WINTER– 2023 EXAMINATION

Model Answer – Only for the Use of RAC Assessors

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY

Subject Code: 20223

Important Instructions to examiners:

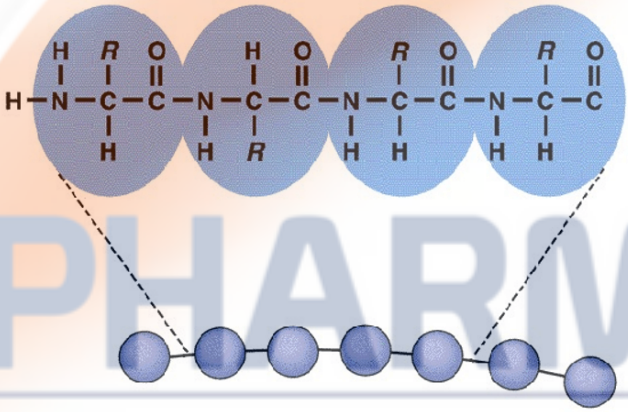
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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 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.

Q. No.	Sub No.	Answers	Marking Scheme
1		**Answer any SIX of the following:**	30M
1	a	**Explain the various structural levels of proteins.** **Marking scheme- marks to be given based on the content** Answer- The various structural levels of proteins are- Primary structure: Linear sequence of amino acids forming the backbone of proteins(Polypeptides). Secondary structure: Spatial arrangement of proteins by twisting of polypeptide chains. Tertiary Structure: 3 dimensional structure. Quaternary structure: Some proteins are composed of 2 or more polypeptide chains called subunits. The spatial arrangement of these subunits is a quaternary structure. **Primary structure:** • It's a straight chain structure.	5

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY
Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme

- The 'N' terminal amino acid i.e. amino acid with free amino group is always on the left end of the polypeptide chain & the 'C' terminal amino acid i.e. amino acid with free –COOH group is at the right end of the chain.



Secondary structure:

- Disulphide bridges & hydrogen bonds are formed.
- As a result the primary chain acquires a characteristic folding or twisting.
- In secondary structure different types of arrangements are seen:
- alpha helix & Beta pleated sheet(Parallel or Antiparallel)

Alpha helix:

- The peptide chain forms regular helical coils.
- In this form there are 3.6 amino acid residues per complete turn.
- The structure is stabilized by intramolecular hydrogen bonding in such a way that the -NH group of one amino acid comes into close proximity to the -CO group of the fourth amino acid residue in the peptide chain.
- Although hydrogen bonds are fairly weak, a large number of bonds involved maintain a stable structure.
- All peptide bonds except first & last, participate in hydrogen bonding.

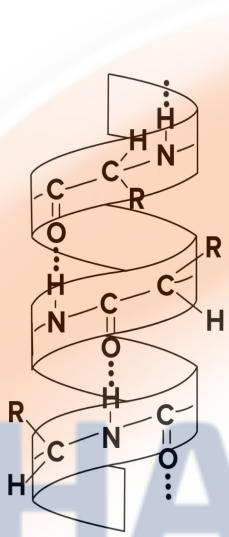
WINTER– 2023 EXAMINATION

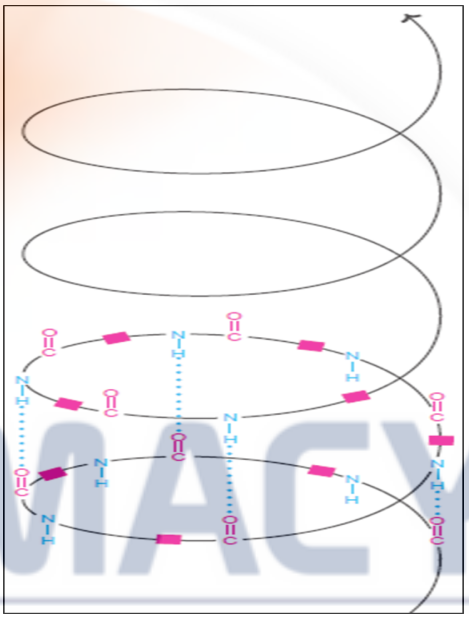
Model Answer – Only for the Use of RAC Assessors

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY

Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme

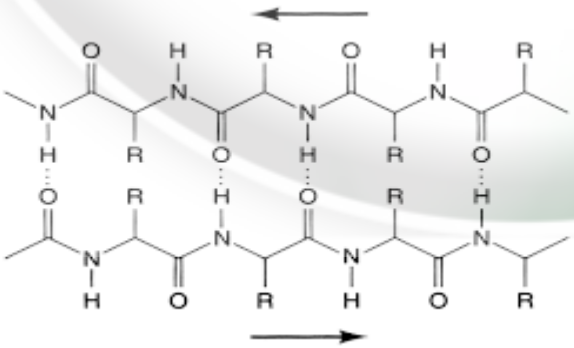




OR

Beta pleated sheet:

- It is another form of secondary structure. This results from hydrogen bonding between two peptide chains.
- The chains may be parallel or antiparallel.
- In a parallel beta pleated sheet 'N' atoms point in the same direction while in antiparallel sheet alternate chains are oriented in the same direction.



Tertiary structure:

- Polypeptide chains may undergo coiling & folding to produce tertiary structure.

WINTER– 2023 EXAMINATION

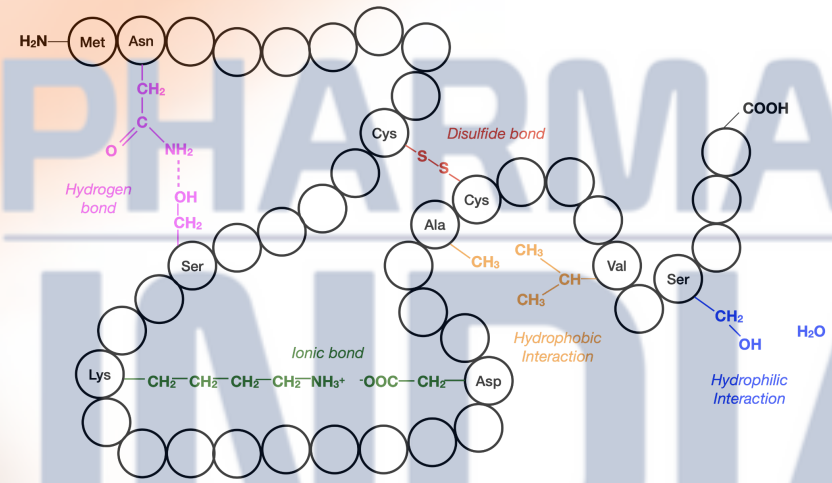
Model Answer – Only for the Use of RAC Assessors

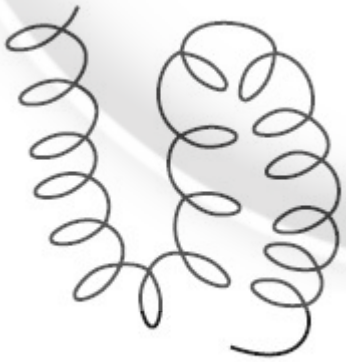
Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY

Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme

- The secondary structure will take on 3 dimensional shape in which there is folding, looping & binding of the chains in such a way as to expose most polar groups to the surface & most nonpolar groups to the interior.
- The shape may be ellipsoid or a globe or any irregular shape. The shape is determined by forces like hydrogen bonds, disulphide bridges, hydrophobic & electrostatic bonds.





