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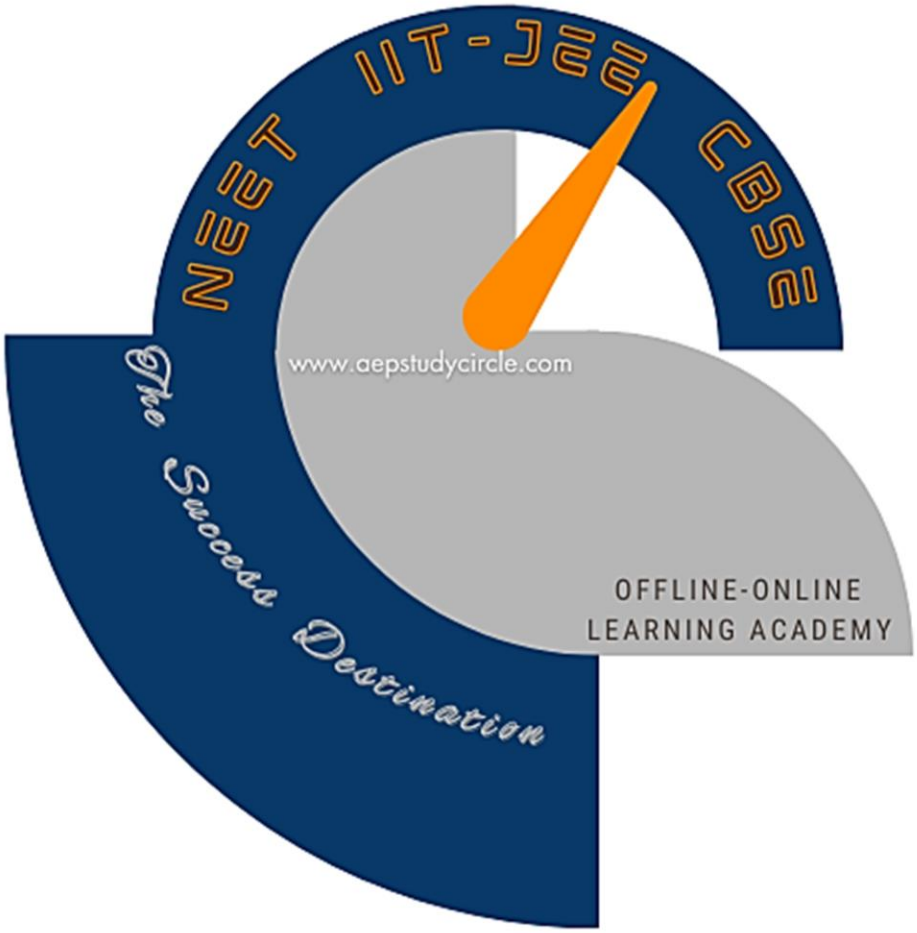

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BIOMOLECULES

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1. INTRODUCTION

Complex organic compounds which govern the common activities of the living organisms are called biomolecules. Living systems are made up of various complex biomolecules like carbohydrates, proteins, nucleic acids, lipids, etc. In addition, some simple molecules like vitamins and mineral salts also play an important role in the functions of organisms.

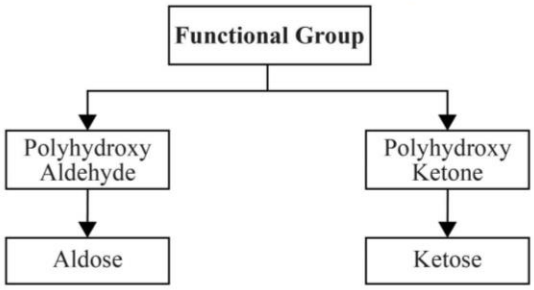
2. CARBOHYDRATES

Carbohydrates are primarily produced by plants and form a very large group of naturally occurring organic compounds. Some common examples are cane sugar, glucose, starch etc. Most of them have a general formula, $C_x H_{2y} O_y$ and were considered as hydrates of carbon from where the name carbohydrate was derived. For example, the molecular formula of glucose ($C_6H_{12}O_6$) fits into this general formula, $C_6(H_2O)_6$. But all the compounds which fit into this formula may not be classified as carbohydrates. Rhamnose, $C_6H_{12}O_5$ is a carbohydrate but does not fit in this definition. Chemically, the carbohydrates may be defined as optically active polyhydroxy aldehydes or ketones or the compounds which produce such units on hydrolysis. Some of the carbohydrates, which are sweet in taste, are also called sugars. The most common sugar, used in our homes is named as sucrose whereas the sugar present in milk is known as lactose.

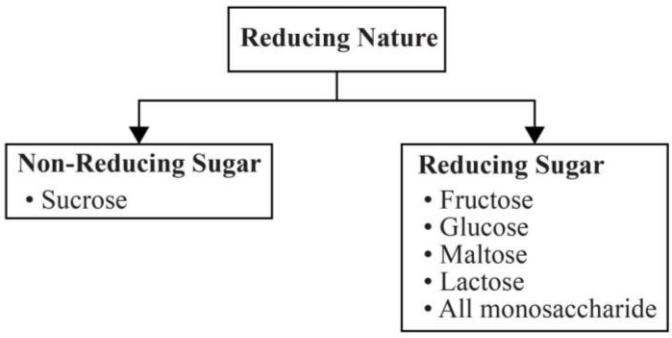
2.1 Classification of Carbohydrates

Carbohydrates are classified on the basis of their behaviour on hydrolysis. They have been broadly divided into following three groups:

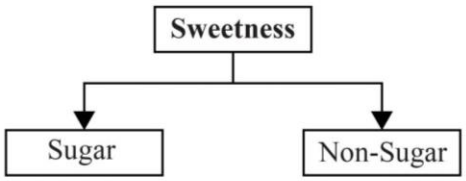
2.1.1 On the basis of Functional Group:



2.1.2 On the basis of Reducing Nature:



2.1.3 On the basis of Sweetness:



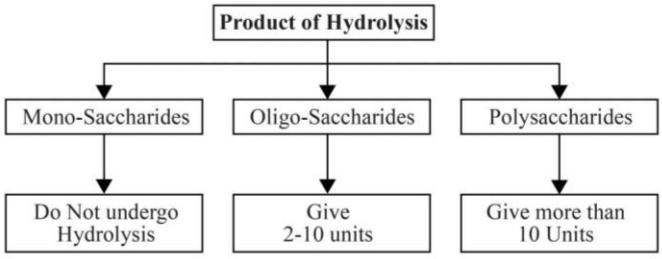
NOTE

Saccharide came from a Latin word Saccharum which means Sugar

2.1.4 On the basis of Number of Carbon atoms:

Carbon Atoms	General Term	Aldehyde	Ketone
3	Triose	Aldotriose	Ketoriose
4	Tetrose	Aldotetrose	Ketotetrose
5	Pentose	Aldopentose	Ketopentose
6	Hexose	Aldohexose	Ketohexose
7	Heptose	Aldoheptose	Ketoheptose

2.1.5 On the basis of Number of Product of Hydrolysis:



2.1.5.1 Monosaccharides

A carbohydrate that cannot be hydrolysed further to give simpler units of polyhydroxy aldehyde or ketone is called a **monosaccharide**. Some common examples are glucose, fructose, ribose, etc.

2.1.5.2 Oligosaccharides

Carbohydrates that yield two to ten monosaccharide units, on hydrolysis, are called oligosaccharides. They are further classified as disaccharides, trisaccharides, tetrasaccharides, etc., depending upon the number of monosaccharides, they provide on hydrolysis. Amongst these the most common are disaccharides. The two monosaccharide units obtained on hydrolysis of a disaccharide may be same or different. For example, sucrose on hydrolysis gives one molecule each of glucose and fructose whereas maltose gives two molecules of glucose only.

2.1.5.3 Polysaccharides

Carbohydrates which yield a large number of monosaccharide units on hydrolysis are called polysaccharides. Some common examples are starch, cellulose, glycogen, gums, etc.

3. GLUCOSE (ALDOHEXOSE)

3.1 Preparation of Glucose

(A) From Sucrose (Cane Sugar)

If sucrose is boiled with dilute HCl or H_2SO_4 in alcoholic solution, glucose and fructose are obtained in equal amounts.

$$\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{H^+} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$$

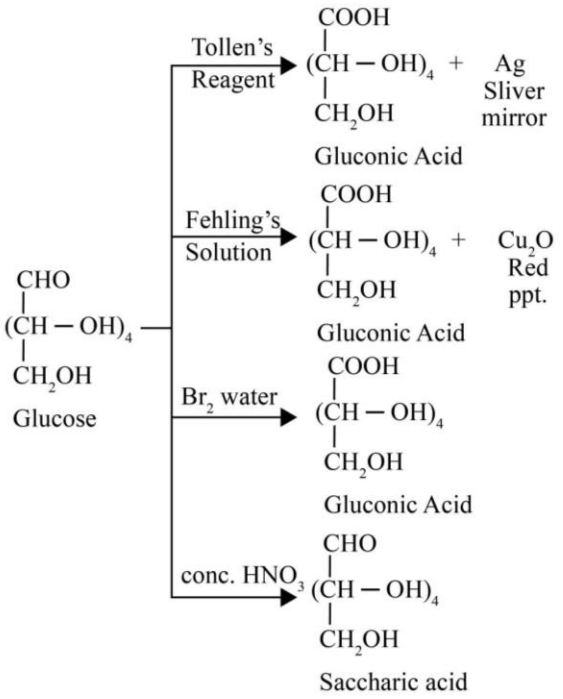
(B) From Starch

Commercially, glucose is obtained by hydrolysis of starch by boiling it with dilute H_2SO_4 at 393 K under pressure.

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

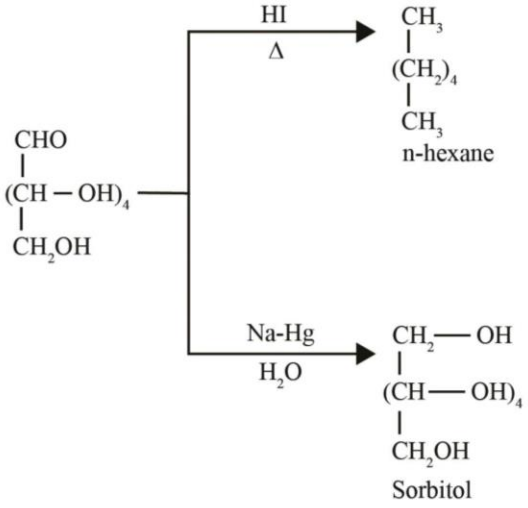
3.2 Reactions

(A) Oxidation



Oxidation Reactions of Glucose

(B) Reduction

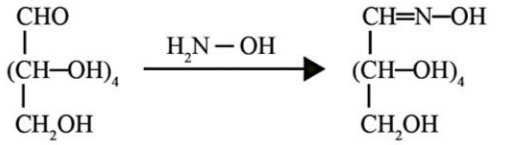


Reduction Reactions of Glucose

NOTE

Reduction with HI gives n-hexane which shows that all the 6 carbons of glucose are arranged in straight chain.

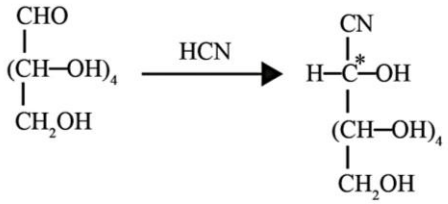
(C) Oxime Formation



Glucose Oxime

Oxime Formation

(D) Cyanohydrin Formation



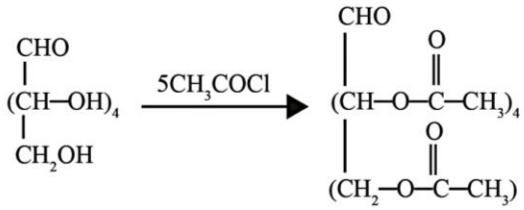
Glucose Cyanohydrin

Cyanohydrin Formation

NOTE

Carbonyl C has become chiral so 2 products are obtained which are diastereomers.

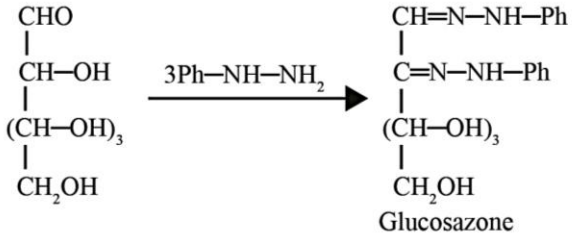
(E) Acetylation



Glucose Pentaacetate

Acetylation

(F) Reaction with phenylhydrazine (formation of osazone)

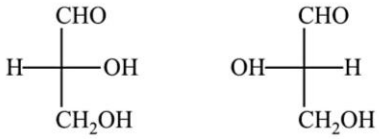


Glucosazone

Reaction with phenylhydrazine

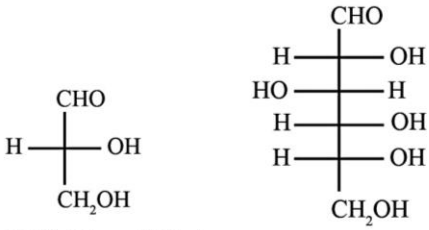
3.3 Configuration in Monosaccharides

Glucose is correctly named as D(+)-glucose. 'D' before the name of glucose represents the configuration whereas '(+)' represents dextrorotatory nature of the molecule. It may be remembered that 'D' and 'L' have no relation with the optical activity of the compound. The meaning of D– and L– notations is given as follows. The letters 'D' or 'L' before the name of any compound indicate the relative configuration of a particular stereoisomer. This refers to their relation with a particular isomer of glyceraldehyde. Glyceraldehyde contains one asymmetric carbon atom and exists in two enantiomeric forms as illustrated.



D-Glyceraldehyde L-Glyceraldehyde

All those compounds which can be chemically correlated to (+) isomer of glyceraldehyde are said to have D-configuration whereas those which can be correlated to (–) isomer of glyceraldehyde are said to have L-configuration. For assigning the configuration of monosaccharides, it is the lowest asymmetric carbon atom (as shown below) which is compared. As in (+) glucose, –OH on the lowest asymmetric carbon is on the right side which is comparable to (+) glyceraldehyde, so it is assigned D-configuration. For this comparison, the structure is written in a way that most oxidised carbon is at the top.



D-(+)-Glyceraldehyde D-(+)-Glucose

3.4 Cyclic Structure of Glucose

Glucose is found to exist in two different crystalline forms which are named as α and β. The α-form of glucose (m.p. 419 K) is obtained by crystallisation from concentrated solution of glucose at 303 K while the β-form (m.p. 423 K) is obtained by crystallisation from hot and saturated aqueous solution at 371 K.

Both α-D-glucose and β-D-glucose undergo mutarotation in aqueous solution. Although the crystalline forms of α- and β-D (+)-glucose are quite stable in aqueous solution but each form slowly changes into an equilibrium mixture of both. This is evident from the fact that the specific rotation of a freshly prepared aqueous solution of α-D(+)-glucose falls gradually from +111° to +52.5° with time and that of β-D(+)-glucose increases from +19.2° to 52.5°. Thus,

α-D(+)-Glucose $\rightleftharpoons$ Equilibrium mixture

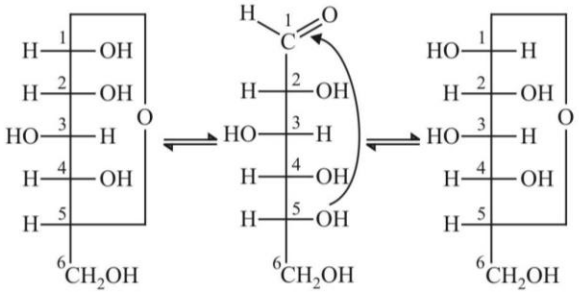
$[\alpha]_D^{298K} = +111^0$ $[\alpha]_D^{298K} = +52.5^0$

β-D(+)-Glucose

$[\alpha]_D^{298K} = +19.2^0$

This spontaneous change in specific rotation of an optically active compound with time, to an equilibrium value, is called mutarotation.

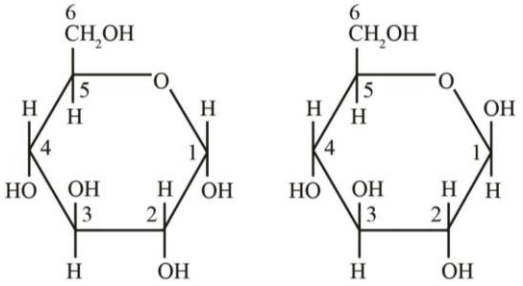
It was found that glucose forms a six-membered ring in which –OH at C-5 is involved in ring formation. This explains the absence of –CHO group and also existence of glucose in two forms as shown below. These two cyclic forms exist in equilibrium with open chain structure.



Cyclic and open chain structure of Glucose

The two cyclic hemiacetal forms of glucose differ only in the configuration of the hydroxyl group at C_1, called anomeric carbon (the aldehyde carbon before cyclisation). Such isomers, i.e., α-form and β-form, are called **anomers**. The six membered cyclic structure of glucose is called **pyranose structure** (α– or β–), in analogy with pyran. Pyran is a cyclic organic compound with one oxygen atom and five carbon atoms in the ring. The cyclic structure of glucose is more correctly represented by Haworth structure.

Pyran

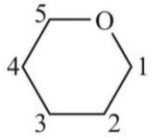


α-D(+)-Glucopyranose β-D(+)-Glucopyranose

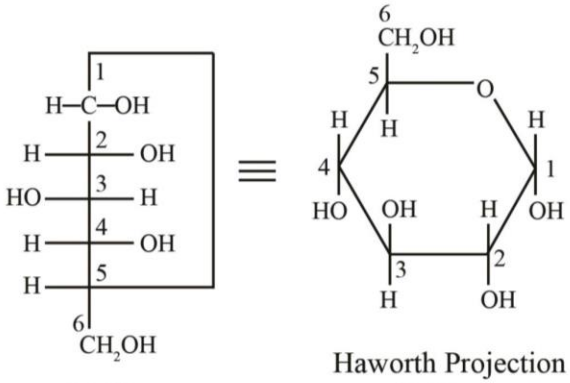
Haworth Structure of Glucose

3.4.1 How to draw a Haworth Projection

A ring of 6 atoms (5 'C' and 1 'O') is drawn in which 'O' atom is placed at right hand top corner as shown below



Carbon atom at the right hand side of oxygen is given number 1. Then other carbon atoms are given numbers 2, 3 ..... in a clockwise fashion. Groups attached to a carbon in Fischer projection lying on the right hand side of that carbon are placed below the ring and on the left hand side are placed above the ring. But CH_2OH group of carbon 5 is placed above the plane of ring by convention

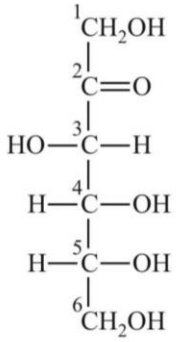


α-D-Glucose Haworth Projection α-D-Glucose

Cyclic and Haworth Projection of a-D-Glucose

4. FRUCTOSE (KETOHEXOSE)

Fructose also has the molecular formula $C_6H_{12}O_6$ and on the basis of its reactions it was found to contain a ketonic functional group at carbon number 2 and six carbons in straight chain as in the case of glucose. It belongs to D-series and is a laevorotatory compound. It is appropriately written as D-(–)-fructose. Its open chain structure is as shown

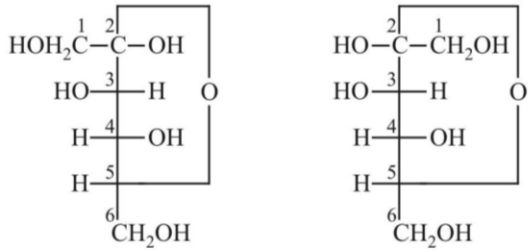


Fructose

It also exists in two cyclic forms which are obtained by the addition of –OH at C5 to the $\left(\rangle C = O\right)$ group. The ring, thus formed is a

five membered ring and is named as furanose with analogy to the compound furan. Furan is a five membered cyclic compound with one oxygen and four carbon atoms.

