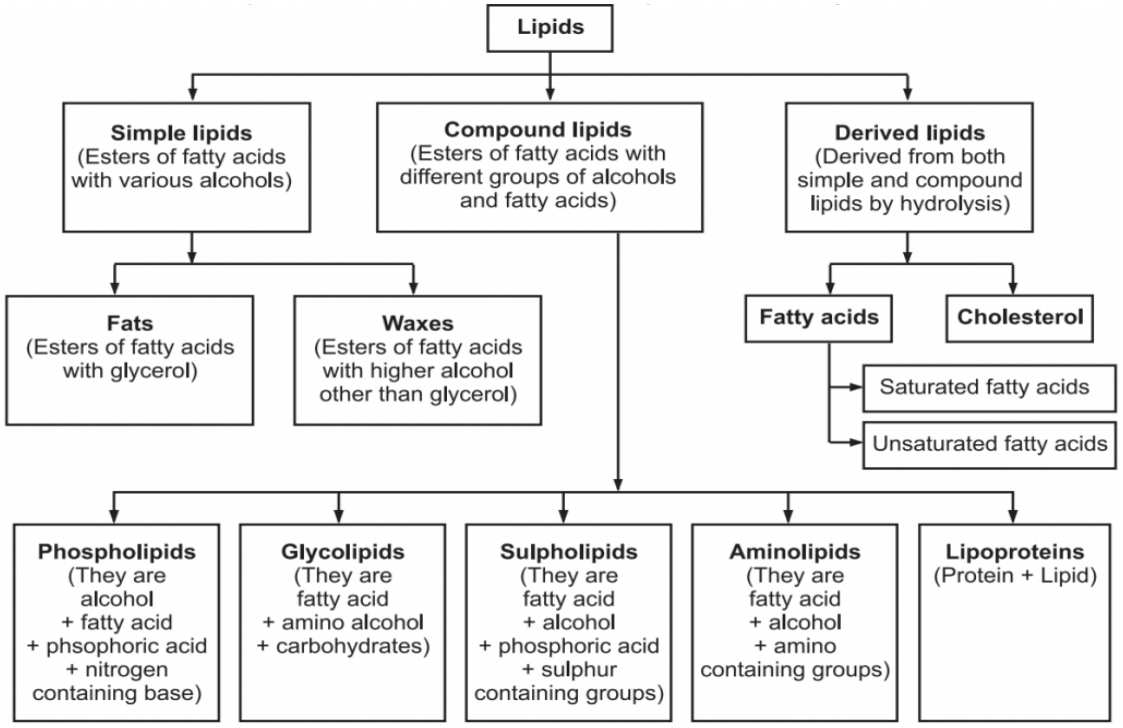
Q. No.	Sub No.	Answers	Marking Scheme
		(1.4) Iron-deficiency anemia: It is caused by inadequate absorption of iron, excessive loss of iron, increased iron requirement, or insufficient intake of iron. Women are at higher risk for this type of anaemia due to menstrual blood loss and increased iron demand during pregnancy**.** **(1.5) Aplastic anaemia:** Destruction of red bone marrow results in a condition called aplastic anaemia. It can be caused due to gamma radiation, toxins and some medications that inhibit enzymes required for haemopoiesis. **(1.6) Haemorrhagic anaemia:** Bleeding due to large wounds, stomach ulcers or heavy menstruation leads to excessive loss of RBCs. This condition is called haemorrhagic anaemia. **(1.7) Hemolytic anaemia:** In hemolytic anaemia, RBC plasma membranes rupture prematurely and the haemoglobin in RBCS is released in plasma which may damage glomeruli in kidneys. **(2) Polycythemia:** When concentration of red blood cells increases abnormally, usually with corresponding increase in haemoglobin level, the condition is called polycythemia. Polycythemia can be classified into two classes relative and absolute polycythemia.	
2	**d**	**What are lipids? Classify them with suitable examples.** **Marking Scheme: Definition (1), Classification (2M).** **Answer:** **Lipids:** Lipids are a heterogeneous group of compounds which are esters of fatty acids relatively insoluble in water but freely soluble in organic solvents like ether, chloroform, alcohol etc. **OR**	**3M**

Q. No.	Sub No.	Answers	Marking Scheme
		Lipids: These are organic compounds containing hydrogen, carbon, and oxygen atoms, which form the framework for the structure and function of living cells. **OR** **Lipids** may be regarded as organic substances relatively insoluble in water, soluble in organic solvents (alcohol, ether etc), actually or potentially related to fatty acids & utilized by the living cells. **Classification of lipids:** **Lipids are classified as follows:** **1. Simple lipids:** (i) Fats and oils (ii) Waxes **2. Compound lipids:** (i) Phospholipids: e.g., lecithins, cephalins, plasmalogens etc. (ii) Glycolipids: e.g., cerebrosides, gangliosides. (iii) Other compound lipids: e.g., Lipoproteins, Sulpholipids, Aminolipids, etc. **3. Derived lipids:** e.g., Fatty acids, Glycerols, Sterols, Sex hormones. prostaglandins, sphingolipids, etc.	

