BIOMOLECULES

TOPIC-WISE STUDY MATERIAL

BY

EXAMS ROAD

"Bringing Excellence to Students"

Concept of Biomolecules

Biomolecules are the complex lifeless organic substances. These build up living organisms and are required for their growth and maintenance. Carbohydrates, proteins, nucleic acids, lipids, etc., are the examples of biomolecules. Vitamins and mineral salts also play an important role in functions of organisms.

Carbohydrates

Carbohydrates are optically active polyhydroxy aldehydes or ketones or compounds which produce such units on hydrolysis.

Classification of Carbohydrates

Carbohydrates are also known as saccharides and classified according to their behaviour towards hydrolysis.

Carbohydrates

depending upon the units produced after hydrolysis

Monosaccharides	**Oligosaccharides**	**Polysaccharides**
Named systematically according to the number of carbon atoms they contain.	(*Oligos*-few) Yield 2-9 monosaccharides on hydrolysis.	Hydrolysed to more than 9 monosaccharides.
Crystalline solids, soluble in water and sweet in taste and collectively called sugars.		Amorphous solids, insoluble in water and tasteless and thus are called non-sugars.
Except sucrose, all are reducing sugars.		All polysaccharides are non-reducing sugars.

Monosaccharides

A carbohydrate that cannot be hydrolysed further to give simpler units is called monosaccharide, e.g. glucose, fructose, galactose are hexose while ribose and arabinose are pentose.
All monosaccharides are reducing sugars, commonly known as glucose.

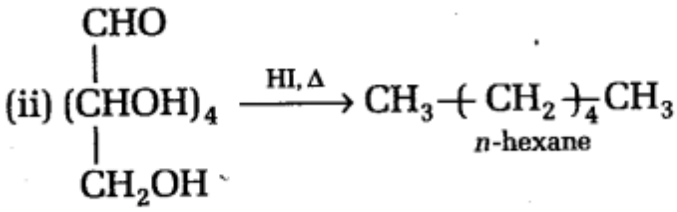
Preparation of Glucose ($C_6H_{12}O_6$)

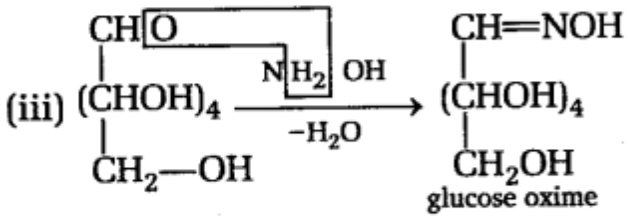
(i) $\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow[\text{or invertase}]{H^+} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$

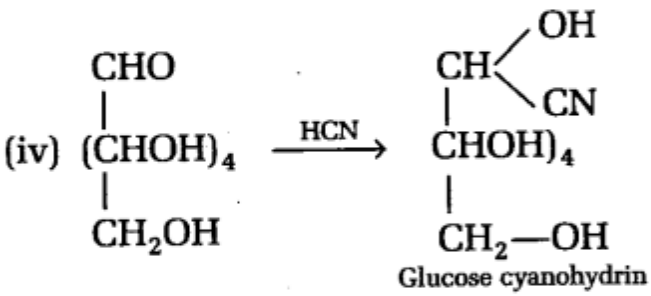
(ii) $\underset{\text{Starch}}{(C_6H_{10}O_5)_n} + nH_2O \xrightarrow[393\,K,\ 2\text{-}3\ atm]{H^+} \underset{\text{Glucose}}{nC_6H_{12}O_6}$

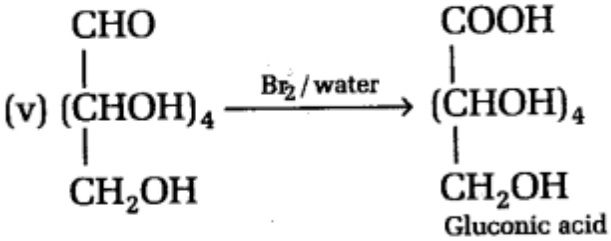
Properties of Glucose

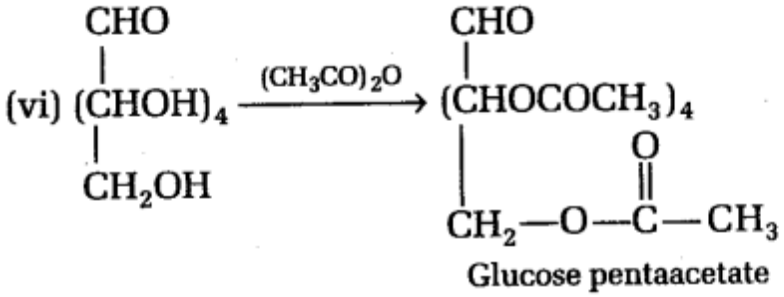
(i) Glucose is an aldohexose and is also known as **dextrose** (Grape sugar).

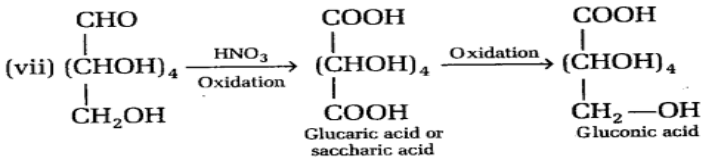


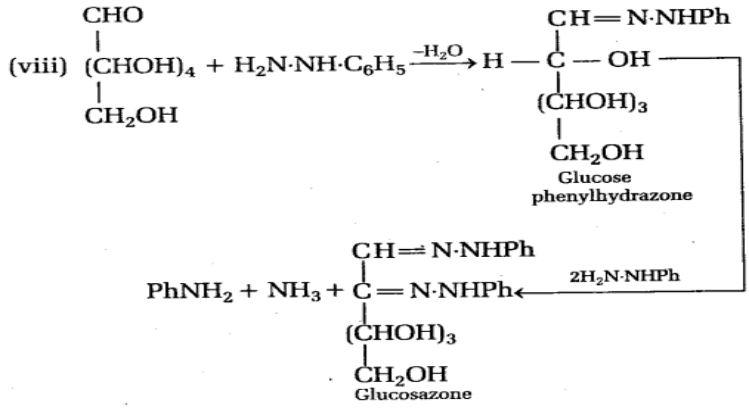








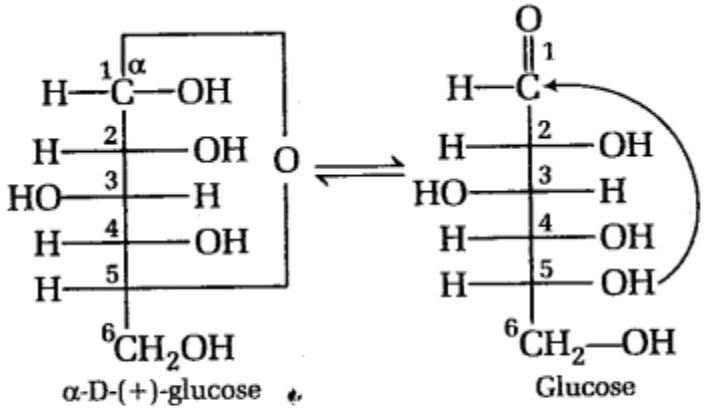


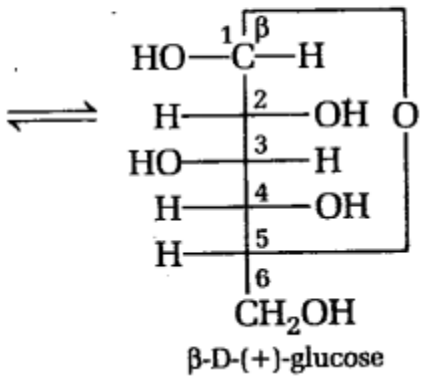


Glycolysis is the anaerobic degradation of glucose into two molecules of pyruvic acid.

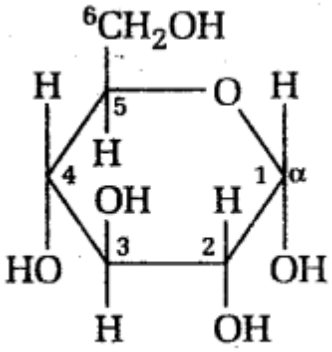
Structure of Glucose

1. **Fischer Projections**

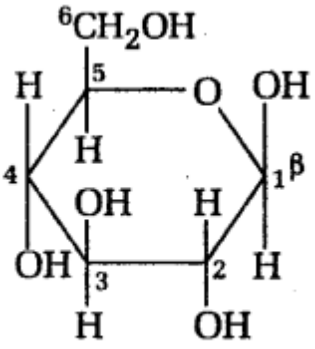




2. **Haworth Structures**



α-D-(+)-glucose



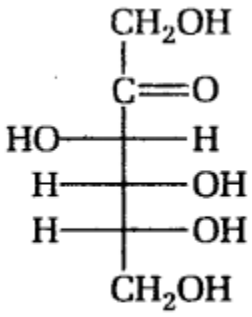
β-D-(+)-glucose

α and β-D-glucose have different configuration at anomeric (C-l) carbon atom, hence are called anomers.

