

BIOMOLECULES & POLYMERS

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JEE (Advanced) Syllabus

Biomolecules & Polymers

Concepts: Carbohydrates :Classification; mono- and di-saccharides (glucose and sucrose); Oxidation, reduction, glycoside formation and hydrolysis of sucrose.

Amino acids and peptides :General structure (only primary structure for peptides) and physical properties.

Properties and uses of some important polymers : Natural rubber, cellulose, nylon, teflon and PVC.

JEE(Main) Syllabus

Biomolecules : General introduction and importance of biomolecules.

Carbohydrates : Classification: aldoses and ketoses; monosaccharides (glucose and fructose), constituent monosaccharides of oligosaccharides (sucrose, lactose, maltose) and polysaccharides (starch, cellulose, glycogen).

Proteins : Elementary Idea of α -amino acids, peptide bond, polypeptides;

Proteins : primary, secondary, tertiary and quaternary structure (qualitative idea only), denaturation of proteins, enzymes.

Vitamins : Classification and functions.

Nucleic Acids : Chemical constitution of DNA and RNA. Biological functions of nucleic acids.

Polymers : General introduction and classification of polymers, general methods of polymerization – addition and condensation, copolymerization; Natural and synthetic rubber and vulcanization; some important polymers with emphasis on their monomers and uses – polythene, nylon, polyester and bakelite.



Biomolecules

Section (A) : Carbohydrates

1. Concept

Generally, carbohydrates are substances with the general formula $C_x(H_2O)_y$. They are called carbohydrates (hydrates of carbon) because they contain hydrogen and oxygen in the same proportion as in water. However, a number of compounds have been found, which are carbohydrates by chemical behaviour but do not confirm to the formula $C_x(H_2O)_y$. E.g : 2-deoxyribose.

(i) carbohydrates are biopolymers of polyhydroxy aldehyde or polyhydroxy ketones.

(ii) monomeric polyhydroxy aldehydes or ketones can also exist in hemiacetal and acetal forms in cyclic structures.

(iii) Almost all of these compounds are chiral and optically active. An exception of this is 1,3-dihydroxypropanone.

(iv) All natural carbohydrates have D-configuration.

2. Classification of Carbohydrates

(a) Classification on the basis of number of hydrolysed products

S.No.	Carbohydrate	No. of units (on hydrolysis)	Examples
1	Monosaccharides	1 or single unit (cannot be hydrolysed)	Glucose, Fructose, Galactose
2	Oligosaccharides	2 to 10 units	Sucrose, Maltose, Lactose
3	Polysaccharides	Many units	Starch, Cellulose, Gums, Resins etc

(b) Classification on the basis of functional groups

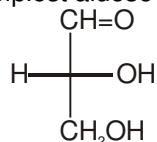
S.No.	Carbohydrate	No. of functional group	Examples
1	Aldose	Aldehyde $\begin{array}{c} \text{CH} = \text{O} \\ \\ (\text{CHOH})_n \\ \\ \text{CH}_2\text{OH} \end{array}$	Glyceraldehyde, Erythrose, Threose, Ribose & 2-Deoxyribose, Glucose, Mannose, Allose.
2	Ketose	Ketone $\begin{array}{c} \text{CH}_2\text{OH} \\ \\ \text{C} = \text{O} \\ \\ (\text{CHOH})_n \\ \\ \text{CH}_2\text{OH} \end{array}$	$n = 0$; Ketotriose, $n = 1$; Ketotetroses, $n = 2$; Ketopentoses, $n = 3$; Ketohexoses

(c) Classification of monosaccharides on basis of carbon atoms in hydrolysed product.

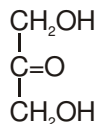
S.No.	Carbon atoms	General term	Aldehyde	Ketone
1	3	Triose	Aldotriose	Ketotriose
2	4	Tetrose	Aldotetrose	Ketotetrose
3	5	Pentose	Aldopentose	Ketopentose
4	6	Hexose	Aldohexose	Ketohexose
5	7	Heptose	Aldoheptose	Ketoheptose

**Some facts :**

1. Number of carbons in monosaccharides are generally 3 to 7.
2. Simplest aldose is Glyceraldehyde and simplest Ketose is Dihydroxyacetone.



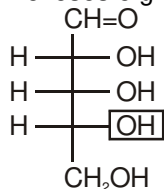
(D-Glyceraldehyde)



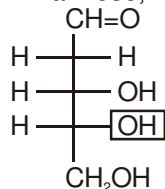
(Dihydroxyacetone)

3. Most naturally occurring monosaccharides are :

- (a) Pentoses e.g. D-Ribose (present in RNA) and 2-Deoxyribose (present in DNA)
- (b) Hexoses e.g. D-Glucose, D-Mannose, D-Allose, D-Galactose and D-Fructose



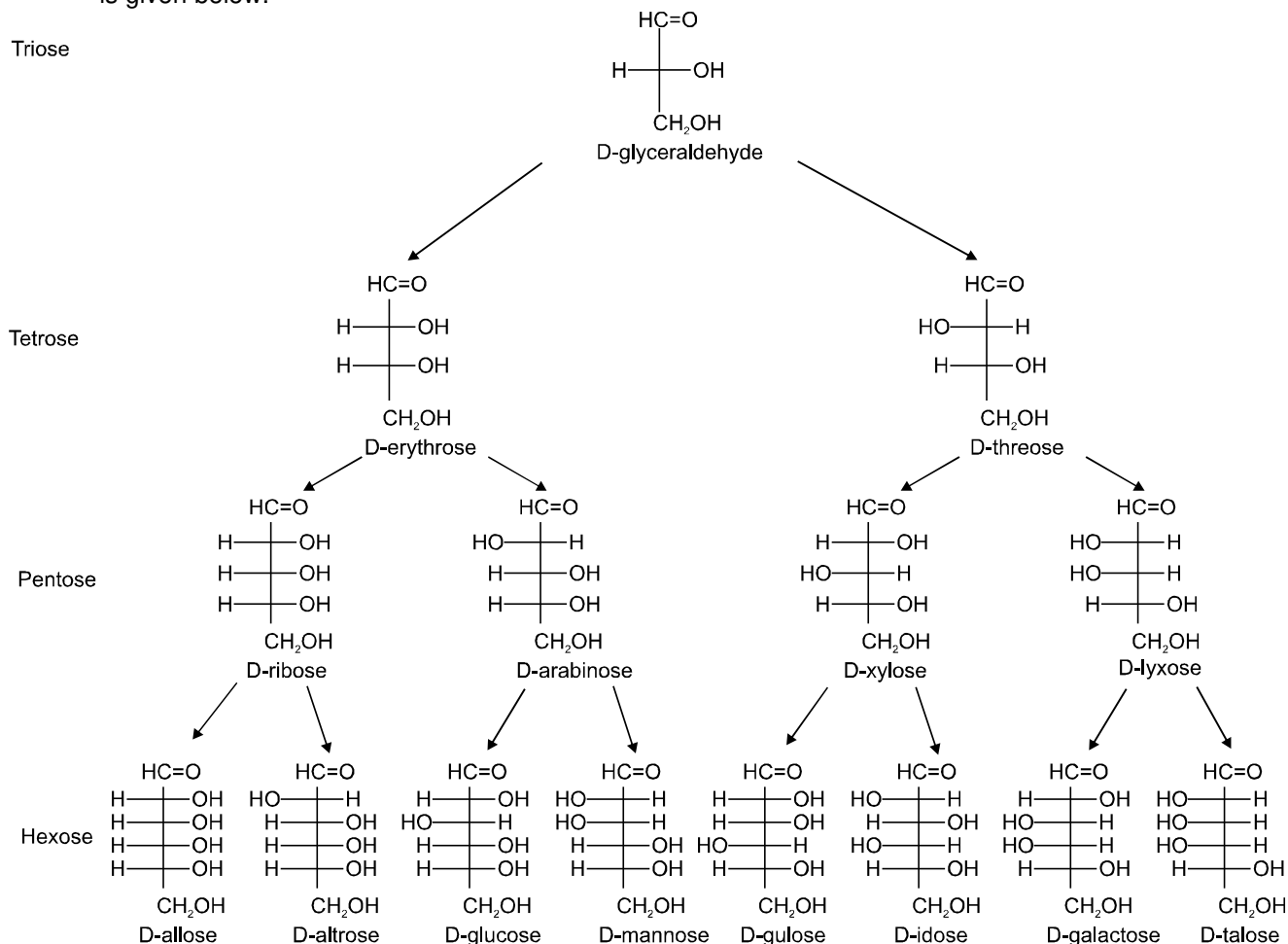
(D-Ribose)



(D-2-Deoxyribose)

3. Stereochemistry of Aldoses :

The monosaccharides are chiral and may have D or L configuration. A simple illustration of all 'D' forms is given below.

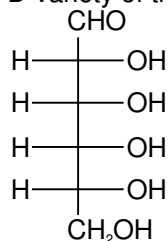


Optical isomers of Aldohexoses : Aldohexoses have four asymmetric carbon atoms, therefore they have sixteen optical isomers out of which 8 are D and 8 are L variety (overall Eight pairs of enantiomers).