SUMMER– 2023 EXAMINATION

Model Answer – Only for the Use of RAC Assessors

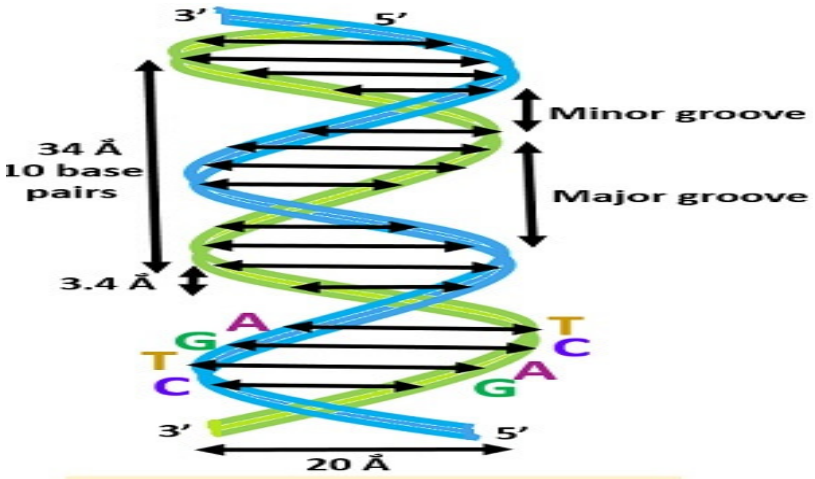
Subject Title: BIOCHEMISTRY & CLINICAL PATHOLOGY **Subject Code: 20223**

Q. No.	Sub No.	Answers	Marking Scheme
			
2	**e**	**Discuss the functions, deficiency and recommended dietary requirement of calcium.** **Marking Scheme: Any two functions (1), Any two deficiency diseases (1M) Recommended dietary requirement (1M).** **Answer:** **Functions of calcium:** 1. Calcium and phosphorus are essential for formation and development of bones and teeth. 2. Ionized calcium is required in the blood coagulation process. 3. It regulates the excitability of nerve fibres and nerve centres. Responsible for transmission of nerve impulse. 4. It is essential for muscular contraction. 5. It regulates permeability of membranes.	**3M**

Q. No.	Sub No.	Answers	Marking Scheme
		6. It is required for activation of several enzymes like succinate dehydrogenase. ATPase, and certain proteolytic enzymes. **Deficiency Diseases of calcium:** Hypoparathyroidism, Tetany, Rickets, Osteoporosis, Renal rickets etc. **Recommended Daily Requirements of Calcium:** 1. Adult males and females: 800 mg per day. 2. Women during pregnancy and lactation: 1.2 gm per day. 3. Children 1-18 years: 0.8-1.2 gm per day. Infants under 1 year: 360-540 mg per day.	
2	f	**Explain structure and functions of DNA.** **Marking Scheme: Structure of DNA (0.5 M for diagram, 1.5 marks explanation), Any two functions (1M)** **Answer:** **Structure of DNA (WATSON AND CRICK MODEL):** ● DNA is a double-stranded molecule. ● It is made of two helical chains or strands that are spirally coiled around a common axis to form a right-handed double helix like a twisted ladder. ● Each strand has two ends; 5' end with a phosphate group and 3' end with a hydroxyl group. The DNA strands run in opposite directions which means the 5'end of one chain and 3'end of another chain are on the same side, so they are antiparallel to each other. ● The diameter of DNA is uniform and is around 2 nm. ● The distance between each turn or the length of each spiral turn is 3.6 nm (earlier 3.4 nm). ● The distance between base pairs or two successive rings is 0.34 nm. ● There are 10.5 nucleotides per turn or in one complete spiral turn or one complete rotation of 360 degrees (earlier 10 nucleotides). ● The alternating deoxyribose sugar and phosphate groups are located on the outside of the double helix. So, it makes the backbone of the helix.	3M