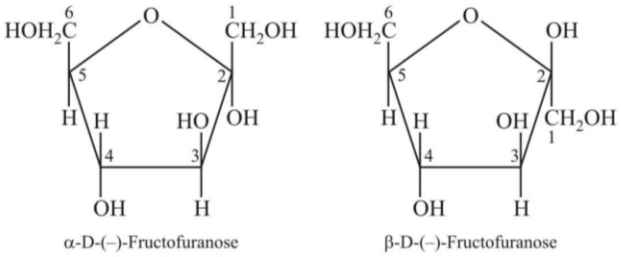
Furan



α-D-(–)-Fructofuranose β-D-(–)-Fructofuranose

Cyclic Structure of Fructose

The cyclic structures of two anomers of fructose are represented by Haworth structures as given.



α-D-(–)-Fructofuranose β-D-(–)-Fructofuranose

Haworth Structure of Fructose

Comparison of Glucose and Fructose

S.No.	Property	Glucose	Fructose
(i)	Molecular formula	$C_6H_{12}O_6$	$C_6H_{12}O_6$
(ii)	Nature	Polyhydroxy aldehyde	Polyhydroxy ketone
(iii)	Melting point	146°C	102°C
(iv)	Optical nature	Dextro rotatory	Laevo rotatory
(v)	Tollen's reagent	Silver mirror	Silver mirror
(vi)	Fehling's solution	Red ppt	Red ppt
(vii)	Molisch test	Violet colour	Violet colour
(viii)	Phenyl hydrazine	Forms osazone	Forms osazone
(ix)	Oxidation by conc. HNO_3	Saccharic acid	Mixture of glycolic acid, Tetaric acid and Trihydroxy Gluteric acid

5. DISACCHARIDES

The two monosaccharides are joined together by an oxide linkage formed by the loss of a water molecule. Such a linkage between two monosaccharide units through oxygen atom is called **glycosidic linkage**.

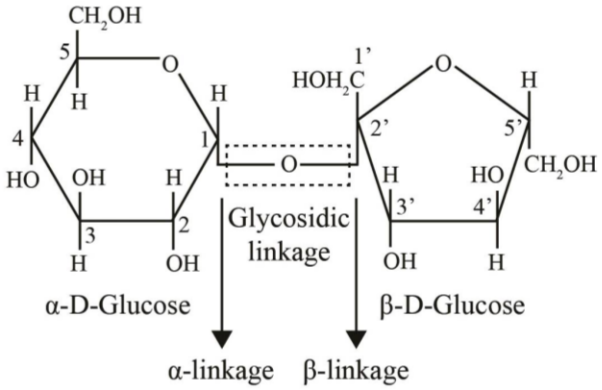
5.1 Sucrose

One of the common disaccharides is **sucrose** which on hydrolysis gives equimolar mixture of D-(+)-glucose and D-(–)-fructose.

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

$[\alpha]_D = +66.5°$ $[\alpha]_D = +52.5°$ $[\alpha]_D = -92.4°$

These two monosaccharides are held together by a glycosidic linkage between C1 of α-glucose and C2 of β-fructose. Since the reducing groups of glucose and fructose are involved in glycosidic bond formation, sucrose is a non reducing sugar.



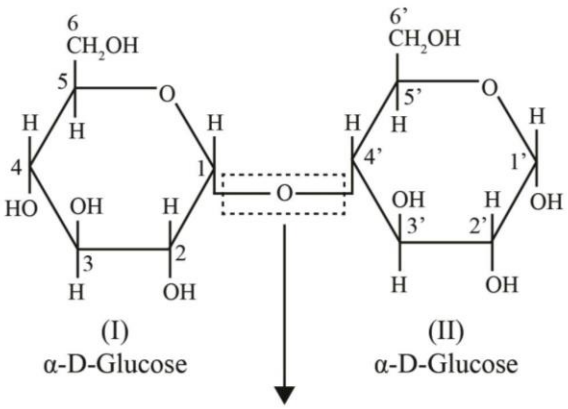
Sucrose

Sucrose is a dextrorotaty compound and its hydrolysis produces an equimolar solution of glucose and fructose. This solution is laevorotaty because laevo rotation of fructose is greater than dextro rotation of glucose.

Thus, hydrolysis of sucrose brings about a change in the sign of rotation, from dextro (+) to laevo (–) and the product is named as invert sugar and this phenomenon is called as inversion of sugar.

5.2 Maltose

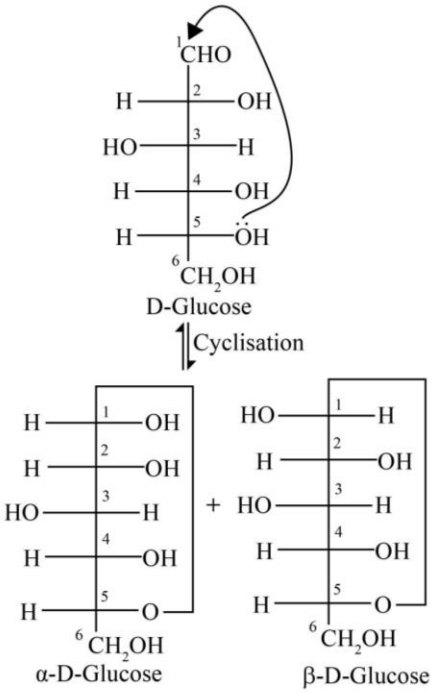
Another disaccharide, maltose is composed of two α-D-glucose units in which C1 of one glucose (I) is linked to C4 of another glucose unit (II). The free aldehyde group can be produced at C1 of second glucose in solution and it shows reducing properties so it is a reducing sugar.

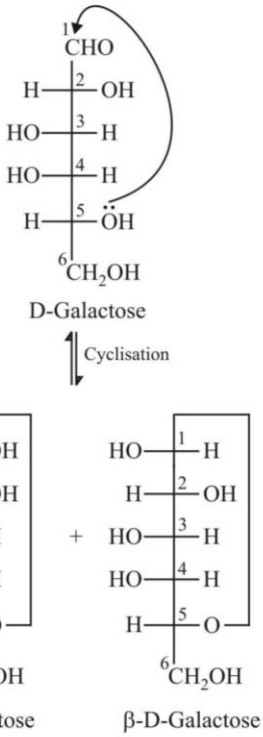


Maltose

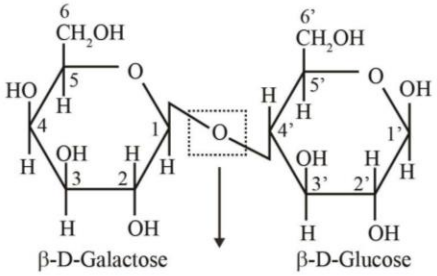
5.3 Lactose

It is more commonly known as milk sugar since this disaccharide is found in milk. It is composed of β-D-galactose and β-D-glucose. Fischer projections of β-D-Glucose and β-D-Galactose are drawn below :





We can see that the configurations of all the carbon atoms in β-D-Glucose and β-D-Galactose is same except at C-4. Such stereoisomers which differ in the configuration at only one carbon other than anomeric carbon are called as epimers and that C atom is called as epimeric carbon atom. Hence we can say that β-D-Glucose and β-D-Galactose are epimers and C-4 is epimeric carbon atom. In lactose, the linkage is between C1 of galactose and C4 of glucose. Hence it is also a reducing sugar.



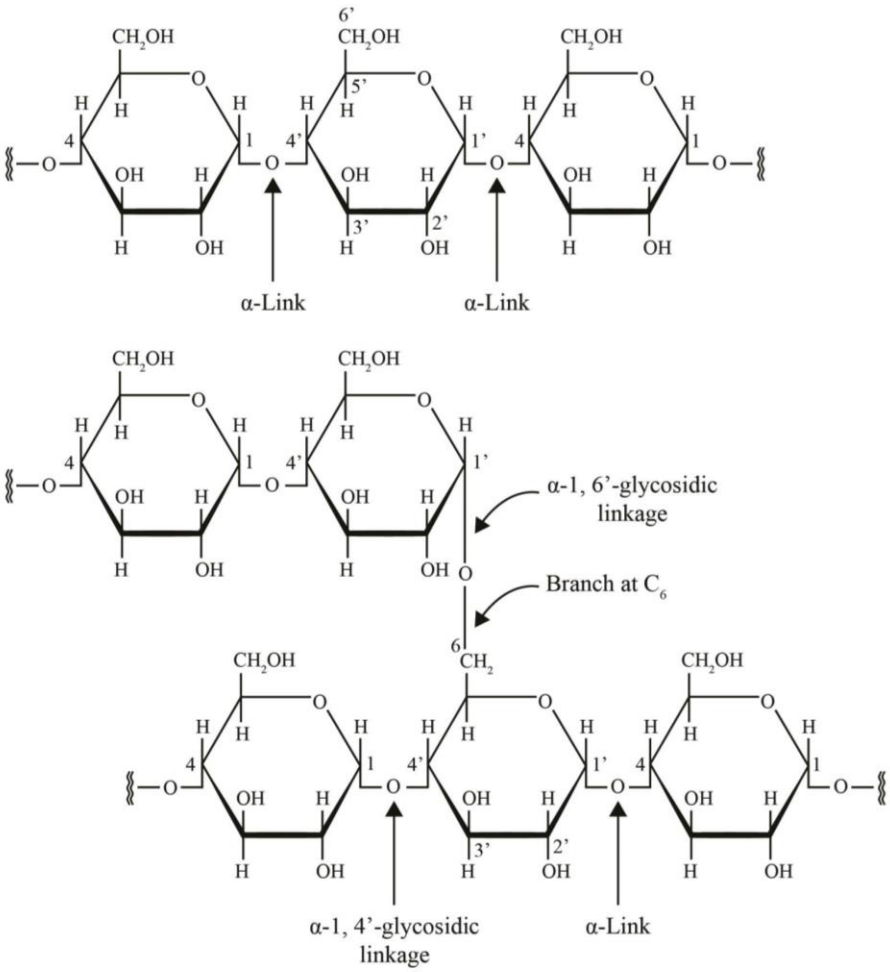
Lactose

6. POLYSACCHARIDES

Polysaccharides contain a large number of monosaccharide units joined together by glycosidic linkages. They mainly act as the food storage or structural materials.

6.1 Starch

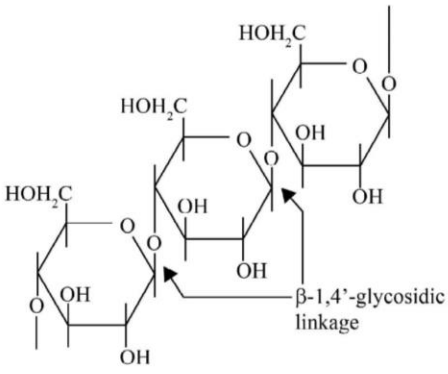
Starch is the main storage polysaccharide of plants. It is the most important dietary source for human beings. High content of starch is found in cereals, roots, tubers and some vegetables. It is a polymer of α-glucose and consists of two components - **Amylose** and **Amylopectin**. Amylose is water soluble component which constitutes about 15-20% of starch. Chemically amylose is a long unbranched chain with 200-1000 α-D-(+)-glucose units held by C1-C4 glycosidic linkage. Amylopectin is insoluble in water and constitutes about 80-85% of starch. It is a branched chain polymer of α-D-glucose units in which chain is formed by C1-C4 glycosidic linkage whereas branching occurs by C1-C6 glycosidic linkage.



Amylose and Amylopectin

6.2 Cellulose

Cellulose occurs exclusively in plants and it is the most abundant organic substance in plant kingdom. It is a predominant constituent of cell wall of plant cells. Cellulose is a straight chain polysaccharide composed only of β-D-glucose units which are joined by glycosidic linkage between C1 of one glucose unit and C4 of the next glucose unit.



Cellulose

6.3 Glycogen

The carbohydrates are stored in animal body as glycogen. It is also known as animal starch because its structure is similar to amylopectin and is rather more highly branched. It is present in liver, muscles and brain. When the body needs glucose, enzymes break the glycogen down to glucose. Glycogen is also found in yeast and fungi.

NOTE

- All the carbohydrates containing CHO group or α-Hydroxy ketonic group or hemiacetal group are reducing sugars.
- All reducing sugars show the phenomenon of mutarotation.

Carbohydrates - types and characteristics

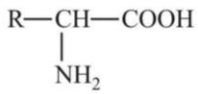
Carbohydrates	Type	Reducing/ Non Reducing	Units	Linkage
Glucose	Monosaccharide	Reducing	Glucose	—
Fructose	Monosaccharide	Reducing	Fructose	—
Sucrose	Disaccharide	Non Reduing	α-D-Glucose and β-D-Fructose	C1 of Glucose and C2 of Fructose
Lactose	Disaccharide	Reducing	β-D-Glucose and β-D-Galactose	β– 1, 4' glycosidic linkage
Maltose	Disaccharide	Reducing	Both are D-Glucose	α– 1, 4'glycosidic linkage
Starch	Polysaccharide	Non Reducing	Amylose + Amylopectin	α– 1, 4'and α– 1, 6'glycosidic linkages
Glycogen	Polysccharide	Non Reducing	Amylopectin	α– 1, 4'and α– 1, 4'glycosidic
Cellulose	Polysccharide	Non Reducing	β-D-Glucose	β– 1, 4'glycosidic linkage

7. PROTEINS

The word protein is derived from Greek word, **"proteios"** which means primary or of prime importance. All proteins are polymers of α-amino acids.

7.1 Amino Acids

Amino acids contain amino ($-NH_2$) and carboxyl (–COOH) functional groups. Depending upon the relative position of amino group with respect to carboxyl group, the amino acids can be classified as α, β, γ, δ and so on. Only α-amino acids are obtained on hydrolysis of proteins. They may contain other functional groups also.

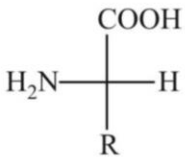


α – amino acid
(R = side chain)

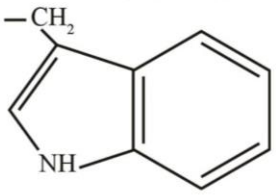
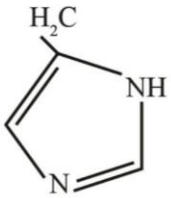
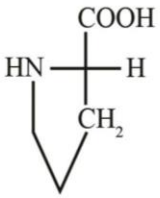
All α-amino acids have trivial names, which usually reflect the property of that compound or its source. Glycine is so named since it has sweet taste (in Greek glykos means sweet) and tyrosine was first obtained from cheese (in Greek, tyros means cheese.)

7.2 Natural Amino Acids

Amino acids are generally represented by a three letter symbol, sometimes one letter symbol is also used. Structures of some commonly occurring amino acids along with their 3-letter and 1-letter symbols are given in Table 2.4.



Natural Amino Acids

S.No.	Nature of the Amino Acids	Characteristic Feature of side chain. R	Three letter symbol	One letter of code
(i)	Glycine (N)	H	Gly	G
(ii)	Alanine (N)	$-CH_3$	Ala	A
(iii)	Valine * (N)	$(H_3C)_2CH_2-$	Val	V
(iv)	Leucine* (N)	$(H_3C)_2CH-CH_2-$	Leu	L
(v)	Isoleucine * (N)	$H_3C-CH_2-CH(CH_3)-$	Ile	I
(vi)	Arginine * (B)	$HN=C(NH_2)-NH-(CH_2)_3-$	Arg	R
(vii)	Lysine * (B)	$H_2N-(CH_2)_4-$	Lys	K
(viii)	Glutamic acid (A)	$HOOC-CH_2-CH_2-$	Glu	E
(ix)	Aspartic acid (A)	$HOOC-CH_2-$	Asp	D
(x)	Glutamine (N)	$H_2N-C(=O)-CH_2-CH_2-$	Gln	Q
(xi)	Asparagine (A)	$H_2N-C(=O)-CH_2-$	Asn	N
(xii)	Threonine * (N)	$H_3C-CHOH-$	Thr	T
(xiii)	Serine (N)	$HO-CH_2-$	Ser	S
(xiv)	Cysteine (N)	$HS-CH_2-$	Cys	C
(xv)	Methionine * (N)	$H_3C-S-CH_2-CH_2-$	Met	M
(xvi)	Phenylalanine * (N)	$C_6H_5-CH_2-$	Phe	F
(xvii)	Tyrosine (N)	$(p)HO-C_6H_4-CH_2-$	Tyr	Y
(xviii)	Tryptophan * (N)		Trp	W
(xix)	Histidine * (B)		His	H
(xx)	Proline (N)		Pro	P

N = Neutral (No. of carboxylic group = No.of amino group)
B = Basic (No. of carboxylic group < No.of amino group)
A = Acidic (No. of carboxylic group > No.of amino group)

NOTE

- *Essential amino acids.
- Arginine has highest isoelectric point i.e. 10.8.
- Cysteine has lowest isoelectric point i.e. 5.1.

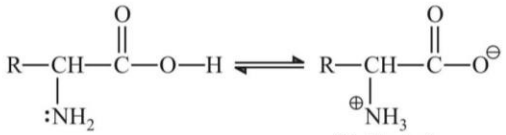
7.3 Classification of Amino Acids

Amino acids are classified as acidic, basic or neutral depending upon the relative number of amino and carboxyl groups in their molecule.

The amino acids, which can be synthesised in the body, are known as **non-essential amino acids**. On the other hand, those which cannot be synthesised in the body and must be obtained through diet, are known as **essential amino acids**.

7.4 Properties of Amino Acids

Amino acids are usually colourless, crystalline solids. These are water-soluble, high melting solids and behave like salts rather than simple amines or carboxylic acids. This behaviour is due to the presence of both acidic (carboxyl group) and basic (amino group) groups in the same molecule.



(Zwitter ion)

In aqueous solution, the carboxyl group can lose a proton and amino group can accept a proton, giving rise to a dipolar ion known as **zwitter ion**. This is neutral but contains both positive and negative charges. In zwitter ionic form, amino acids show amphoteric behaviour as they react both with acids and bases.