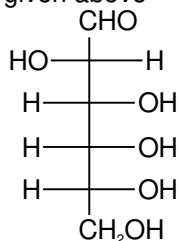




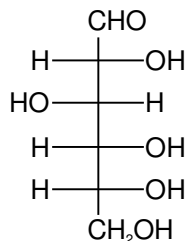
D-variety of them are given above



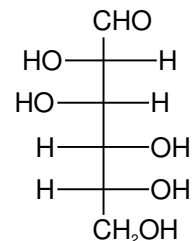
D(+)-allose
(I)



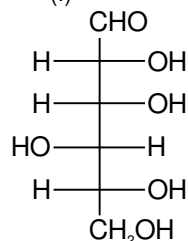
D(+)-altrose
(II)



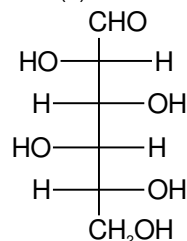
D(+)-glucose
(III)



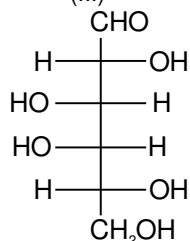
D(+)-mannose
(IV)



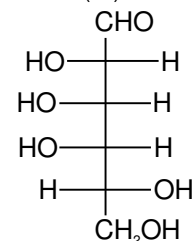
D(-)-gulose
(V)



D(-)-idose
(VI)



D(+)-galactose
(VII)



D(+)-talose
(VIII)

- Note :** 1. D-aldohehexoses shown above have diastereomeric relationship with each other
2. D-aldohehexoses can be either dextro (+) or laevo (-).

4. Structure of aldohexoses : All form of Aldose or ketose may exist in open chain form as well as in cyclic pyranose or furanose form.

(i) **Open chain structure of monosaccharides :**

Carbohydrate	Structure	Functional Group	Typical nature
D-Glucose	$ \begin{array}{c} \text{HC}=\text{O} \\ \\ \text{H} - \text{C} - \text{OH} \\ \\ \text{HO} - \text{C} - \text{H} \\ \\ \text{H} - \text{C} - \text{OH} \\ \\ \text{H} - \text{C} - \text{OH} \\ \\ \text{CH}_2\text{OH} \end{array} $	Aldehyde	3rd (L)
D-Allose	$ \begin{array}{c} \text{HC}=\text{O} \\ \\ \text{H} - \text{C} - \text{OH} \\ \\ \text{H} - \text{C} - \text{OH} \\ \\ \text{H} - \text{C} - \text{OH} \\ \\ \text{H} - \text{C} - \text{OH} \\ \\ \text{CH}_2\text{OH} \end{array} $	Aldehyde	No (L)
D-Mannose	$ \begin{array}{c} \text{HC}=\text{O} \\ \\ \text{HO} - \text{C} - \text{H} \\ \\ \text{HO} - \text{C} - \text{H} \\ \\ \text{H} - \text{C} - \text{OH} \\ \\ \text{H} - \text{C} - \text{OH} \\ \\ \text{CH}_2\text{OH} \end{array} $	Aldehyde	2, 3 (L)
D-Galactose	$ \begin{array}{c} \text{HC}=\text{O} \\ \\ \text{H} - \text{C} - \text{OH} \\ \\ \text{HO} - \text{C} - \text{H} \\ \\ \text{HO} - \text{C} - \text{H} \\ \\ \text{H} - \text{C} - \text{OH} \\ \\ \text{CH}_2\text{OH} \end{array} $	Aldehyde	3, 4 (L)



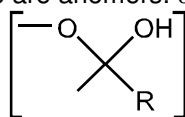
D-Fructose	$ \begin{array}{c} \text{CH}_2 - \text{OH} \\ \\ \text{C} = \text{O} \\ \\ \text{HO} - \text{C} - \text{H} \\ \\ \text{H} - \text{C} - \text{OH} \\ \\ \text{H} - \text{C} - \text{OH} \\ \\ \text{CH}_2 - \text{OH} \end{array} $	Ketone	3 (L)
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(ii) **Cyclic structure of monosaccharide**

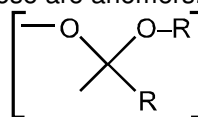
Carbohydrate	Cyclic structure	
Glucose	 $\alpha^\circ = (112^\circ)$ $\alpha\text{-D-glucopyranose}$	 $\alpha^\circ = (19^\circ)$ $\beta\text{-D-glucopyranose}$
Allose	 $\alpha\text{-D-Allopyranose}$	 $\beta\text{-D-Allopyranose}$
Mannose	 $\alpha\text{-D-Mannopyranose}$	 $\beta\text{-D-Mannopyranose}$
Fructose	 $\alpha\text{-fructofuranose}$	 $\beta\text{-fructofuranose}$

Anomers :

Anomers are diastereomers that differ in the configuration at the acetal or hemiacetal C atom of a sugar in its cyclic form (Anomeric carbon: A carbon bonded with two 'O' atoms). For example, α D(+) and β - D(+) glucose are anomers. α -D(-) and β -D(-) fructose are anomers.



Hemiacetal functional group



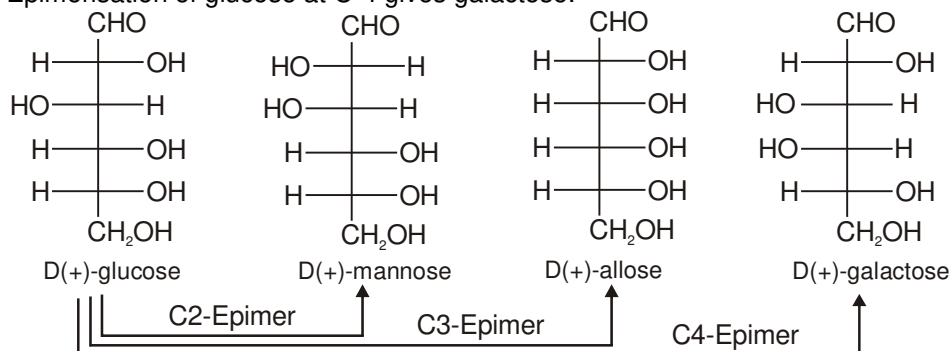
Acetal functional group





Epimers : Diastereomers with more than one stereocentre that differ in the configuration about only one stereocentre (other than anomeric carbon) are called epimers.

- D-Erythrose and L-threose are epimers.
- D-glucose and D-galactose are C-4 epimers and
- D-idose and D-talose are C-3 epimers.
- D-glucose and D-mannose are C-2 epimers.
- Epimerisation of glucose at C-2 gives mannose.
- Epimerisation of glucose at C-3 gives allose.
- Epimerisation of glucose at C-4 gives galactose.



Reducing and non Reducing properties of (Sugars) :

	(I) Reducing sugars	(II) Non Reducing sugars
1.	Reduces Tollen's reagent, Fehling's solution & Benedict's solution.	Don't reduce Tollen's, Fehling's & Benedict's solution.
2.	Should have atleast one hemiacetal or hemiketal functional group. Ex. All Mono and Oligosaccharides except Sucrose	Should have acetal linkage. Ex. All Polysaccharides and few Oligosaccharides (Ex. Sucrose)

MONOSACCHARIDES

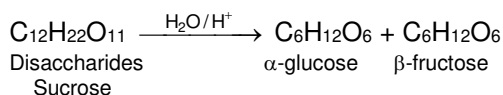
GLUCOSE

Glucose is the most common monosaccharide. It is known as Dextrose because it occurs in nature principally as the optically active dextrorotatory isomers. It acts as a reducing agent (reduces both Fehling's solution and ammoniacal silver nitrate solution ; **Tollen's reagent**). It is known as **dextrose** and found as grapes, honey, cane sugar, starch and cellulose.

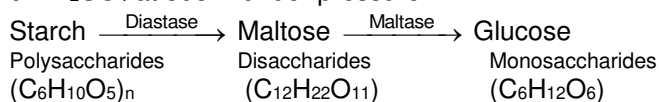
Preparation :

(i) By acid hydrolysis of cane sugar (a disaccharide) :

If sucrose is boiled with dil. HCl or H₂SO₄ in alcoholic solution. Glucose & fructose are obtained in equal amount.



(ii) By enzymatic action over starch : Glucose is obtained by hydrolysis of starch by boiling it with dil. H₂SO₄ at 393 K under pressure.



Structure of Glucose :

Open chain structure (Fisher projection) and Cyclic structure (Haworth projection) :

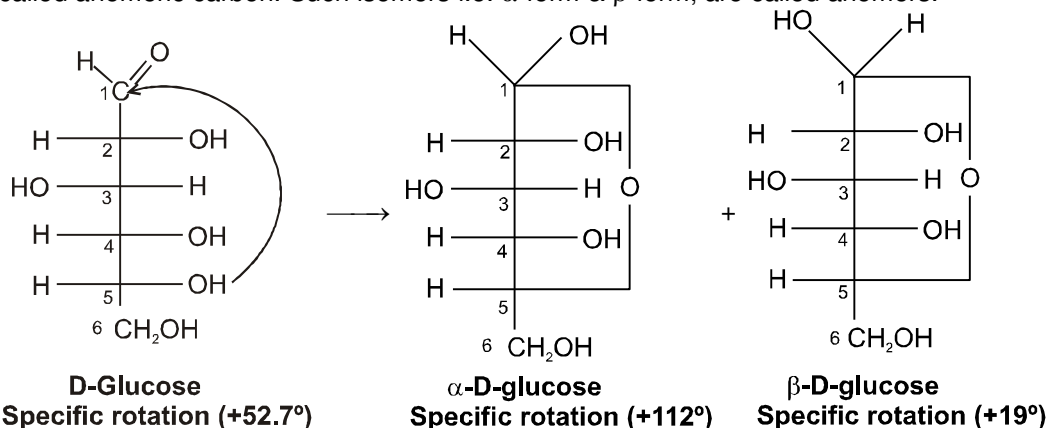
(1) Despite having aldehyde group, glucose does not give Schiff's test & it does not form the hydrogen sulphite (bisulphite) addition product with NaHSO₃.