While the pair of diastereomeric aldoses, e.g. glucose and mannose that differ only in configuration about C-2 are called epimers. Glucose and galactose differ in configuration at C-4 are called C-4 epimers

Structure of Fructose
(Laevulose: Fruit Sugar)

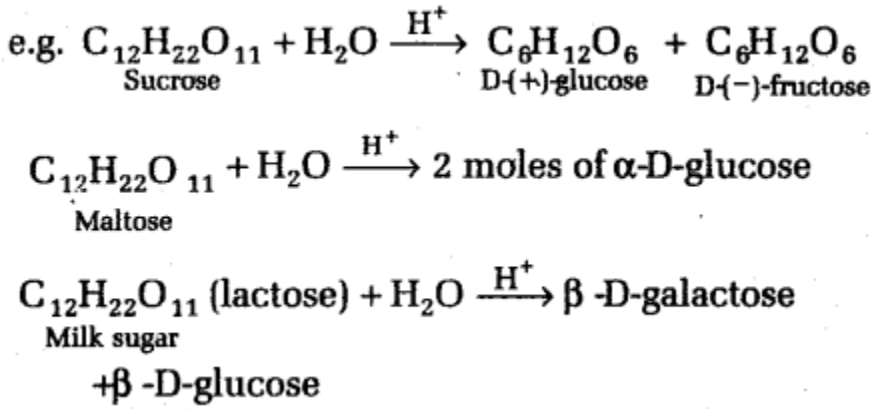
It is a functional isomer of glucose and has ketone group.



D-(–)-fructose

Oligosaccharides

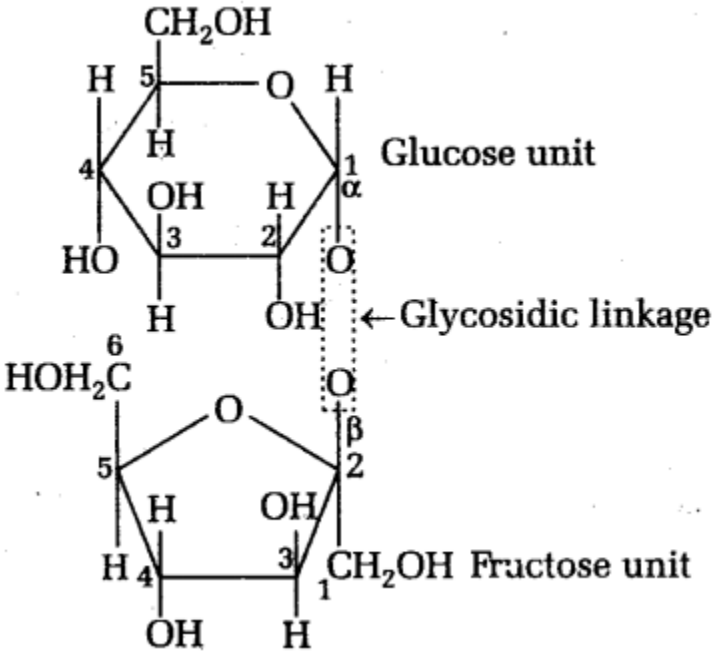
These are the carbohydrates that yield two to ten monosaccharide units on hydrolysis.
Oligosaccharides are further, classified as disaccharides, trisaccharides, tetrasaccharides etc., on the basis of number of monosaccharide units obtained on their hydrolysis, **e.g.** disaccharides : sucrose, maltose, lactose etc. trisaccharides : raffinose: tetrasaccharides : stachyrose.
Except sucrose, all other disaccharides are reducing in nature and hence, are called reducing sugars.
In disaccharides, the two monosaccharide units are joined together by an oxide linkage formed by the loss of a water molecule, this linkage is known as glycosidic linkage.



Sucrose

- It is non-reducing due to absence of free aldehyde or ketone group. It is cane sugar or table sugar.
- Sucrose is also known as invert sugar. It is due to the fact that on hydrolysis, **(+)-sucrose** gets inverted to give a mixture of **D-(+)-glucose and D-(-)-fructose**.
- In sucrose, free aldehyde or ketone group is absent. It is shown by the facts that it does not form osazone, does not exist in anomeric forms and also does not show mutarotation.

Structure of Sucrose

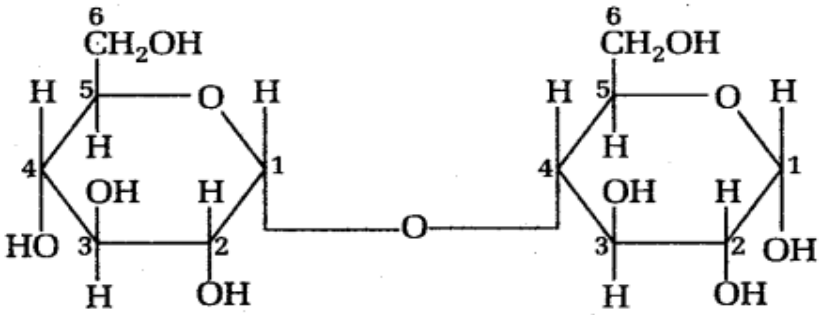


Maltose ($C_{12}H_{22}O_{11}$)

It is obtained by partial hydrolysis of starch by diastase enzyme present in malt, i.e. sprouted barley seeds (hence named maltose or malt sugar).

$$2(C_6H_{10}O_5)_n + nH_2O \xrightarrow{\text{Diastase}} nC_{12}H_{22}O_{11}$$

Maltose is'a white crystalline solid (**with mp 160°-165°C**), soluble in water and dextrorotatory. When it is hydrolysed with dilute acid or by enzyme maltase, maltose yields two molecules of **D-(+)-glucose**. Hence, maltose is a condensation product of two a-D-glucose units

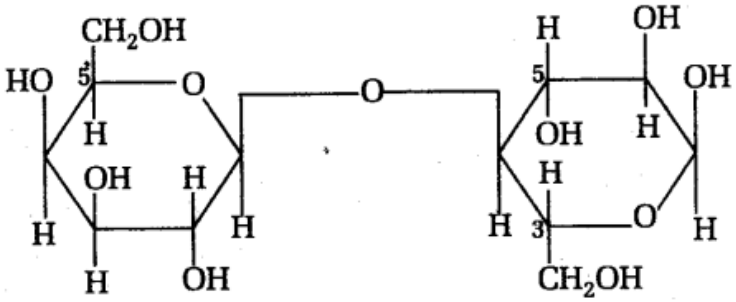


(+)-maltose

Maltose is a reducing sugar. It reduces Fehling's solution and Tollen's reagent, it forms an oxime and an osazone and undergoes mutarotation. This indicates that atleast one aldehyde group is free in maltose.

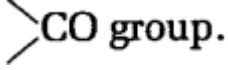
Lactose ($C_{12}H_{22}O_{11}$)

It occurs in the milk of all animals [milk sugar]. It is a white crystalline solid (**with mp 203°C**), soluble in water and is dextrorotatory. It is hydrolysed by dilute acid or enzyme lactase, to an equimolar mixture oi **D-(+)-glucose and D-(+)-galactose**. Lactose is a reducing sugar, forms an oxime and osazone and also undergoes mutarotation.
It gets hydrolysed by emulsin also, an enzyme which specifically hydrolyses β **-glycosidic linkage**.



(+)-lactose

Polysaccharides

- Carbohydrates which yield a large number of monosaccharide units on hydrolysis are called polysaccharides, **e.g.** starch, cellulose, glycogen, gums arabic etc.
  Polysaccharides are not sweet in taste, hence they are also called non-sugars. Moreover, all polysaccharides are non-reducing due to absence of free **—CHO** or  group.

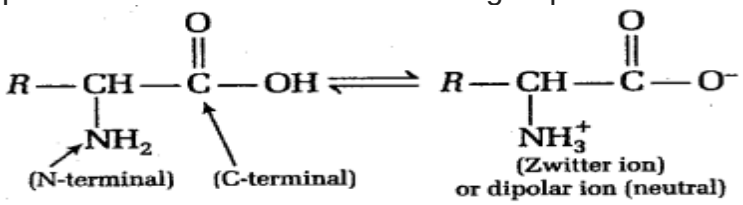
- Starch is the main storage polysaccharide of plants. It is a polymer of α – **D-glucose** units and consists of two components-amylose and amylopectin.
- Cellulose is a predominant constituent of cell wall of plant cells. It is a straight chain polysaccharide composed only of β **-D-glucose** units which are joined together by β **-1, 4-glycosidic linkage**, i.e. the **P-glycosidic** linkages between **C-l** of one glucose and **C-4** of the next glucose unit.
- Glycogen is the carbohydrate (a condensation polymer of α – **D-glucose**) which is stored in animal body. When the body needs glucose, enzymes break the glycogen down to glucose.