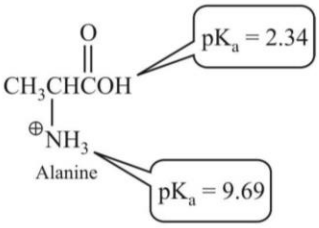
Except glycine, all other naturally occurring α-amino acids are optically active, since the α-carbon atom is asymmetric. These exist both in 'D' and 'L' forms. Most naturally occurring amino acids have L-configuration. L-Amino acids are represented by writing the $-NH_2$ group on left hand side.

7.4.1 Isoelectric Point

The **isoelectric point** (pI) of an amino acid is the pH at which it has no net charge. In other words, it is the pH at which the amount of negative charge on an amino acid exactly balances the amount of positive charge.

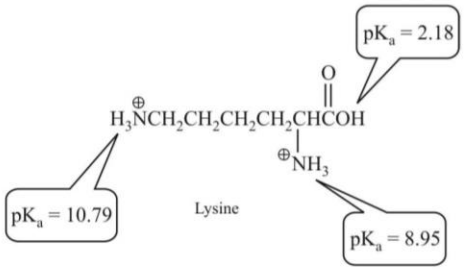
pI (isoelectric point) = pH at which there is no net charge

The pI of an amino acid that does not have an ionizable side chain–such as alanine–is midway between its two pK_a values. This is because at pH = 2.34, half the molecules have a negatively charged carboxyl group and half have an uncharged carboxyl group, and at pH = 9.69, half the molecules have a positively charged amino group and half have an uncharged amino group. As the pH increases from 2.34, the carboxyl group of more molecules becomes negatively charged; as the pH decreases from 9.69, the amino group of more molecules becomes positively charged. Therefore at the average of the two pK_a values, the number of negatively charged groups equals the number of positively charged groups.

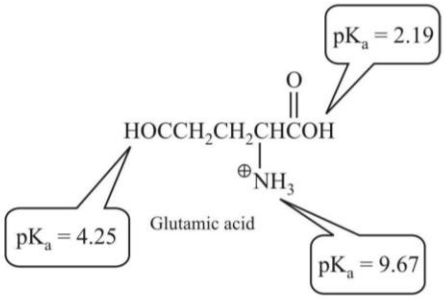


$$pI = \frac{2.34 + 9.69}{2} = \frac{12.03}{2} = 6.02$$

If an amino acid has an ionizable side chain, its pI is the average of the pK_a values of the similarly ionizing groups (positive ionizing to uncharged, or uncharged ionizing to negative). For example, the pI of lysine is the average of the pK_a values of the two groups that are positively charged in their acidic form and uncharged in their basic form. The pI of glutamate, on the other hand, is the average of the pK_a values of the two groups that are uncharged in their acidic form and negatively charged in their basic form.



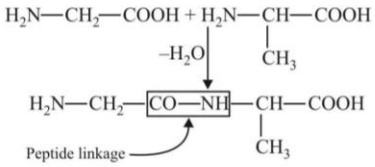
$$pI = \frac{8.95 + 10.79}{2} = \frac{19.74}{2} = 9.87$$



$$pI = \frac{2.19 + 4.25}{2} = \frac{6.44}{2} = 3.22$$

7.5 Structure of Proteins - Peptide Bond

Proteins are the polymers of α-amino acids and they are connected to each other by **peptide bond** or **peptide linkage**. Chemically, peptide linkage is an amide formed between –COOH group and $-NH_2$ group.



Peptide linkage in proteins

The reaction between two molecules of similar or different amino acids, proceeds through the combination of the amino group of one molecule with the carboxyl group of the other. This results in the elimination of a water molecule and formation of a peptide bond –CO–NH–.

7.6 Classification of Proteins

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

(A) Fibrous Proteins

When the polypeptide chains run parallel and are held together by hydrogen and disulphide bonds, then fibre- like structure is formed. Such proteins are generally insoluble in water.

Some common examples are **keratin** (present in hair, wool, silk) and **myosin** (present in muscles), etc.

(B) Globular Proteins

This structure results when the chains of polypeptides coil around to give a spherical shape. These are usually soluble in water. **Insulin and albumins** are the common examples of globular proteins. Structure and shape of proteins can be studied at four different levels, i.e., primary, secondary, tertiary and quaternary.

(i) Primary Structure

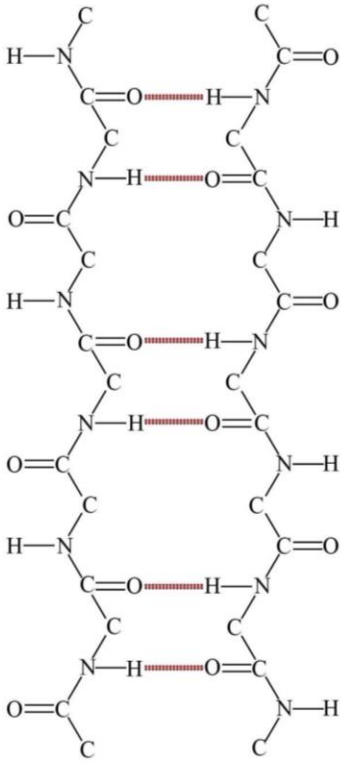
Proteins may have one or more polypeptide chains. Each polypeptide in a protein has amino acids linked with each other in a specific sequence and it is this sequence of amino acids that is said to be the primary structure of that protein. Any change in this primary structure i.e., the sequence of amino acids creates a different protein.

(ii) Secondary Structure

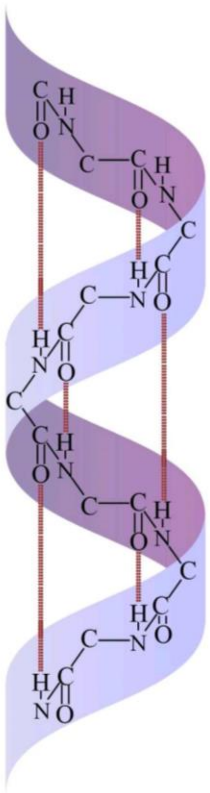
The secondary structure of protein refers to the shape in which a long polypeptide chain can exist. They are found to exist in two different types of structures viz. α-helix and β-pleated sheet structure. These structures arise due to the regular folding of the backbone of the polypeptide chain due to hydrogen bonding between C = O and –NH– groups of the peptide bond.

α-Helix is one of the most common ways in which a polypeptide chain forms all possible hydrogen bonds by twisting into a right handed screw (helix) with the –NH group of each amino acid residue hydrogen bonded to the C = O of an adjacent turn of the helix.

In β-structure all peptide chains are stretched out to nearly maximum extension and then laid side by side which are held together by intermolecular hydrogen bonds.



β- Pleated sheet structure of proteins



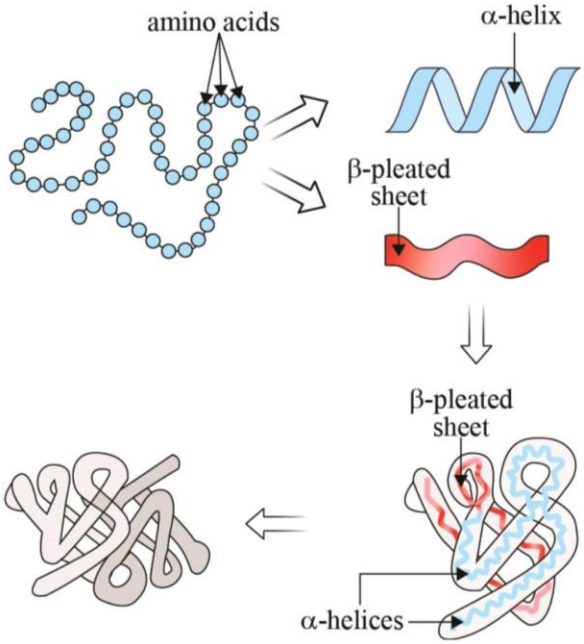
α-Helix structure of protein

(iii) Tertiary Structure

The tertiary structure of proteins represents overall folding of the polypeptide chains i.e., further folding of the secondary structure. It gives rise to two major molecular shapes viz. fibrous and globular. The main forces which stabilise the 2° and 3° structures of proteins are hydrogen bonds, disulphide linkages, van der Waals and electrostatic forces of attraction.

(iv) Quaternary Structure

Some of the proteins are composed of two or more polypeptide chains referred to as sub-units. Subunits with respect to each other is known as quaternary structure.



Primary, Secondary, Tertiary, Quaternary Structure of Protein

7.7 Denaturation of Proteins

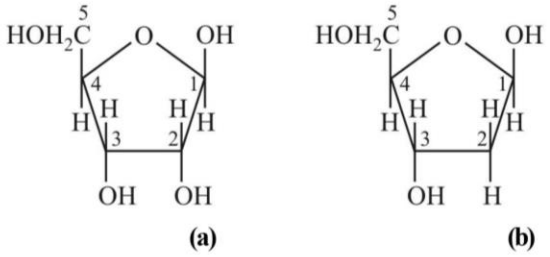
Protein found in a biological system with a unique three-dimensional structure and biological activity is called a native protein. When a protein in its native form, is subjected to physical change like change in temperature or chemical change like change in pH, the hydrogen bonds are disturbed. Due to this, globules unfold and helix get uncoiled and protein loses its biological activity. This is called **denaturation** of protein. The coagulation of egg white on boiling is a common example of denaturation. Another example is curdling of milk which is caused due to the formation of lactic acid by the bacteria present in milk.

8. NUCLEIC ACIDS

Every generation of each and every species resembles its **ancestors** in many ways. How are these characteristics transmitted from one generation to the next ? It has been observed that nucleus of a living cell is responsible for this transmission of inherent characters, also called **heredity**. The particles in nucleus of the cell, responsible for heredity, are called chromosomes which are made up of proteins and another type of biomolecules called **nucleic acids**. These are mainly of two types, the **deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).** Since nucleic acids are long chain polymers of **nucleotides**, so they are also called polynucleotides.

8.1 Chemical Composition of Nucleic Acids

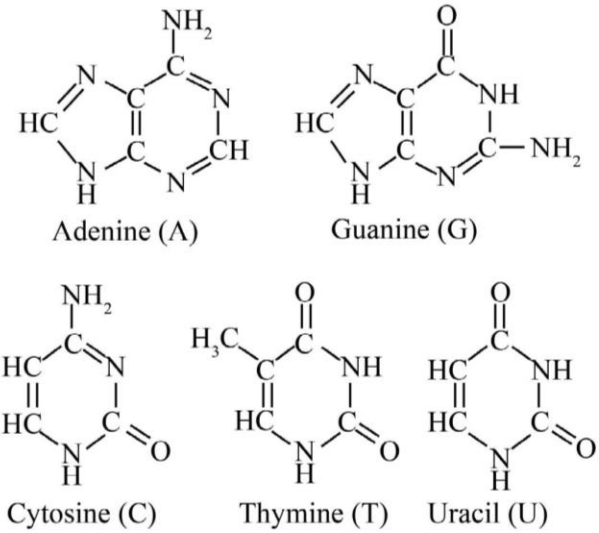
Complete hydrolysis of DNA (or RNA) yields a pentose sugar, phosphoric acid and nitrogen containing heterocyclic compounds (called bases). In DNA molecules, the sugar moiety is β-D-2-deoxyribose whereas in RNA molecule, it is β-D-ribose.



(a) **(b)**

(a) β-D- ribose (b) β-D-2deoxyribose

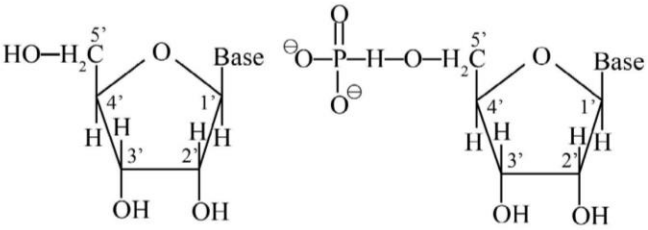
DNA contains four bases viz. **adenine** (A), **guanine** (G), **cytosine** (C) and **thymine** (T). RNA also contains four bases, the first three bases are same as in DNA but the fourth one is uracil (U).



Bases in DNA and RNA

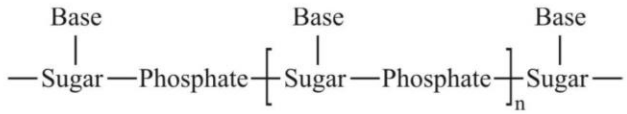
8.2 Structure of Nucleic Acids

A unit formed by the attachment of a base to 1′ position of sugar is known as **nucleoside**. In nucleosides, the sugar carbons are numbered as 1′, 2′, 3′, etc. In order to distinguish these from the bases. When nucleoside is linked to phosphoric acid at 5′-position of sugar moiety, we get a nucleotide.



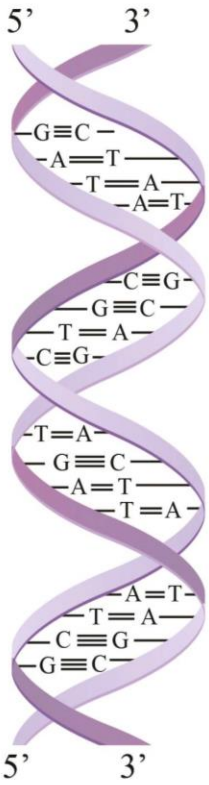
Structure of (a) a nucleoside and (b) a nucleotide

Nucleotides are joined together by phosphodiester linkage between 5′ and 3′ carbon atoms of the pentose sugar. A simplified version of nucleic acid chain is as shown below



Information regarding the sequence of nucleotides in the chain of a nucleic acid is called its primary structure. Nucleic acids have a secondary structure also. James Watson and Francis Crick gave a double strand helix structure for DNA. Two nucleic acid chains are wound about each other and held together by hydrogen bonds between pairs of bases. The two strands are complementary to each other because the hydrogen bonds are formed between specific pairs of bases. Adenine forms hydrogen bonds with thymine whereas cytosine forms hydrogen bonds with guanine.

In secondary structure of RNA, helices are present which are only single stranded. Sometimes they fold back on themselves to form a double helix structure. RNA molecules are of three types and they perform different functions. They are named as **messenger RNA (m-RNA), ribosomal RNA (r-RNA) and transfer RNA (t-RNA).**



Double strand helix structure for DNA

8.3 DNA vs RNA

DNA vs RNA

S.No.	Deoxyribonucleic Acid (DNA)	Ribonucleic Acid (RNA)
(i)	DNA occurs in the nucleus of the cell.	RNA occurs in the cytoplasm of the cell.
(ii)	The sugar present in DNA is D-(–)-2-deoxyribose.	The sugar present in RNA is D(-) ribose
(iii)	DNA contains cytosine and thymine as pyrimidine bases and guanine and adenine as purine bases.	RNA contains cytosine and uracil as pyrimidine bases and guanine and adenine as purine bases.
(iv)	DNA has double-stranded α-helix structure.	RNA has single stranded α-helix structure.
(v)	DNA undergoes replication.	RNA usually does not undergo replication
(vi)	DNA controls the transmission of hereditary effects.	RNA controls the synthesis of proteins.

8.4 Biological Functions of Nucleic Acids

DNA is the chemical basis of heredity and may be regarded as the reserve of genetic information. DNA is exclusively responsible for maintaining the identity of different species of organisms over millions of years. A DNA molecule is capable of self duplication during cell division and identical DNA strands are transferred to daughter cells. Another important function of nucleic acids is the protein synthesis in the cell. Actually, the proteins are synthesised by various RNA molecules in the cell but the message for the synthesis of a particular protein is present in DNA.

9. ENZYMES

Enzymes are biological catalysts. Chemically all enzymes are globular proteins. Some important enzymes and their functions are given

Enzymes

S.No.	Enzyme	Reaction Catalysed
(i)	Invertase or sucrase	Sucrose → Glucose + Fructose
(ii)	Maltase	Maltose → 2 Glucose
(iii)	Lactase	Lactose → Glucose + Galactose
(iv)	α-Amylase	Starch → n × Glucose
(v)	Emulsin	Cellulose → n × Glucose
(vi)	Urease	NH_2CONH_2 → CO_2 + $2NH_3$
(vii)	Carbonic anhydrase	H_2CO_3 → CO_2 + H_2O
(viii)	Pepsin	Proteins → α - Amino acids
(ix)	Trypsin	Proteins → α - Amino acids
(x)	Nucleases	DNA or RNA → Nucleotides
(xi)	DNA polymerase	Deoxynucleotide triphosphates → DNA
(xii)	RNA polymerase	Ribonucleotide triphosphates → RNA

10. VITAMINS

They are generally regarded as 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. Vitamins are designated by alphabets A, B, C, D, etc. Some of them are further named as sub-groups e.g. B_1, B_2, B_6, B_{12}, etc. Excess of vitamins is also harmful and vitamin pills should not be taken without the advice of doctor.

10.1 Classification of Vitamins

Vitamins are classified into two groups depending upon their solubility in water or fat.

(i) **Fat soluble vitamins:** Vitamins which are soluble in fat and oils but insoluble in water are kept in this group. These are vitamins A, D, E and K. They are stored in liver and adipose (fat storing) tissues.

(ii) **Water soluble vitamins:** B group vitamins and vitamin C are soluble in water so they are grouped together. Water soluble vitamins must be supplied regularly in diet because they are readily excreted in urine and cannot be stored (except vitamin B_{12}) in our body.

Some important Vitamins, their Sources and their Deficiency Diseases

S.No.	Vitamin	Sources	Deficiency diseases
(i)	Vitamin-A (Retinol or eye vitamin)	Milk, cod liver oil, butter, carrots, green leaves, tomatoes, eggs, etc.	Night blindness, xerophthalmia (i.e, hardening of cornea of eye) and xerosis.
(ii)	Vitamin-B_1	Pulses, nuts, green vegetables, Polished rice, yeast and egg yolk.	Beriberi (a disease of nervous system) and loss apetite.
(iii)	Vitamin-B_2 or Riboflavin or Lactoflavin	Milk, meat, green vegetables and yeast.	Inflammation of tongue or dark red tongue (glossitis), and cheilosis (cracking or fissuring the lips and corners of the mouth)
(iv)	Vitmain-B_6 or Pyridoxine or Adermine	Rice, bran, yeast, meat, fish, egg, yolk, maize, spinach and lettuce.	Specific dermatitlis called acrodynia, pellagra (shrivelled skin anaemia and convulsions.
(v)	Vitamin-B_{12}	Milk, liver, kidney and eggs.	Inflammation of tongue, mouth etc. and pernicious anaemia
(vi)	Vitamin-C or L-Ascorbic acid	Citrous fruits, amla, (oranges, lemons), sprouted pulses, geminated.	Scurvy and brittleness of bones, swelling and bleeding of gums and lossening of teeth.
(vii)	Vitamin D (sunshine vitamin)	Fish liver oil, cod liver oil, milk and egss.	Rickets (softening and bending of bones) in children, controls Ca and P metabolism.
(viii)	Vitamin-E	Eggs, milk, fish, wheat germs, oil cotton seed oil etc.	Sterility (loss of sexual power and reproduction)
(ix)	Vitamin-K	Cabbage, alfalfa, spinach and carrot tops.	Haemorrhage and increased blood clotting time.