(2) The pentaacetate of glucose does not react with hydroxylamine indicating the absence of free –CHO group.

This behaviour could not be explained by open chain structure. It was proposed that one of –OH group add to CHO group, forms a cyclic structure.

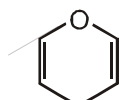
These two cyclic hemiacetal form of glucose differs only in configuration of the hydroxyl group at C1, called anomeric carbon. Such isomers i.e. α -form & β -form, are called anomers.



Note : β -form of D-glucose is more stable than α -D-Glucose.

Haworth projection

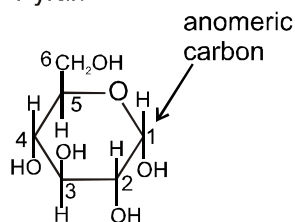
The six membered cyclic structure of glucose is called pyranose structure (α - or β -), in analogy with pyran and five membered cyclic structure of monosaccharides is called furanose structure (α or β) in analogy with furan



Pyran



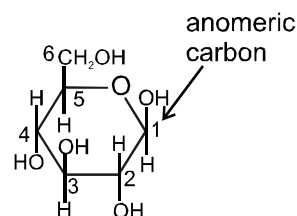
Furan



Specific rotation (112°)

α -D-glucose

α -D-glucopyranose

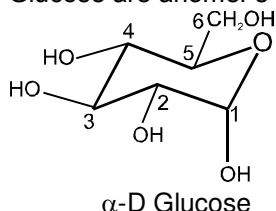


Specific rotation (19°)

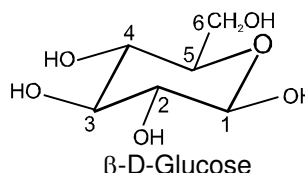
β -D-glucose

β -D-glucopyranose

α and β -Glucose are anomers of each other (i.e change in configuration of 1st carbon atom only)



α -D Glucose

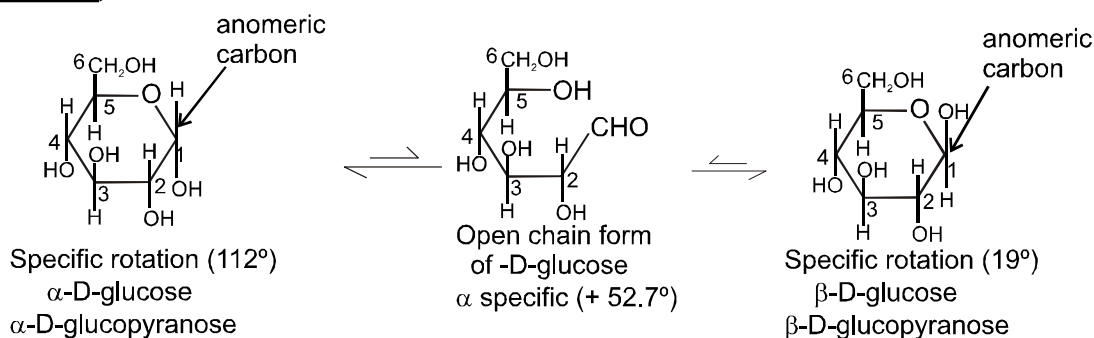


β -D-Glucose

Properties of Anomers : Mutarotation

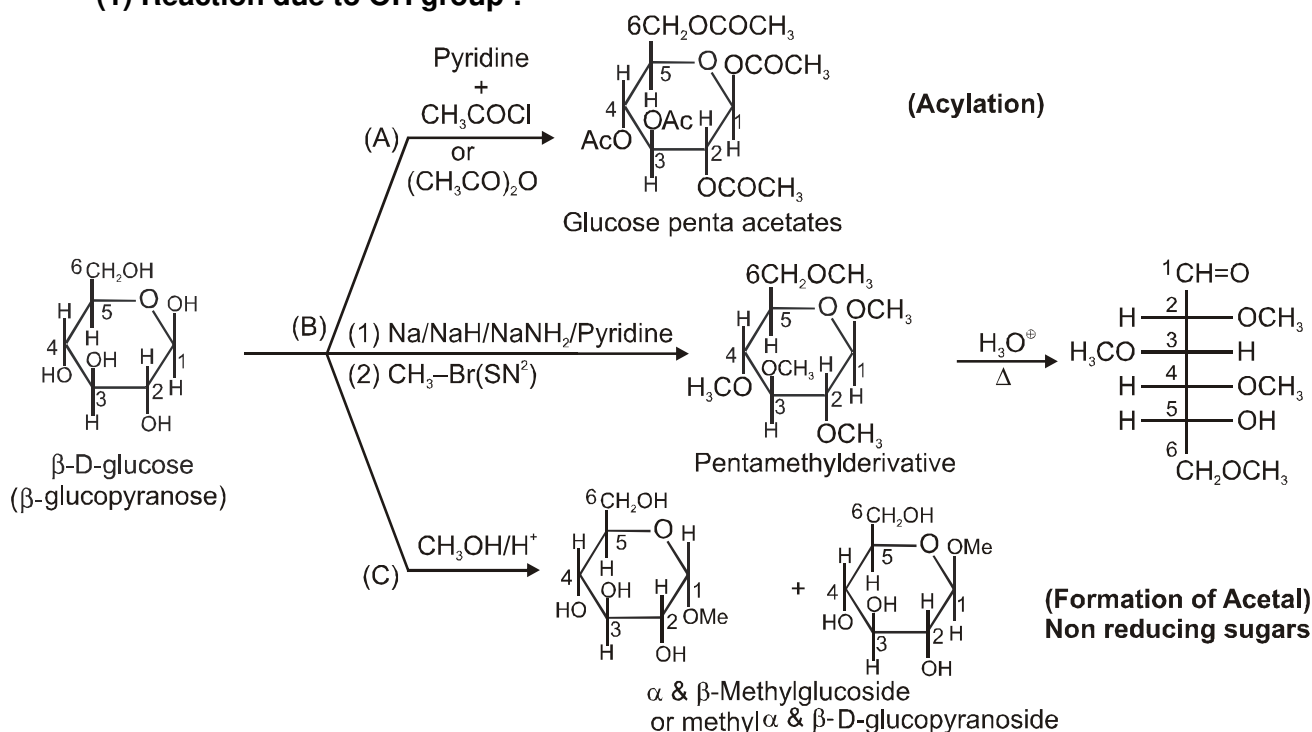
When one of the pure glucose anomers dissolve in water, an interesting change in the specific rotation is observed. When the α -anomer dissolves, its specific rotation gradually decreases from an initial value of +112° to +52.7°. When the pure β anomer dissolves, its specific rotation gradually increases from +19° to the same value of +52.7°. **This change (mutation) in the specific rotation is called mutarotation.** What is happening to each solution ?

Initially solution with only one anomeric form, undergoes equilibrium to the same mixture of α -and β -forms. The open chain form is in intermediate in the process of equilibrium. For mutarotation atleast one hemiacetal group must be present in the sugar therefore **all reducing sugars will mutarotate.**



Chemical Reactions of Anomers (Glucose)

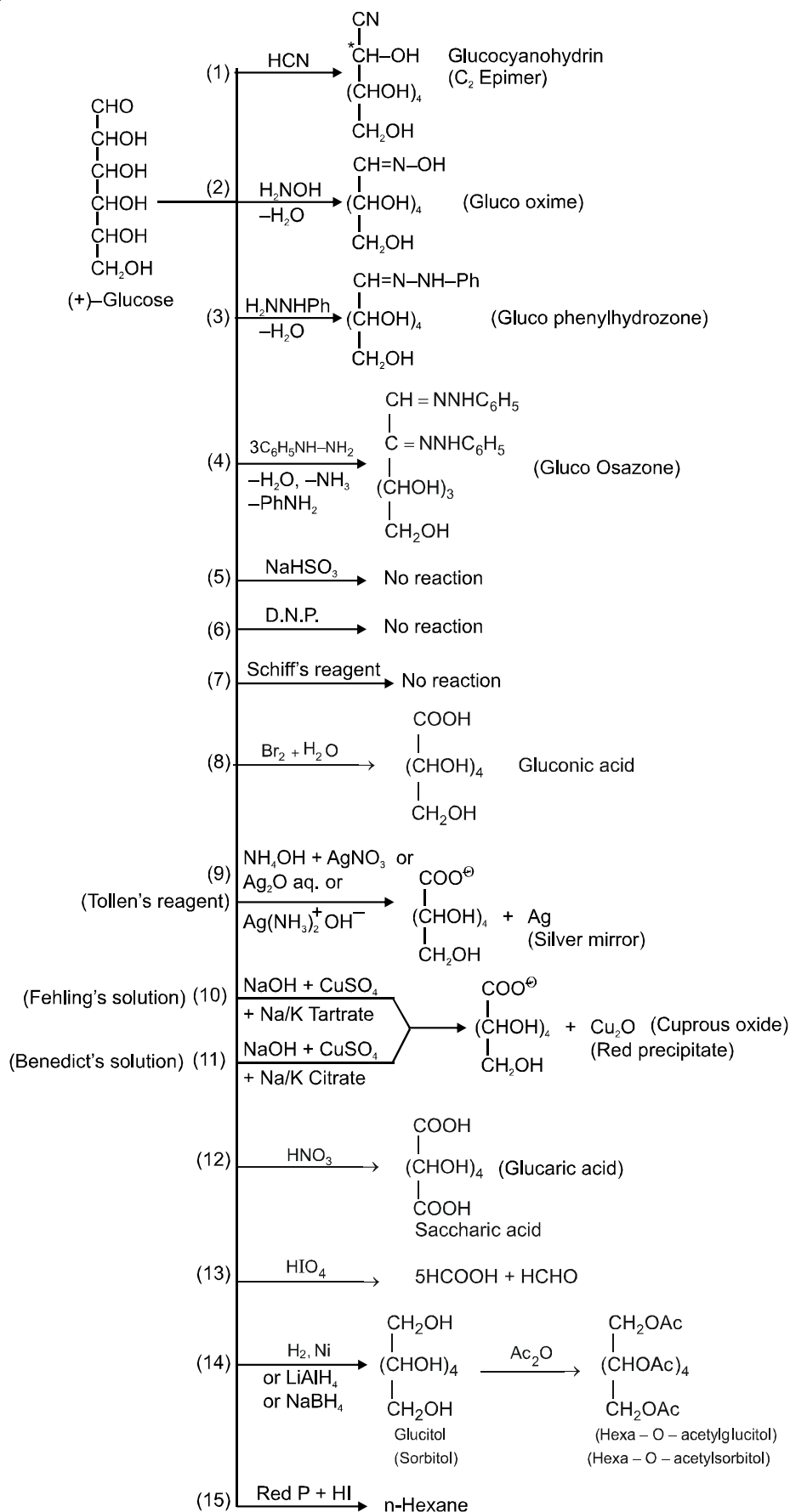
(1) Reaction due to OH group :