Tertiary structure

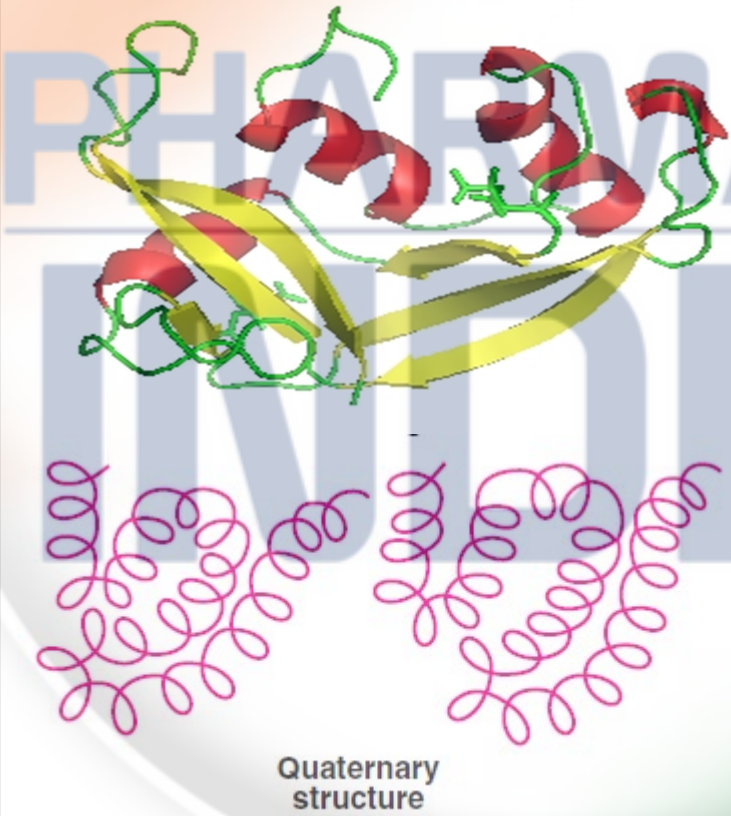
Quaternary structure:

WINTER– 2023 EXAMINATION

Model Answer – Only for the Use of RAC Assessors

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY

Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme
		• There is association of two or more polypeptide chains. • Association is due to hydrophobic interactions, hydrogen bonds & electrostatic bonds. • Protein like hemoglobin exhibits quaternary structure. • If protein consists of identical units it is said to have homogenous quaternary structure otherwise heterogeneous quaternary structure.  	

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY
Subject Code: 20223

1	b	**Discuss the pathway for the conversion of glucose to pyruvate.**	5

Marking scheme- appropriate marks should be given based on the contents

Answer-

GLYCOLYSIS(EMBDEN-MEYERHOF PATHWAY E.M. pathway)

- Glycolysis is defined as 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 enzymes of this pathway are present in the cytosomal fraction of the cell.
- It occurs in absence of oxygen (anaerobic) or in the presence of oxygen(aerobic).Lactate is the end product under anaerobic condition. In aerobic condition, pyruvate is formed which is then oxidized to CO2 & H2O.

The various steps of the pathway are-

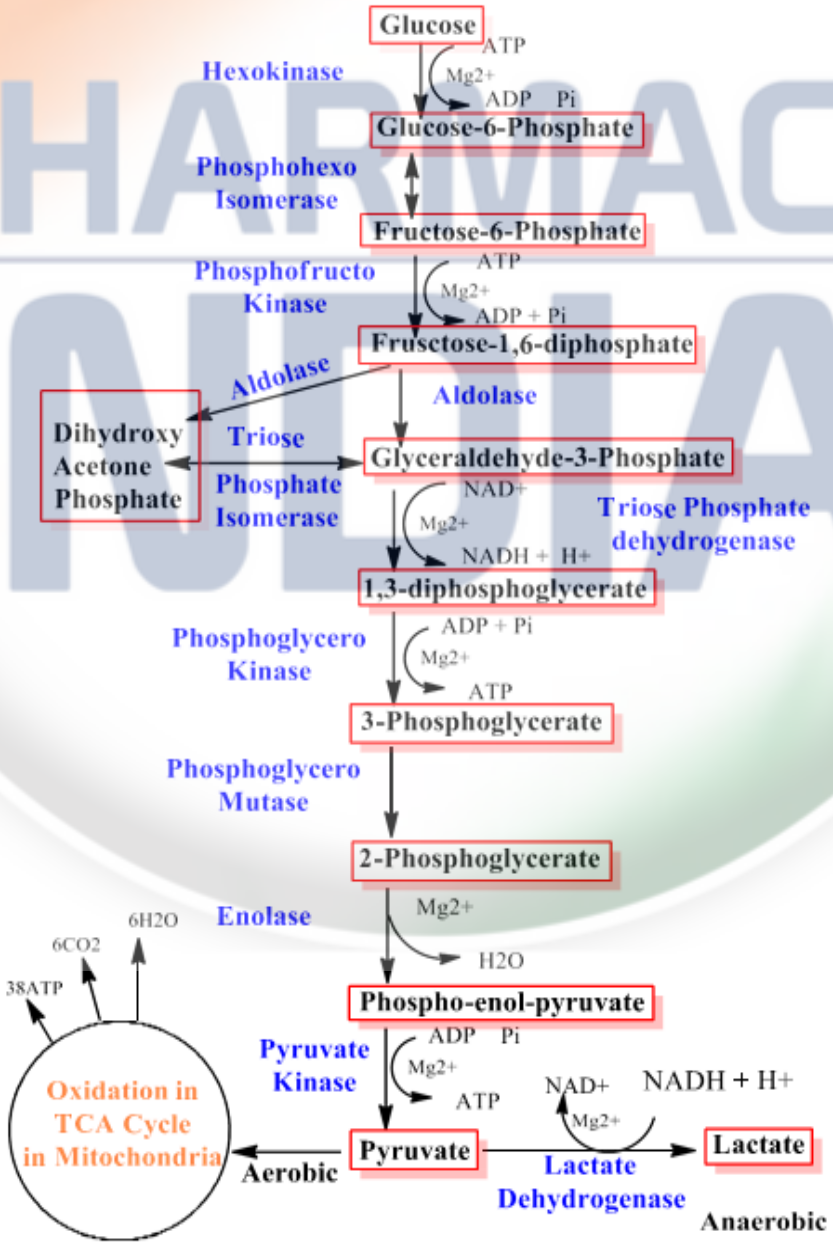
1. Phosphorylation of glucose to glucose 6-phosphate in presence of enzyme hexokinase & ATP & Mg.
2. Isomerisation of Glucose 6-phosphate to fructose 6-phosphate in presence of phosphohexose isomerase.
3. Phosphorylation of fructose 6-phosphate to fructose 1,6-diphosphate in presence of phosphofructokinase, 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 molecules 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.

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY
Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme

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

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.



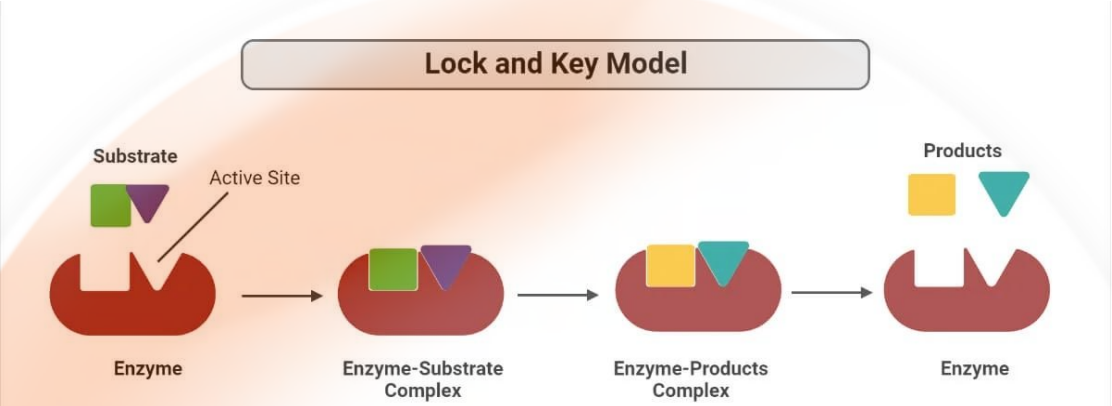
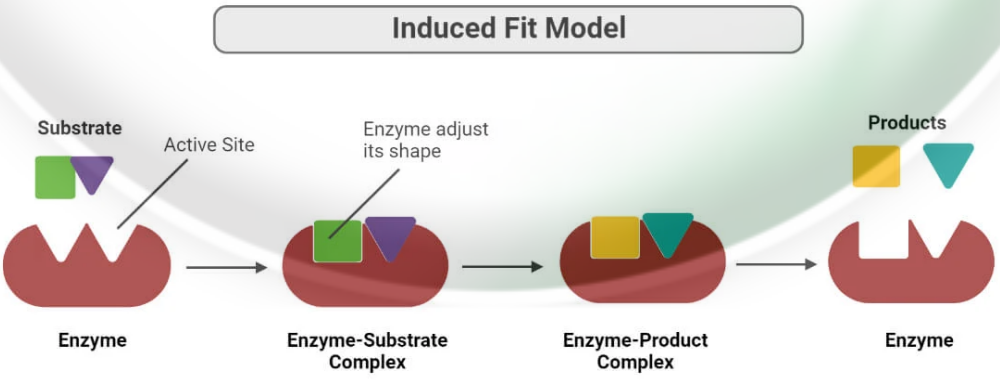
Q. No.	Sub No.	Answers	Marking Scheme
		Other correct representations can also be considered. **Net reaction for glycolysis is:** Glucose + NAD+ + 2 ADP + 2 Pi → 2 Pyruvate + 2 ATP + 2 NADH + 2 H_2O	
1	c	**Explain the mechanism of action of enzymes with various theories.** **Marking scheme- 2.5 marks for each theory** **Answer-** **MECHANISM OF ACTION OF ENZYMES** • Catalysis is the prime function of enzymes. • The nature of catalysis taking place in the biological system is similar to that of non-biological catalysis. • The enzyme lowers the energy barrier of reactants, thereby making the reaction go faster. • The enzymes reduce the activation energy of the reactants in such a way that all the biological reactions occur at body temperature(below 40oC). • The prior requirement for enzyme catalysts is that the substrate[S] must combine with the enzyme[E] at the active site to form enzyme substrate complex [ES] which ultimately results in the product formation[P]. • [E] + [S] ➡ [ES] ➡ [E] + [P] Some theories have been postulated to explain the mechanism of enzymes. **LOCK & KEY MODEL(FISCHER'S TEMPLATE THEORY)** • Shape of the active site & that of the substrate is complementary to each other. • Based on its fitting it is called the Lock & key model. • According to this model, the structure of the enzyme is rigid. • The substrate fits to the binding site(active site) just as a key fits into the proper lock. • Thus the active site of an enzyme is a rigid & pre-shaped template where only a specific substrate can bind.	5