11. LIPIDS

Biological substances which are insoluble in water are known as lipids. This characteristic physical property of lipids makes them very different from other biomolecules like carbohydrates, proteins, and nucleic acids. Lipids have extremely varied structure.

Lipids play important roles in many cellular processes like energy storage, structural support, protection, and communication. Common lipid groups are waxes, steroids, triglycerides, and phospholipids.

11.1 Function of Lipids

The function of lipids are very diverse.

(i) Some lipids are used to store energy.

(ii) In addition to serving as energy sources, some lipids accumulate in tissues around to act as insulation and protection.

(iii) Other lipids carry chemical messages and help regulate cell activity from one part of the body to another.

12. HORMONES

Hormones are biomolecules which are produced in the ductless (endocrine) glands and are carried to different parts of the body by the blood stream where they control various metabolic processes. These are required in minute quantites and unlike fats and carbohydrates these are not stored in the body but are continuously produced.

12.1 Steroidal Hormones

Steroidal Hormones

S. No.	Name	Organ of Secretion	Functions
(i)	Adrenaline or Epinephrine	Adrenal medulla	It is an amine compound and was the first hormone to be isolated. Prepares animals and humans for emergency in many ways by raising the pulse rate, blood pressure etc. stimulates the breakdown of liver glycogen into blood glucose and fats into fatty acids during emergency. These properties make adrenaline as one of the most valuable drugs used in medicine.
(ii)	Thyroxine	Thyroid gland	Controls metabolism of carbohydrates, lipids and proteins.

12.2 Peptide Hormones

Peptide Hormones

S. No.	Name	Organ of Secretion	Functions
(i)	Oxytocin	Posterior pituitary	Control the contraction of the uterus after child birth and releases milk from the mammary glands
(ii)	Vasopressin	Posterior pituitary gland	Control the reabsorption of water in the kidney.
(iii)	Angiotensin II	Blood Plasma of persons	Potent vasoconstrictor i.e. contracts the blood vessels with high blood pressure.
(iv)	Insulin	Pancreas	Controls the metabolism of glucose, maintains glucose level in the blood.

12.3 Amine Hormones

Amine Hormones

S. No.	Name	Organ of Secretion	Functions
(i)	Sex hormones		Control the development and normal functioning of Androsterone and male sex organs.
	(a) Androgens (Testosterone)	Testes	
	(b) Estrogens (Estrone, Estradiol,Estriol)	Ovary	Control the development and normal functioning of female sex organs.
	(c) Gestogens (Progesterone)	Corpus luteum	Control the development and maintenance of pregnancy
(ii)	Adrenal corex hormones or corticoids (Cortisone, Corticosterone Aldosterone etc.)	Adrenal cortex	Regulate the metabolism of fats, proteins and carbohydrates: control the balance of water and minerals in the body.

13. TEST FOR BIOMOLECULES

13.1 Tests for Carbohydrates

13.1.1 Molisch Test

Molisch test is used for detection of all types of carbohydrates, i.e. monosaccharides, disaccharides and polysaccharides.

Molisch reagent (1% alcoholic solution of α-naphthol) is added to the aqueous solution of a carbohydrate followed by conc. H_2SO_4 along the sides of the test tube. A violet ring is formed at the junction of the two layers.

13.1.2 Benedict's Test

Benedict's solution contains copper sulfate that provides cupric ions, Sodium carbonate that makes solution alkaline, and Sodium Citrate that provides citrate ions.

It is a test for reducing sugars. Carbohydrates having free functional group, that is not involved in a glycosidic bond, give this test positive. All monosaccharides and reducing disaccharides give positive Benedict's test. This test is negative for polysaccharides.

In the presence of an alkali, reducing sugars undergo tautomerization to form enediols. These enediols reduce the cupric ions (Cu^{+2}) to form cuprous ions (Cu^{+}). The cuprous ions from cuprous hydroxide. Upon heating, it is converted to cuprous oxide that forms precipitates. The citrate ions present in the reagent release the cuprous ions slowly for reduction and prevent the formation of $Cu(OH)_2$ until the oxidation-reduction process is completed.

13.1.3 Barfoed's Test

Barfoed's reagent contains copper acetate in glacial acetic acid. It is a differentiating test to distinguish between monosaccharides and disaccharides. Barfoed's test is also based on the reducing ability of sugar. However, sucrose also gives this test positive as it undergoes hydrolysis in the presence of an acid. Monosaccharides give early positive test while the disaccharides give late positive test.

Formation of red precipitates after the initial first 5 minutes indicates the presence of a monosaccharide. If precipitates are formed after 15 minutes, a disaccharide is present in the test solution.

13.1.4 Seliwanoff's Test

Seliwanoff's reagent contains water, resorcinol and concentrated HCl This test is used to detect monosaccharides with a ketonic functional group. It is widely used to differentiate fructose, a keto sugar, from glucose and galactose. This test involves the formation of furfural derivatives by monosaccharides with hydrochloric acid. The furfural derivatives formed by a sugar with ketonic functional group condense with resorcinol to form a chromogen having cherry-red color.

13.1.5 Iodine Test

This test is only given by starch. Starch reacts with iodine solution forms complex blue colour solution. On heating the blue colour disappears and on cooling the blue colour reappears.

Note:

The appearance of blue colour solution confirms the presence of starch.

13.2 Tests for Proteins

13.2.1 Biuret Test

An alkaline solution of a protein when treated with a few drops of 1% $CuSO_4$ solution, produces a violet colouration. The colour is due to the formation of a coordination complex of Cu^{+2} with $>C{=}O$ and –NH– groups of the peptide linkages.

13.2.2 Xanthoproteic Test

When a protein is treated with conc. HNO_3 a yellow colour is produced. This test is given by a protein which consists of α-amino acids containing a benzene ring such as tyrosine, phenylalanine etc. and the yellow colour is due to the nitration of the benzene ring. An important example of this test is that when conc. HNO_3 is spilled on your hands, the skin turns yellow due to nitration of benzene ring of the amino acids of the proteins present in your skin.

13.2.3 Millon's Test

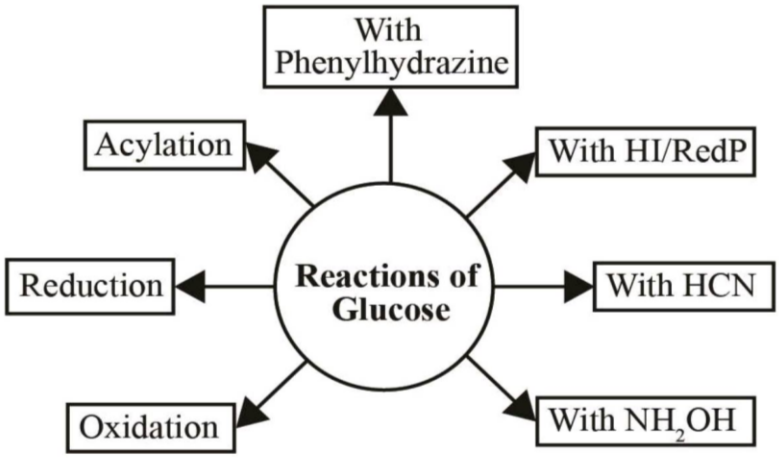
Millon's reagent is a solution of mercurous nitrate and mercuric nitrate in nitric acid containing little nitrous acid. When Millon's reagent is added to aqueous solution of protein, a white ppt. is formed. This test is given by all proteins containing phenolic α-amino acids i.e. tyrosine. As such gelatin which does not contain phenolic α-amino acids does not give this test.

13.2.4 Ninhydrin Test

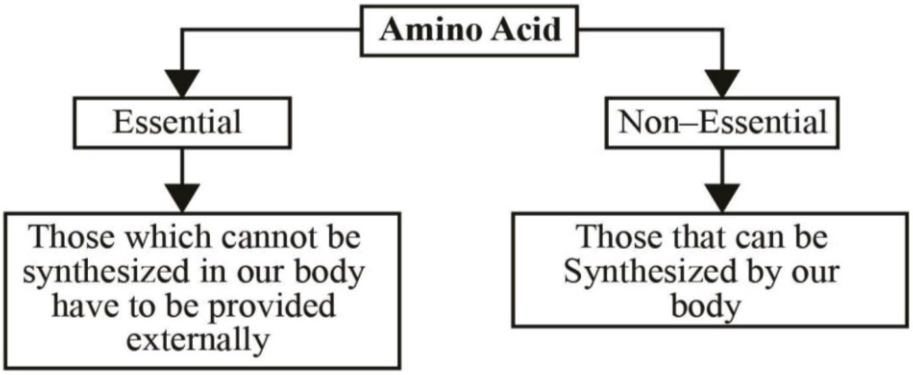
When proteins are boiled with a dilute aqueous solution of ninhydrin (2, 2-dihydroxyindane-1,3-dione), a blue-violet colour is produced. This test is actually given by all α-amino acids. Since proteins on hydrolysis give α-amino acids, therefore, proteins and peptides also give this test.

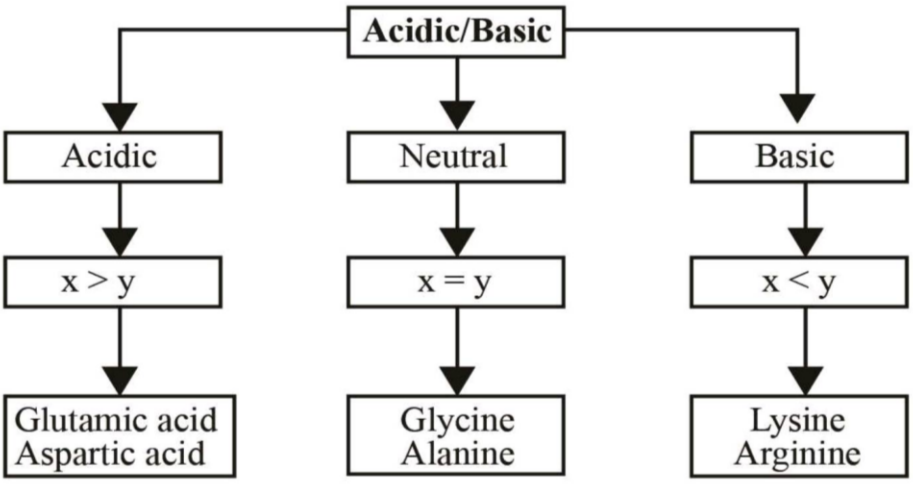
Summary

Reactions of Glucose



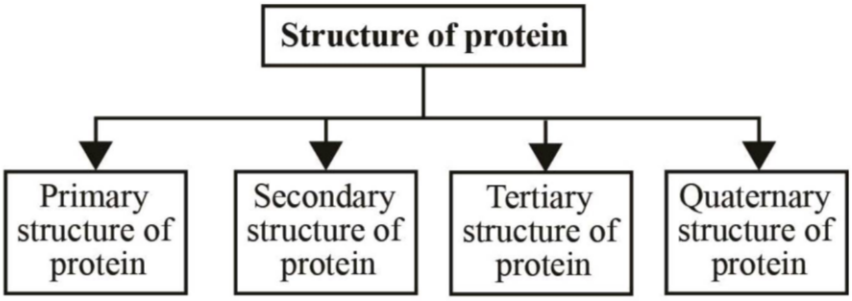
Classification of Amino Acids



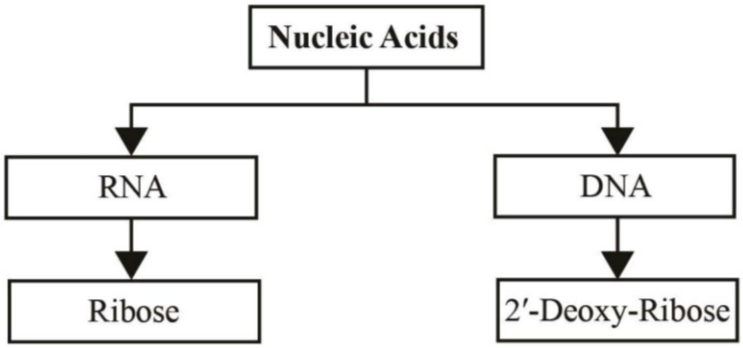


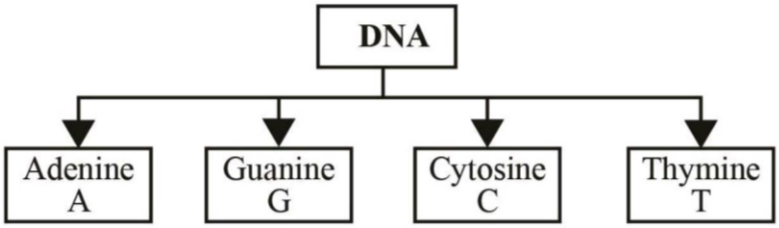
Number of Carboxyl groups is 'x'
Number of Amino groups is 'y'

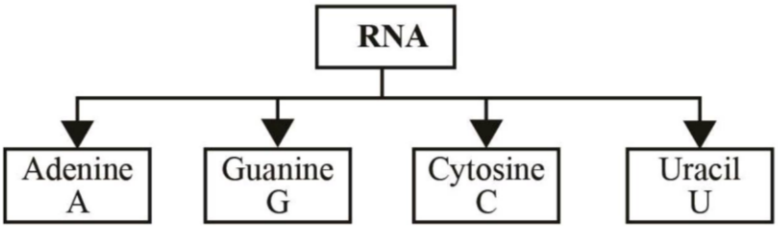
Structure of Proteins



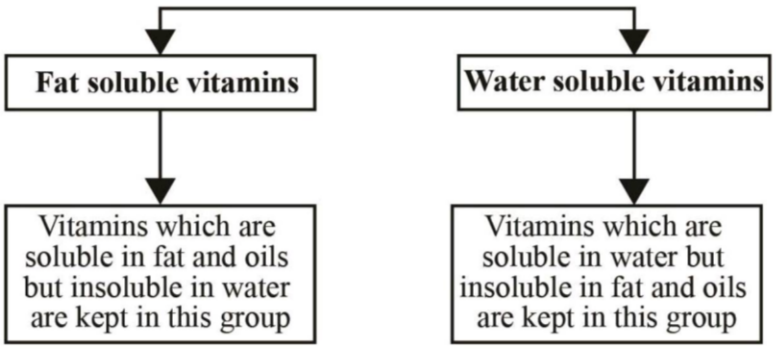
Chemical Composition of Nucleic Acids







Classification of Vitamins



SOLVED EXAMPLES

Example - 1

What are monosaccharides?

Sol. Monosaccharides are carbohydrates that cannot be hydrolysed further to give simpler units of polyhydroxy aldehyde or ketone.

Example - 2

What are reducing sugars?

Sol. Reducing sugars are carbohydrates that reduce Fehling's solution and Tollen's reagent. All monosaccharides and disaccharides, excluding sucrose, are reducing sugars.

Example - 3

What is glycogen? How is it different from starch?

Sol. Glycogen is a carbohydrate (polysaccharide). In animals, carbohydrates are stored as glycogen. Starch is a carbohydrate consisting of two components - amylose (15-20%) and amylopectin (80-85%).

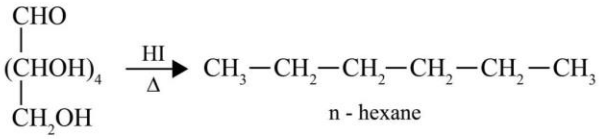
However, glycogen consists of only one component whose structure is similar to amylopectin. Also, glycogen is more branched than amylopectin.

Example - 4

What happens when D-glucose is treated with the following reagents?

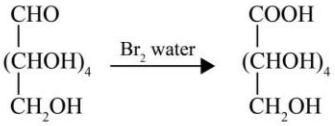
I. HI II. Bromine water

Sol. I. When D-glucose is heated with HI for a long time, n-hexane is formed.



D - glucose

II. When D-glucose is treated with Br_2 water, D-gluconic acid is produced.



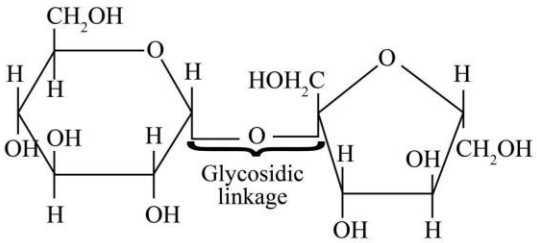
D - glucose D - gluconic acid

Example - 5

What do you understand by the term glycosidic linkage?

Sol. Glycosidic linkage refers to the linkage formed between two monosaccharide units through an oxygen atom by the loss of water molecule.

For example, in a sucrose molecule, two monosaccharide units, α -D-glucose and β -D-fructose, are joined together by a glycosidic linkage.



α -D-glucose β -D-fructose

Sucrose

Example - 6

Glucose or sucrose are soluble in water but cyclohexane or benzene (simple six membered ring compounds) are insoluble in water. Explain.

Sol. A glucose molecule contains five -OH groups while a sucrose molecule contains eight -OH groups. Thus, glucose and sucrose undergo extensive H-bonding with water.

Hence, these are soluble in water.

But cyclohexane and benzene do not contain -OH groups. Hence, they cannot undergo H-bonding with water and as a result, are insoluble in water.

Example - 7

Classify the following into monosaccharides, disaccharides and polysaccharides : Ribose, glycogen, maltose, deoxyribose, lactose, fructose, glucose, cane sugar, starch, cellulose.

Sol. Monosaccharides : Ribose, deoxyribose, glucose, fructose.

Disaccharides : Maltose, lactose, cane sugar.

Polysaccharides : Glycogen, starch, cellulose.

Example - 8

Name the monomers of starch.

Sol. α - D - Glucose.

Example - 9

Name the monomers of cellulose.

Sol. β - D - Glucose.

Example - 10

What is mutarotation?

Sol. Mutarotation is a change in the optical rotation of a solution due to a change in the equilibrium between alpha (α) and beta (β) anomers, upon dissolution in the aqueous solution.

Example - 11

What happens when Glucose is made to react with Tollen's reagent?

Sol.

$$C_6H_{12}O_6 + 2Ag(NH_3)_2OH \longrightarrow \underset{\text{Silver mirror}}{\overset{\overset{COONH_4}{|}}{(CHOH)_4}\overset{}{\underset{|}{}}\underset{CH_2OH}{}} + 2Ag + 3NH_3 + H_2O$$

Example - 12

What are essential and non-essential amino acids? Give two examples of each type.

Sol. Essential amino acids are required by the human body but they cannot be synthesised in the body. They must be taken through food. For example: valine and leucine.

Non-essential amino acids are also required by the human body but they can be synthesised in the body. For example: glycine and alanine.

Example - 13

What is the effect of denaturation on the structure of proteins?

Sol. As a result of denaturation, globules get unfolded and helixes get uncoiled. Secondary and tertiary structures of protein are destroyed, but the primary structures remain unaltered.

Example - 14

Where does the water present in the egg go after boiling the egg?

Sol. When an egg is boiled, the proteins present inside the egg get denatured and coagulate. After boiling the egg. the water present in it is absorbed by the coagulated protein by H-bonding.

Example - 15

Name the protein that stores oxygen in the muscle tissue

Sol. Myoglobin.

Example - 16

The two strands in DNA are not identical but are complementary. Explain.