- Note :**
- (A) Acylation with acid halide or acetic anhydride gives pentaacetates which confirms the presence of five $-\text{OH}$ groups.
 - (B) After Hydrolysis product of pentamethyl derivatives, aldehyde group and hydroxy of C_5 regenerated hence hydroxy of C_5 is involved in the hemiacetal formation.
 - (C) (i) Sugars in the form of **acetals** are called **glycosides**. (glucose \rightarrow glucoside, mannose \rightarrow mannoside, ribose \rightarrow riboside, fructose \rightarrow fructoside etc).
 (ii) In the formation of glycosides only one mole of alcohol is required so monosaccharides are already present in the hemiacetal with one mole of the hydroxyl group and carbonyl group.
 (iii) Glycosides are non-reducing and will not show mutarotation because in neutral and basic condition glycosides are stable (cyclic form cannot open to the free carbonyl compound).
 (iv) After acidic hydrolysis of glycosides, product form will have reducing property and also show mutarotation.

(2) Reaction due to aldehyde :

In aqueous solution, α-Anomer or β-Anomer remains in the equilibrium with each other by small amount of open chain forms (0.02%), in which carbonyl group is regenerated and gives various reactions.

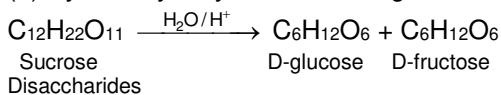




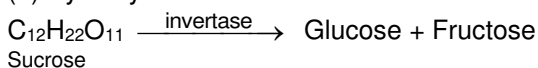
FRUCTOSE

Fructose preparation :

(1) By acid hydrolysis of cane sugar.



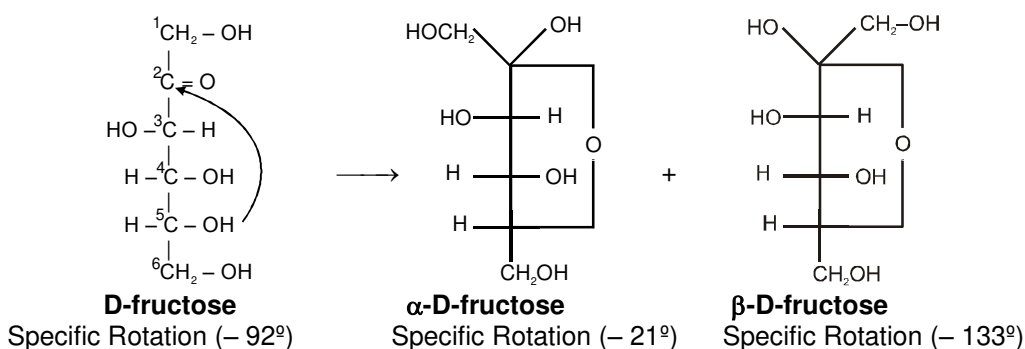
(2) By enzymatic action of sucrose.



- Note :** (i) Glucose & fructose obtained by acid hydrolysis of sucrose can be separated by treating with $\text{Ca}(\text{OH})_2$ which forms calcium glucosate & calcium fructosate. Calcium fructosate, being water insoluble, is separated out easily.
- (ii) Fructose is the sweetest monosaccharide.

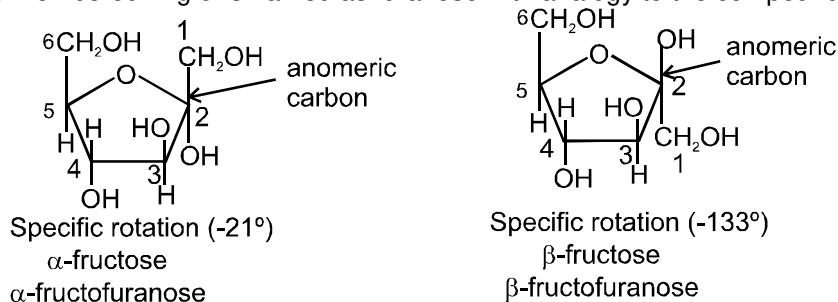
Structure of fructose :

It also exist in two cyclic forms which are obtained by the addition of $-\text{OH}$ at C5 to the $(>\text{C}=\text{O})$ group.



Haworth projection : Fructofuranose

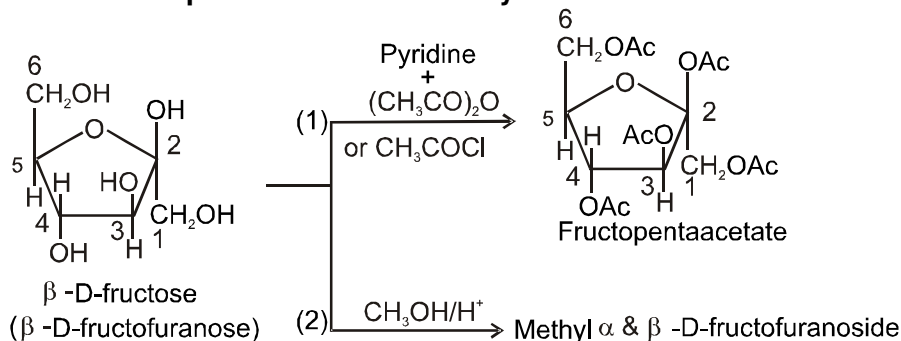
The five membered ring & is named as furanose with analogy to the compound furan.



Chemical Reactions of Fructose :

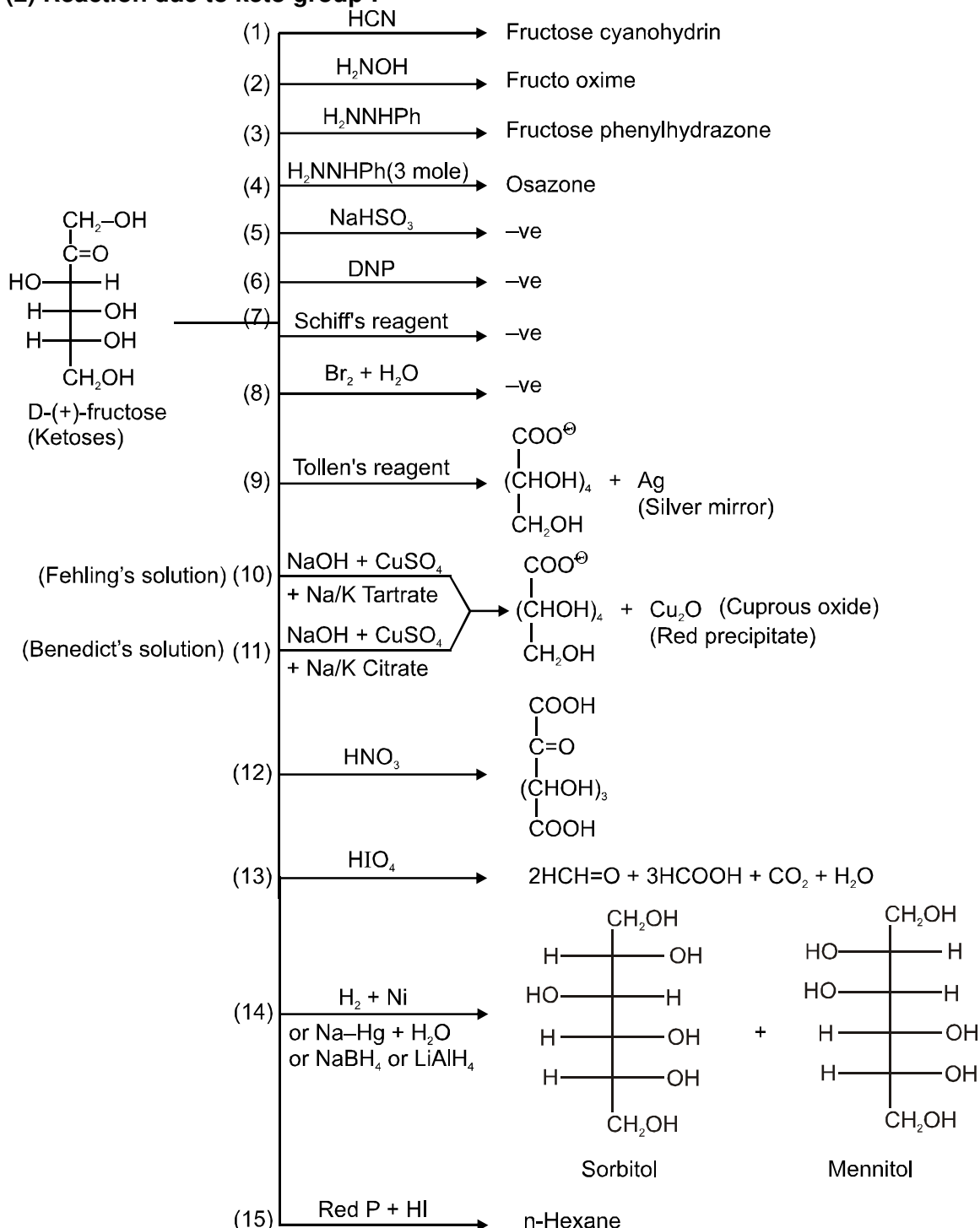
Reaction due to $-\text{OH}$ group at 2nd carbon :