Proteins

Proteins are polymers of amino acids (the compounds which have both the acid and amino group). The total number of amino acids that have been found in proteins are twenty.
On the basis of their synthesis, amino acids are divided into two classes :

1. **Essential Amino Acids** are the amino acids which cannot be synthesised in the body and must be obtained through diet, e.g. valine, leucine, lysine, isoleucine, arginine etc. ’
2. **Non-essential Amino Acids** are the amino acids which can be synthesised in the body, e.g. glycine, alanine, glutamic acid, aspartic acid etc.

- Amino acids behave like salts rather than simple amines or carboxylic acids. This is due to the presence of both acidic and basic groups in the same molecule.

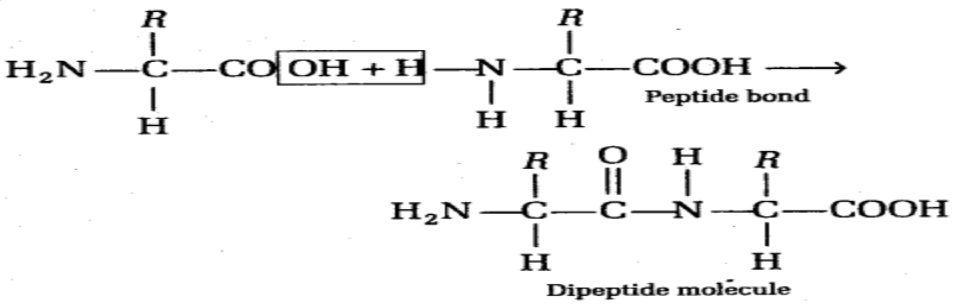


- At a certain pH of the medium, called the isoelectric point of an amino acid, the structure behaves as a dipolar ion and does not migrate to any electrode on passing current.
- Proteins give biuret test, Millon’s test, ninhydrin test. Those proteins give Molisch’s test, which contain a carbohydrate group. Carbohydrates also gives Molisch’s test.

Peptide Bond

Amino acids may be joined together by an amide linkage called peptide linkage **(—CO—NH—).**

e.g.



The molecule derived from two amino acids containing a single peptide linkage is called a dipeptide, that derived from three amino acids is termed as a tripeptide.
The peptides having 2-10 amino acid residues are called oligopeptides while those with greater than 10 amino acid residues are called polypeptides.
Polypeptide with molecular weight greater than 10,000 u is termed as a protein. Proteins generally have more than 70 amino acid residues, but a polypeptide with fewer α – Amino acids may also be called a protein if it has a well defined conformation characteristic of a protein such as insulin

Classification of Proteins

Proteins can be classified into two types on the basis of their molecular shape.

1. **Fibrous proteins** Polypeptide chains form fibre like structure, e.g. keratin and myosin etc.
2. **Globular proteins** This structure results when the chains of polypeptides coil around to give a spherical shape. These are usually soluble in water, e.g. insulin and albumins.

Structure of Proteins

N-terminal of one amino acid combines with C-terminal of other amino acid and forms peptide bond **(—NHCO—).**
In the same way, many amino acids combine to each other and form polypeptide bonds. Polypeptides with fewer amino acids are likely to be called proteins. Structure and shape of proteins may be discussed at four different levels.

1. **Primary Structure**
   Proteins may have one or more polypeptide chains. Specific sequence of amino acids in a chain gives the primary structure of that protein. Any change in this structure gives a different protein.
2. **Secondary Structure**
   The polypeptide chains are linked by hydrogen bonds. They are found to exist in two different types of structures α – helix and β pleated sheet structure.
3. **Tertiary Structure**
   It has polypeptide bonds, hydrogen bonds, disulphide linkages, van der Waals' forces and electrostatic forces of attraction. It gives rise to two major molecular shapes viz. fibrous and globular.
4. **Quarternary Structure**
   Some of the proteins are composed of two or more polypeptide chains referred to as subunits. The spatial arrangement of these subunits with respect to each other is known as quarternary structure.

Denaturation of Proteins

Disturbance of hydrogen bonds either by acids or alcohols or heat, results in unfolding of globules. Thus, helix get uncoiled and protein loses its biological activity due to change in temperature or pH.

This is called denaturation of proteins. During denaturation, secondary and tertiary structures of proteins are destroyed while primary structures remains intact.

Enzymes

Enzymes are globular protein bodies, which are biological catalysts. Enzyme inhibitors reduce the activity of a particular enzyme. These are mostly inorganic ions or complex organic molecules. Congenital and albinism diseases are caused by the deficiency of the enzymes phenyl ketone urea and tryosinase respectively.

Vitamins

Organic compounds required in the diet in small amounts to perform specific biological functions for normal maintenance of optimum growth and health of the organism, are termed as vitamins.

Types of Vitamins

- Fat or oil soluble vitamins, e.g. A D, E and K.
- Water soluble vitamins, e.g. B group vitamins and vitamin C.

Some important vitamins, their sources and their deficiency diseases

Name of vitamin	Sources	Deficiency diseases
Vitamin-A (Retinol)	Fish liver oil, carrots, butter and milk	Xerophthalmia (hardening of cornea of eye) or nigh blindness
Vitamin-B_1 (Thiamine)	Yeast, milk, green vegetables	Beri-beri (loss of appetite)
Vitamin-B_2 (Riboflavin)	Milk, egg white, liver, kidney	Cheilosis (fissuring at corners of mouth and lips)
Vitamin-B_6 (Pyredoxine)	Yeast, milk, egg yolk, cereals	Convulsions, nervousness
Vitamin-B_{12} (Cyanocobalamine)	Meat, fish, egg and curd	Pernicious anaemia (RBC deficient in haemoglobin)
Vitamin-C (Ascorbic acid)	Citrus fruits, amla and green leafy vegetables	Scurvy (bleeding gums)
Vitamin-D	Exposure to sunlight, fish and egg yolk	Rickets and osteomalacia
Vitamin-E	Wheat, germ oil, sunflower oil	Increased fragility of RBC and muscular weakness
Vitamin-K	Green leafy vegetables	Increased blood clotting time

Cyanides $(R—C \equiv N)$

Nomenclature Its IUPAC name is alkylcyanide.

Preparation of Cyanides

$$RX + KCN(alc.) \longrightarrow \underset{\text{Cyanide}}{RCN} + KX$$

$$\underset{\text{Amide}}{RCONH_2} \xrightarrow{P_2O_5} \underset{\text{Cyanide}}{RCN} + H_2O$$

Properties of Cyanides

Alkyl cyanides act as both nucleophile and electrophile. Cyanide provides a synthetic root for stepping up in a particular series.

(i) Mendius Reaction

$$\underset{\text{Cyanide}}{R-C\equiv N} + 2H_2 \xrightarrow{C_2H_5OH\text{-}Na} R-\underset{1^\circ \text{ amine}}{CH_2-NH_2}$$

(ii) Stephen's Reduction It is partial reduction of alkyl or aryl cyanides with $SnCl_2$ + conc. HCl to prepare aldehydes.

$$\underset{\text{Alkyl cyanide}}{R-C\equiv N} \xrightarrow[\Delta]{SnCl_2 + \text{conc. HCl}} \underset{\text{Aldehyde}}{RCHO}$$

(iii) Hydrolysis

$$RCN \xrightarrow{H_2O/OH^-} \underset{\text{Amide}}{RCONH_2}$$

$$RCN \xrightarrow{2H_2O/OH^-} \underset{\text{Carboxylic acid}}{RCOOH} + NH_4^+$$

$$RCN \xrightarrow[(ii)\ H_2O + H^+]{(i)\ R'MgX} \underset{\text{Ketone}}{RCOR'}$$

$$RCN \xrightarrow[(ii)\ HCl]{(i)\ R'OH + H_2O} \underset{\text{Ester}}{RCOOR'}$$

Isocyanides $(R-N\rightleftharpoons C)$

They are commonly called as carbylamines.