Sol. In the helical structure of DNA, the two strands are held together by hydrogen bonds between specific pairs of bases. Cytosine forms hydrogen bond with guanine, while adenine forms hydrogen bond with thymine. As a result, the two strands are complementary to each other.

Example - 17

What are the different types of RNA found in the cell?

Sol. **I.** Messenger RNA (m-RNA)

II. Ribosomal RNA (r-RNA)

III. Transfer RNA (t-RNA)

Example - 18

What products would be formed when a nucleotide from DNA containing thymine is hydrolysed?

Sol. When a nucleotide from the DNA containing thymine is hydrolyzed, thymine *β–D–*2- deoxyribose and phosphoric acid are obtained as products.

Example - 19

Name the sugars present in nucleic acids.

Sol. Deoxyribose and ribose.

Example - 20

Name the base present in RNA.

Sol. RNA consists of four nitrogenous bases: adenine, cytosine, uracil, and guanine.

Example - 21

What are enzymes?

Sol. Enzymes are biological catalyst. Each biological reaction requires a different enzymes, Thus, as compared to conventional catalyst enzymes are very specific and efficient in their action. Each type of enzyme has its own specific optimum conditions of concentration, pH and temperature at which it works best.

Example - 22

Name the disease caused due to the deficiency of

(a) Vitamin B_{12}

(b) Vitamin C

(c) Vitamin B_1

Sol. (a) Pernicious anaemia,

(b) Scurvy

(c) Beri beri.

Example - 23

How are vitamins classified? Name the vitamin responsible for the coagulation of blood.

Sol. On the basis of their solubility in water or fat, vitamins are classified into two groups.

I. **Fat-soluble vitamins:** Vitamins that are soluble in fat and oils, but not in water, belong to this group. For example: Vitamins A, D, E, and K

II. **Water-soluble vitamins:** Vitamins that are soluble in water belong to this group. For example: B group vitamins (B_1, B_2, B_6, B_{12}, etc.) and vitamin C

However, biotin or vitamin H is neither soluble in water nor in fat.

Vitamin K is responsible for the coagulation of blood.

Example - 24

Why can not vitamin C be stored in our body?

Sol. Vitamin C can not be stored in our body because it is water soluble. As a result it is readily excreted in the urine.

Example - 25

(a) Name the vitamins, deficiency of which cause :

(i) Night-blindness (ii) Rickets

(iii) Poor coagulation (iv) Beri beri

(b) Name the sources of following vitamins:

(i) Vitamin A

(ii) Vitamin C

(iii) Vitamin D

Ans. (a)

Sol. (i) Vitamin A, (ii) Vitamin D,

(iii) Vitamin K, (iv) Vitamin B_1

(b) (i) Synthesised in cells of liver and intestinal mucous membrane from carotenoid pigments found in milk, butter, egg yolk, fish liver oil, etc.

(ii) Lemon, orange and other citrus fruits, tomatoes, green vegetables, etc.

(iii) Synthesised in skin cells in sunlight, found in egg yolk and fish.

EXERCISE - 1 : BASIC OBJECTIVE QUESTIONS

Carbohydrates

1. A disaccharide on hydrolysis gives
(a) Two molecules of the same monosaccharide
(b) One molecule each of two different monosaccharides
(c) Three molecules of the same monosaccharide
(d) Two molecules of the same or one molecule each of the two different monosaccharides.

2. Glucose is a/an
(a) Aldohexose (b) Aldopentose
(c) Aldotetrose (d) Ketohexose

3. In polysaccharides, the linkage connecting monosaccharides is called
(a) Glycosidic linkage (b) nucleoside linkage
(c) glycogen linkage (d) peptide linkage

4. Rapid interconversion of a-D- glucose and b-D- glucose in solution is known as
(a) racemization (b) asymmetric induction
(c) fluxional isomerization (d) mutarotation

5. The reagent which forms crystalline osazone derivative when treated with glucose is
(a) Fehling solution (b) Phenylhydrazine
(c) Benedict solution (d) Hydroxylamine

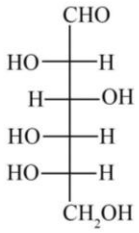
6. Lactose is a disaccharide of
(a) Glucose only (b) Glucose and fructose
(c) Glucose and galactose (d) Galactose only

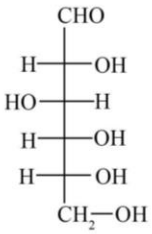
7. The pH of blood is around
(a) 8.0 (b) 6.0
(c) 5.4 (d) 7.4

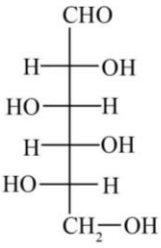
8. Which of the following is a reducing sugar ?
(a) Glucose (b) Fructose
(c) Maltose (d) All of these

9. Which of the following is a non-reducing sugar ?
(a) Sucrose (b) Maltose
(c) Lactose (d) Ribose

10. What is the structure of L-Glucose ?

(a) 

(b) 

(c) 

(d) None of these

11. In fructose, the possible optical isomers are
(a) 12 (b) 8
(c) 16 (d) 4

12. When amylases catalyse the hydrolysis of starch, the final product obtained is chiefly
(a) Cellubiose (b) Glucose
(c) Maltose (d) Sucrose

13. D-Glucose $\xrightarrow[\Delta]{HNO_3}$ (A), Product (A) is
(a) D-Gluconic acid (b) D-Glucitol
(c) D-Fructose (d) D-Glucaric acid

14. Acid or enzymatic hydrolysis of sucrose to give an equimolar mixture of glucose and fructose is called
(a) Esterification (b) Inversion
(c) Saponification (d) Insertion

15. D-Glucose exists in x different forms. The value of x (stereoisomer) is
(a) 2 (b) 3
(c) 4 (d) 5

16. All monosaccharides containing five or six carbon atoms have
(a) Open chain structures
(b) Pyranose structures
(c) Furanose structures
(d) May have pyranose or furanose structures

17. Glucose and fructose are

(a) Optical isomers (b) Tautomers

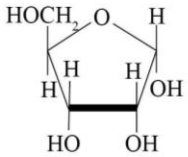
(c) Functional isomers (d) Chain isomers

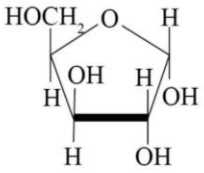
18. a-D- Glucose and b-D- glucose differ from each other due to difference in one carbon with respect to its ?

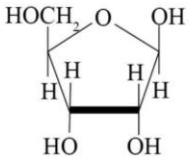
(a) Size of hemiacetal ring (b) Number of OH groups

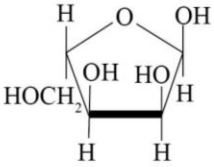
(c) Configuration (d) Conformation

19. Which of the following represents the anomer of the compound shown ?



(a) 

(b) 

(c) 

(d) None of these

20. In lactose, the reducing part is

(a) Galactose (b) Glucose

(c) Fructose (d) Mannose

21. Which of the following reduces Tollen's reagent ?

(a) Glucose (b) Fructose

(c) Lactose (d) All

22. Glucose reduces

(a) Tollen's reagent (b) Fehling's solution

(c) Benedict's solution (d) All

23. D-glucose & D-fructose can be differentiated by

(a) Fehling solution (b) Tollens reagent

(c) Benedict test (d) Br_2/H_2O

24. For the complex conversion of D-glucose into the corresponding osazone, the minimum number of equivalents of phenyl hydrazine required is

(a) two (b) three

(c) four (d) five

25. Sucrose reacts with acetic anhydride to form

(a) Penta-acetate (b) Hexa-acetate

(c) Tetra-acetate (d) Octa-acetate

26. A certain compound gives negative test with ninhydrin and positive test with Benedict's solution. The compound is

(a) A protein (b) A monosacchride

(c) A lipid (d) An amino acid

27. Glucose and mannose are

(a) Optical isomers (b) Anomers

(c) Epimers (d) Chain isomers

28. Oxidation of glucose with Ag_2O gives

(a) D-Gluconic acid (b) L-Glucaric acid

(c) L-Gluconic acid (d) L-Glucaric acid

Amino Acids

29. The acid showing salt-like character in aqueous solution is

(a) Acetic acid (b) Benzoic acid

(c) Formic acid (d) α-Aminoacetic acid

30. Which of the following does not exist as a zwitter ion ?

(a) Glycine (b) Alanine

(c) Sulphanilic acid (d) p-Aminobenzoic acid

31. In aqueous solutions, amino acids mostly exist as

(a) $NH_2-CHR-COOH$ (b) $NH_2-CHR-COO^{\ominus}$

(c) $N_3\overset{\oplus}{N}-CHR-COOH$ (d) $H_3\overset{\oplus}{N}-CHR-COO^{\ominus}$

32. Which of the following a-amino acids does not contain a chiral carbon ?

(a) Glycine (b) Alanine

(c) Phenylalanine (d) Valine

33. In glycine, the basic group is

(a) $-NH_2$ (b) $-NH_3^{\oplus}$

(c) –COOH (d) $-COO^-$

34. Which statement correctly completes the statement ?

Except for glycine, which is achiral, all the amino acids present in proteins .....

(a) are chiral, but racemic

(b) have the L configuration at their α carbon

(c) have the R configuration at their α carbon

(d) have the S configuration at their α carbon

35. Which amino acid does not contain chiral centre ?

(a) Valine (b) Leucine

(c) Glycine (d) Iso-leucine

36. In an amino acid, the carboxyl group ionises at $pKa_1 = 2.34$ and ammonium ion at $pKa_2 = 9.60$. The isoelectric point of the amino acid is at pH

(a) 5.97 (b) 2.34

(c) 9.60 (d) 6.97

37. The relation of the isoelectric point for an amino acid, to solubility is

(a) the two are not related

(b) an amino acid is least soluble at its isoelectric point

(c) an amino acid has the maximum solubility at the isoelectric point

(d) solubilities of only some amino acids depend on it.

38. Assume that a particular amino acid has an isoelectric point of 6.0. In a solution at pH 1.0, which of the following species will predominate ?

(a) 

(b) 

(c) 

(d) 

39. At Iso-electric point

(a) conc. of cation is equal to conc. of anion

(b) Net charge is zero.

(c) Maximum conc. of di-polar ion (Zwitter ion) will be present

(d) All of the above

40. The number of amino acids found in proteins that a human body can synthesize is

(a) 20 (b) 10

(c) 5 (d) 14

41. Lack of essential amino acids in the diet leads to the disease called

(a) Night blindness (b) Pernicious anaemia

(c) Kwashiorkor (d) Sickel cell anaemia

42. Which of following amino acid has lowest iso-electric point?

(a) Glycine (b) Alanine

(c) Aspartic acid (d) Lysine

43. When pieces of human hair are heated strongly with soda-lime, smell of ammonia can be detected. Which one of the following conclusion can be drawn from this observation?

(a) Ammonia is present in the human hair

(b) Ammonium salt is present in hair

(c) Hair contains amino acids

(d) None of the above

44. How many amino acids (approx) are involved during the synthesis of protein?

(a) 15 (b) 18

(c) 20 (d) 91

Proteins

45. Proteins are condensation polymers of

(a) α-Amino acids (b) β-Amino acids

(c) α-Hydroxy acids (d) β-Hydroxy acids

46. Proteins are

(a) Polyamides (b) Polyesters

(c) Polyhydric alcohols (d) Polycarboxylic acids

47. Which of the following contains nitrogen ?

(a) Fats (b) Proteins

(c) Carbohydrates (d) None

48. The sequence in which the a-amino acids are linked to one another in a protein molecule is called its

(a) Primary structure (b) Secondary structure

(c) Tertiary structure (d) Quaternary structure

49. The peptide bond is

(a) $-CONH_2$ (b) $-CONH-$

(c) $-COONH_4$ (d) $-N=C=O$

50. The bond that determines the secondary structure of a protein is

(a) Co-ordinate bond (b) Covalent bond

(c) Hydrogen bond (d) Ionic bond

51. The dipeptide glycylalanine contains

(a) glycine as C-terminal residue

(b) glycine as N-terminal residue

(c) alanine as N-terminal residue

(d) either (a) or (b)

52. The number of tripeptides formed by three different amino acids are

(a) Three (b) Four

(c) Five (d) Six

53. Mark the wrong statement about denaturation of proteins

(a) The primary structure of the protein doesn't change

(b) Globular proteins are converted into fibrous proteins

(c) Fibrous proteins are converted into globular proteins

(d) The biological activity of the protein is destroyed

Nucleic Acids

54. If one strand of DNA has the sequence ATGCTTGA, the sequence in the complimentary strand would be

(a) TACGAACT (b) TCCGAACT

(c) TACGTACT (d) TACGTAGT

55. The sugar present in DNA is

(a) Glucose (b) Deoxyribose

(c) Ribose (d) Fructose

56. Which of the following sets of bases is present both in DNA and RNA ?

(a) Adenine, uracil, thymine

(b) Adenine, guanine, cytosine

(c) Adenine, guanine, uracil

(d) Adenine, guanine, thymine

57. A nucleotide consists of

(a) carbon sugar (b) nitrogen containing base

(c) phosphoric acid (d) all of these

58. In nucleic acids, the nucleotides are linked to one another through

(a) Hydrogen bond (b) Peptide bond

(c) Glycosidic linkage (d) Phosphate groups

59. The pentose sugar in DNA and RNA has the

(a) Open chain structure (b) Pyranose structure

(c) Furanose structure (d) None of the above

60. In nucleic acids, the sequence is

(a) Phosphate–Base–sugar

(b) Sugar–Base–phosphate

(c) Base–sugar–phosphate

(d) Base–phosphate–sugar

61. If the sequence of bases in DNA is TGAACCCTT then the sequence of bases in m-RNA is

(a) ACUUGGGAA (b) TCUUGGGTT

(c) ACUUCCCAA (d) None of the above

62. Which of the following statements about RNA is not correct?

(a) It has a single strand.

(b) It does not undergo replication in cytoplasm.

(c) It does not contain any pyridimine base.

(d) It controls the synthesis of proteins.

63. Consider the double helix structure of DNA. the base pairs are

(a) Part of the back bone structure

(b) Inside the helix

(c) Outside the helix

(d) None of these

64. Which of the following statements about DNA is not correct?

(a) It has a double helix structure.

(b) It undergoes replication.

(c) The two strands in a DNA molecule are exactly similar.

(d) It contains the pentose sugar, 2-deoxyribose.

65. Chargaff's rule states that in an organism

(a) amount of adenine (A) is equal to that of guanine (G) and the amount of thymine (T) is equal to that of cytosine (C)

(b) amount of adenine (A) is equal to that of cytosine (C) and the amount of thymine (T) is equal to that of guanine (G)

(c) amount of all bases are equal

(d) amount of adenine (A) is equal to that of thymine (T) and the amount of guanine (G) is equal to that of cytosine (C)

66. DNA molecule takes the shape of…I…helix which are made up of alternate units of …II…and…III….

(a) I → double II → phosphate III → Sugar ribose

(b) I → β-pleated II → phosphate III → Sugar deoxyribose

(c) I double II → phosphate III → sugar deoxyribose

(d) I β-pleated II → phosphate III → sugar ribose

67. Which of the following match is correct?

(a) DNA → β-D-3-deoxyribose

(b) DNA → β-D-1-deoxyribose

(c) RNA → β-D-ribose

(d) RNA → β-D-3-deoxyribose

Enzymes

68. Enzymes in the living systems

(a) Provide energy

(b) Provide immunity

(c) Transport oxygen

(d) Catalyse biological processes

69. Enzymes take part in a reaction and

(a) decrease the rate of a chemical reaction

(b) increase the rate of a chemical reaction

(c) both (a) and (b)

(d) None of these

70. Enzymes are made up of

(a) edible proteins

(b) proteins with specific structure

(c) nitrogen containing carbohydrates

(d) carbohydrates

71. The function of enzymes in the living system is to

(a) transport oxygen

(b) provide immunity

(c) catalyse biochemical reactions

(d) provide energy

72. The enzyme which catalyse the oxidation of one substrate with simultaneous reduction of another substrate are called as…I…enzyme. The enzyme ends with the name of …II…Identify. I and II for the above blanks from the options given below.

(a) I → reductioxidase II → ase

(b) I → oxidoreductase II → ase

(c) I → oxidoreductase II → ese

(d) I → reductoxidese II → ese

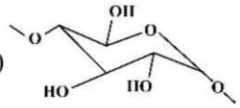
73. Enzymes are needed only in ……quantity for the progress of reaction.

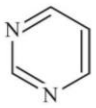
Select the appropriate word to fill the blank.

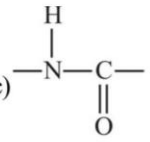
(a) small (b) large

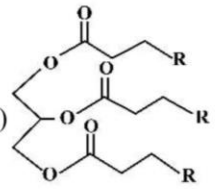
(c) Both (a) and (b) (d) None of these

74. Which one of the following chemical units is certainly to be found in enzyme ?

(a) 

(b) 

(c) 

(d) 

Lipids and Hormones

75. The number of molecules of ATP produced in the lipid metabolism of a molecule of palmitic acid is

(a) 56 (b) 36

(c) 130 (d) 86

76. The chemical messengers produced in the ductless glands are

(a) Vitamins (b) Lipids

(c) Hormones (d) Antibodies

77. Which of the following hormones contains iodine ?

(a) Insulin (b) Thyroxine

(c) Adrenaline (d) Testosterone

78. Insulin is a

(a) Steroid hormone (b) Peptide hormone

(c) Amine hormone (d) None of the above

79. Which of the following is not an amine hormone?

(a) Norepinephrine (b) Adrenaline

(c) Thyroxine (d) Oxytocin

80. The hormone which controls the processes like burning of fats, proteins and carbohydrates to liberate energy in the body is

(a) cortisone (b) thyroxine

(c) adrenaline (d) insulin

EXERCISE - 2 : PREVIOUS YEAR JEE MAINS QUESTIONS

1. The incorrect statement among the following is : **(2017)**

(a) α-D- glucose and β-D- glucose are anomers.

(b) α-D- glucose and β-D- glucose are enantiomers.

(c) Cellulose is a straight chain polysaccharide made up of only β-D- glucose units.

(d) The penta acetate of glucose does not react with hydroxyl amine.

2. Among the following, the essential amino acid is : **(2017)**

(a) Alanine (b) Valine

(c) Aspartic acid (d) Serine

3. Among the following, the incorrect statement is : **(2018)**

(a) Maltose and lactose has 1, 4- glycosidic linkage

(b) Sucrose and amylose has 1, 2- glycosidic linkage.

(c) Cellulose and amylose has 1, 4-glycosidic linkage.

(d) Lactose contains β -D- galactose and β -D- glucose.

4. Which of the following statements is not true about sucrose? **(2019)**

(a) The glycosidic linkage is present between C_1 of $\alpha-$ glucose and C_2 of $\beta-$ fructose.

(b) It is non-reducing sugar.

(c) It is also named as invert sugar.

(d) On hydrolysis it produces glucose and fructose.