(1) It forms fructose pentaacetate with acetyl chloride :





(2) Reaction due to keto group :

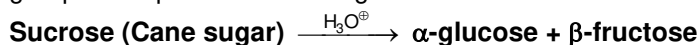


Some Highlights :

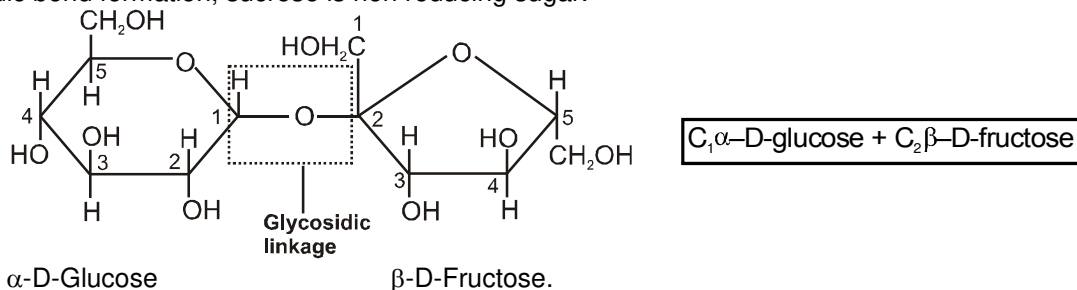
- Since glucose & fructose (Aldoses/Ketoses) reacts with HCN, H₂NOH, H₂NNHPh which indicates the presence of carbonyl group but they don't react with DNP, NaHSO₃ & Schiff's reagent (weak reagents) therefore we can conclude that carbonyl group is not free, but remains in the form of cyclic structures.
- In the formation of osazone, C₁ & C₂ are only involved so glucose, fructose and C-2 epimers (Glucose & Mannose), (Threose and Erythrose) give same osazone. Osazone are crystalline solid having sharp melting point so used for identifying the carbohydrates. In the osazone formation three molecules of NH₂NNHPh is overall consumed out of which two molecule react with nucleophilic addition/elimination reaction forming hydrazone whereas one molecule undergoes redox reaction.



(v) Sucrose is not a reducing sugar, e.g., it will not reduce Fehling's solution or Tollen's reagent. It does not form an oxime or an osazone, and does not undergo mutarotation. This indicates that hemiacetal group is not present in the rings.



In sucrose two monosaccharides are joined together by an oxide linkage formed by loss of water molecule. Such linkage through oxygen atom is called glycosidic linkage. In sucrose linkage is between C1 of α -glucose and C2 of β -fructose. Since the reducing group of glucose & fructose are involved in glycosidic bond formation, sucrose is non reducing sugar.

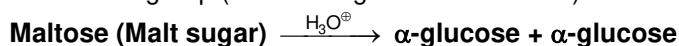


(b) Maltose : (Malt sugar)

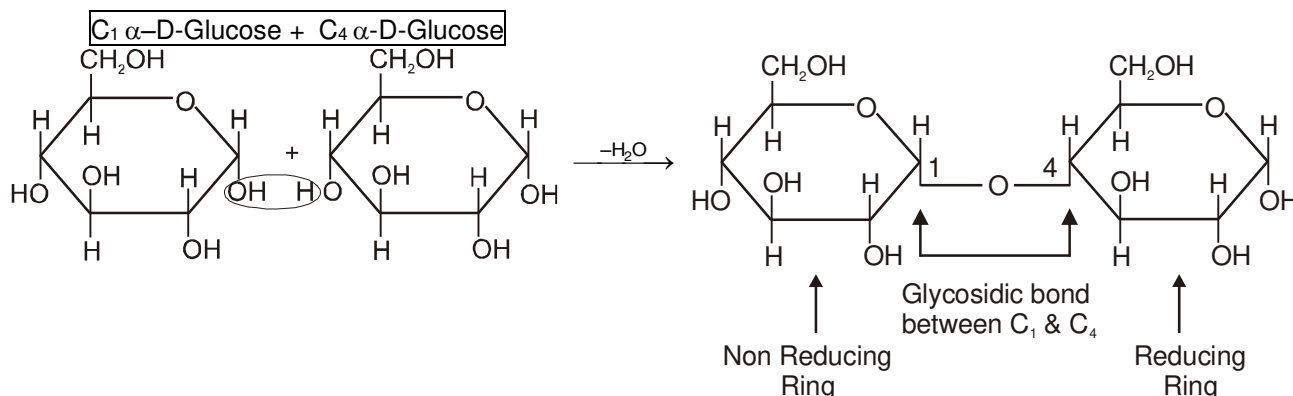
Maltose ($\text{C}_{12}\text{H}_{22}\text{O}_{11}$) is produced by the action of malt (which contains the enzyme diastase) on starch:



When it is hydrolysed with dilute acids or by the enzyme maltase, maltose yields two molecules of D (+)-glucose. Maltose is a reducing sugar, e.g., it reduces Fehling's solution or Tollen's reagent; it forms an oxime and an osazone, and undergoes mutarotation. This indicates that at least one hemiacetal group (of the two glucose molecules) is free in maltose.

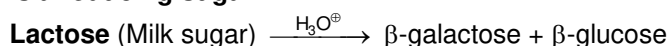


Formation of Maltose ($\text{C}_{12}\text{H}_{22}\text{O}_{11}$)

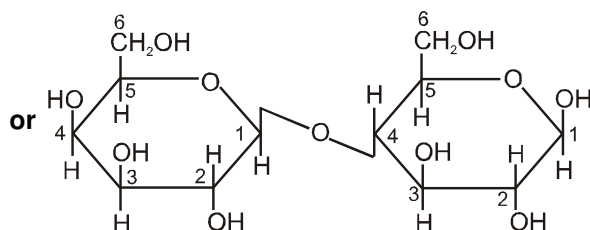
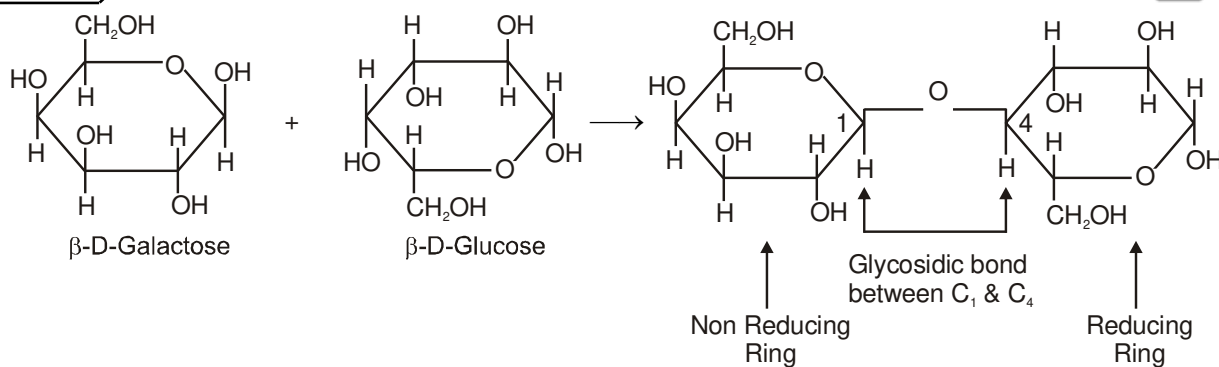


(c) Lactose : (Milk Sugar)

Lactose occurs in the milk of all animals and is dextrorotatory. It is hydrolysed by dilute acids or by the enzyme lactase, to an equimolecular mixture of D(+)-glucose and D(+)-galactose. Lactose is a reducing sugar.