Preparation of Isocyanides

(i) $\underset{\text{Alkyl halide}}{R—X} + \underset{\text{Silver cyanide}}{AgCN} \longrightarrow RN \rightleftharpoons C + AgX$

(ii) Carbylamine Reaction

$$\underset{\substack{1^\circ \text{ amine} \\ (\text{aliphatic or aromatic})}}{RNH_2} + \underset{\text{Chloroform}}{CHCl_3} + 3KOH \xrightarrow{\Delta} \underset{\substack{\text{Isocyanide} \\ (\text{bad smelling compound})}}{RNC} + 3KCl + 3H_2O$$

Properties of Isocyanides

(i) Hydrolysis

$$\underset{\text{Isocyanide}}{RNC} + 2H_2O \xrightarrow{H^+} \underset{1^\circ \text{amine}}{RNH_2} + \underset{\text{Formic acid}}{HCOOH}$$

(ii) Reduction

$$\underset{\text{Isocyanide}}{RNC} \xrightarrow[4[H]]{Na-C_2H_5OH} \underset{2^\circ \text{amine}}{R—NHCH_3}$$

(iii) Methyl isocyanate (MIC) $CH_3N{=}{=}C{=}{=}O$ was responsible for Bhopal gas tragedy in December 1984.

Difference between Cyanides and Isocyanides

- Alkyl cyanides have pleasant smell but isocyanides have highly unpleasant odour.
- Alkyl cyanides have lower dipole moment than isocyanides.

$$\text{Cyanides} \xrightarrow{H^+/OH^-} \underset{\text{Amide}}{RCONH_2}$$

$$\text{Isocyanides} \xrightarrow{\text{Acids}} 1^\circ \text{ amine} + HCOOH$$

- Alkyl cyanide undergoes both acidic and alkaline hydrolysis while alkyl isocyanide undergoes only acidic hydrolysis because negatively charged carbon atom repel **OH**$^-$ ion of the base.
- Reduction

$$\text{Cyanides} \xrightarrow{\text{Reduction}} 1^\circ \text{ amine}$$

$$\text{Isocyanides} \xrightarrow{\text{Reduction}} 2^\circ \text{ amine}$$

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Question 1.
The change in the optical rotation of freshly prepared solution of glucose is known as
(a) tautomerism
(b) racemisation
(c) specific rotation
(d) mutarotation

- **Question 2.**
Amylopectin is a polymer of
(a) α-D-glucose
(b) α-D-fructose
(c) lactose
(d) amylose

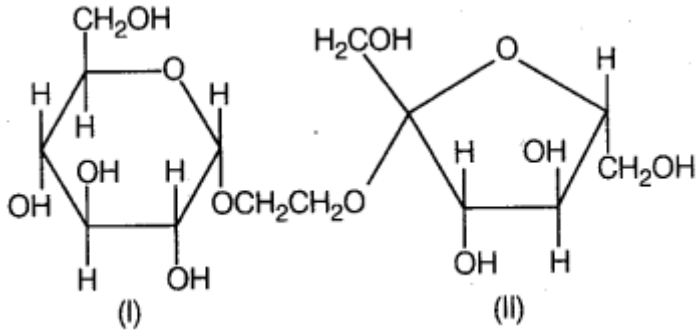
- **Question 3.**
The term anomers of glucose refers to
(a) isomers of glucose that differ in configuration at carbons one and four (C-1 and C-4)
(b) a mixture of D-glucose and L-glucose
(c) enantiomers of glucose
(d) isomers of glucose that differ in configuration at carbon one C-1

- **Question 4.**
Methyl α-D-glucoside and methyl-β-D-glucoside are
(a) epimers
(b) anomers
(c) enantiomers
(d) conformational diastereomers

- **Question 5.**
Number of chiral carbon atoms in β-D-(+)-glucose is
(a) five
(b) six
(c) three
(d) four

- **Question 6.**
Glycogen is a branched chain polymer of α-D-glucose units in which chain is formed by CrC4 glycosidic linkage whereas, branching occurs by the formation of CrC6 glycosidic linkage. Structure of glycogen is Similar to
(a) amylose
(b) amylopectin
(c) cellulose
(d) glycogen

- **Question 7.**
The correct statement about the following disaccharide is



(I) (II)

(a) Ring (I) is pyranose with α-glycosidic link
(b) Ring (I) is furanose with α-glycosidic link
(c) Ring (II) is furanose with α-glycosidic link
(d) Ring (II) is pyranose with α-glycosidic link

- **Question 8.**
Which of the following is an example of ketohexose?
(a) Mannose
(b) Galactose
(c) Maltose
(d) Fructose

- **Question 9.**
Which one of the following does not reduce Fehling's solution?
(a) Benzaldehyde
(b) Formic acid
(c) Glucose
(d) Fructose

- **Question 10.**
Sucrose (cane sugar) is a disaccharide. One molecule of sucrose on hydrolysis gives
(a) 2 molecules of glucose
(b) 2 molecules of glucose + 1 molecule of fructose
(c) 1 molecule of glucose + 1 molecule of fructose
(d) 2 molecules of fructose

- **Question 11.**
A compound give negative test with ninhydrin and positive test with Benedict's solution. The compound is
(a) a protein
(b) an amino acid
(c) a lipid
(d) a monosaccharide

- **Question 12.**
  Which of the following polymer is stored in the liver of animals?
  (a) Amylose
  (b) Cellulose
  (c) Amylopectin
  (d) Glycogen

- **Question 13.**
  Complete hydrolysis of cellulose gives
  (a) D-fructose
  (b) D-ribose
  (c) D-g1ucose
  (d) L-glucose

- **Question 14.**
  Raffinose is a
  (a) disaccharide
  (b) monosaccharide
  (c) trisaccharide
  (d) None of these

- **Question 15.**
  Which one is a fibrous protein?
  (a) Globulin
  (b) Collagen
  (c) Hordein
  (d) Glutin

- **Question 16.**
  Casein contained in milk is a/an
  (a) carbohydrate
  (b) lipid
  (c) protein
  (d) important molecule

- **Question 17.**
  Which of the following has an imino (⁄NH) group instead of an amino group (-NH2) ?
  (a) Proline
  (b) Isoleucine
  (c) Tyrosine
  (d) Serine

- **Question 18.**
  Insulin is a/an
  (a) protein
  (b) amino acid
  (c) carbohydrate
  (d) lipid

- **Question 19.**
  The number of amino acids in insulin is
  (a) 21
  (b) 574
  (c) 51
  (d) 5733

- **Question 20.**
  Which functional group participates in disulphide bond formation in proteins?
  (a) Thiolactone
  (b) Thiol
  (c) Thioether
  (d) Thioester

- **Question 21.**
  Which one of the following biomolecules is insoluble in water?
  (a) α-keratin
  (b) Haemoglobin
  (c) Ribonuclease
  (d) Adenine

- **Question 22.**
  Which one of the following is a conjugated protein?
  (a) Phosphoprotein
  (b) Glycoprotein
  (c) Chromoprotein
  (d) All of these

- **Question 23.**
  There are 20 naturally occurring amino acids. The maximum number of tripeptides that can be obtained is
  (a) 8000
  (b) 6470
  (c) 7465
  (d) 5360

- **Question 24.**
  Which amino acid has imidazole ring?
  (a) Alanine
  (b) Leucine
  (c) Tyrosine
  (d) Histidine

- **Question 25.**
  Which of the following set consists only of essential amino acids?
  (a) Alanine, tyrosine, cystine
  (b) Leucine, lysine, tryptophan
  (c) Alanine, glutamine, lycine
  (d) Leucine, proline, glycine

- **Question 26.**
  Isoelectric point is
  (a) specific temperature
  (b) suitable concentration of amino acid
  (c) hydrogen ion concentration that does not allow migration of amino acid under electric field
  (d) melting point of an amino acid under the influence of electric field

- **Question 27.**
  Proteins when heated with cone. HNO_3 give a yellow colour. This is
  (a) Hoppe's test
  (b) acid-base test
  (c) Biuret test
  (d) xanthoproteic test

- **Question 28.**
  The enzymes which have control site in addition to active site are called
  (a) holozymes
  (b) coenzymes
  (c) apoenzymes
  (d) allosteric enzymes

- **Question 29.**
  The change in optical rotation with time of freshly prepared solution of sugar (with enzymes) is known as
  (a) specific rotation
  (b) inversion
  (c) rotatory motion
  (d) mutarotation

- **Question 30.**
  Which of the following contains cobalt?
  (a) Vitamin-A
  (b) Vitamin-C
  (c) Vitamin-B_{12}
  (d) Vitamin-K

- **Question 31.**
  Which of the following acids is a vitamin?
  (a) Aspartic acid
  (b) Ascorbic acid
  (c) Adipic acid
  (d) Saccharic acid

- **Question 32.**
  Night blindness may be caused by the deficiency of vitamin
  (a) A
  (b) B
  (c) C
  (d) D