Q. No.	Sub No.	Answers	Marking Scheme

- The spiral arrangement of chains creates major and minor grooves between the two chains or strands. The major groove is large, whereas the minor groove is small.
- Each DNA strand consists of a long sequence of four bases that include Adenine (A), Cytosine (C), Guanosine (G) and Thymine (T). The bases on one strand are bonded or paired with the complementary bases on the opposite strand.
- The alternating deoxyribose sugar and phosphate groups are located on the outside of the double helix. So, it makes the backbone of the helix.
- The pyrimidine (Thymine and Cytosine) and purine (Adenine and Guanine) bases are located inside the double helix.
- A specific purine base is bonded or made pair with a specific pyrimidine base through hydrogen bonds. For example, Adenine (A) pairs with Thymine (T) and Guanine (G) pairs with Cytosine (C).
- Adenine and Thymine are joined through two hydrogen bonds (A=T), whereas, Guanine and Cytosine are joined through three Hydrogen bonds (G≡C).
- The double helix structure is stabilized by hydrogen bonds that are formed between purine and pyrimidine bases.



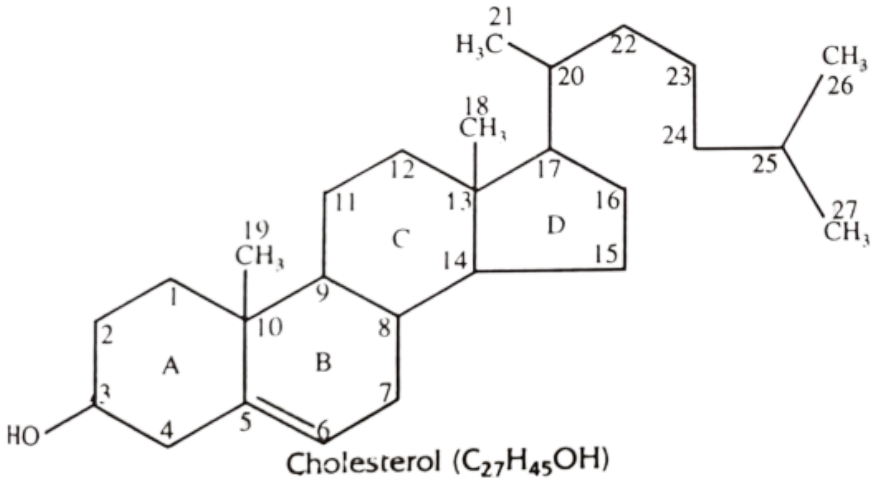
STRUCTURE OF DNA BY WATSON AND CRICK

Functions of DNA:

1. Genetic Information: DNA is the genetic material. It carries all hereditary information, coded in the arrangement of its nitrogen bases.

Q. No.	Sub No.	Answers	Marking Scheme
		2. Replication: DNA has a unique property of replication through which genetic information is transferred to one cell to its daughters and from one generation to the next. **3. Chromosomes:** DNA occurs inside chromosomes, essential for equitable distribution of DNA during cell division. **4. Recombination:** During meiosis, crossing over gives rise to new combinations of genes called recombinations. **5. Mutations:** Changes in sequence of nitrogen bases due to addition, deletion or wrong replication give rise to mutations which are responsible for variations and formation of new species. **6. Transcription:** DNA gives rise to RNAs through the process of transcription. **7. Cellular metabolism:** Cellular metabolism in a cell is controlled through the help of specific RNAs, synthesis of specific proteins, enzymes and hormones. **8. Differentiation**: Due to differential functioning of some specific regions of DNA or genes, different parts of organisms get differentiated in shape, size and functions. **9. Development:** DNA controls development of an organism through working of an internal genetic clock with or without the help of extrinsic information.	