5. The increasing order of pKa of the following amino acids in aqueous solution is: Gly Asp Lys Arg **(2019)**

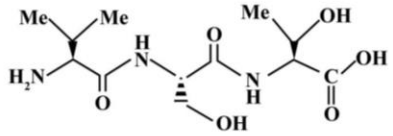
(a) Asp < Gly < Arg < Lys

(b) Gly < Asp < Arg < Lys

(c) Asp < Gly < Lys < Arg

(d) Arg < Lys < Gly < Asp

6. The correct sequence of amino acids presents in the tripeptide given below is: **(2019)**



(a) Val - Ser - Thr (b) Thr - Ser - Val

(c) Leu - Ser - Val (d) Thr - Ser - Leu

7. Maltose on treatment with dilute HCl gives: **(2019)**

(a) D – Fructose

(b) D – Galactose

(c) D – Glucose and D – Fructose

(d) D – Glucose

8. Which of the given statements is INCORRECT about glycogen? **(2019)**

(a) It is a straight chain polymer similar to amylose.

(b) Only α-linkages are present in the molecule.

(c) It is present in animal cells.

(d) It is present in some yeast and fungi.

9. Number of stereo centers present in linear and cyclic structures of glucose are respectively: **(2019)**

(a) 5 & 4 (b) 4 & 4

(c) 5 & 5 (d) 4 & 5

10. The correct match between item 'I' and item 'II' is: **(2019)**

Item - 'I' (compound)	**Item - 'II' (reagent)**
(A) Lysine	(P) 1-Naphthol
(B) Furfural	(Q) Ninhydrin
(C) Benzyl alcohol	(R) $KMnO_4$
(d) Styrene	(S) Ceric ammonium nitrate

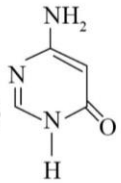
(a) (A)-(Q); (B)-(P); (C)-(S); (D)-(R)

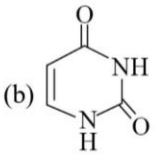
(b) (A)-(Q); (B)-(P); (C)-(R); (D)-(S)

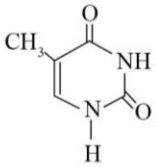
(c) (A)-(R); (B)-(P); (C)-(Q); (D)-(S)

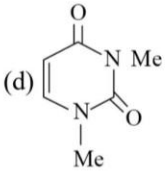
(d) (A)-(Q); (B)-(R); (C)-(S); (D)-(P)

11. Among the following compounds, which one is found in RNA? **(2019)**

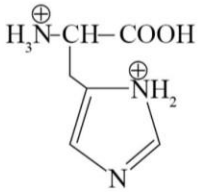
(a) 

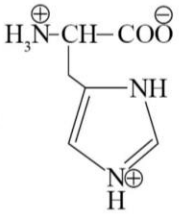
(b) 

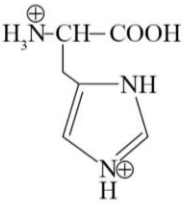
(c) 

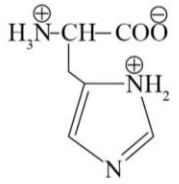
(d) 

12. The correct structure of histidine in a strongly acidic solution (pH = 2) is: **(2019)**

(a) 

(b) 

(c) 

(d) 

13. Which of the following statements is not true about sucrose? **(2019)**

(a) It is a non-reducing sugar.

(b) The glyosidic linkage is present between C_1 of α – glucose and C_1 of β – fructose.

(c) It is also named as invert sugar.

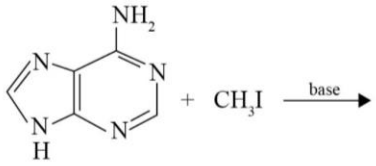
(d) On hydrolysis, it produces glucose and fructose.

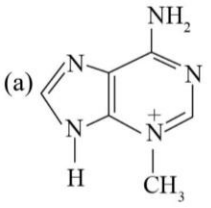
14. The peptide that gives positive ceric ammonium nitrate and carbylamines tests is: **(2019)**

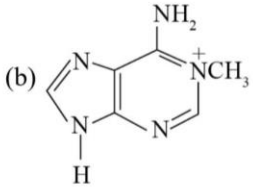
(a) Ser – Lys (b) Gln – Asp

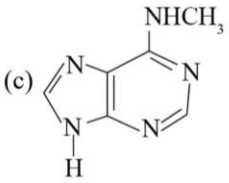
(c) Lys – Asp (d) Asp – Gln

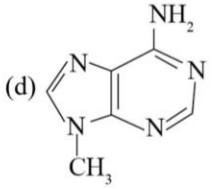
15. The major product in the following reaction is: **(2019)**



(a) 

(b) 

(c) 

(d) 

16. Which of the following statements is correct? **(2020)**

(a) Gluconic acid can form cyclic (acetal/hemiacetal) structure

(b) Gluconic acid is a dicarboxylic acid

(c) Gluconic acid is obtained by oxidation of glucose with HNO_3

(d) Gluconic acid is a partial oxidation product of glucose

17. Consider the following reactions : **(2020)**

(i) $\text{Glucose} + \text{ROH} \xrightarrow{\text{dry HCl}} \text{Acetal} \xrightarrow[(CH_3CO)_2O]{\text{x eq. of}} \text{acetyl derivative}$

(ii) $\text{Glucose} \xrightarrow{Ni/H_2} \text{A} \xrightarrow[(CH_3CO)_2O]{\text{y eq. of}} \text{acetyl derivative}$

(iii) $\text{Glucose} \xrightarrow[(CH_3CO)_2O]{\text{Z eq. of}} \text{acetyl derivative}$

'x', 'y' and 'z' in these reactions are respectively.

(a) 4, 5 & 5 (b) 5, 4 & 5

(c) 5, 6 & 5 (d) 4, 6 & 5

18. The correct observation in the following reactions is : **(2020)**

$$\text{Sucrose} \xrightarrow[\text{Cleavage (Hydrolysis)}]{\text{Glycosidic bond}} \text{A} + \text{B} \xrightarrow[\text{reagent}]{\text{Seliwanoff's}} ?$$

(a) Formation of red colour

(b) Formation of blue colour

(c) Formation of violet colour

(d) Gives no colour

19. What are the functional groups present in the structure of maltose? **(2020)**

(a) one acetal and one hemiacetal

(b) One acetal and one ketal

(c) One ketal and one hemiketal

(d) Two acetals

20. Which of the following will react with $CHCl_3$ + alc. KOH? **(2020)**

(a) Thymine and proline (b) Adenine and thymine

(c) Adenine and lysine (d) Adenine and proline

21. The number of chiral centres present in threonine is _____. **(2020)**

22. The number of chiral carbons present in sucrose is …… **(2020)**

23. Which one of the following statement is not true? **(2020)**

(a) Lactose contains a-glycosidic linkage between C_1 of galactose and C_4 of glucose.

(b) Lactose is a reducing sugar and it gives Fehling's test.

(c) On acid hydrolysis, lactose gives one molecule of D(+)-glucose and one molecule of D(+)- galactose.

(d) Lactose $(C_{11}H_{22}O_{11})$ is a disaccharide and it contains 8 hydroxyl groups.

24. Match the following: **(2020-01-07/shift-1)**

List - I	List - II
i) Riboflavin	p) Beri beri
ii) Thiamine	q) Scurvy
iii) Ascorbic acid	r) Cheliosis
iv) Pyridoxine	s) Convulsions

(a) i) - s; ii) - q; iii) - p; iv) - r

(b) i) - r; ii) - p; iii) - q; iv) - s

(c) i) - p; ii) - r; iii) - q; iv) - s

(d) i) - s; ii) - r; iii) - q; iv) - p

25. Which of the given statement is not true for glucose? **(2020)**

(a) The pentacetate glucose does not react with hydroxylamine to give oxime.

(b) Glucose reacts with hydroxylamine to form oxime.

(c) Glucose gives Schiff's test for aldehyde.

(d) Glucose exists in two crystalline forms α and β.

26. Two monomers of maltose are: **(2020)**

(a) α-D-Glucose and α-D-Galactose

(b) α-D-Glucose and α-D-Glucose

(c) α-D-Glucose and α-D-Fructose

(d) α-D-Glucose and β-D-Glucose

27. A, B and C are three biomolecules. The results of the tests performed on them are given below : **(2020)**

	Molisch's Test	Barfoed's Test	Biuret Test
A	Positive	Negative	Negative
B	Positive	Positive	Negative
C	Negative	Negative	Positive

A, B and C are respectively

(a) A=Lactose B=Glucose C=Albumin

(b) A=Lactose B=Glucose C=Alanine

(c) A=Lactose B=Fructose C=Alanine

(d) A=Glucose B=Sucrose C=Albumin

28. The number of $\rangle C=O$ groups present in a tripeptide Asp–Glu–Lys is …. **(2020)**

29. Which of the following is not essential amino acid ? **(2020)**

(a) Valine (b) Tyrosine

(c) Lysine (d) Leucine

30. The number of chiral carbon(s) present in peptide, Ile-Arg-Pro, is ……. **(2020)**

31. Out of the following, which type of interaction is responsible for the stabilisation of α -helix structure of proteins?

(2021-02-24/Shift-1)

(a) Ionic bonding (b) Vander Waals forces

(c) Hydrogen bonding (d) Covalent bonding

32. Which of the glycosidic linkage between galactose and glucose is present in lactose? **(2021-02-25/Shift-1)**

(a) C-1 of galactose and C-4 of glucose

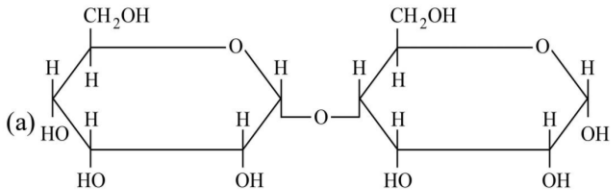
(b) C-1 of galactose and C-6 of glucose

(c) C-1 of glucose and C-4 of galactose

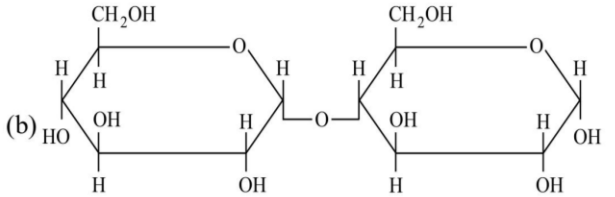
(d) C-1 of glucose and C-6 of galactose

33. Which of the following is correct structure of α -anomer of maltose? **(2021-02-25/Shift-2)**

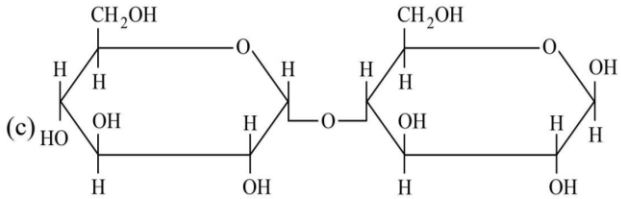
(a)



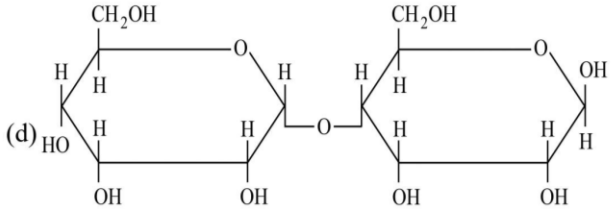
(b)



(c)



(d)



34. Which of the following vitamin is helpful in delaying the blood clotting ? **(2021-02-26/Shift-1)**

(a) Vitamin E (b) Vitamin C

(c) Vitamin K (d) Vitamin B

35. Match List-I with List-II:

List - I		List - II
A Sucrose	(i)	β -D-Galactose and β -D-Glucose
B Lactose	(ii)	α -D-Glucose and β -D-Fructose
C Maltose	(iii)	α -D-Glucose and α -D-Glucose

(2021-02-26/Shift-2)

(a) A – (iii), B – (i), C – (ii)

(b) A – (i), B – (iii), C – (ii)

(c) A – (iii), B – (ii), C – (i)

(d) A – (ii), B – (i), C – (iii)

36. Seliwanoff test and Xanthoproteic test are used for the identification of _____ and _____ respectively.

(2021-02-26/Shift-2)

(a) Ketoses, aldoses (b) Proteins, ketoses

(c) Aldoses, ketoses (d) Ketoses, proteins

37. Which among the following pairs of Vitamins is stored in our body relatively for longer duration?

(2021-03-16/Shift-1)

(a) Thiamine and Vitamin A

(b) Thiamine and Ascorbic acid

(c) Ascorbic acid and Vitamin D

(d) Vitamin A and Vitamin D

38. The secondary structure of protein is stabilised by

(2021-03-16/Shift-2)

(a) glycosidic bond (b) Hydrogen bonding

(c) Peptide bond (d) Van der Waals forces

39. $\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{\text{Enzyme A}} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$

$\underset{\text{Glucose}}{C_6H_{12}O_6} \xrightarrow{\text{Enzyme B}} 2C_2H_5OH + 2CO_2$

In the above reactions, the enzyme A and enzyme B respectively are : **(2021-03-17/Shift-2)**

(a) Invertase and Amylase

(b) Invertase and Zymase

(c) Amylase and Invertase

(d) Zymase and Invertase

40. A non-reducing sugar "A" hydrolyses to give two reducing mono saccharides. Sugar A is: **(2021-03-18/Shift-1)**

(a) Sucrose (b) Glucose

(c) Fructose (d) Galactose

41. Deficiency of vitamin K causes : **(2021-03-18/Shift-2)**

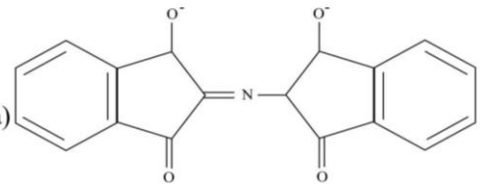
(a) Increase in blood clotting time

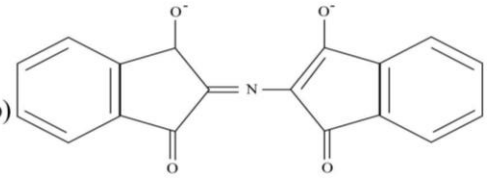
(b) Increase in fragility of RBC's

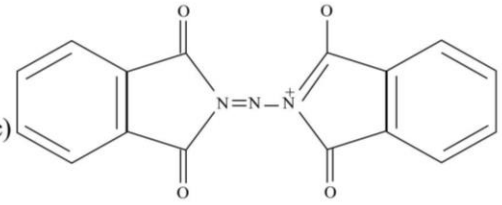
(c) Decrease in blood clotting time

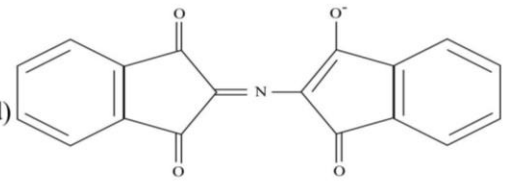
(d) Cheilosis

42. The correct structure of Rhumann's Purple, the compound formed in the reaction of ninhydrin with proteins is: **(2021-07-20/Shift-1)**

(a) 

(b) 

(c) 

(d) 

43. Identify the incorrect statement from the following **(2021-07-20/Shift-1)**

(a) Amylose is a branched chain polymer of glucose

(b) Starch is a polymer of α-D glucose

(c) β-Glycosidic linkage makes cellulose polymer

(d) Glycogen is called as animal starch

44. Thiamine and pyridoxine are also known respectively as: **(2021-07-22/Shift-2)**

(a) Vitamin B_2 and Vitamin E (b) Vitamin E and Vitamin B_2

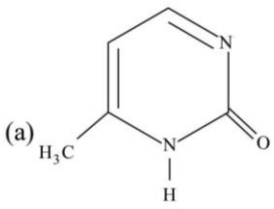
(c) Vitamin B_6 and Vitamin B_2 (d) Vitamin B_1 and Vitamin B_6

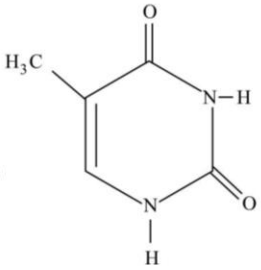
45. The water-soluble protein is: **(2021-07-25/Shift-1)**

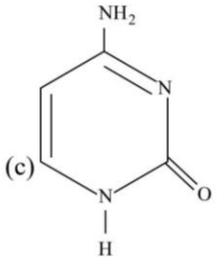
(a) Fibrin (b) Albumin

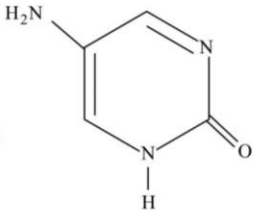
(c) Myosin (d) Collagen

46. Which one of the following is correct structure for cytosine? **(2021-07-25/Shift-2)**

(a) 

(b) 

(c) 

(d) 

47. Compound A gives D-Galactose and D-Glucose on hydrolysis. The compound A is: **(2021-07-27/Shift-2)**

(a) Amylose (b) Sucrose

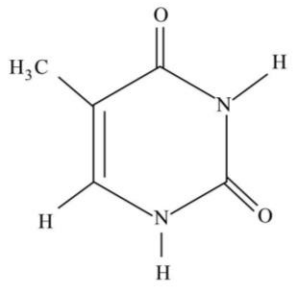
(c) Maltose (d) Lactose

48. Which one among the following chemical tests is used to distinguish monosaccharide from disaccharide? **(2021-07-27/Shift-1)**

(a) Seliwanoff's test (b) Iodine test

(c) Barfoed test (d) Tollen's test

49.



(A)

The compound 'A' is a complementary base of _____ in DNA strands. **(2021)**

(a) Uracil (b) Guanine

(c) Adenine (d) Cytosine

50. Given below are two statements: One is labelled as Assertion (A)and the other is labelled as Reason (R).

Assertion (A) : Sucrose is a disaccharide and a non-reducing sugar.

Reason (R) : Sucrose involves glycoside linkage between C_1 of β -Glucose and C_2 of α -fructose.

Choose the most appropriate answer from the options given below. **(2021-08-26/Shift-2)**

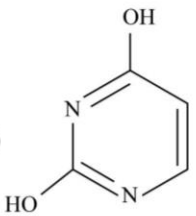
(a) Both (A) and (R) are true but (R) is not the true explanation of (A)

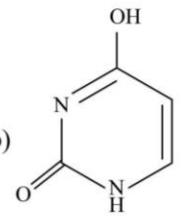
(b) (A) is false but (R) is true

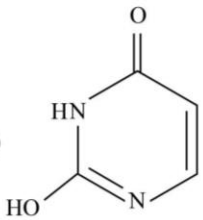
(c) (A) is true but (R) is false

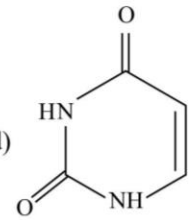
(d) Both (A) and (R) are true and (R) is true explanation of (A)

51. Out of following isomeric forms of uracil, which one is present in RNA? **(2021-08-27/Shift-1)**

(a) 

(b) 

(c) 

(d) 

52. Which one of the following tests used for the identification of functional groups in organic compounds does not use copper reagent? **(2021-08-27/Shift-2)**

(a) Barfoed's test

(b) Seliwanoff's test

(c) Benedict's test

(d) Biuret test for peptide bond

53. Hydrolysis of sucrose gives : **(2021-08-27/Shift-2)**

(a) α -D-(–)-Glucose and β -D-(–)-Fructose

(b) α -D-(+)-Glucose and α -D-(–)-Fructose

(c) α -D-(–)-Glucose and α -D-(+)-Fructose

(d) α -D-(+)-Glucose and β -D-(–)-Fructose

54. Which one of the following compounds contains β -C_1–C_4 glycosidic linkage ? **(2021-08-31/Shift-1)**

(a) Lactose (b) Sucrose

(c) Maltose (d) Amylose

55. Which of the following is NOT an example of fibrous protein? **(2021-08-31/Shift-2)**

(a) Keratin (b) Albumin

(c) Collagen (d) Myosin

EXERCISE - 3 : ADVANCED OBJECTIVE QUESTIONS

Objective Questions I [Only one correct option]

1. "Carbohydrate that cannot be hydrolysed further to give simpler unit of polyhydroxy aldehyde or ketone". Name the type of carbohydrates.