WINTER– 2023 EXAMINATION

Model Answer – Only for the Use of RAC Assessors

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY

Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme
		 **INDUCED FIT THEORY OR KOSHLAND'S MODEL** • Active site of enzymes is considerably flexible to accommodate a wide variety of substrate molecules. • Shape of the active site is made complementary to the substrate to a certain extent. • The interaction of the substrate with the enzyme induces a fit or a conformational change in the enzyme, resulting in the formation of a strong substrate binding site. 	
1	d	**Explain Kreb's cycle.** **Marking scheme- appropriate marks should be given based on the contents**	5

Q. No.	Sub No.	Answers	Marking Scheme

Answer-

Tricarboxylic acid Cycle (TCA Cycle) / Kreb's Cycle:

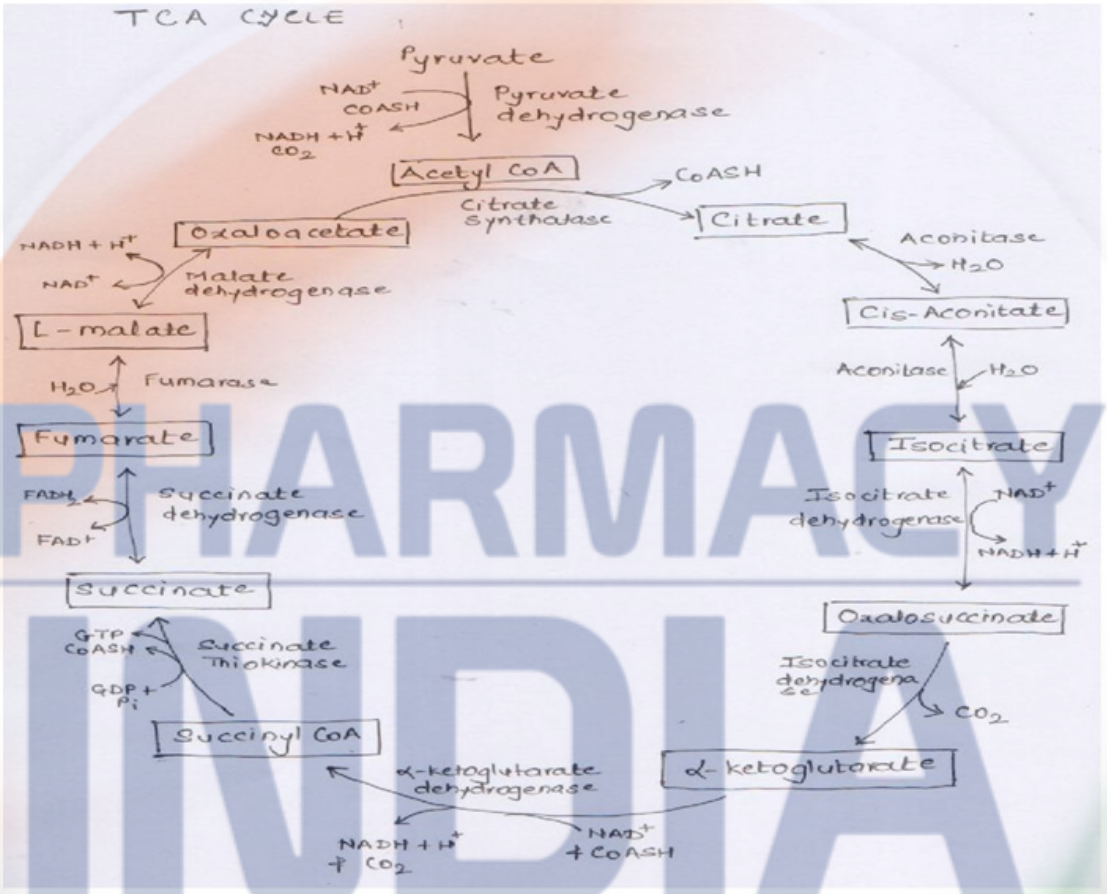
- It's a central pathway for release of energy from acetyl CoA which is produced from glycolysis, catabolism of fatty acids or amino acids.
- 1. Condensation of acetyl CoA obtained from pyruvic acid/pyruvate with oxaloacetate to form citric acid in presence of citrate synthase.
- 2. Conversion of citric 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.
- 4. Decarboxylation of oxalosuccinic acid/oxalosuccinate to alpha ketoglutaric acid/alpha ketoglutarate in presence of isocitric acid dehydrogenase, Mg/ Mn.
- 5. Oxidative decarboxylation of alpha ketoglutaric acid/alpha ketoglutarate to succinyl CoA in presence of alpha ketoglutarate dehydrogenase, CoA-SH, NAD+, Mg.
- 6. Succinyl CoA gets converted to succinic acid/succinate in presence of succinate thiokinase/succinyl CoA synthetase, GDP, Mg.
- 7. Succinic acid/succinate undergoes dehydrogenation in presence of succinate dehydrogenase, FAD+ to form fumaric acid/fumarate.
- 8. Fumaric acid/fumarate takes up water molecules in presence of fumarase to form maleic acid/malate.
- 9. Maleic acid/malate undergoes oxidation in presence of malate dehydrogenase, NAD+ to form oxaloacetic acid/oxaloacetate.
- 10. Cycle gets repeated again by the entrance of another molecule of Acetyl CoA.

WINTER– 2023 EXAMINATION

Model Answer – Only for the Use of RAC Assessors

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY

Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme
		 ***Other correct representations can also be considered.***	
1	e	**What is dehydration? What are the causes of dehydration? Write a note on ORS.** **Scheme- Dehydration- 1 mark, causes- 2 marks, ORS- 2 marks** **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. Dehydration is generally classified into 2 types- Due to loss of water alone. Due to deprivation of water & electrolytes **Causes of dehydration:** 1. Non-availability of water in certain areas.	**5**

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY
Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme

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.

ORAL REHYDRATION SALTS

- Oral rehydration therapy (ORS) is a type of fluid replacement used to prevent and treat dehydration, especially due to diarrhea.
- It involves drinking water with modest amounts of sugar and salts, specifically sodium and potassium.
- Use of oral rehydration Salts has been estimated to decrease the risk of death from diarrhea by up to 93%.
- Mild to moderate dehydration in children seen in an emergency department is best treated with ORS
- Oral rehydration Salts therapy may also be used as a treatment for the symptoms of dehydration and rehydration in burns in resource-limited settings.
- A number of other formulations are also available including versions that can be made at home.
- The recommended formulation includes sodium chloride, sodium citrate, potassium chloride, and glucose.
- Glucose may be replaced by sucrose and sodium citrate may be replaced by sodium bicarbonate, if not available.
- It works as glucose increases the uptake of sodium and thus water by the intestines.
- Sodium & potassium are needed to replace the body losses of these essential ions during diarrhea & vomiting.