- **Question 33.**
  Which of the following B group vitamins can be stored in our body?
  (a) Vitamin B_1
  (b) Vitamin B_2
  (c) Vitamin B_6
  (d) Vitamin B_{12}

- **Question 34.**
  A nucleotide consists of
  (a) base and a sugar
  (b) sugar and phosphate
  (c) base, sugar and phosphate
  (d) base and phosphate

- **Question 35.**
  RNA contains
  (a) ribose sugar and thymine
  (b) ribose sugar and uracil
  (c) deoxyribose sugar and uracil
  (d) deoxyribose sugar and thymine

- **Question 36.**
  Gene is a segment of
  (a) DNA
  (b) protein
  (c) mRNA
  (d) tRNA

- **Question 37.**
  Codon is present in
  (a) tRNA
  (b) mRNA
  (c) fats
  (d) rRNA

- **Question 38.**
  Nucleic acids are polymers of
  (a) nucleosides
  (b) globulins
  (c) nucleons
  (d) nucleotides

- **Question 39.**
  The reason for double helical structure of DNA is operation of
  (a) van der Waals' forces
  (b) dipole-dipole interaction
  (c) hydrogen bonding
  (d) electrostatic attractions

- **Question 40.**
  The pyrimidine bases present in DNA are
  (a) cytosine and adenine
  (b) cytosine and guanine
  (c) cytosine and thymine
  (d) cytosine and uracil

- **Question 41.**
  RNA and DNA are chiral molecules, their chirality is due to
  (a) L-sugar component
  (b) chiral bases
  (c) D-sugar component
  (d) chiral phosphate ester units

- **Question 42.**
  In both DNA and RNA, heterocyclic base and phosphate ester linkages are at
  (a) C'_5 and C'_1 respectively of the sugar molecule
  (b) C'_1 and C'_5 respectively of the sugar molecule
  (c) C'_2 and C'_5 respectively of the sugar molecule
  (d) C'_5 and C'_2 respectively of the sugar molecule

- **Question 43.**
  DNA and RNA contain four bases each. Which of the following base is not present in RNA?
  (a) Adenine
  (b) Uracil
  (c) Thymine
  (d) Cytosine

- **Question 44.**
  Antibiotic inhibiting translation in eukaryotes is
  (a) tetracycline
  (b) penicillin
  (c) puromycin
  (d) Chloromycetin

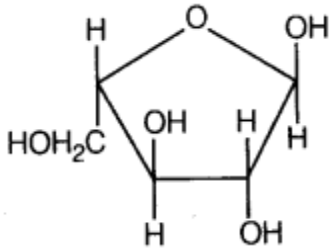
- **Question 45.**
  Which one of the following is a peptide hormone?
  (a) Glucagon
  (b) Testosterone
  (c) Thyroxine
  (d) Adrenaline

- **Question 46.**
  Insulin production of its action in human body are responsible for the level of diabetes. This compound belongs to which of the following categories?
  (a) A coenzyme
  (b) A hormone
  (c) An enzyme
  (d) An antibiotic

- **Direction (Q.Nos.47-48):** In the following questions more than one of the answers given may be correct. Select the correct answers and mark it accordingly to the codes.
  Codes
  (a) 1,2 and 3 are correct
  (b) 1 and 2 are correct
  (c) 2 and 4 are correct
  (d) 1 and 3 are correct

- **Question 47.**
  Which of the following statements are true?
  1. Maltose forms an osazone
  2. Lactose undergoes mutarotation
  3. Galactose is a C_4-epimer of glucose
  4. in starch, the glucose units are linked by β-linkages

- **Question 48.**
  Which set of terms correctly identifies the carbohydrate shown?



  1. Pentose
  2. Aldose
  3. Furanose
  4. Pyranose

- **Question 49.**
  Match the vitamin in Column I with deficiency disease in Column II and choose the correct codes given below.

Column I		Column II	
A.	Vitamin A	1.	Scurvy
B.	Vitamin B_{12}	2.	Pernicious anaemia
C.	Vitamin C	3.	Sterility
D.	Vitamin E	4.	Xerophthalmia

Codes

	A	B	C	D
(a)	3	4	5	2
(c)	4	2	1	3

	A	B	C	D
(b)	3	4	5	1
(d)	3	5	4	2

- **Question 50.**

Match the Column I with Column II and choose the correct codes given below.

Column I	Column II
A. Thymine	1. Cell wall component
B. Insulin	2. Enzyme
C. Pepsin	3. Hormone
D. Phospholipids	4. Pyrimidine

Codes

	A	B	C	D
(a)	1	2	3	4
(c)	4	1	3	2

	A	B	C	D
(b)	4	3	2	1
(d)	2	1	4	3

- **Direction (Q.Nos.51-54):** Each of these questions contain two statements: Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a),(b), (c) and (d) given below.
(a) Assertion is true, Reason is true; Reason is a correct explanation for Assertion
(b) Assertion is true, Reason is true; Reason is not a correct explanation for Assertion
(c) Assertion is true, Reason is false
(d) Assertion is false, Reason is true

- **Question 51.**
Assertion: DNA undergoes replication.
Reason: DNA contains cytosine and thymine as pyrimidine base.

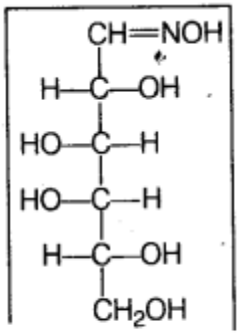
- **Question 52.**
Assertion: Maltose is a reducing sugar which give two moles of D-glucose on hydrolysis.
Reason: Maltose has a 1,4-p-glycosidic linkage.

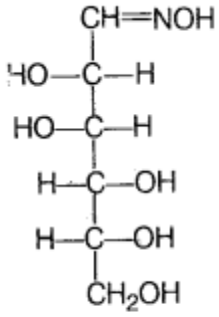
- **Question 53.**
Assertion: The term anomers of glucose refers to isomers of glucose that differ in configuration at carbon one (C-1).
Reason: Anomers of glucose are cyclic diastereomers differ in configuration at C-1 existing in two forms a and b respectively.

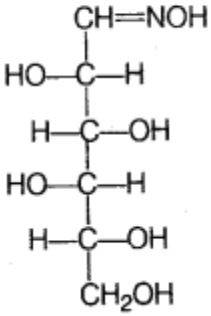
- **Question 54.**
Assertion: CO and NO both combine with haemoglobin.
Reason: NO has more affinity than CO towards haemoglobin.

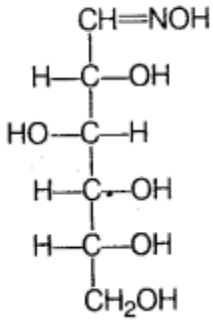
- **Question 55.**
D-(+)-glucose reacts with hydroxylamine and yields an oxime. The structure of the oxime

would be

(a) 

(b) 

(c) 

(d) 

- **Question 56.**
  Which of the following hormones is produced under the condition of stress which stimulates glycogenolysis in the liver of human beings?
  (a) Thyroxine
  (b) Insulin
  (c) Adrenaline
  (d) Estradiol

- **Question 57.**
  Deficiency of vitamin B_1 causes the disease
  (a) convulsions
  (b) beri-beri
  (c) cheilosis
  (d) sterility

- **Question 58.**
  Which one of the following sets of monosaccharides forms sucrose?
  (a) α-D-galactopyranose and α-D-glucopyranose
  (b) α-D-glucopyranose and β-D-fructofuranose
  (c) β -D-glucopyranose and α-D-fructofuranose
  (d) α-D-galactopyranose and β-D-fructofuranose

- **Question 59.**
  DNA multiplication is called
  (a) translation
  (b) transduction
  (c) transcription
  (d) replication

- **Question 60.**
  Glucose molecule reacts with X number of molecules of phenyl hydrazine to yield osazone. The value of X is
  (a) four
  (b) one
  (c) two
  (d) three

- **Question 61.**
  Which base is present in RNA but not in DNA?
  (a) Uracil
  (b) Cytosine
  (c) Guanine
  (d) Thymine

- **Question 62.**
  Which one of the following statements is not true regarding (+) lactose?
  (a) (+) lactose is a b-glycoside formed by the union of a molecule of D-(+)-glucose and a molecule of D-(+)-galactose
  (b) (+) lactose is a reducing sugar and does not exhibit mutarotation
  (c) (+) lactose, $C_{12}H_{22}O_{11}$ contains 8 —OH groups
  (d) On hydrolysis, (+) lactose gives equal amount of D-(+)-glucose and D-(+)-galactose

- **Question 63.**
  Which one of the following is an example of non-reducing sugar?
  (a) Sucrose
  (b) Lactose
  (c) Maltose
  (d) Cellobiose