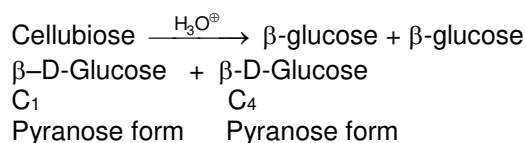
Formation of Lactose ($\text{C}_{12}\text{H}_{22}\text{O}_{11}$)



C₁β-D-Galactose + C₄β-D-Glucose

The linkage is between C-1 of Galactose and C-4 of Glucose.

(d) Cellulose :



DISACCHARIDE

Disaccharide	Structure	Monomeric unit linkage	Properties
Maltose	<p style="text-align: center;">Maltose (α-1,4-glycosidic linkage)</p>	α-D (+) Glucose + α-D(+) Glucose (α-1, 4-glycosidic linkage)	Produced by action of malt on starch. Undergoes mutarotation.
Sucrose	<p style="text-align: center;">Glycosidic linkage</p>	α-D-glucose + β-D-fructose (α-1,β-2 glycosidic linkage)	White crystalline solid, soluble in water. dextrorotatory specific rotation + 66.5°
Lactose	<p style="text-align: center;">Lactose (β-1,4-glycosidic linkage)</p>	β-D(+) Glucose + β-D (+) galactose (β-1,4- glycosidic linkage)	dextrorotatory



POLYSACCHARIDES

Polysaccharides : It contains large number of monosaccharide units joined together by glycosidic linkage (acetal bond). They are food storage or structural material.

(i) Starch, $(C_6H_{10}O_5)_n$

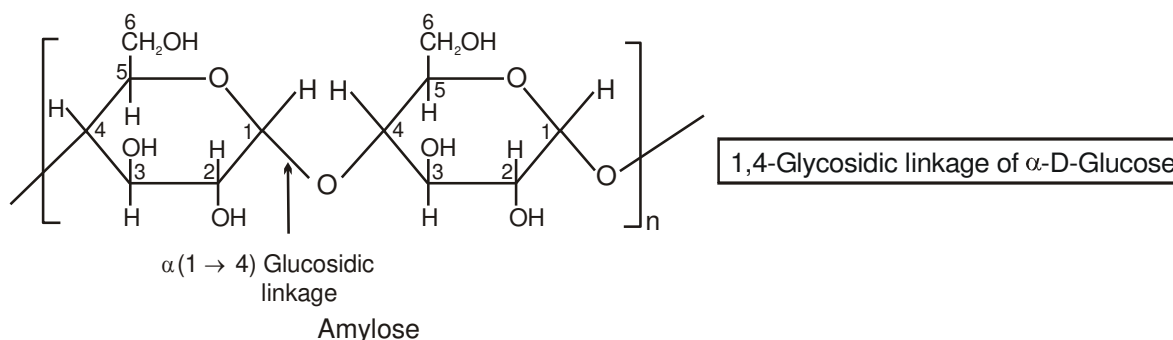
(i) Starch is the main contributor of carbohydrates in our diet. It exists exclusively in plants, stored in the seeds, roots, and fibres as food reserve. Example rice, potato.

(ii) Starch is actually a mixture of two structurally different polysaccharides, Amylose (15-20%) and Amylopectin (80-85%).

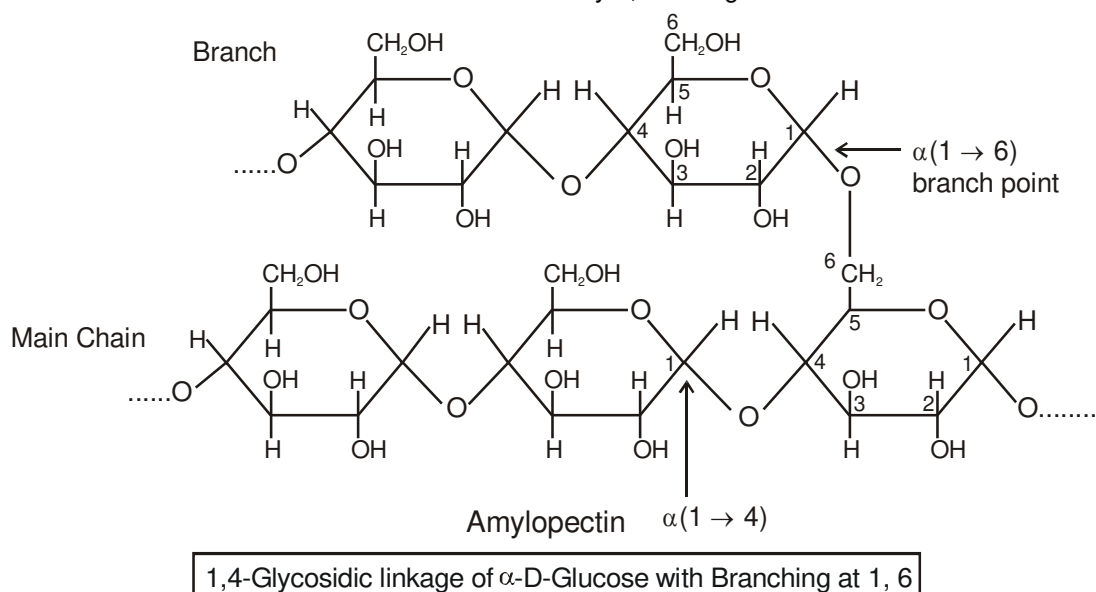
(iii) When starch is heated with hot water, it can be separated into its components. The part that is soluble in water is amylose and remaining fraction is amylopectin.

(iv) Both amylose and amylopectin are composed of D-glucose units.

(v) The **amylose** molecule is made up of D-glucose unit joined by α -glycosidic linkages between C-1 of one glucose unit and C-4 of the next glucose unit. The number of D-glucose units in amylose range from 60-300.



(vi) **Amylopectin** has a branched-chain structure. It is composed of chains of 25 to 30 D-glucose units joined by α -glycosidic linkages between C-1 to one glucose unit and C-4 of the next glucose unit. These chains are in turn connected to each other by 1, 6-linkages.



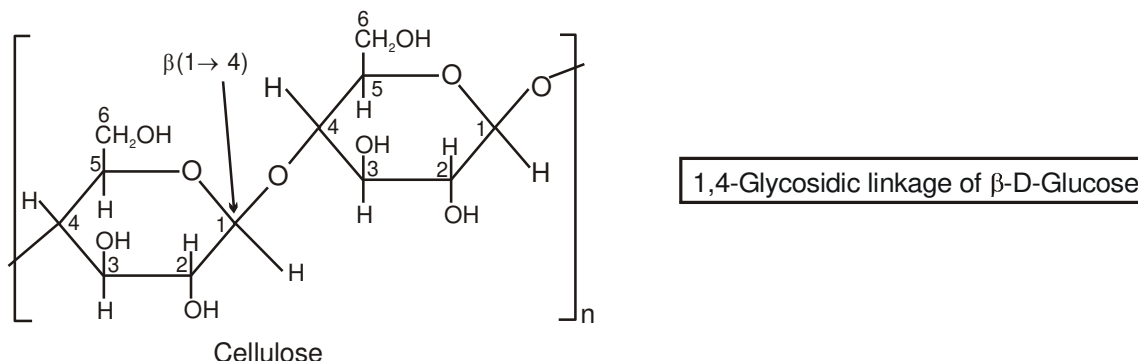


α -amylose soluble in water, and the solution gives a blue colour with iodine. Amylopectin is insoluble in water, is stable in contact with water, and gives a violet colour with iodine.

(ii) Glycogen (Animal Storage)

It is also like amylopectin but branching will take place after every 5 to 6 glucose unit. (highly branched)

(iii) Cellulose, $(C_6H_{10}O_5)_n$



1. Cellulose is linear chain natural polymers of β -D glucose units joined by 1, 4-glycosidic linkage (Natural linear polymers).
2. Cellulose is the main structural material of tree and other plants. Wood is 50% cellulose, while cotton wool is almost pure cellulose.
3. Artificial silk, rayon, is used collectively to cover all synthetic or manufactured fibres from cellulose.
4. The nitrates are prepared by the reaction of cellulose with a mixture of nitric and sulphuric acids, and the degree of 'nitration' depends on the concentrations of the acids and the time of the reaction. Cellulose trinitrate (12.2 – 13.2%N) is known as **gun-cotton** and is used in the manufacture of blasting explosives and smokeless powders.

Starch : (Plant Storage, Polymer of α -D-glucose),

Glycogen : (Animal Storage, Polymer of α -D-glucose),

Cellulose : (Plant Skeleton, Polymer of β -D-glucose)

Section (B) : Amino Acids & Proteins

Proteins : Proteins are the most abundant-biomolecules of the living beings. The chief sources of proteins are milk, cheese, pulses, peanuts, fish, meat etc. These are high molecular mass complex, biopolymers of amino acids.

Amino Acids : Each living cell is made up of thousands of different proteins. All natural proteins are polymers of α -(L) amino acids and on partial hydrolysis give peptides of varying molecular masses which upon complete hydrolysis give α -amino acids.