2	g	**Define dehydration. Explain causes, symptoms and treatment of dehydration.** **Marking Scheme: Definition of dehydration & any one cause (1M), and any two symptoms (1M) and treatment of dehydration (1M).** **Answer:** **Dehydration:** It is a condition characterized by water depletion in the body. It may be due to loss of water alone or due to deprivation of water & electrolytes. **Causes of dehydration:** 1. Non-availability of water in certain areas. 2. Difficulty in swallowing, unconsciousness and impairment of the sensation of thirst. 3. Diabetes insipidus and diabetes mellitus conditions. 4. Chronic nephritis due to inability of tubule to concentrate urine. 5. Severe diarrhoea and vomitting. 6. Excessive sweating and loss of fluids from skin in burns. 7. Excessive loss of water through respiration on prolonged exposure to sun. **Symptoms of dehydration:** 1. Feeling thirsty, dark yellow and strong smelling pee. 2. Feeling dizzy or lightheaded. 3. Feeling tired. 4. A dry mouth, lips and eyes. 5. Peeling little, and fewer than 4 times a day.Increased pulse rate. **Treatment of dehydration:** 1. Intake of plenty of water. If a person can't take orally water, be given intravenously in an isotonic solution (5%glucose). 2. If dehydration is due to loss of electrolytes, then electrolytes can be given orally or intravenously. **ORS (Oral Rehydration Solution / Salts)** is a type of fluid replacement used to prevent or treat dehydration especially that is due to diarrhoea. 3. The Oral Rehydration therapy involves drinking water with modest amounts of sugar and salt added. Mild to moderate dehydration in children is best treated with ORT. 4. Persons taking ORT should eat within 6 hours and return to their full diet within 24–48 hours.	**3M**

Q. No.	Sub No.	Answers	Marking Scheme
		5. Oral rehydration therapy is commonly used to treat cholera & other diarrheal diseases.	
2	h	**Draw the structure of cholesterol and give functions of it.** **Marking Scheme: structure (1M) and any four functions (2M)** **Answer:** **Structure of cholesterol:**  Cholesterol ($C_{27}H_{45}OH$) **Functions of cholesterol:** 1. It is a structural component of cell membrane e.g.of red blood cells and in myelinated nerve cells. 2. It is an essential ingredient in the structure of lipoprotein. 3. It plays an essential role in secretion of several other vital enzymes and hormones including aldosterone, cortisol, estrogen, cortisone, progesterone, testosterone etc. 4. It plays an important role in the synthesis of vitamin-D3 which is responsible for proper bone calcification. 5. It acts as a precursor to fat-soluble vitamins A,D,E,K . 6. It regulates membrane fluidity over the range of physiological temperatures. 7. It is also helpful in the healing process after a surgery.	**3M**

Q. No.	Sub No.	Answers	Marking Scheme
		8. It helps in maintenance of our body temperature and protects our internal organs. 9. In pharmaceutical industries, cholesterol is used in the manufacture of steroid hormones and vitamin D. 10. It is a poor conductor of heat and electricity and serves as an insulator. In the brain, where it is present abundantly, it acts as an insulator against nerve impulses which are electric in nature. 11. Cholesterol, when oxidized under suitable conditions, undergoes rapid oxidation to form a ketone called cholestenone. 12. The hydroxyl group of cholesterol readily forms ester with fatty acids like stearic acid.	
2	**i**	**Enlist different abnormal constituents of urine.** **Marking Scheme: Any six constituents (3M)** **Answer:** **Abnormal constituents of urine:** 1. Proteins (Albumin, glycoproteins, globulins) 2. Blood (RBCs, haemoglobin, myoglobin) 3. Glucose & other sugars (e.g, galactose, lactose, fructose, pentose, maltose etc.) 4. Ketone bodies (e.g., Acetone, Acetoacetate, Beta Hydroxybutyric acid) 5. Bile pigment (bilirubin and urobilinogen) 6. Bile salts. 7. WBCs/Pus cells 8. Cast (Granular, hyaline, cellular & epithelial cast) 9. Bacterial microbes in urine 10. Yeast cells/parasites 11. Crystals (Amorphous urates, uric acid crystals, amorphous phosphates, amorphous carbonates, calcium oxalate etc.) 12. Porphyrins 13. Proteose.	**3M**
2	**j**	**Discuss in detail about Lipolysis.** **Marking Scheme: Lipolysis (3M)**	**3M**

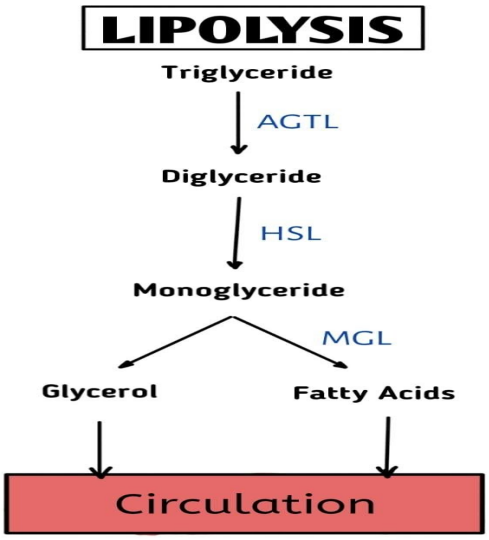
Q. No.	Sub No.	Answers	Marking Scheme

Answer:

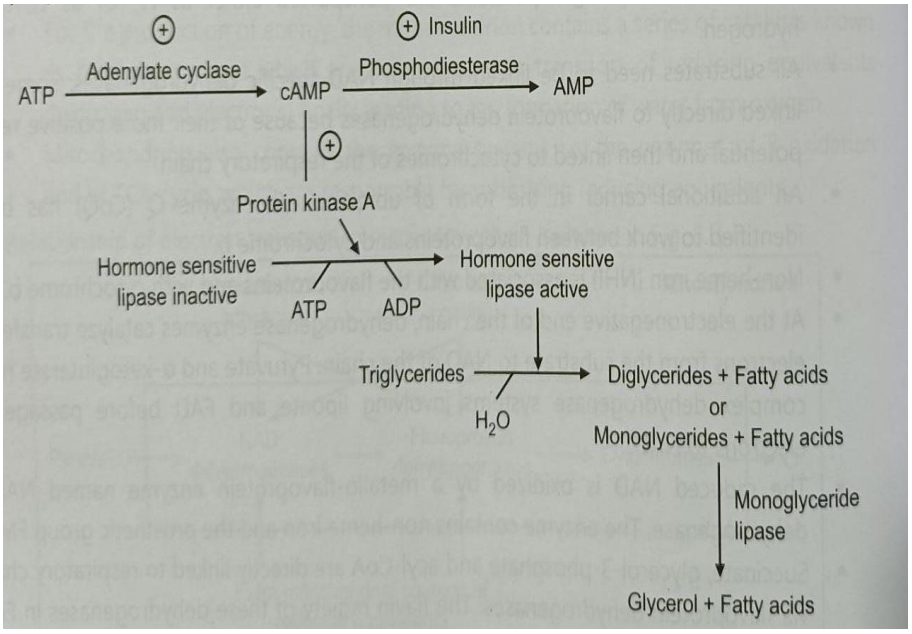
Lipolysis:

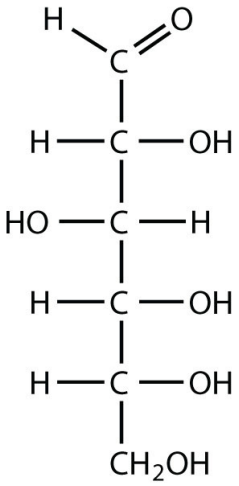
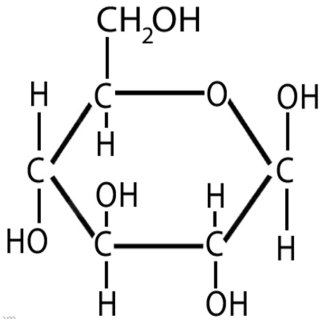
1. Chemically lipids are esters of glycerol and fatty acids. During metabolism, lipids are broken down with the process called lipolysis.
2. Triglycerides stored in adipose tissue are degraded when there is stress or in energy deficient conditions like starvation or diabetes. It happens through the process of breakdown of lipids called lipolysis.
3. Hormone sensitive lipase present in adipose tissue converts triglycerides to di- or mono triglycerides and fatty acids. Additional di- or monoglyceride lipase converts mono- or diglyceride to free fatty acids and glycerol.
4. The free fatty acids are released into circulation. They reach other tissues after combining with plasma albumin. Most of them are used for energy production in peripheral tissues. Liver converts them into ketone bodies. The glycerol is released into circulation, Glucose is formed from glycerol in the liver.

Process of Lipolysis is shown below:



OR

Q. No.	Sub No.	Answers	Marking Scheme
			
2	k	**What is the clinical significance of lipid profile?** **Marking Scheme: Clinical Significance of Lipid Profiles (Any three 3M).** **Answer:** **Clinical Significance of Lipid Profiles:** Primary prevention recommendations for adults aged between 40 to 75 years old with an LDL level of 70 to 189 mg/dL. 1. High levels of low-density lipoprotein-cholesterol (LDL-C) and low levels of high-density lipoprotein cholesterol (HDL-C) are risk factors for atherosclerosis, heart attack, stroke and coronary heart disease. 2. Large clinical trials have shown that lowering LDL-C levels significantly reduces cardiovascular events and mortality rate. 3. Increased plasma lipoproteins is known as hyperlipoproteinemia and decreased plasma lipoproteins is known as hypolipoproteinemia. 4. Excess triglycerides can increase the likelihood of heart attack, stroke & obesity. 5. The cholesterol/HDL ratio is used to help to calculate a person's risk of heart attack or stroke. 6. Excessive total cholesterol causes health problems like heart diseases.	3M