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY
Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme
		• Citrate/ Bicarbonate corrects the acidosis which occurs as a result of diarrhea & dehydration. • The particular advantage of citrate containing ORS(over bicarbonate containing ORS) is its stability in tropical countries where even at room temperatures of 60oC, there is no discoloration. • Preparation- WHO and UNICEF have jointly developed official guidelines for the manufacture of oral rehydration solution and the oral rehydration salts used to make it (both often abbreviated as ORS). They also describe acceptable alternative preparations, depending on material availability. Commercial preparations are available as either prepared fluids or packets of oral rehydration salts ready for mixing with water.	
1	f	**Enlist various functions of the liver. What are the routinely performed tests for assessing the functions of the liver?** **Marking scheme- Functions-(any four functions) 2 marks Tests- 3 marks** **Answer-** **Functions of Liver-** **Metabolic functions-** • Liver actively participates in carbohydrate, Lipid, Protein, Mineral & Vitamin metabolisms. • Excretory functions- Bile pigments, bile salts & cholesterol are excreted in the bile into the intestine. **Protective functions & detoxification-** • Kupffer cells of the liver perform phagocytosis to eliminate foreign compounds. Ammonia is detoxified to urea. • Liver is responsible for the metabolism of xenobiotics(detoxification). **Hematological functions-**	5

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY
Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme

- Liver participates in the formation of blood(particularly in the embryo), synthesis of plasma proteins(including blood clotting factors) & destruction of erythrocytes.

Storage functions-

- Glycogen, Vitamins A, D, B12 & trace element iron are stored in the liver.

Tests to assess liver function

- LFT helps to detect the abnormalities & the extent of liver damage.
- Tests based on excretory functions- measurement of bile pigments, bile salts, bromosulfophthalein.
- Tests based on serum enzymes derived from liver determination of transaminases, alkaline phosphatase, 5'-nucleotidase, γ-glutamyl transpeptidase.
- Tests based on metabolic capacity- Galactose tolerance, Antipyrine clearance.
- Tests based on synthetic functions- prothrombin time, serum albumin
- Tests based on detoxification- Hippuric acid synthesis

1. **BILIRUBIN**

Bilirubin in Urine

- The conjugated bilirubin, being water soluble, is excreted in urine.
- The bilirubin in urine can be detected by Fouchet's test or Gmelin's test.
- Bilirubin in urine tests measures the levels of bilirubin in your urine. Normally, urine doesn't have any bilirubin. If there is bilirubin in your urine, it may be an early sign of a liver condition.A positive (+) result of bilirubin in urine (bilirubinuria) is indicative of a liver problem or a bile obstruction.

2. **TESTS BASED ON SERUM ENZYMES FROM LIVER**

- Liver cells contain several enzymes which may be released into the circulation in liver damage.
- Measurement of selected enzymes in serum is often used to assess liver function.

a.Transaminases or aminotransferases

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY
Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme

- The activities of 2 enzymes-serum glutamate pyruvate transaminase(SGPT; recently known as alanine transaminase-ALT) & serum glutamate oxaloacetate transaminase(SGOT; recently known as aspartate transaminase-AST)--are widely used to assess the liver function.
- The activity of these enzymes is low in normal serum(SGPT-5-40 IU/litre; SGOT-5-45 IU/Iitre).

b. Alkaline phosphatase

- Alkaline phosphatase(ALP) is mainly derived from bone & liver.
- A rise in serum ALP(normal 3-13 KAunits/dl KING ARMSTRONG), usually associated with elevated serum bilirubin is an indicator of biliary obstruction(obstructive jaundice).
- ALP is also elevated in liver cirrhosis & hepatic tumors.

Measurement of other serum enzymes like γ-glutamyl transpeptidase(GGT), 5'-Nucleotidase, isocitrate dehydrogenase & isoenzymes of lactate dehydrogenase are also useful in LFT.

3. LFT BASED ON SERUM PROTEINS(Albumin)

- Albumin is only synthesized by the liver.
- It is a good marker to assess chronic liver damage.
- Low serum albumin is commonly observed in patients with severe liver damage.
- It must however, be noted that the serum albumin concentration is also decreased due to malnutrition.

4. LFT BASED ON SERUM PROTEINS(Globulin)

- Increased synthesis of Globulins indicates impairment of liver.
- Cirrhosis of the liver is indicated by the reversal of albumin/globulin(A/G) ratio.

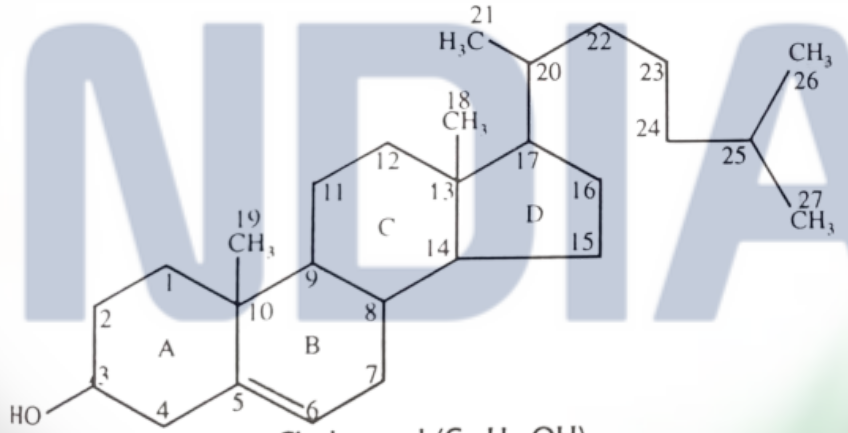
5. GALACTOSE TOLERANCE TEST

- Galactose is a monosaccharide, almost exclusively metabolized by the liver.
- The liver function can be assessed by measuring the utilization of galactose.
- This is referred to as the Galactose Tolerance Test.

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY
Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme
		• In normal individuals, the half-life of galactose is about 10-15 minutes. • This is markedly elevated in infective hepatitis & cirrhosis. 6. **PROTHROMBIN TIME** • The liver synthesizes all the blood clotting factors. • A decrease in the concentration of plasma clotting factors is found in the impairment of liver function. • This can be checked by measuring prothrombin time which is prolonged in patients with liver damage compared to normal. • The half-lives of clotting factors are relatively short(5-72 hrs.), therefore, changes in prothrombin time occur quickly. • Hence this test is useful to assess acute as well as chronic liver damage. 7. **HIPPURIC ACID SYNTHESIS** • The liver is the major site for the metabolism of xenobiotics(detoxification). • Measurement of hippuric acid synthesis is an ideal test for assessing the detoxification function of the liver. **CHOICE OF LIVER FUNCTIONS TESTS** **The choice of biochemical test to measure liver functions mostly depends on the purpose of the investigation.** **A combination of laboratory investigations are employed in LFT.** **These include Serum bilirubin(conjugated & unconjugated), SGPT, SGOT, Alkaline phosphatase & Proteins(albumin & globulins).**	
1	**g**	**Define Lipids. Write about the structure and functions of Cholesterol in the body. Enlist any two properties of triglycerides.** **Marking scheme- Define- 1mark, Structure- 1 mark, functions-2 marks for any 4 functions, properties- 1 mark for any 2 properties** **Answer-**	**5**

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY
Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme
		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 **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. **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.	

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY
Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme

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.It helps in maintenance of our body temperature and protects our internal organs.
8. In pharmaceutical industries, cholesterol is used in the manufacture of steroid hormones and vitamin D.
9. 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.
10. Cholesterol, when oxidized under suitable conditions, undergoes rapid oxidation to form a ketone called cholestenone.
11. The hydroxyl group of cholesterol readily forms ester with fatty acids like stearic acid.

PROPERTIES OF TRIGLYCERIDES

Physical properties-

- They are non-polar, hydrophobic in nature.
- They are insoluble in water & soluble in organic solvents.
- The specific gravity is less than water. Therefore fats & oil float on water.
- They serve as solvent for other fats. E.g. fat soluble vitamins A, D, E & K.
- The saturated fatty acids have higher melting points than unsaturated fatty acids of corresponding length.