- **Question 64.**
  The amino acid which is not optically active is
  (a) lactic acid
  (b) serine
  (c) alanine
  (d) glycine

- **Question 65.**
  A codon has a sequence of A and specifies a particular B that is to be incorporated into a C. What are A, B, C?
  A B C
  (a) 3 bases Amino acid Carbohydrate
  (b) 3 acids Carbohydrate Protein
  (c) 3 bases Protein Amino acid
  (d) 3 bases Amino acid Protein

- **Question 66.**
  Which one of the following does not exhibit the phenomenon of mutarotation?
  (a) (+) sucrose
  (b) (+) lactose
  (c) (+) maltose
  (d) (-) fructose

- **Question 67.**
  Hydrolysis of sucrose is called
  (a) inversion
  (b) esterification
  (c) hydration
  (d) saponification

- **Question 68.**
  Carbohydrates which differ in configuration at the glycosidic carbon (i.e. C_1 in aldose and C_2 in ketose) are called
  (a) anomers
  (b) epimers
  (c) diastereomers
  (d) enantiomers

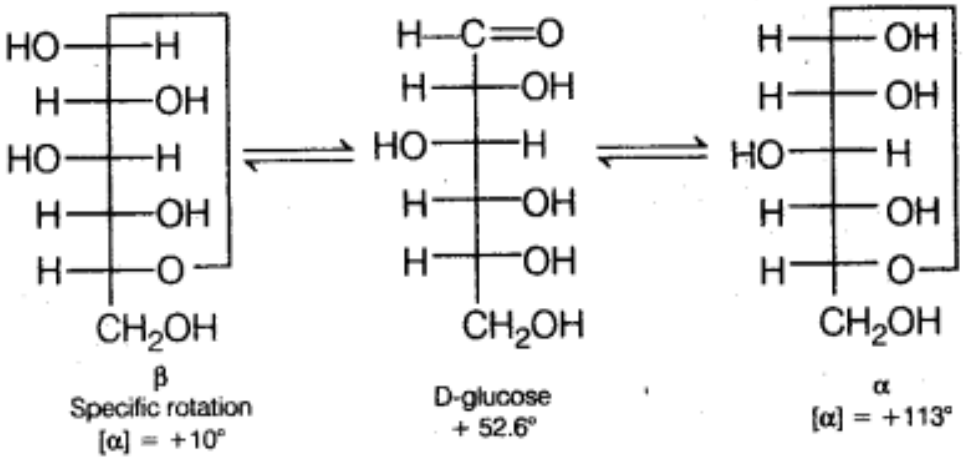
- **Question 69.**
  Secondary structure of proteins refers to
  (a) mainly denatured proteins and structure of prosthetic group
  (b) three dimensional structure, especially the bond between amino acid residue that are distant from each other in the polypeptide chain
  (c) linear sequence of amino acid residues in the polypeptide chain
  (d) regular folding patterns of continuous portions of the polypeptide chain

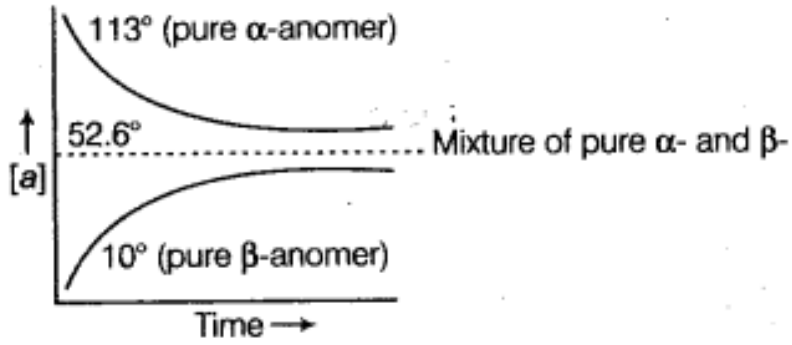
- **Answers:**

1. (d)	2. (a)	3. (d)	4. (b)	5. (a)	6. (b)	7. (a)	8. (d)	9. (d)	10. (c)
11. (d)	12. (d)	13. (c)	14. (c)	15. (a)	16. (c)	17. (a)	18. (a)	19. (c)	20. (b)
21. (a)	22. (d)	23. (a)	24. (d)	25. (b)	26. (c)	27. (d)	28. (d)	29. (b)	30. (c)
31. (b)	32. (a)	33. (d)	34. (c)	35. (b)	36. (a)	37. (b)	38. (d)	39. (c)	40. (c)
41. (c)	42. (a)	43. (c)	44. (c)	45. (a)	46. (b)	47. (a)	48. (a)	49. (c)	50. (b)
51. (b)	52. (c)	53. (a)	54. (b)	55. (d)	56. (c)	57. (b)	58. (b)	59. (d)	60. (d)
61. (a)	62. (b)	63. (a)	64. (d)	65. (d)	66. (a)	67. (a)	68. (a)	69. (d)	

Hints And Solutions:

1. A spontaneous change in the specific rotation of a solution of an optically active compound is called mutarotation. Hemiacetal forms of α and β-D-glucose are stable in solid state but in aqueous solution, there is opening of the cyclic structure which gives solution of constant specific rotation.

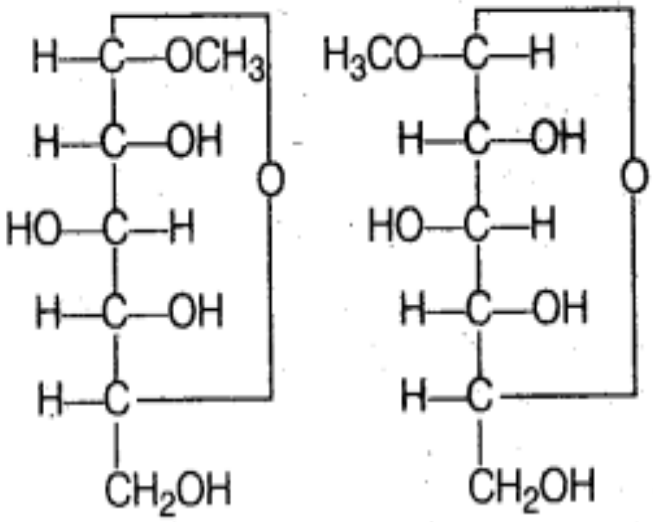




2. Amylopectin is a polymer of α-D-glucose. It consists of branched chains of α-D-glucose involving about 1000 or more units per molecule.

3. Anomers of glucose are cyclic diastereomers differ in configuration at C-1 existing in two forms α and β respectively.

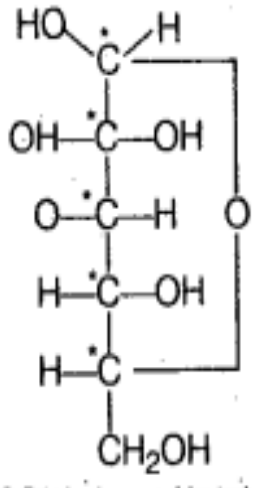
4. Anomers are differing in configuration at asymmetric carbon produced due to ring formation.



Methyl α-D-glucoside (dextro)

Methyl β-D-glucoside (laevo)

5.



β-D(+)-glucose (dextro)

Chiral carbon atoms = 5.

7. Ring *A* is pyranose (6 membered ring containing one O-atom) with α-glycosidic linkage and ring is furanose with β -glycosidic linkage.

8. Fructose is an example of ketohexose while glucose is an example of aldohexose.

9. Fructose does not reduce Fehling's solution because it contains ketonic group.

10. $\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} + H_2O \longrightarrow \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$

11. Protein gives blue violet colour with ninhydrin while carbohydrate gives negative test with ninhydrin. Carbohydrates give brown red precipitate with Benedict's solution. Hence, compound is monosaccharide.

13. Cellulose is a polysaccharide, composed of D-glucose units which are joined by β -glycosidic linkages.

$$\underset{\text{Cellulose}}{(C_6H_{10}O_5)_n} + nH_2O \xrightarrow{H^+} \underset{\text{D-glucose}}{nC_6H_{12}O_6}$$

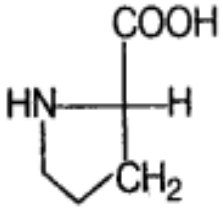
14. Raffinose is a trisaccharide because it gives three molecules of monosaccharide on hydrolysis.

$$C_{18}H_{32}O_{16} + H_2O \longrightarrow \underset{\text{(1 glucose + 1 fructose + 1 mannose)}}{3C_6H_{12}O_6}$$

15. Globulin is a fibrous protein. These are long and thread like molecules and insoluble in water.

16. Casein contained in milk is a protein.

17. Proline;



has an imino group instead of $-NH_2$ group.