Q. No.	Sub No.	Answers	Marking Scheme
		7. High levels of HDL help to protect against heart attack.	
3		**Attempt the following**	**20M**
3	a	**Draw the structure of glucose** **Answer:**  **OR**  	**1M**
3	b	**Write any two functions of RNA.** • The primary function of RNA is to create proteins via translation. • RNA carries genetic information that is translated by ribosomes into various proteins necessary for cellular processes.	**1M**

Q. No.	Sub No.	Answers	Marking Scheme
		• mRNA, rRNA, and tRNA are the three main types of RNA involved in protein synthesis. • mRNA is a direct carrier of genetic information from the nucleus to the cytoplasm. • Usually molecule of mRNA contains information required for the formation of one protein molecule • t-RNA is the carrier of amino acid to the site of protein synthesis. • r-RNAs are required for the formation of ribosomes.	
3	c	**Name any two sulphur containing amino acids.** **Answer:** Methionine and cysteine	1M
3	d	**Give two Pharmaceutical applications of enzymes.** **Answer:** • Rennin is used for cheese preparation • Glucose isomerase is used for production of syrup • Alpha amylase is used in food industry to convert starch to glucose • Penicillin acylase is used for production of 6- aminopenicillanic acid • Papain, pepsin and trypsin are used in preparation of digestants. • The action of certain drugs depend upon the enzyme inhibition. • Antimetabolites have been prepared on the basis of Competitive Inhibition. • Sulphanilamide because of its similarity with PABA competes with it & inhibits enzyme folic acid synthase & selectively kills pathogenic organisms. • Xanthine oxidase enzyme is involved in conversion of xanthine & hypoxanthine to uric acid. Allopurinol acts as a competitive inhibitor of xanthine and reduces its conversion to uric acid .So it is useful in treatment of gout.	1M
3	e	**Write any two functions of lymphocytes.** **Answer:** • The main function of Lymphocytes is that they serve as part of the immune system. • They produce specific antibodies.	1M

Q. No.	Sub No.	Answers	Marking Scheme
		• This helps in providing protection against infectious diseases. • The T- lymphocytes help in cell-mediated response while the humoral immunity is provided by B- lymphocytes.	
3	f	**The chemical name of vitamin D is .....** **Answer:** Calciferol	1M
3	g	**Define biotechnology** **Answer:** Biotechnology is defined as utilization of organisms or its organelles or biological processes to make products or to solve problems for the welfare of mankind.	1M
3	h	**Coenzyme form of vitamin riboflavin is.....** **Answer:** Flavin mononucleotide (FMN) and flavin adenine dinucleotide (FAD)	1M
3	i	**Name the site for protein synthesis in the cell.** **Answer:** Ribosomes.	1M
3	j	**Write deficiency diseases of vitamin Thiamine.** **Answer:** Beriberi	1M
3	k	**The extracellular fluid comprises……..** **Answer:** iii) Plasma and interstitial fluid	1M
3	l	**Synthesis of cholesterol and steroid is the function of……..** **Answer:** iii) Endoplasmic reticulum	1M
3	m	**The nitrogen base found in RNA but not in DNA is** **Answer:** Uracil.	1M

SUMMER– 2023 EXAMINATION

Model Answer – Only for the Use of RAC Assessors

Subject Title: BIOCHEMISTRY & CLINICAL PATHOLOGY **Subject Code**: **20223**

Q. No.	Sub No.	Answers	Marking Scheme
3	n	**The protein part of enzyme is known as** **Answer:** iv) Apoenzyme.	1M
3	o	**Where does oxidative phosphorylation take place?** **Answer:** Mitochondria	1M
3	p	**Body water is regulated by the hormone** **Answer:** i) ADH	1M
3	q	**Biotechnology has made contribution in which areas** **Answer:** iv) All of these	1M
3	r	**Give significance to the SGPT test.** **Answer:** The test is primarily used to diagnose liver disease, to monitor the course of treatment for hepatitis, cirrhosis, and the effect of drug therapy.	1M
3	s	**Write full form of ECF and ICF.** **Answer:** Extracellular fluid (ECF) Intracellular fluid (ICF)	1M
3	t	**Rothera's test is for detection of……. in the urine.** **Answer:** Ketone Bodies	1M