Chemical properties

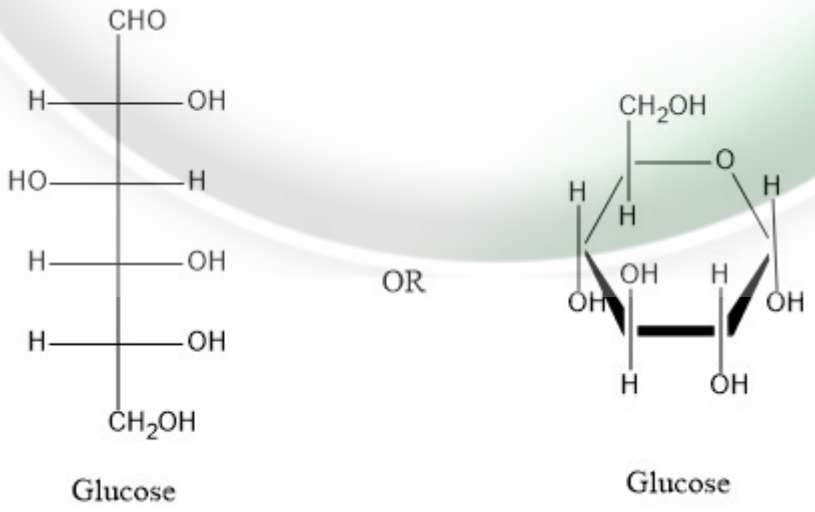
- 1.Hydrolysis: Triacylglycerols undergo stepwise enzymatic hydrolysis to finally liberate free fatty acids & glycerol. This process of hydrolysis catalyzed by lipases is important for digestion of fat in the gastrointestinal tract & fat mobilization from the adipose tissues.
- 2.Saponification: The hydrolysis of triacylglycerols by alkali to produce glycerol & soaps is known as saponification.

WINTER– 2023 EXAMINATION

Model Answer – Only for the Use of RAC Assessors

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY

Subject Code: 20223

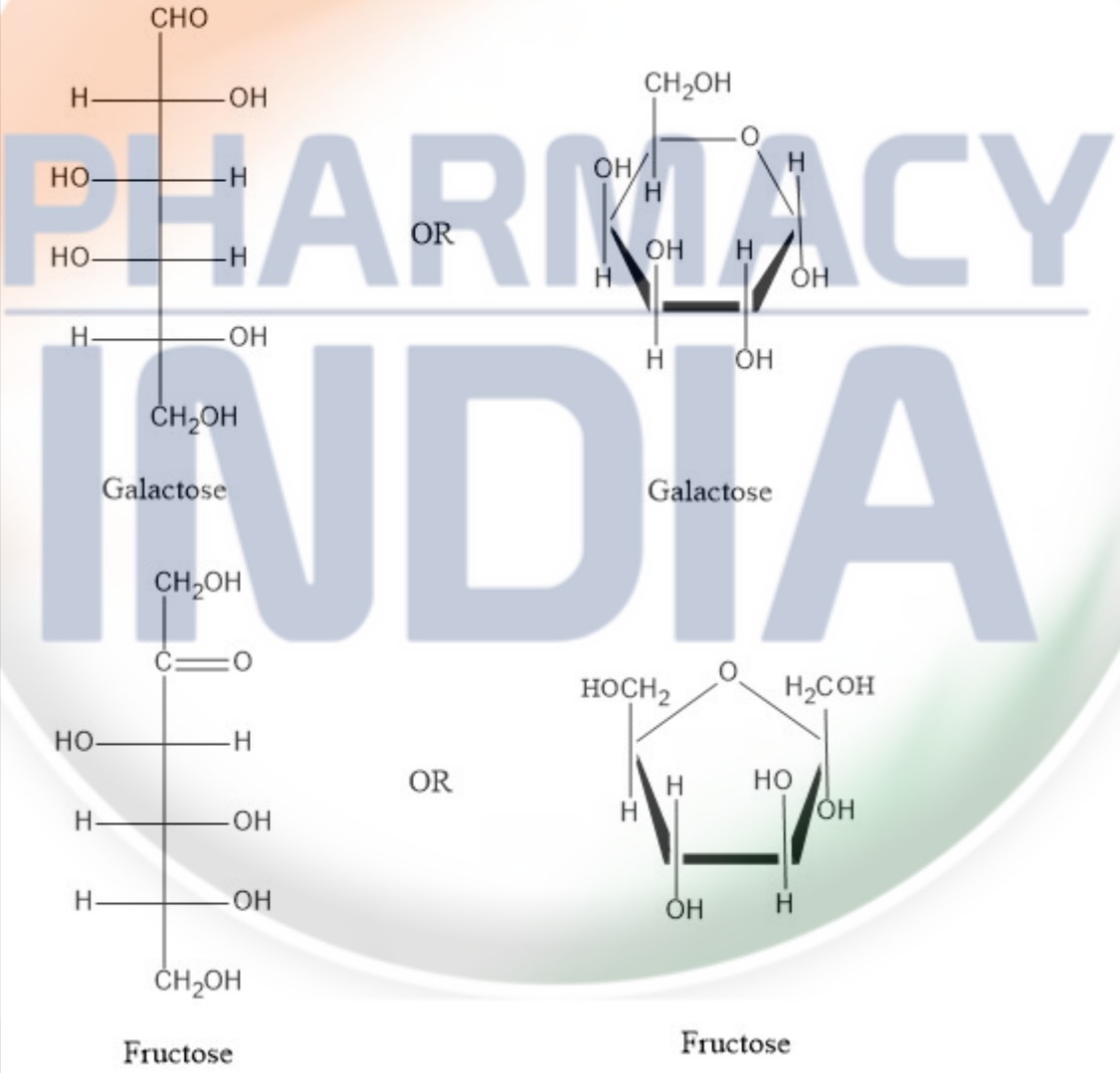
Q. No.	Sub No.	Answers	Marking Scheme
		Triacylglycerol + 3NaOH → Glycerol + 3 R-COONa(soaps) • 3. Rancidity: Rancidity is the term used to represent the deterioration of fats & oils resulting in an unpleasant taste. Fats containing unsaturated fatty acids are more susceptible to rancidity. Rancidification is the process of complete or incomplete autoxidation or hydrolysis of fats and oils when exposed to air, light, moisture, or bacterial action, producing short-chain aldehydes, ketones and free fatty acids. When these processes occur in food, undesirable odors and flavors can result. Rancid oils & fats are unsuitable for human consumption. • 4. Lipid peroxidation in vivo-In the living cells, lipids undergo oxidation to produce peroxides & free radicals which can damage the tissue. The free radicals are believed to cause inflammatory diseases, aging, cancer, atherosclerosis etc. It is fortunate that the cells possess antioxidants such as Vitamin E, urate & superoxide dismutase to prevent in vivo lipid peroxidation.	
2		**Answer any TEN of the following:**	**30 M**
2	**a** **Ans:**	**Draw structure of any three reducing monosaccharides.** **(1 mark each for any three correct structures)**  Glucose Glucose	**3**

WINTER– 2023 EXAMINATION

Model Answer – Only for the Use of RAC Assessors

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY

Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme
			
2	b Ans:	**Define Carbohydrates. Classify them.** **(1 Mark for definition, 2Marks for any suitable classification)**	3

WINTER– 2023 EXAMINATION

Model Answer – Only for the Use of RAC Assessors

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY

Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme

Carbohydrates may be defined as polyhydroxy aldehydes or ketones or compounds, which produce them on hydrolysis.

Two major classes of Carbohydrates are **Sugars and Non-sugars**.

Sugar type of carbohydrates are classified into two groups based on the number of sugar units-

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. Dihydroxyacetone, Fructose

B) On basis of number of carbon atoms-

Trioses -three carbon atoms e.g.- glyceraldehyde, dihydroxyacetone.

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.