18. Insulin is a protein, it consists of 51 amino acids in two chains α and β.

19. There are 51 amino acids in insulin. It has two polypeptide chains with 21 and 30 amino acids.

20. Disulphide bond may be reduced to thiol by means of reagents, i.e. $NaBH_4$, which shows the presence of thiol group in disulphide bond formation.

21. α-keratin is water insoluble fibrous protein. It is the major constituent of nail, hair and skin.

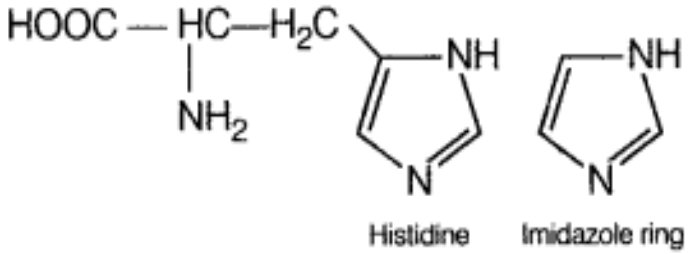
22. Conjugated proteins on hydrolysis give a non-protein portion alongwith α-amino acid. The non-protein portion is called prosthetic group.

Protein	Prosthetic group
Phosphoprotein	Lipid (e.g., lecithin)
Glycoprotein	Sugar
Chromoprotein	Coloured matter such as red coloured protophyrin

Since, all of them have non-protein part hence, all of them are conjugated proteins.

23. Naturally occurring amino acids are 20.
Hence, number of possible tripeptides $= 20^3 = 8000$

24. Histidine is the unique amino acid, which contains imidazole ring.



Histidine Imidazole ring

25. Essential amino acids (10) are as follows:

(i) Arginine	(vi) Methionine
(ii) Histidine	(vii) Phenylalanine
(iii) Isoleucine	(viii) Threonine
(iv) Leucine	(ix) Tryptophan
(v) Lysine	(x) Valine

26. Isoelectric point is a pH at which Zwitter ions do not migrate towards any of the electrode. Amino acids are also Zwitter ions hence, they do not migrate under electric field at isoelectric point.

27. Xanthoproteic test is given by only those proteins which consists of α-amino acid containing benzene ring.
e.g. tyrosine.

$$\text{Proteins} + \text{conc. } HNO_3 \xrightarrow{\Delta} \text{Yellow colour}$$

28. Allosteric site is a control site in addition to the active site in enzymes.

29. It is known as inversion of sugar.

30. Vitamin B_{12} contains cobalt and its chemical name is cyanocobalamin. Its deficiency causes pernicious anaemia.

31. Vitramin C is also known as ascorbic acid.

32. Night blindness is caused by the deficiency of vitamin A or retinol.

34. A nucleotide consists of three chemical components.

(i) A nitrogen containing heterocyclic base (amine)

(ii) A five carbon sugar

(iii) A phosphate group

35. RNA contains ribose sugar and uracil base.

36. Gene is a part of DNA molecule. It codes for a specific protein or polypeptide.

37. Codon is present in *m*RNA which is responsible for translation.

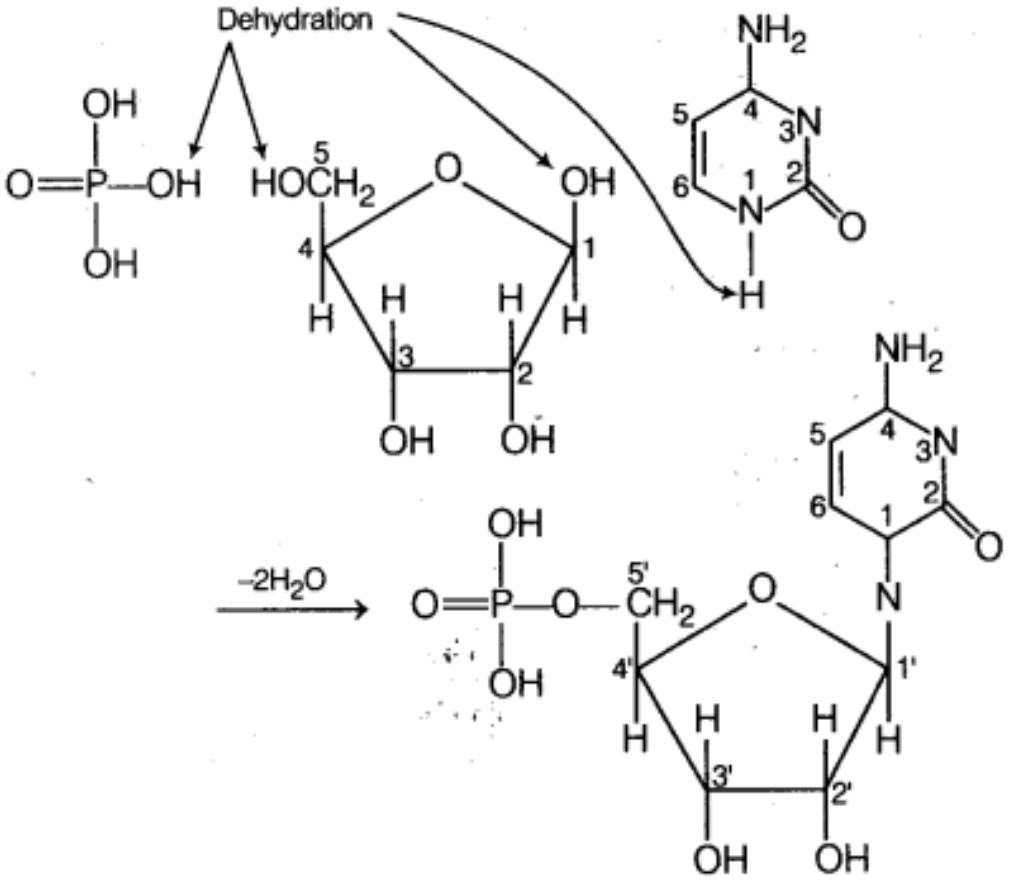
38. Nucleic acids are polymers of nucleotides. They play an important role in all living cells. There are two types of nucleic acids, DNA and RNA.

39. Hydrogen bonding is present in between purine-pyrimidine bases in DNA molecule.

40. The pyrimidine bases present in DNA are cytosine and thymine while adenine and guanine are purine bases.

41. RNA and DNA molecules have ribose and deoxyribose sugar respectively. Both are chiral, their chirality is due to D-ribose or deoxyribose sugar component.

42. Synthesis of RNA/DNA from phosphoric acid, ribose and cytosine is given below



Thus, ester linkages are at C_5' and C_1' of sugar molecule.

43. In RNA, uracil is present instead of thymine.

44. The antibiotic puromycin inhibit protein synthesis by causing nascent polypeptide chains to be released before their synthesis is completed.

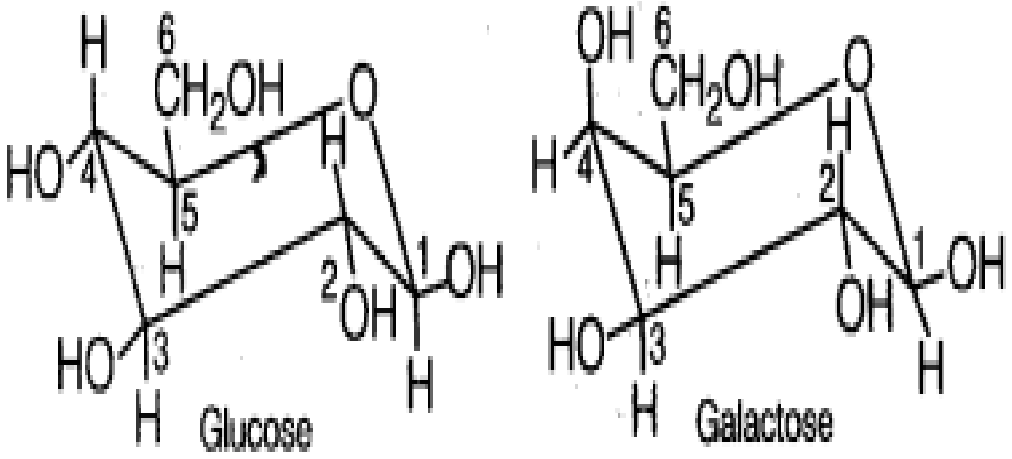
45. Glucagon is a peptide hormone because in it, peptide linkage is present.

46. Insulin is a proteinaceous hormone. It is secreted by pancreas and controls the metabolism of glucose and maintains glucose level in the blood.

47. (1) Maltose ($C_{12}H_{22}O_{11}$), a disaccharide, reacts with phenyl hydrazine to give an osazone ($C_{12}H_{20}O_9 = N \cdot NHC_6H_5)_2$.