(a) Monosaccharide (b) Oligosaccharide

(c) Polysaccharide (d) All of these

2. α and β form of glucose are

(a) at equilibrium (b) the anomers

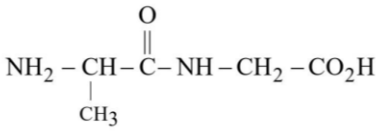
(c) the cyclic structures (d) all of these

3. Which of the following form/s osazone with phenylhydrazine?

(a) Glucose (b) Fructose

(c) Maltose (d) All the three above

4.



Identify the amino acid obtained by hydrolysis of the above compound.

(a) Glycine (b) Alanine

(c) Both (a) and (b) (d) None of these

5. On hydrolysis sucrose will give

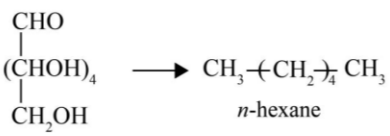
(a) one molecule of glucose

(b) two molecule of glucose

(c) one molecule of glucose and fructose

(d) one molecule of glucose and maltose

6. Name the reagent and condition required for the following reaction.



(a) HF, Δ (b) HCl, Δ

(c) HBr, Δ (d) HI, Δ

7. What does 'D' and (+) signifies in D – (+) – glucose?

(a) D represent conformation and (+) represents the laevorotatory nature of molecule

(b) D represent configuration and (+) represent the dextrorotatory nature of molecule

(c) D represent conformation and (+) represent the dextrorotatory nature of molecule

(d) D represent configuration and () represent the laevorotatory nature of molecule

8. I. Pyran is a cyclic organic compound with one oxygen atom and five carbon atom.

II. The cyclic structure of glucose is correctly represented by Haworth structure.

III. Five membered cyclic structure of glucose is called pyranose structure.

Which of the following statements) is/are true?

Choose the correct option.

(a) I and III (b) I and II

(c) Only III (d) I, II and III

9. I. Disaccharides on hydrolysis with dilute acid gives three molecules of same or different monosaccharides.

II. Disaccharides are formed by the loss of water with an oxide likage.

III. The oxide linkage in the disaccharide is called glycosidic linkage.

Choose the incorrect statement about disaccharide and select the most appropriate option.

(a) Only I (b) Only II

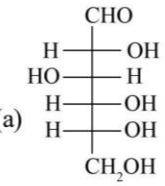
(c) Only III (d) Only II and III

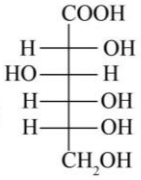
10. Name the components(s) that constitute(s) the starch.

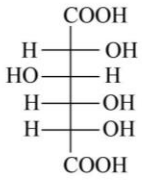
(a) Amylose (b) Amylopectin

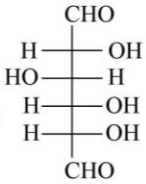
(c) Both (a) and (b) (d) None of these

11. What is the product formed when D-glucose is treated with Br_2 water?

(a) 

(b) 

(c) 

(d) 

12. Name the enzyme that catalyses the reaction given below.

$$\underset{\text{maltose}}{C_{12}H_{22}O_{11}} \xrightarrow{(?)} 2\underset{\text{glucose}}{C_6H_{12}O_6}$$

(a) Talose (b) Lactose

(c) Pepsin (d) Maltase

13. Which of the following statement(s) is/are correct regarding vitamins ?

(a) They ae designated by A, B, C, D

(b) They are further named as B_1, B_2, B_6 and B_{12}...

(c) Vitamins pills should not be taken without the advice of doctor

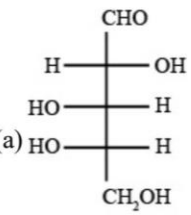
(d) All of the above

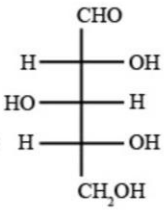
14. Which one of the following does not constitute the nucleic acid ?

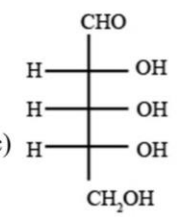
(a) Uracil (b) Ribose sugar

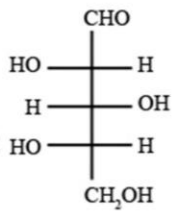
(c) Phosphoric acid (d) Guanidine

15. Which L-sugar on oxidation gives an optically active dibasic acid (2 COOH groups) ?

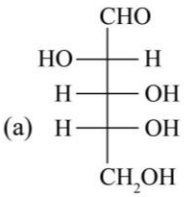
(a) 

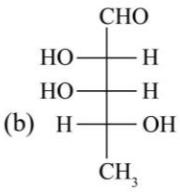
(b) 

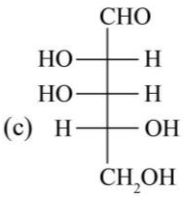
(c) 

(d) 

16. Among the three compounds shown below, two yield the same product on reaction with warm HNO_3. The exception is

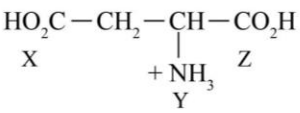
(a) 

(b) 

(c) 

(d) None of these

17. The pK_a values for the three ionizable groups X, Y and Z of glutamic acid are 4.3, 9.7 and 2.2 respectively



The isoelectric point for the amino acid is

(a) 7.00 (b) 3.25

(c) 4.95 (d) 5.95

18. $H-C\equiv C-H \xrightarrow[H_2SO_4]{HgSO_4} (A) \xrightarrow[(2)H_3O^{\oplus}]{(1)NH_3+HCN} (B)$;

Product (B) of above reaction is

(a) Glycine (b) Alanine

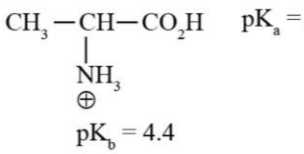
(c) Valine (d) Leucine

19. Stereoisomers of aldoheptose is (x) and stereoisomers of ketoheptose is (y). Ratio of x/y is

(a) $\frac{1}{2}$ (b) $\frac{2}{1}$

(c) $\frac{4}{1}$ (d) $\frac{1}{4}$

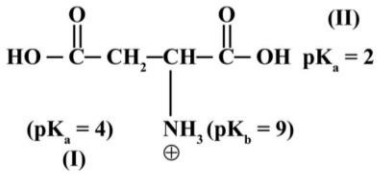
20. Find iso-electric point of given amino acid



(a) 3.3 (b) 5.9

(c) 9.6 (d) 11.8

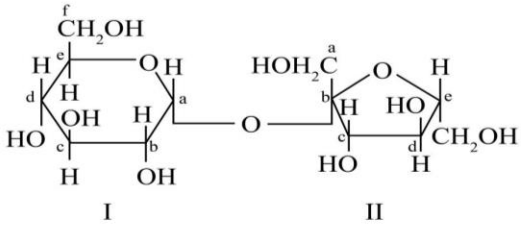
21. Find iso-electric point of the given amino acid



(a) 5.5 (b) 6.5

(c) 3 (d) 5

22. Identify the monosaccharide units in the given structure.



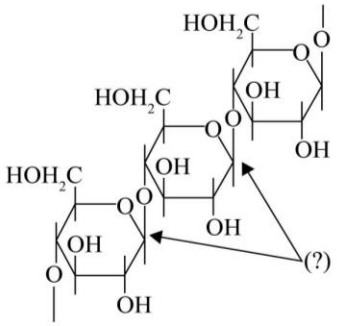
(a) I $\rightarrow \alpha$ -D-glucose, II $\rightarrow \beta$ -D-fructose

(b) I $\rightarrow \alpha$ -D-fructose, II $\rightarrow \beta$ -D-glucose

(c) I $\rightarrow \alpha$ -D-fructose, II $\rightarrow \beta$ -D-glucose

(d) I $\rightarrow \alpha$ -L-glucose, II $\rightarrow \beta$ -L-fructose

23.



Name the linkage which is present in the above figure.

(a) α -linkage (b) β -linkage

(c) γ -linkage (d) δ -linkage

24. Which one of the following amino acid does not give purple colour in the ninhydrin test?

(a) Aspartic acid (b) Glycine

(c) Proline (d) Lysine

25. Which of the following statement(s) is/are true ?

(a) Every individual has unique fingerprints and it occur at the tips of fingers

(b) A sequence of bases on DNA is also unique for a person and information regarding this is called fingerprinting

(c) Fingerprints can be altered by the surgery

(d) All of the above

Objective Questions II

[One or more than one correct option]

26. Which of the following statements are corect?

(a) Hydrolysis of sucrose with dilute acid yields an equimolar mixture of D-Glucose and D-fructose.

(b) Acidic hydrolysis of sucrose is accompanied by a change in optical reaction.

(c) In sucrose, the glycosidic linkage is between C-1 glucose and C-2 of fructose.

(d) Aqueous solution of sucrose exhibits mutarotation.

27. Which of the following carbohydrate is a disaccharide?

(a) Glucose (b) Fructose

(c) Maltose (d) Lactose

28. Which of the following do not undergo hydrolysis :

(a) glucose (b) fructose

(c) galactose (d) sucrose

29. Starch molecules are polymer with repeating glucose units. Select the correct statement(s).

(a) Glucose units are joined through α -glycosidic linkage

(b) The branches of amylopectin are linked to the chain with alpha -1,6'- glycosidic linkages.

(c) The linear linkages of amylopectin are formed by α -1, 6-glycosidic bond.

(d) Amylose has an unbranched skeleton of glucose molecules with α -1, 4-glycosidic linkages.

30. α -D-Glucopyranose and β -D-Glucopyranose are

(a) Anomers (b) Epimer

(c) Diastereomers (d) Enantiomers

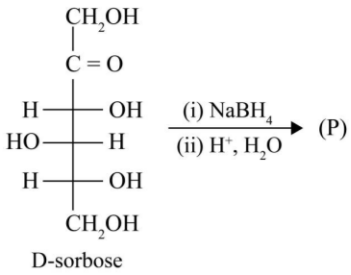
Numeric Value Type Questions

31. The number of chiral carbon atoms in α -D-glucose is.

32. Glucose molecule reacts with 'X' number of molecules of phenylhydrazine to yield osazone. The value of X is:

33. What is the maximum number of tripeptides which can be obtained from the 20 naturally occurring amino acids

34.



D-sorbose

Number of stereoisomers of product (P) is-

Assertion Reason

(A) If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

(B) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

(C) If Assertion is true but Reason is false.

(D) If Assertion is false but Reason is true.

35. **Assertion (A) :** Oligosaccharides are classified as disaccharides, trisaccharides, tetrasaccharides

Reason (R) : It depends upon the number of monosaccharides produced on hydrolysis.

(a) A (b) B

(c) C (d) D

36. **Assertion (A) :** Acetic acid is a carbohydrate.

Reason (R) : Acetic acid fits into general formula $C_2(H_2O)_y$.

(a) A (b) B

(c) C (d) D

37. **Assertion (A) :** Glucose on acetylation gives pentaacetate.

Reason (R) : It contains five OH group.

(a) A (b) B

(c) C (d) D

38. **Assertion (A) :** Glucose does not form the hydrogen bisulphate addition product.

Reason (R) : Glucose is not so reactive to form the product with $NaHSO_3$.

(a) A (b) B

(c) C (d) D

39. **Assertion (A) :** The sucrose mixture is laevorotatory.

Reason (R) : Sucrose on hydrolysis gives dextrorotatory glucose ($+52.5^\circ$) and laevorotatory of fructose (-92.4°).

(a) A (b) B

(c) C (d) D

40. **Assertion (A) :** Sucrose is called an invert sugar.

Reason (R) : On hydrolysis, sucrose bring the change in the sign of rotation from dextro (+) to laevo (–).

(a) A (b) B

(c) C (d) D

41. **Assertion (A) :** Cellulose is not digestable in the human body.

Reason (R) : The human system contain cellulose enzyme which hydrolyse cellulose into glucose.

(a) A (b) B

(c) C (d) D

42. **Assertion (A) :** Amino acids react with acid and base both.

Reason (R) : In Zwitter ionic form, amino acids show the amphoteric behavior.

(a) A (b) B

(c) C (d) D

43. **Assertion (A) :** All naturally occurring α -amino acids except glycine are optically active.

Reason (R) : Most naturally occurring amino acids have L-configuration.

(a) A (b) B

(c) C (d) D

44. **Assertion (A) :** α -helix structure of proteins is in the shape of right handed screw.

Reason (R) : There is hydrogen bond between the > NH group of each amino acid to the >= O of an adjacent turn of the helix.

(a) A (b) B

(c) C (d) D

45. **Assertion (A) :** There is the coagulation of egg white on boiling.

Reason (R) : When a protein in its native form is subjected to physical change like change in temperature or chemical change the hydrogen bonds are disturbed and protein loses its biological activity. This is called denaturation of protein.

(a) A (b) B

(c) C (d) D

46. **Assertion (A) :** The term vitamine is replaced by vitamin now days.

Reason (R) : Vitamine came from vital + amine and it was identified that vitamine did not contain amino groups.

(a) A (b) B

(c) C (d) D

47. **Assertion (A) :** Vitamin A, D, E and K are stored in liver and adipose tissue.

Reason (R) : Vitamins are soluble in fats and oils.

(a) A (b) B

(c) C (d) D

48. **Assertion (A) :** Vitamin B and C must be supplied regularly in the diet.

Reason (R) : Vitamins B and C are soluble in water which are readily excreted through urine and cannot be stored (except vitamin B_{12}) in our body.

(a) A (b) B

(c) C (d) D

49. **Assertion (A) :** The two strands of DNA are complementary to each others.

Reason (R) : Adenine forms hydrogen bonds with guanine and thymine forms hydrogen bonds with cytosine.

(a) A (b) B

(c) C (d) D

50. **Assertion (A) :** When RNA is hydrolysed, there is no relationship among the quantities of different bases obtained.

Reason (R) : RNA molecules are of three types (mRNA, rRNA, tRNA) and they perform different functions.

(a) A (b) B

(c) C (d) D

51. **Assertion (A) :** D-(+) glucose is dextrorotatory in nature

Reason (R) : 'D' represents its dextrorotatory nature

(a) A (b) B

(c) C (d) D

52. **Assertion (A) :** Rhamnose is not a carbohydrate

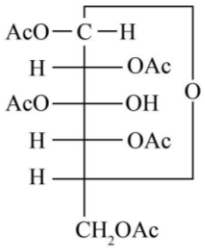
Reason (R) : It contains optically active polyhydroxy aldehydes or ketones or the compounds which produce such units on hydrolysis.

Choose the most appropriate choice from the given choices below.

(a) A (b) B

(c) C (d) D

53. **Assertion (A) :**



This compound does not form oxime.

Reason (R) : Glucose pentaacetate doesn't have a free –OH group at C1 and so can't be converted to the open chain form to give –CHO group and hence doesn't form the oxime.

(a) A (b) B

(c) C (d) D

54. **Assertion (A) :** DNA is responsible for maintaining the identity of different species of organisms over millions of years.

Reason (R) : DNA molecule is capable of self duplication during cell division and identical DNA strands are transferred to daughter cell.

(a) A (b) B

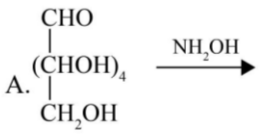
(c) C (d) D

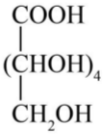
Match the Following

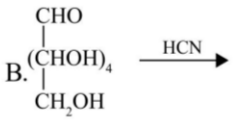
Each question has two columns. Four options are given representing matching of elements from Column-I and ColumnII. Only one of these four options corresponds to a correct matching.For each question, choose the option corresponding to the correct matching.

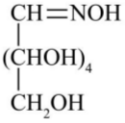
55. Match the following Column I with product given in the Column II and select the correct option from the codes given below.

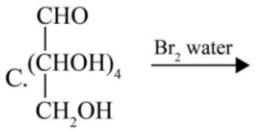
Column - I **Column - II**

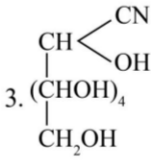
A. 

1. 

B. 

2. 

C. 

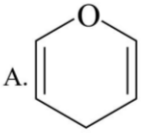
3. 

(a) $A \to 1, B \to 2, C \to 3$ (b) $A \to 1, B \to 3, C \to 2$

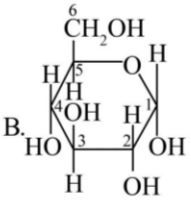
(c) $A \to 2, B \to 3, C \to 1$ (d) $A \to 2, B \to 1, C \to 3$

56. Match the column I with their names given in the column II and select the correct option from the codes given below.

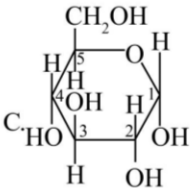
Column - I **Column - II**

A. 

1. α -D-(+)-glucopyranose

B. 

2. β -D-(+)-glucopyranose

C. 

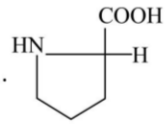
3. Pyran

(a) $A \to 1, B \to 2, C \to 3$ (b) $A \to 2, B \to 1, C \to 3$

(c) $A \to 3, B \to 1, C \to 2$ (d) $A \to 3, B \to 2, C \to 1$

57. Match the following amino acid in Column I with their characteristic feature of side chain given in the Column II and select the appropriate option from the codes given below.

Column - I **Column - II**

A. Asparagine (Asn, N) 1. 

B. Proline (Pro, P) 2. $HOOC-CH_2-CH_2-$

C. Glutanic acid (Glu, E) 3. $HO-CH_2-$

D. Serine (Ser, S) 4. $H_2N-COCH_2-$

(a) $A \to 4, B \to 1, C \to 2, D \to 3$

(b) $A \to 4, B \to 2, C \to 1, D \to 3$

(c) $A \to 4, B \to 3, C \to 1, D \to 2$

(d) $A \to 4, B \to 1, C \to 3, D \to 2$

58. Match the following enzymes given in Colmum I with the reactions they catalyse given in Column II and select the correct option from the Choices given below:

Column - I (Enzymes)	**Column - II (Reactions)**
A. Invertase	1. decomposition of urea into NH_3 and CO_2
B. Maltase	2. Conversion of glucose into ethyl alcohol
C. Pepsin	3. Hydrolysis of maltose into glucose
D. Urease	4. Hydrolysis of cane sugar
E. Zymase	5. Hydrolysis of proteins into peptides

(a) $A \to 4, B \to 1, C \to 5, D \to 3, E \to 2$

(b) $A \to 4, B \to 3, C \to 5, D \to 1, E \to 2$

(c) $A \to 4, B \to 1, C \to 3, D \to 5, E \to 2$

(d) $A \to 4, B \to 5, C \to 1, D \to 3, E \to 2$

59. Match the vitamins given in Column I with their deficiency disease given in column II and selct the correct option from the codes given below.