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY
Subject Code: 20223

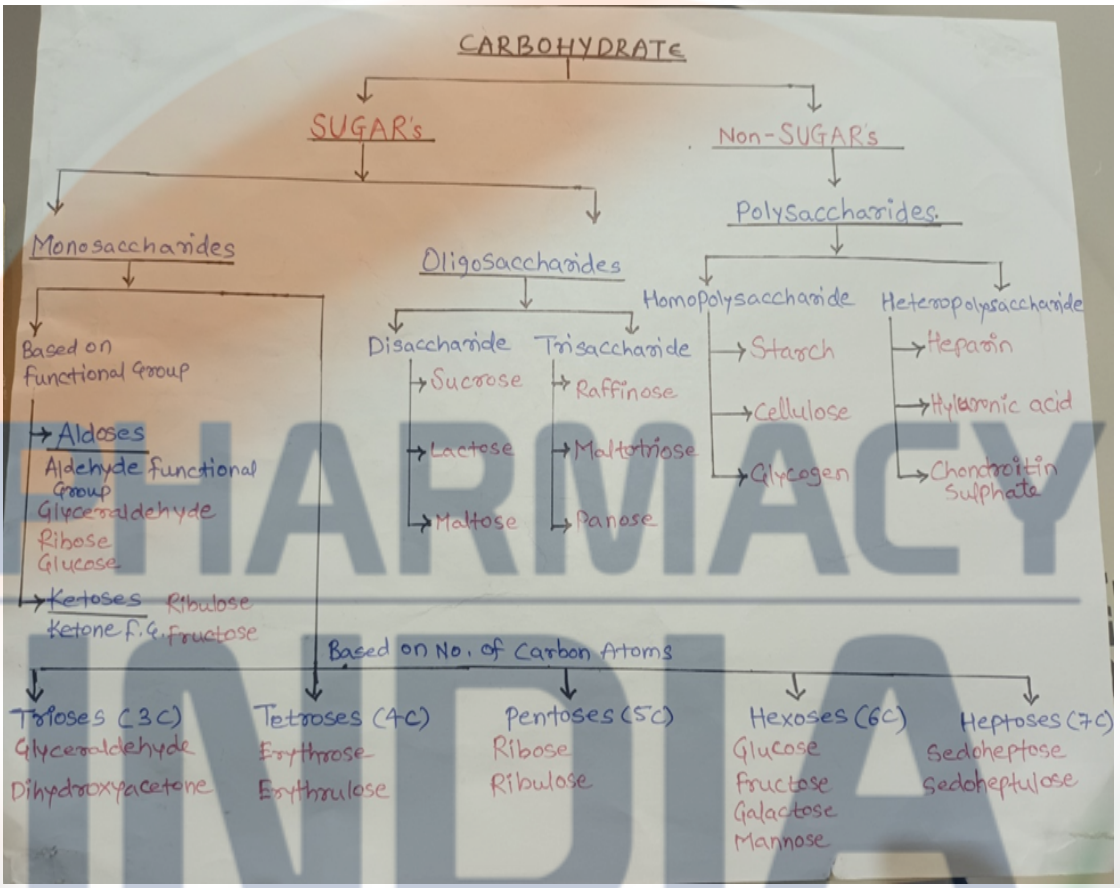
Q. No.	Sub No.	Answers	Marking Scheme
		eg. *Sucrose* (glucose+ fructose), *lactose* (galactose+ glucose), *maltose* (glucose + glucose). ii. **Trisaccharide**- class of oligosaccharide consisting of three monosaccharide units. e.g. *Raffinose* (three galactose sugar units), *maltotriose* (three glucose 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** **Any schematic classification of carbohydrates can be considered**	

WINTER– 2023 EXAMINATION

Model Answer – Only for the Use of RAC Assessors

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY

Subject Code: 20223

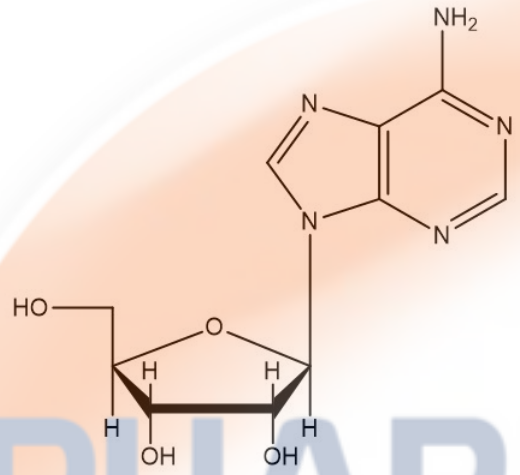
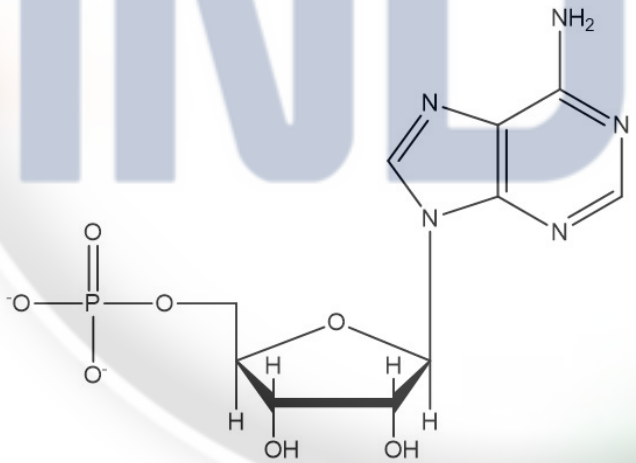
Q. No.	Sub No.	Answers	Marking Scheme
			
2	c Ans:	**What are Nucleosides and Nucleotides?** **(1.5 marks for explanation of each)** • Upon complete hydrolysis of nucleic acid yields, a mixture of basic substances called 'Purines' and 'Pyrimidines', a Pentose or Deoxypentose sugar component and Phosphoric acid. • Upon partial hydrolysis of nucleic acids, Nucleotides and Nucleosides can be isolated. • **Nucleoside** is a compound formed by union of nitrogenous bases along with pentose Sugar. • If Pentose Sugar is Ribose it is Ribonucleoside eg. Adenosine	3

WINTER– 2023 EXAMINATION

Model Answer – Only for the Use of RAC Assessors

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY

Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme
		 • **Nucleotide** is a compound formed by union of nitrogenous base along with pentose Sugar & Phosphate. • If Pentose Sugar is Ribose then it is Ribonucleotide e.g. **AMP (Adenosine-5'-monophosphate)** 	
2	**d Ans:**	**Enlist factors affecting enzyme action.** **(Any six correct factors for full marks)** Following are the factors affecting the Enzyme action; 1. Concentration of enzyme 2. Concentration of substrate	**3**

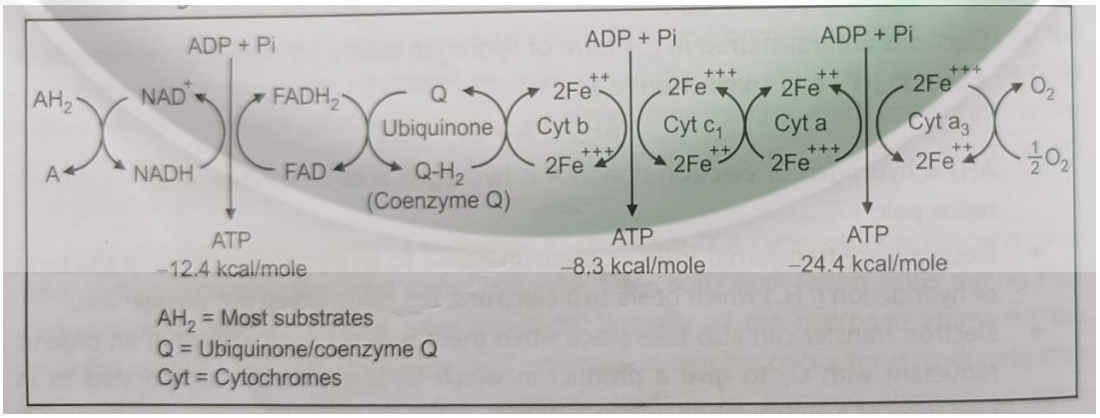
Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY
Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme
		3. Temperature 4. pH 5. Product concentration 6. Activators (Coenzymes & Cofactors) 7. Time 8. Light & radiation 9. Oxidizing agents 10. Enzyme Inhibitors 11. Anti-enzymes	
2	e Ans:	**Explain ETC Chain.** **Marking scheme- appropriate marks should be given based on the contents** 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.	3

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'.