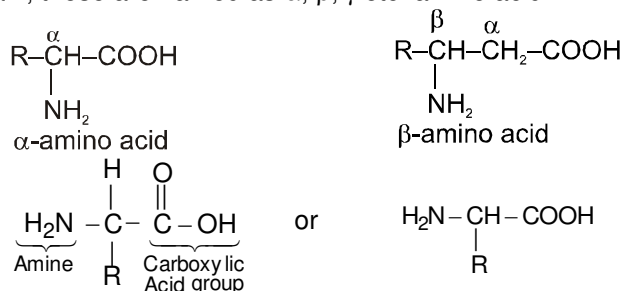




Type of α -amino acids :

Nonpolar, aliphatic R groups <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+-\text{C}-\text{H} \\ \\ \text{H} \end{array}$ Glycine </div> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+-\text{C}-\text{H} \\ \\ \text{CH}_3 \end{array}$ Alanine </div> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+-\text{C}-\text{H} \\ \\ \text{CH} \\ \quad \\ \text{CH}_3 \quad \text{CH}_3 \end{array}$ * Valine </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 20px;"> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+-\text{C}-\text{H} \\ \\ \text{CH}_2 \\ \\ \text{CH} \\ \quad \\ \text{CH}_3 \quad \text{CH}_3 \end{array}$ * Leucine </div> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+-\text{C}-\text{H} \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{S} \\ \\ \text{CH}_3 \end{array}$ * Methionine </div> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+-\text{C}-\text{H} \\ \\ \text{H}-\text{C}-\text{CH}_3 \\ \\ \text{CH}_2 \\ \\ \text{CH}_3 \end{array}$ * Isoleucine </div> </div>		
Polar, uncharged R groups <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+-\text{C}-\text{H} \\ \\ \text{CH}_2\text{OH} \end{array}$ Serine </div> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+-\text{C}-\text{H} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{CH}_3 \end{array}$ * Threonine </div> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+-\text{C}-\text{H} \\ \\ \text{CH}_2 \\ \\ \text{SH} \end{array}$ Cysteine </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 20px;"> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{H}_2\text{N}^+-\text{C}-\text{H} \\ \quad \\ \text{H}_2\text{C} \quad \text{CH}_2 \end{array}$ Proline </div> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+-\text{C}-\text{H} \\ \\ \text{CH}_2 \\ \\ \text{C}=\text{O} \\ \\ \text{H}_2\text{N} \end{array}$ Asparagine </div> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+-\text{C}-\text{H} \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{C}=\text{O} \\ \\ \text{H}_2\text{N} \end{array}$ Glutamine </div> </div>		
Aromatic R groups <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+-\text{C}-\text{H} \\ \\ \text{CH}_2 \\ \\ \text{C}_6\text{H}_5 \end{array}$ * Phenylalanine </div> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+-\text{C}-\text{H} \\ \\ \text{CH}_2 \\ \\ \text{C}_6\text{H}_4\text{OH} \end{array}$ Tyrosine </div> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+-\text{C}-\text{H} \\ \\ \text{CH}_2 \\ \\ \text{C}=\text{CH} \\ \quad \\ \text{C}_6\text{H}_5 \quad \text{NH} \end{array}$ * Tryptophan </div> </div>		
Positively charged R groups <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+-\text{C}-\text{H} \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{NH}_3^+ \end{array}$ * Lysine </div> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+-\text{C}-\text{H} \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{NH} \\ \\ \text{C}=\text{NH}_2^+ \\ \\ \text{NH}_2 \end{array}$ * Arginine </div> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+-\text{C}-\text{H} \\ \\ \text{CH}_2 \\ \\ \text{C}=\text{NH} \\ \quad \\ \text{H} \quad \text{H} \end{array}$ * Histidine </div> </div>		
Negatively Charged R groups <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+-\text{C}-\text{H} \\ \\ \text{CH}_2 \\ \\ \text{COO}^- \end{array}$ Aspartate </div> <div style="text-align: center;"> $\begin{array}{c} \text{COO}^- \\ \\ \text{H}_3\text{N}^+-\text{C}-\text{H} \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{COO}^- \end{array}$ Glutamate </div> </div>		

The amino acids contain amino as well as carboxylic acid group. On the basis of position of amino group in the chain, these are named as α , β , γ etc. amino acid.

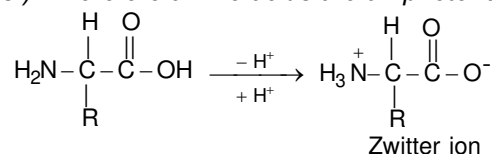


where, R = alkyl, aryl, or any other group, but never contain unstable, strained cycles or functional groups.



Zwitter ion (Dipolar Nature of Amino acids) :

In a neutral amino acid solution, the —COOH loses a proton and the —NH_2 of the same molecule picks up one. The resulting ion is dipolar, charged but overall electrically neutral. This is called Zwitterion (German, "two ions"). Therefore amino acids are amphoteric.



There are around 20 amino acids in the living system.

Classification of Amino Acids

(A) On the basis of synthesis:

(i) **Non essential amino acids** : 10 amino acids are synthesised in our body and these are said to be non essential amino acids (eg. Gly, Ala, Glu, Asp, Pro, Cys, Asn, Tyr, Ser, Gln). (**CAAATS-GGCP**).

(ii) **Essential amino acid** : 10 amino acids which are necessarily be present in our diet are called essential amino acids (eg. Val, Leu, Ile, Lys, Phe, Thr, Trp, Met, His, Arg). (**PVT-TIM HALL**)

(B) On the basis of functional groups present :

(i) **Neutral amino acids** : If only one —NH_2 and one —COOH groups are present. **eg.** Glycine, Alanine, Valine, Leucine etc.

(ii) **Acidic amino acid** : If one basic and two acidic groups are present. Additional acidic functional group must be present in the side chain. **E.g.** Aspartic acid and Glutamic acid.

(iii) **Basic amino acid** : If two basic and one acidic group is present. Additional basic group must be present in the side chain. **E.g.** Arginine, Lysine & Histidine.

Note :

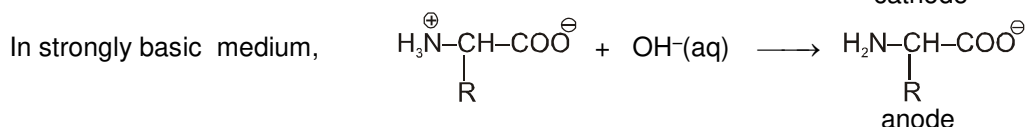
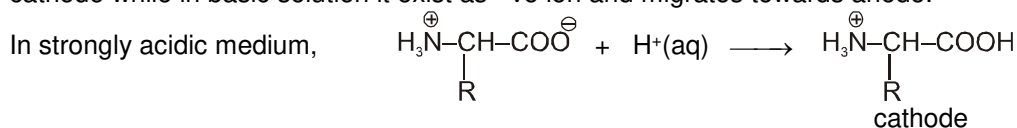
(i) Amino acids with aromatic chain : E.g. Phenylalanine, Tyrosine, Tryptophan

(ii) Amino acids with sulphur : E.g. Cysteine

Isoelectric point of α -amino acids :

Isoelectric Point (PI) : The pH at which the amino acid shows no tendency to migrate when placed in an electric field is known as its isoelectric point.

Because of amphoteric nature in acidic solution it exist as the +ve ion. Hence it migrate towards cathode while in basic solution it exist as -ve ion and migrates towards anode.



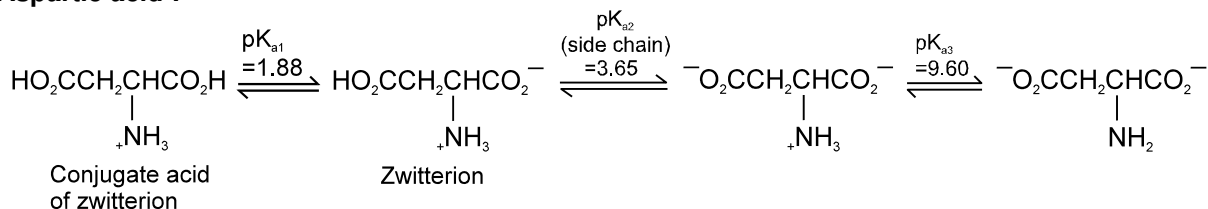
At some intermediate pH amino acids exist as a neutral dipolar ion i.e. the concentration of the cation and anions are equal and it does not migrate towards either electrode, this pH is called isoelectric point of amino acid which is different for different amino acids.

For example :

(i) **For neutral amino acid** : pH of isoelectric point varies between 5.1 to 6.5. E.g. Glycine has pH value 6.0

PI for neutral amino acid is calculated as $\frac{\text{pK}_{a_1} + \text{pK}_{a_2}}{2}$

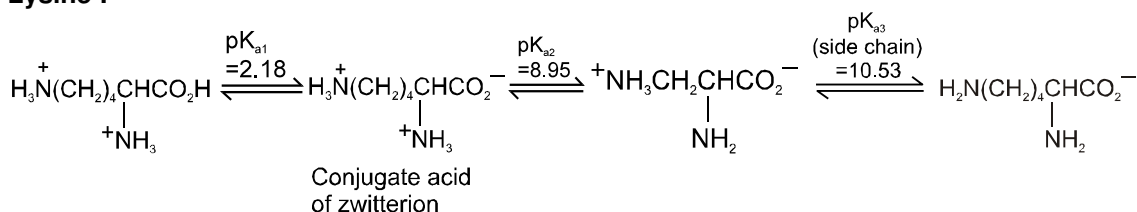
(ii) **For acidic amino acid** : Where there are two COOH groups and one NH_2 group then isoelectric pH is around 3. e.g. Aspartic acid.

**Aspartic acid :**

PI for acidic amino acid is calculated as $\frac{pK_{a1} + pK_{a2}}{2}$

The pI of aspartic acid is the average of pK_{a1} (1.88) and the pK_{a2} of the side chain (3.65) or 2.77.