(2) All monosaccharides and reducing disaccharides undergo mutarotation.

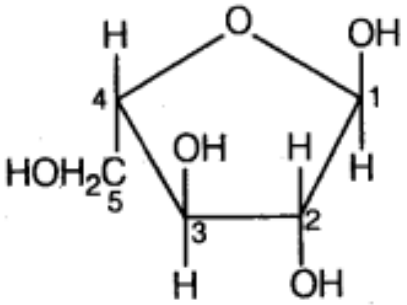
(3) The structure of glucose and galactose are as



Thus, galactose is C-4 epimer of glucose.

(4) In starch, the glucose units are linked by α-linkages.

48.



This compound contains five carbons atoms, so it is a pentose. Its first carbon contains —H and —OH groups. This suggests that it is an aldose (i.e. contains aldehyde group). Since, its structure is similar to furan (a heterocyclic compound), so it has furanose structure.

Hence, this compound is a pentose, aldose and have furanose structure.

49.

	Vitamin I	Deficiency Disease II
A.	Vitamin A	Xerophthalmia
B.	Vitamin B_{12}	Pernicious anaemia
C.	Vitamin C	Scurvy
D.	Vitamin E	Sterility

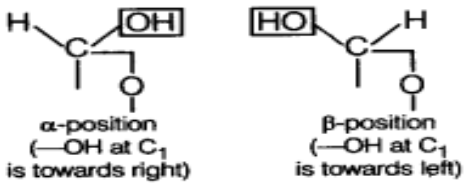
50.

	Biomolecule I	Nature II
A.	Thymine	Pyrimidine base
B.	Insulin	Hormone
C.	Pepsin	Enzyme
D.	Phospholipids	Cell wall component

51. The genetic information of the cell is contained in the sequences of base A, T, G and C in DNA molecule. When a cell divides, DNA molecules replicate and make exact copies of themselves so, that each daughter cell will have DNA identical to that of the parent cell.

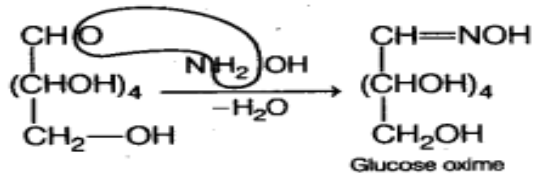
52. Maltose, a disaccharide ($C_{12}H_{22}O_{11}$) is a reducing sugar, which upon hydrolysis yield 2 moles of D-(+)-glucose. In it the two D-glucose units are linked through α-glycosidic linkage between C-1 of one glucose unit and C-4 of the other.

53.



54. Both Assertion and Reason are true but Reason is not the true explanation of Assertion.

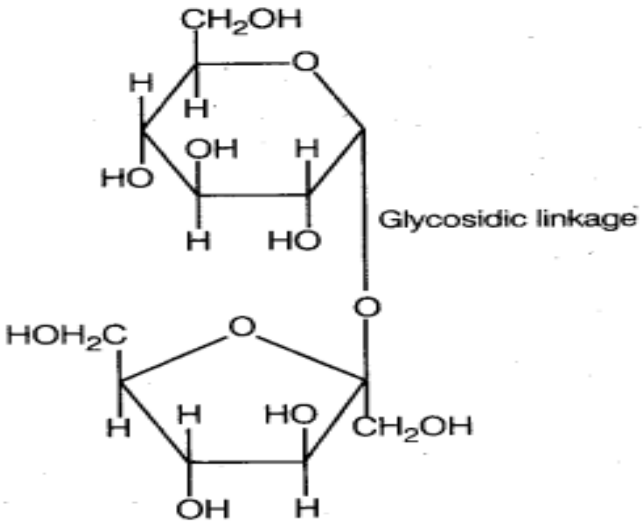
55.



56. Epinephrine (adrenaline) hormone produced in the adrenal medulla that helps the body to respond to emergency situations. This stimulates glycogenolysis in the liver of human beings.

57. Deficiency of vitamin B_1 causes beri-beri in which there occurs loss of appetite and vigour, weak heart beat etc.

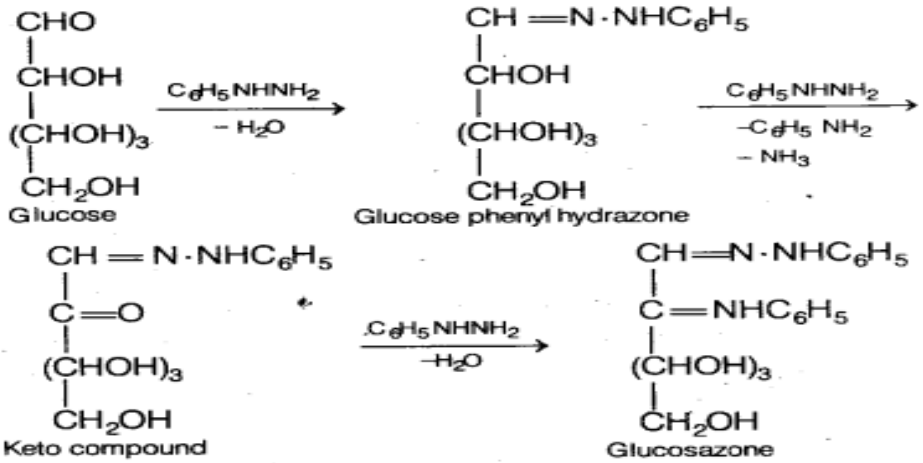
58. Sucrose is composed of α-D-glucopyranose and a β-D-fructofruanose units which are joined by α, β-glycosidic linkage between C-1 of the glucose unit and C-2 of the fructose unit.



Structure of sucrose

59. The formation of DNA from older one is called replication. It requires a DNA templete, a primer deoxyribonucleoside triphosphates (dATP. dGTP, dTTP, dCTP), Mg^{2+}, DNA unwinding protein supper helix releasing protein. It is also called as DNA multiplication.

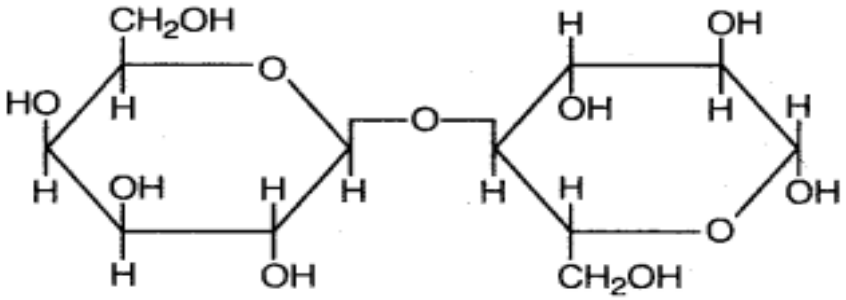
60.



Thus, only three phenyl hydrazine molecules and one molecule of glucose is required to form osazone.

61. RNA contains cytosine and uracil as pyrimidine bases while DNA has cytosine and thymine as pyrimidine bases. Both RNA and DNA have the same purine bases, i.e. guanine and adenine.

62.

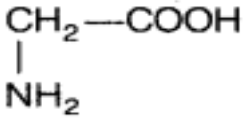


Lactose

Lactose is a reducing sugar and all reducing sugars show mutarotation.

63. The sugar which cannot reduce Fehling's solution and Tollen's reagent are called non-reducing sugar, e.g. sucrose and all polysaccharides.

64. Glycine is an optically inactive amino acid due to absence of chiral carbon atom.



Glycine

65. A codon is a specific sequence of three adjacent bases on a strand of DNA or RNA that provides genetic code information for a particular amino acid.

66. Reducing sugars that exist in hemiacetal and hemiketal forms, undergo mutarotation in aqueous solution.

Among the given carbohydrates, only sucrose is a non-reducing sugar as in it, the hemiacetal and hemiketal groups of glucose and fructose are linked together through O-atom and thus, not free. Due to the absence of free hemiacetal or hemiketal group, sucrose does not exhibit mutarotation.

67. On hydrolysis, sucrose gives an equimolar mixture of D-(+)-glucose and D-(–) fructose.

$$\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} + H_2O \longrightarrow \underset{\text{(+) Glucose}}{C_6H_{12}O_6} + \underset{\text{(–) fructose}}{C_6H_{12}O_6}$$

Here, the configuration of sucrose changes (gets inverted) after hydrolysis, thus its hydrolysis is called inversion.

68. Anomers have different configuration at the glycosidic or anomeric carbon atoms.

69. Secondary structure of proteins refers to regular folding patterns of continuous portion of the polypeptide chain, as a result of hydrogen bonding between the $>C=O$ and N—H groups.