Multiprotein complexes in Electron Transport Chain can be shown as follow:



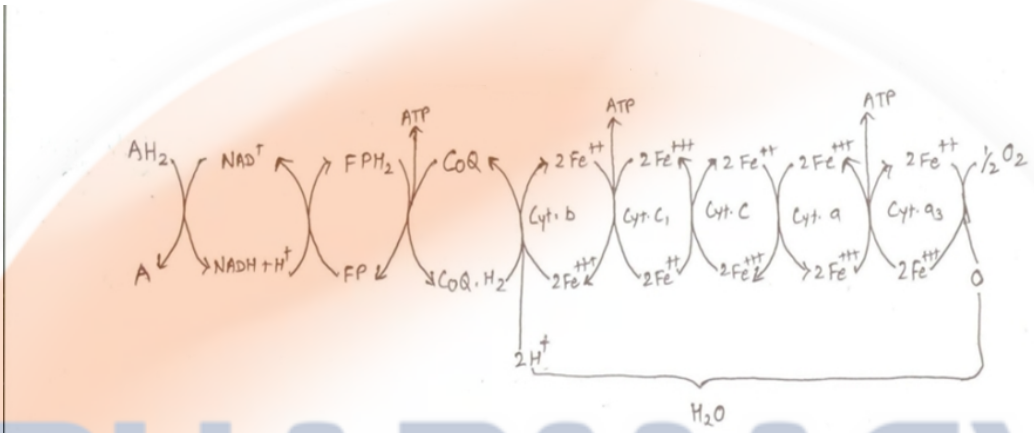
OR

WINTER– 2023 EXAMINATION

Model Answer – Only for the Use of RAC Assessors

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY

Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme
		 ***Other correct representations can also be considered.***	
2	**f Ans:**	**Write the functions of Calcium and its deficiency diseases.** **(2 Marks for the functions, 1 Mark for any two deficiency diseases)** **Functions of Calcium are as follows:** 1. Development of bones and teeth 2. Muscle contraction 3. Blood Coagulation 4. Nerve transmission 5. Membrane integrity and permeability 6. Activation of enzymes 7. Calmodulin mediated action 8. Calcium as an intracellular messenger 9. Release of hormones	**3**

WINTER– 2023 EXAMINATION

Model Answer – Only for the Use of RAC Assessors

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY

Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme
		10. Secretory process 11. Contact inhibition 12. Action on heart **Following diseases observed due to deficiency of Calcium:** 1. Hypocalcemia (Tetany) 2. Rickets 3. Osteoporosis 4. Osteopenia	
2	g Ans:	**Which pathological conditions are observed due to abnormal constituents in urine?** **(0.5marks for enlisting each constituent with its significance)**	3

Abnormal Constituents	Significance
Sugar / Glucose	Glycosuria, Diabetes mellitus
Ketone Bodies	Ketonuria-Diabetes mellitus Pregnancy, Carbohydrate starvation
Protein / Albumin	Proteinuria-Pregnancy, Severe exercise, High protein meal, Nephritis
Bile pigments	Jaundice / Hepatitis
Blood	Haematuria- Acute inflammation of urinary organs, T.B., Cancer, Haematolytic jaundice etc.
Pus	Pyuria-Inflammation of urinary bladder, urethra, kidney

WINTER– 2023 EXAMINATION

Model Answer – Only for the Use of RAC Assessors

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY

Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme
2	h Ans:	**Discuss Glycogenesis.** **Marking scheme- appropriate marks should be given based on the contents** • It is the process of conversion of glucose into glycogen in the liver. • It takes place in the cytosol , requires ATP and UTP, besides glucose. **Importance of glycogenesis:** 1. Excess of glucose is utilised to form glycogen, which is stored in the liver and muscles reserved for muscular activities. 2. Helps to maintain blood glucose level. 3. In case of carbohydrate starvation stored glycogen is converted to glucose to give energy. **The process of Glycogenesis is as follows:** **1.Synthesis of UDP-glucose:** • Hexokinase and Glucokinase convert glucose into Glucose-6-phosphate. • Glucose-6-phosphate conversion to Glucose-1-phosphate is catalyzed by phosphoglucomutase. • Uridine diphosphate glucose (UDPG) is synthesized from Glucose-1-phosphate and UTP by UDP-glucose pyrophosphate. **2. Requirement of primer to initiate glycogenesis:** • A small fragment of pre-existing glycogen must act as a primer. • In absence of primer, a protein 'Glycogenin' can accept the glucose from UDPG. • The enzyme glycogen initiator synthase transfers the glucose to glycogenin. • Later, glycogenin itself takes up glucose molecules to form a fragment to accept the rest of the glucose molecules.	3

WINTER– 2023 EXAMINATION

Model Answer – Only for the Use of RAC Assessors

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY

Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme
		3. Glycogen synthesis by glycogen synthase: • Glycogen synthase is responsible for the formation of 1,4-glycosidic linkage. **4. Formation of branches in glycogen:** • Glycogen synthase catalyses synthesis of linear unbranched molecules with 1,4-α-glycosidic linkage. • Formation of branching is brought about by a branching enzyme called glucosyl 4-6 transferase. **Overall reaction:** **Glucose)n + Glucose + 2ATP —> (Glucose)n+1 + 2ADP + Pi**	
2	**i** **Ans:**	**What is Lymphocytosis, Lymphocytopoenia and Phenylketonuria?** **(1 Mark for explanation of each)** **1. Lymphocytosis:** • Increase in the number of lymphocytes count above the normal range in blood. • It is observed in viral infections like Hepatitis A, Pneumonia in newborn babies as well as in pregnancy. **2. Lymphocytopenia: (Lymphopenia)** • Decrease in number of Lymphocytes below the normal value • It is observed in CHF, Tuberculosis & in temporary conditions of administration of adrenocorticosteroid hormones. **3. Phenylketonuria (PKU):**	**3**

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY
Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme
		• It is the most common disorder in amino acid metabolism. The incidence of PKU is 1 in 10000 births. It is due to the deficiency of hepatic enzyme, phenylalanine hydroxylase. • Phenylketonuria primarily causes the accumulation of phenylalanine in the tissues and blood, and results in increased excretion in urine. • Mental retardation, failure to walk or talk, failure of growth, seizures and tremors are observed. **Treatment of PKU:** • The maintenance of plasma phenylalanine concentration within the normal range is done by selecting foods with the low phenylalanine content and or feeding synthetic amino acid preparation, low in phenylalanine.	
2	j Ans:	**Write the functions of any three fat soluble vitamins.** **(1 Mark each for any two correct functions of any three vitamins)** **Vitamin A functions** 1. Vit. A plays important role in vision 2. Vitamin A helps in maintaining the integrity of epithelial tissue, such as epithelial layers of skin, respiratory mucosa, esophagus, and genito-urinary tract. 3. It is also involved in the preservation of structural integrity and the normal permeability of the cell membrane. 4. It helps in the normal formation of bones and teeth. 5. It acts as a growth promoting factor in children. 6. Cholesterol synthesis requires vitamin A. 7. Carotenoids (most important beta-carotene) function as antioxidants and reduce the risk of cancers initiated by free radicals and strong oxidants. 8. Vitamin A is considered essential for the maintenance of a proper immune system.	3

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY
Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme

9. Retinol is necessary for normal reproduction.

Vitamin D functions

1. Vitamin D is responsible for increasing the availability and retention of calcium and phosphorus and their utilization for proper mineralization of the skeleton.

2. The major function of vit. D is to stimulate transcription of mRNA for calcium transport.

3. It increases the excretion of phosphate by kidney and decreases concentration of serum phosphate.

4. It decreases the pH in the lower intestinal tract which helps in increasing the absorption of calcium and phosphorus.

5. It is required for the development of bones and normal growth of the body.

6. It stimulates calcification of bones in both the adults and growing children.

7. It increases the citrate level of blood, bone, kidney and heart tissues and also excretion of citric acid.

8. It stimulates the activity of phytase which catalyses the hydrolysis of phytic acid in the intestine.

Vitamin E functions

1. It acts as a powerful 'antioxidant', where it stabilises polyunsaturated fatty acids and certain fats, vit. A, and sulphur containing acids, by molecular oxygen in the formation of peroxides.