Column - I (Vitamins)	**Column - II (Diseases)**
A. Vitamin B_{12}	1. Increased blood clotting time
B. Vitamic C	2. Pernicious anaemia
C. Vitamin D	3. Increased fragility of RBCs and muscular weakness
D. Vitamin E	4. Scurvy
E. Vitamin K	5. Rickets and Osteomalacia

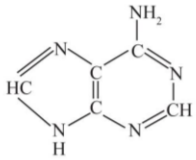
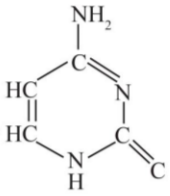
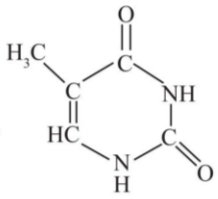
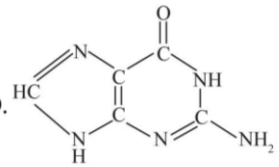
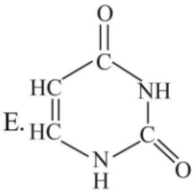
(a) $A \to 1, B \to 2, C \to 4, D \to 3, E \to 5$

(b) $A \to 2, B \to 4, C \to 5, D \to 3, E \to 1$

(c) $A \to 2, B \to 5, C \to 3, D \to 4, E \to 1$

(d) $A \to 1, B \to 2, C \to 3, D \to 4, E \to 5$

60. Match the following structure of base given in column I with their name given in the Coloumn II and select the correct option from the codes given below

Column - I	**Column - II**
A. 	1. Thymine (T)
B. 	2. Guanine (G)
C. 	3. Cytosine (C)
D. 	4. Ademine (A)
E. 	

(a) $A \to 5, B \to 3, C \to 2, D \to 1, E \to 4$

(b) $A \to 5, B \to 1, C \to 2, D \to 3, E \to 4$

(c) $A \to 2, B \to 3, C \to 1, D \to 5, E \to 4$

(d) $A \to 5, B \to 3, C \to 1, D \to 2, E \to 4$

Paragraph Type Questions

Use the following passage, to anwers Q. 61 to Q. 64

Passage

Carbohydrates are those substances that contain a carbon atom, an hydrogen atom, and a oxygen atom in the ratio of 1:2:1 and are present in food. These organic compounds act as a source of energy for the body. For ages, people have been consuming carbohydrate-rich foods. The carbohydrates present in food are consumable and called dietary carbohydrates. Dietary carbohydrates are those that can be metabolically transformed directly into glucose. Chemically, the carbohydrates may be defined as optically active polyhydroxy aldehydes or ketones or the compounds which produce such units on hydrolysis. Carbohydrates are generally optically active because they have one or more chiral carbon atoms. Some of the sweet carbohydrates are also called sugars. The most common sugar used in our homes is sucrose, whereas the sugar present in milk is lactose.

61. The formula of carbohydrates is

(a) $C_x(H_2O)_y$ (b) $C_xH_xO_y$

(c) $C_{2x}H_yO_y$ (d) $C_xH_{2y}O_y$

62. Carbohydrates break down into which of the following substances?

(a) Phosphoric acids (b) Glucose

(c) Linoleic acid (d) Glutaric acid

63. Household sugar granules are also called-

(a) Glucopyranose (b) Lactose

(c) Sucrose (d) Galactose

64. Carbohydrates have one or more chiral carbon atoms. This makes them-

(a) An alkyl group (b) Naturally less abundant

(c) Coloured (d) Optically active

Use the following passage, to anwers Q. 65 to Q. 67

Passage

It has been observed that there is a strong need to promote health and independence through dietary approaches in an individual's life. With an aging population, people are less worried about their health and lifestyle which should not be the case. Of all the macronutrients, it has been seen that protein is the most satiating. Proteins are straight chain amino acids that are important macronutrients (along with carbohydrates and fats) that helps in the development of muscles, boosts metabolism, increases fat burning, lowers blood pressure, etc. Protein sources include animal meat, eggs, milk, cheese, soybeans, etc. However, excess consumption of animal meat protein is an environmental threat and hence, in recent years, alternate substitutes of protein like vegan protein are becoming a choice of individuals.

65. Organic molecules containing an amino group and a carboxylic acid group are called-

(a) Amines (b) Amylopectin

(c) Amino acids (d) Nitriles

66. Proteins are:

(a) Linear citric acid chains

(b) Branched amino acid chain

(c) Linear chain amino acids

(d) Globular maleic acid chains

67. Which of the following is not an amino acid?

(a) Alanine (b) Cyanocobalamin

(c) Cysteine (d) Asparagine

Use the following passage, to anwers Q.68 to Q.70

Passage

For many medical conditions, glucose has been administered in patients for a long time. Diseases like hypoglycemia, hyperkalemia, etc. are treated by administering glucose in patients. Thus, it was necessary to manufacture glucose in larger quantities. This gave rise to the discovery of laboratory methods of preparation of glucose. Some of which are-

From sucrose: Boiling sucrose with dilute hydrochloric acid or sulphuric acid in an alcoholic solution leads to the formation of glucose and fructose. The reaction is-

$$\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{H^+} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$$

Sucrose is also called **cane sugar.**

From starch: When starch is hydrolyzed by boiling it with dilute sulphuric acid at 393 K under pressure, it leads to the formation of glucose. This technique is mostly used for the commercial preparation of glucose.

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

68. The preparation of glucose from sucrose and starch requires which of the following substances?

(a) Low pressure (b)Higher surface area

(c) Dilute acids (d) 1000 K temperature

69. The hybridization of the carbonyl carbon in glucose is-

(a) sp^3 (b) sp^3d^2

(c) sp^2 (d) d^2sp^3

70. The commercial preparation of glucose involves which of the following starting materials?

(a) Mannose (b) Fructose

(c) Raffinose (d) Cellulose

EXERCISE - 4 : PREVIOUS YEAR JEE ADVANCED QUESTIONS

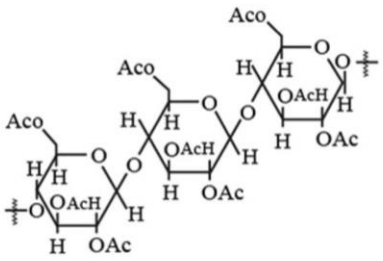
Objective Questions I
[Only one correct option]

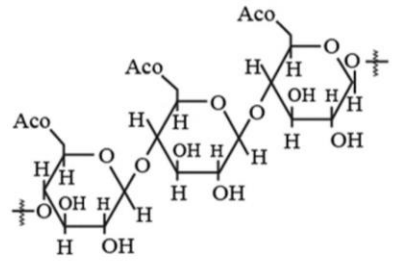
1. Two forms of D-glucopyranose, are called **(2005)**

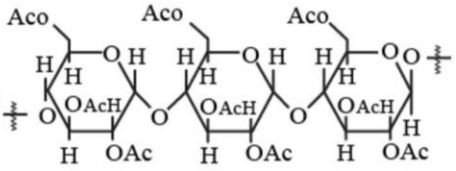
(a) enantiomers (b) anomers

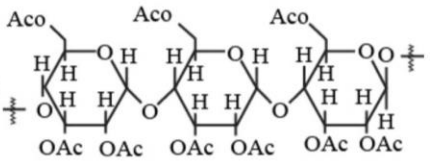
(c) epimers (d) diastereomers

2. Cellulose upon acetylation with excess acetic anhydride/ H_2SO_4 (catalytic) gives cellulose triacetate whose structure is **(2008)**

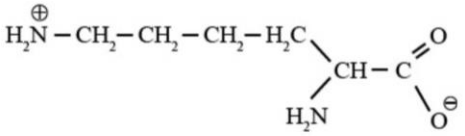
(a) 

(b) 

(c) 

(d) 

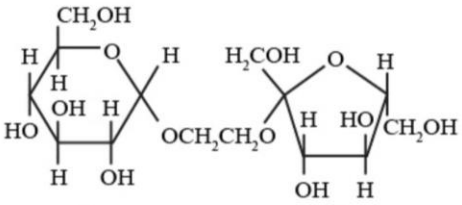
3. The total number of basic groups in the following form of lysine is **(2010)**



(a) 0 (b) 1

(c) 2 (d) 3

4. The correct statement about the following disaccharide is **(2018)**



(a) (b)

(a) Ring (a) is pyranose with α-glycosidic link

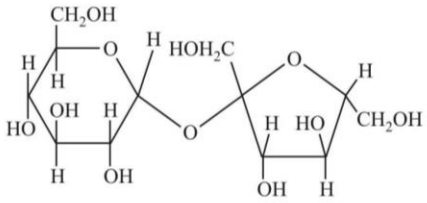
(b) Ring (a) is furanose with α-glycosidic link

(c) Ring (b) is furanose with α-glycosidic link

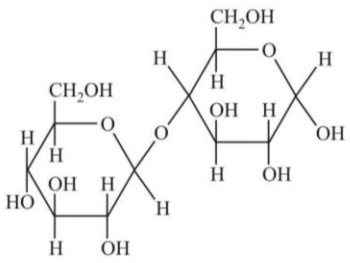
(d) Ring (b) is pyranose with β-glycosidic link

Objective Questions II
[One or more than one correct option]

5. The correct statement(s) about the following sugars X and Y is (are) **(2009)**



X



Y

(a) X is a reducing sugar and Y is a non-reducing sugar

(b) X is a non-reducing sugar and Y is a reducing sugar

(c) The glucosidic linkages in X and Y are α and β respectively

(d) The glucosidic linkages in X and Y are β and α respectively

6. Which of the following statements(s) is(are) true? **(2019)**

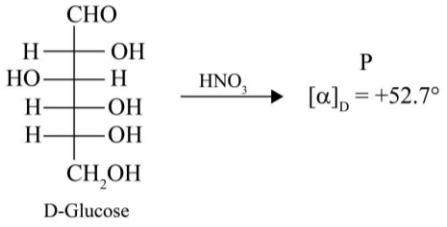
(a) The two six-membered cyclic hemiacetal forms of D-(+)-glucose are called anomers.

(b) Hydrolysis of sucrose gives dextrorotatory glucose and laevorotatory fructose

(c) Monosaccharides cannot be hydrolysed to give polyhydroxy aldehydes and ketones.

(d) Oxidation of glucose with bromine water gives glutamic acid.

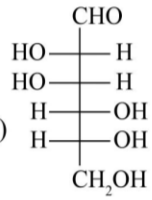
7. Given **(2021)**

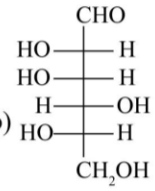


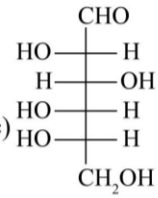
D-Glucose

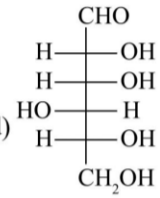
The compound(s), which on reaction with HNO_3 will give the product having degree of rotation,

$[\alpha]_D = -52.7°$ is (are)

(a) 

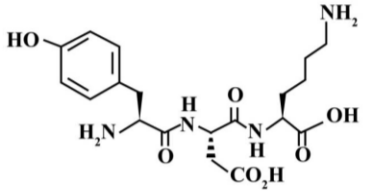
(b) 

(c) 

(d) 

Numeric Value Type Questions

8. The structure of a peptide is given below



If the absolute values of the net charge of the peptide at pH = 2, pH = 6, and pH = 11 are $|z_1|, |z_2|$ and $|z_3|$ respectively, then what is $|z_1| + |z_2| + |z_3|$? **(2020)**

Assertion Reason

(A) If both Assertion and Reason are correct and reason is the correct explanation of Assertion.

(B) If both Assertion and Reason are true but reason is not the correct explanation of Assertion.

(C) If Assertion is true but Reason is false.

(D) If Assertion is false but Reason is true.

9. **Assertion (A) :** Glucose gives a reddish-brown precipitate with Fehling's solution.

Reason (R) : Reaction of glucose with Fehling's solution gives CuO and gluconic acid. **(2007)**

(a) A (b) B

(c) C (d) D

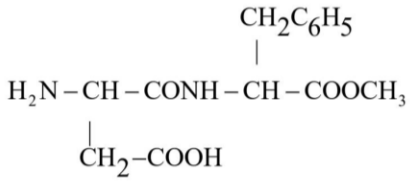
Subjective Type Questions

10. Write the structure of alanine at pH = 2 and pH = 10. **(2000)**

11. Give the structures of the products in the following reaction

$$\text{Sucrose} \xrightarrow{H^{\oplus}} A + B$$ **(2000)**

12. Aspartame, an artificial sweetener, is a peptide and has the following structure **(2001)**



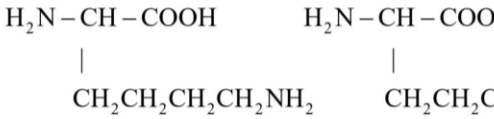
(i) Identify the four functional groups.

(ii) Write the Zwitter ionic structure.

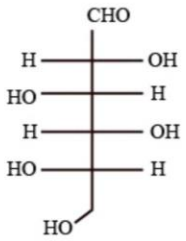
(iii) Write the structures of the amino acids obtained from the hydrolysis of aspartame.

(iv) Which of the two amino acids is more hydrophobic ?

13. Following two amino acids lysine and glutamine form dipeptide linkage. What are two possible dipeptides ? **(2003)**



14. The structure of D-glucose is as follows : **(2004)**

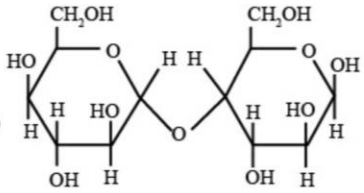


(a) Draw the structure of L-glucose.

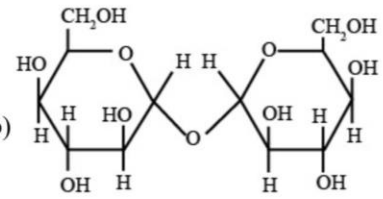
(b) Give the reaction of L-glucose with Tollen's reagent.

15. Which of the following disaccharide will not reduce Tollen's reagent ? **(2005)**

(a)



(b)



CHAPTER -7 | BIOMOLECULES

EXERCISE - 1 :
BASIC OBJECTIVE QUESTIONS

1. (d)	**2.** (a)	**3.** (a)	**4.** (d)	**5.** (b)
6. (c)	**7.** (d)	**8.** (d)	**9.** (a)	**10.** (a)
11. (b)	**12.** (b)	**13.** (d)	**14.** (b)	**15.** (b)
16. (d)	**17.** (c)	**18.** (c)	**19.** (b)	**20.** (b)
21. (d)	**22.** (d)	**23.** (d)	**24.** (b)	**25.** (d)
26. (b)	**27.** (c)	**28.** (a)	**29.** (d)	**30.** (d)
31. (d)	**32.** (a)	**33.** (d)	**34.** (b)	**35.** (c)
36. (a)	**37.** (b)	**38.** (a)	**39.** (d)	**40.** (b)
41. (c)	**42.** (c)	**43.** (c)	**44.** (c)	**45.** (a)
46. (a)	**47.** (b)	**48.** (a)	**49.** (b)	**50.** (c)
51. (b)	**52.** (c)	**53.** (c)	**54.** (a)	**55.** (b)
56. (b)	**57.** (d)	**58.** (d)	**59.** (c)	**60.** (c)
61. (a)	**62.** (c)	**63.** (b)	**64.** (c)	**65.** (d)
66. (c)	**67.** (c)	**68.** (d)	**69.** (b)	**70.** (b)
71. (c)	**72.** (b)	**73.** (a)	**74.** (c)	**75.** (c)
76. (c)	**77.** (b)	**78.** (b)	**79.** (d)	**80.** (b)

EXERCISE - 2 :
PREVIOUS YEAR JEE MAINS QUESTIONS

1. (b)	**2.** (b)	**3.** (b)	**4.** (a)	**5.** (c)
6. (a)	**7.** (d)	**8.** (a)	**9.** (d)	**10.** (a)
11. (b)	**12.** (c)	**13.** (b)	**14.** (a)	**15.** (d)
16. (d)	**17.** (d)	**18.** (a)	**19.** (a)	**20.** (c)
21. (2.00)	**22.** (9.00)	**23.** (a)	**24.** (b)	**25.** (c)
26. (b)	**27.** (a)	**28.** (5.00)	**29.** (4.00)	**30.** (4.00)
31. (c)	**32.** (a)	**33.** (b)	**34.** (c)	**35.** (d)
36. (d)	**37.** (d)	**38.** (b)	**39.** (b)	**40.** (a)
41. (a)	**42.** (d)	**43.** (a)	**44.** (d)	**45.** (b)
46. (c)	**47.** (d)	**48.** (c)	**49.** (c)	**50.** (c)
51. (d)	**52.** (b)	**53.** (d)	**54.** (a)	**55.** (b)

EXERCISE - 3 :
ADVANCED OBJECTIVE QUESTIONS

1. (a)	**2.** (d)	**3.** (d)	**4.** (c)	**5.** (c)
6. (d)	**7.** (b)	**8.** (b)	**9.** (a)	**10.** (c)
11. (b)	**12.** (d)	**13.** (d)	**14.** (d)	**15.** (a)
16. (b)	**17.** (b)	**18.** (b)	**19.** (a)	**20.** (b)
21. (c)	**22.** (a)	**23.** (b)	**24.** (c)	**25.** (d)
26. (a,b,c)		**27.** (c,d)	**28.** (a,b,c)	
29. (a,b,d)		**30.** (a,b,c)		**31.** (5.00)
32. (3.00)	**33.** (8000)	**34.** (10.00)		**35.** (a)
36. (d)	**37.** (a)	**38.** (c)	**39.** (d)	**40.** (a)
41. (c)	**42.** (a)	**43.** (b)	**44.** (a)	**45.** (a)
46. (a)	**47.** (b)	**48.** (a)	**49.** (c)	**50.** (b)
51. (c)	**52.** (d)	**53.** (a)	**54.** (a)	**55.** (c)
56. (c)	**57.** (a)	**58.** (b)	**59.** (b)	**60.** (d)
61. (a)	**62.** (b)	**63.** (c)	**64.** (d)	**65.** (c)
66. (c)	**67.** (b)	**68.** (c)	**69.** (c)	**70.** (d)

EXERCISE - 4 :
PREVIOUS YEAR JEE ADVANCED QUESTIONS

1. (b)	**2.** (a)	**3.** (c)	**4.** (a)	**5.** (b,c)
6. (a,b,c)		**7.** (c,d)	**8.** (5.00)	**9.** (c)