2. The antioxidant property of vit. E protects the lung tissue from damage by oxidants in the air.

3. It plays a part in stabilization of cellular membranes.

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY
Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme
		4. It protects enzymes in muscle, nerves or gonads from destruction. 5. It prevents hepatic necrosis, produced by the lack of sulphur containing amino acids in dietary proteins. 6. It prevents the development of cerebral disorders. 7. It is believed to be involved in heme synthesis. **Vitamin K functions** 1. It catalyses the synthesis of 'prothrombin' by the liver. 2. It reduces prothrombin time. 3. It regulates the synthesis of clotting factors viz. factor VII, IX, and factor X. 4. It is involved in the oxidative phosphorylation in animal tissues. 5. It maintains the normal level of blood clotting factors, - II, VII, IX and X. 6. It is used therapeutically to prevent poisoning by dicoumarol -type drugs.	
2	k Ans:	**Discuss diseases related to abnormal carbohydrate metabolism.** **(1 mark each for any three diseases described)** Following diseases are observed in abnormal carbohydrate metabolism: **1. Diabetes mellitus:** • When the body is unable to utilize the glucose then there is an appearance of excessive sugar in the blood, as well as in the urine, called 'glycosuria' and the disease is termed as 'diabetes mellitus'. • The blood sugar level is regulated by the pancreatic protein hormone, insulin, which is secreted by the β-cells of islets of Langerhans of pancreas. • If the insulin is unable to utilize the sugar, the sugar level may be increased in the blood and excreted in the urine.	3

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY
Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme

Symptoms of diabetes mellitus

(i)Hyperglycemia

(ii) Glycosuria

(iii) Increased fat and protein metabolism

(iv) Ketosis

(v) Hypercholesterolemia

(vi) Atherosclerosis

(vii) Polyuria (increased urine volume)

(viii) Polydipsia (increased thirst)

(ix) Polyphagia (excessive ingestion of food)

(x) Coma and death.

Treatment

Diabetes mellitus can be treated by administering insulin subcutaneously or by giving oral antidiabetic agents. The patient may be advised to take a protein diet, but not the carbohydrate diet.

2. Glycosuria

Appearance of usually high amounts of sugar in the urine is called 'glycosuria'.

Depending upon the causes, glycosuria has been classified into various groups as:

(1) Alimentary glycosuria:

This term is used to denote glycosuria which sets up after the consumption of excessive amounts of sweet things like glucose, cane sugar, sweets or even starch via diet.

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY
Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme

(2) Diabetic glycosuria:

It is a pathological condition in which carbohydrate metabolism gets impaired which results in the appearance of sugar in the urine.

(3) Renal glycosuria (Renal diabetes):

This occurs due to some defect in the renal tubular transport mechanism of glucose.

(4) Adrenaline glycosuria:

It is also known as 'emotional' or 'psychic-glycosuria'. It occurs generally due to hypersecretion of adrenaline hormone from adrenal cortex.

3. Glycogen storage diseases

These diseases are referred to as the diseases caused by the accumulation of polysaccharide-glycogen. These are –

(1)**Von Gierke's disease:** It is due to hepatic glycogen storage.

(2)**Pompe's disease**: It is due to storage of normal glycogen in almost every organ of the body, including the heart.

(3)**Limit Dextinosis; Forbe's or Cori's disease:** It is due to Increased deposition of glycogen with very outer branches in the liver and other tissues.

(4) **Amylopectonosis or Anderson's disease**: It is due to deficiency of branching enzymes, which results in accumulation of glycogen.

4. Galactosemia:

- Due to deficiency of the enzyme Galactose-1-phosphate uridyl transferase (G1PUT) & Galactokinase, galactose cannot be converted into glucose, which leads to a condition called Galactosemia.
- It is characterized by increased galactose levels in circulation and urine.
- Accumulated galactose is converted into galactitol, which is responsible for the development of cataract.

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY
Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme
		• The clinical symptoms include Jaundice, Hepatosplenomegaly, mental retardation etc. **5. Fructose intolerance:** • One of the very normal hexose sugars of fruits(i.e. fructose) gets normally metabolized to give energy and CO2. • Defective metabolism of fructose develops in high concentration of this sugar in blood, known as Fructose intolerance.	
3		**Answer the following**	**20M**
3	**a**	**Define anemia.** **Answer:** Anemia is one type of red blood cell disorder where there is decrease in oxygen carrying capacity of blood due to deficiency of haemoglobin or due to decrease in RBCs count than normal or due to deficiency of iron.	**1**
3	**b**	**Which of the following is a sulphur containing amino acid?** **Answer: iii)** Methionine.	**1**
3	**c**	**Enlist any two routinely performed kidney function tests. (Any two= 1M)** **Answer:** **Routinely performed kidney function tests are as follows:** 1. Complete urine analysis, 2. Plasma urea and creatinine, 3. Plasma electrolytes, 4. Glomerular filtration rate, 5. Clearance tests: Urea clearance test, Inulin clearance test, creatinine clearance test etc. 6. Glomerular permeability, Proteinuria, 7. Reabsorption studies: Blood Urea Nitrogen, 8. Secretion, 9. Concentration and dilution tests,	**1**

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY
Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme
		10. Renal acidification etc.	
3	d	**Name any two lipid profile tests. (Any two tests: 1M)** **Answer:** **The lipid profile tests are as follows:** 1. Total cholesterol (TC) 2. High density lipoprotein cholesterol (HDL-C) 3. Low density lipoprotein cholesterol (LDL-C) 4. Triglycerides (TGs) 5. Very low density lipoprotein cholesterol (VLDL-C).	1
3	e	**What are the coenzymes of Riboflavin and Nicotinic acid? (½ Mark for each)** **Answer:** **Coenzyme of Riboflavin:** Flavin mononucleotide (FMN) & Flavin adenine dinucleotide (FAD). **Coenzyme of Nicotinic acid:** Nicotinamide adenine dinucleotide (NAD) & Nicotinamide adenine dinucleotide phosphate (NADP).	1
3	f	**Which of the following diseases is caused by the deficiency of Niacin?** **Answer: iii)** Pellagra.	1
3	g	**Explain fatty liver.** **Answer: Fatty liver:** It is the condition when excessive fat is deposited in the liver and results in deposition of toxic materials in the liver, this condition also known as hepatic steatosis. In this condition, weight of the liver increases about 10% than that of normal weight and causes inflammation, poor appetite, weight loss, abdominal pain, fatigue, weakness, fibrosis and cirrhosis of liver.	1
3	h	**Alkaptonuria is a disease related to ……..** **Answer:** Abnormal metabolism of amino acids.	1
3	i	**Define Essential amino acids.**	1

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY
Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme
		Answer: Essential amino acids are those which can not be synthesized by the body and hence it is essential to supply/consume from diet.	
3	j	**When glucose reacts with bromine water it forms -** **Answer: iv)** Gluconic acid.	1
3	k	**Name any two diseases due to malnutrition of proteins. (Any two: 1M)** **Answer:** Kwashiorkor, Nutritional oedema, Marasmus etc.	1
3	l	**Which of the following essential fatty acids has three double bonds?** **Answer:** i) Linolenic acid.	1
3	m	**Stearic acid has …….. carbon atoms.** **Answer:** 18.	1
3	n	**Name of vitamin A is ……** **Answer:** Retinol (Vit.A1) Dehydroretinol (Vit. A2)	1
3	o	**Hypercholesterolemia is caused due to ……..** **Answer:** High/increased level of cholesterol (>200 mg/dl) in blood than normal.	1
3	p	**Write full form of SGOT and SGPT.** **Answer:** SGOT: Serum glutamic oxalo-acetic transaminase. SGPT: Serum glutamic pyruvic transaminase.	1
3	q	**Jaundice is a symptom of disease. True or False.** **Answer:** True.	1
3	r	**What is the significance of BUN?** **Answer:** BUN i.e. Blood Urea Nitrogen, it shows how well the kidneys are functioning.	1
3	s	**Chloride and Bicarbonate ions occur predominantly in ……** **Answer:** Extracellular fluid.	1

WINTER– 2023 EXAMINATION

Model Answer – Only for the Use of RAC Assessors

Subject Name: BIOCHEMISTRY & CLINICAL PATHOLOGY

Subject Code: 20223

Q. No.	Sub No.	Answers	Marking Scheme
3	t	**Identify the purine base of nucleic acids in the following-** **Answer:** iv) Adenine.	1