(iii) **For basic amino acid** : where there are two NH_2 groups and one COOH group then isoelectric point varies between 7.6 to 10.8. e.g. Lysine (9.8)

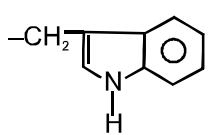
Lysine :

PI for basic amino acid is calculated as $\frac{pK_{a2} + pK_{a3}}{2}$

The PI of Lysine is the average of pK_{a2} (8.95) and the pK_a of the side chain (10.53) or 9.74.

Note : Amino acid has minimum aqueous solubilities at their isoelectric points.

Amino acids, their symbols and Isoelectric point :

S.No.	Name of the Amino acid	Three letter Symbol	One letter Code	Side chain (R)	Isoelectric point
		Neutral amino acids			
1	Glycine	Gly	G	- H	6.0
2	Alanine	Ala	A	-CH ₃	6.0
3	Valine*	Val	V	-CH-(CH ₃) ₂	6.0
4	Leucine*	Leu	L	-CH ₂ -CH-(CH ₃) ₂	6.0
5	Isoleucine*	I leu	I	$ \begin{array}{c} -\text{CH}-\text{C}_2\text{H}_5 \\ \\ \text{CH}_3 \end{array} $	6.1
6	Phenylalanine*	Phe	F	-CH ₂ -C ₆ H ₅ or CH ₂ Ph	5.5
7	Cysteine	Cys	C	-CH ₂ -SH	5.1
8	Methionine*	Met	M	-CH ₂ -CH ₂ -S-CH ₃	5.8
9	Tryptophan*	Trp	W		5.9
10	Serine	Ser	S	-CH ₂ -OH	5.7
11	Asparagine	Asn	N	-CH ₂ -CO.NH ₂	5.4
12	Glutamine	Gln	Q	-CH ₂ -CH ₂ -CO-NH ₂	5.7
13	Threonine*	Thr	T	-CH-CH ₃	6.5

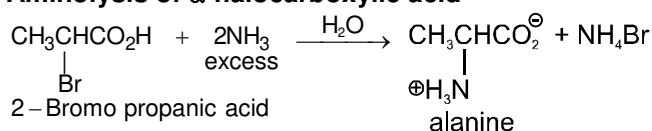


14	Tyrosine	Tyr	Y		5.7
15	Proline	Pro	P	 (It is complete structure)	6.3
		Acidic amino acids			
16	Aspartic acid	Asp	D	$-\text{CH}_2-\text{COOH}$	3.0
17	Glutamic acid	Glu	E	$-\text{CH}_2-\text{CH}_2-\text{COOH}$	3.2
		Basic amino acids			
18	Lysine*	Lys	K	$-\text{CH}_2-(\text{CH}_2)_3-\text{NH}_2$	9.8
19	Arginine*	Arg	R	$-\text{CH}_2-(\text{CH}_2)_2-\text{NH}-\text{C}(=\text{NH})-\text{NH}_2$	10.8
20	Histidine*	His	H		7.6

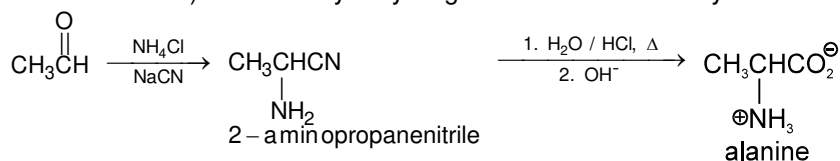
* Essential α -amino acids

(a) General methods of preparation

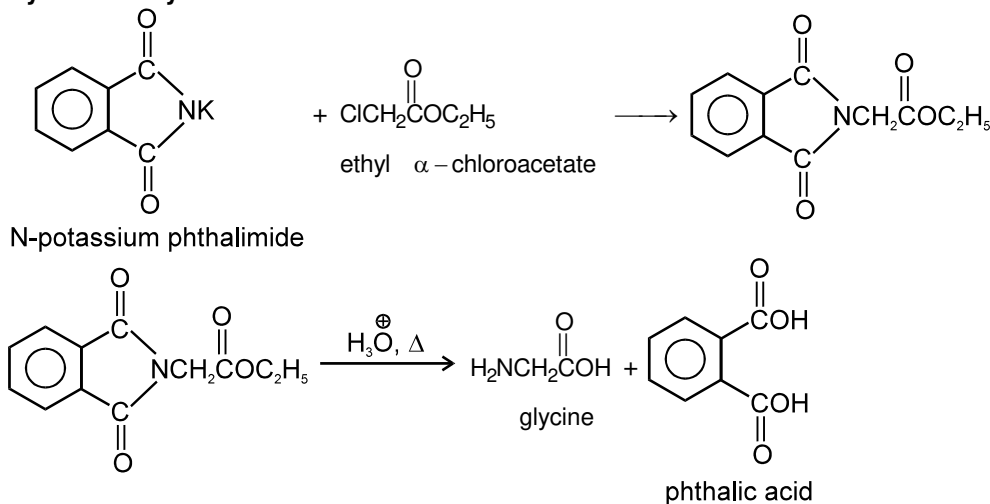
1. Aminolysis of α -halocarboxylic acid



2. By strecker synthesis : Aldehyde reacts with a mixture of NH_4Cl and NaCN to form α -aminonitrile (as an intermediate) which on hydrolysis gives an amino carboxylic acid.

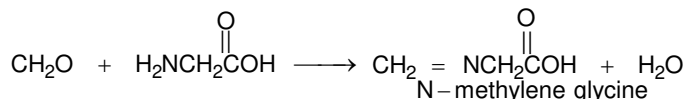


3. By Gabriel Synthesis :

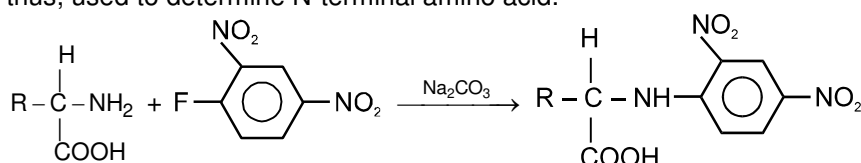



(b) Chemical reactions :

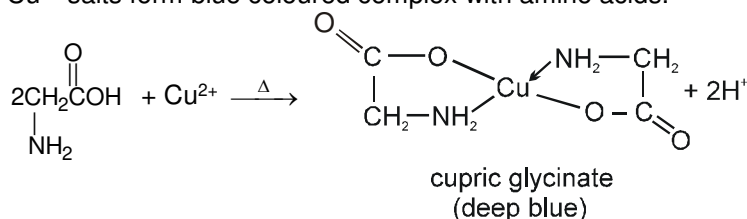
1. Formaldehyde reacts with amino acids to form N-methylene amino acids. In this reaction basic character is lost and thus, free acid can be determined by titration - Sorenson titration method for amino acids.



2. DNFB (2, 4-dinitrofluorobenzene) also called **Sanger's reagent** reacts with the free amino group of terminal amino acid in a peptide or protein to form yellow coloured dinitro phenyl amino acid. This is thus, used to determine N-terminal amino acid.

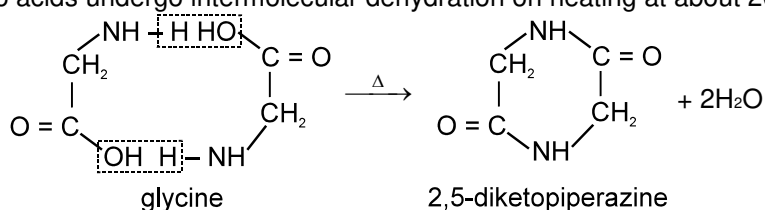


3. Cu^{2+} salts form blue coloured complex with amino acids.

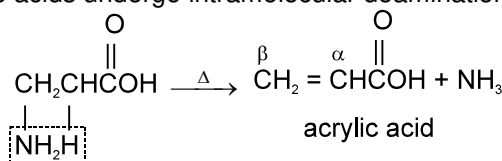


4. **Effect of Heat :**

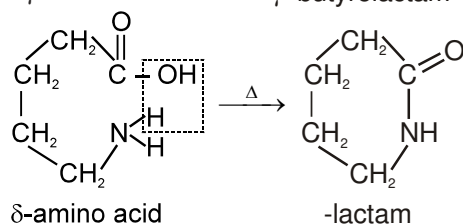
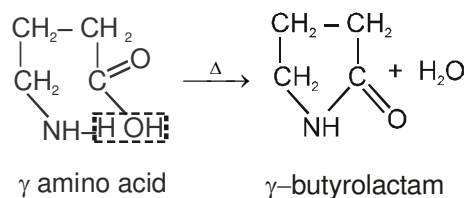
α -amino acids undergo intermolecular dehydration on heating at about 200°C to give diketopiperazines.



β -amino acids undergo intramolecular deamination on heating to form α , β -unsaturated acids.

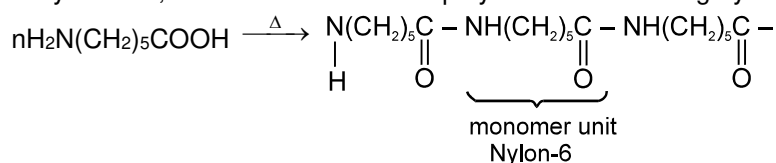


γ -amino acids and δ -amino acid undergo intramolecular dehydration to form cyclic amides called **Lactams**.

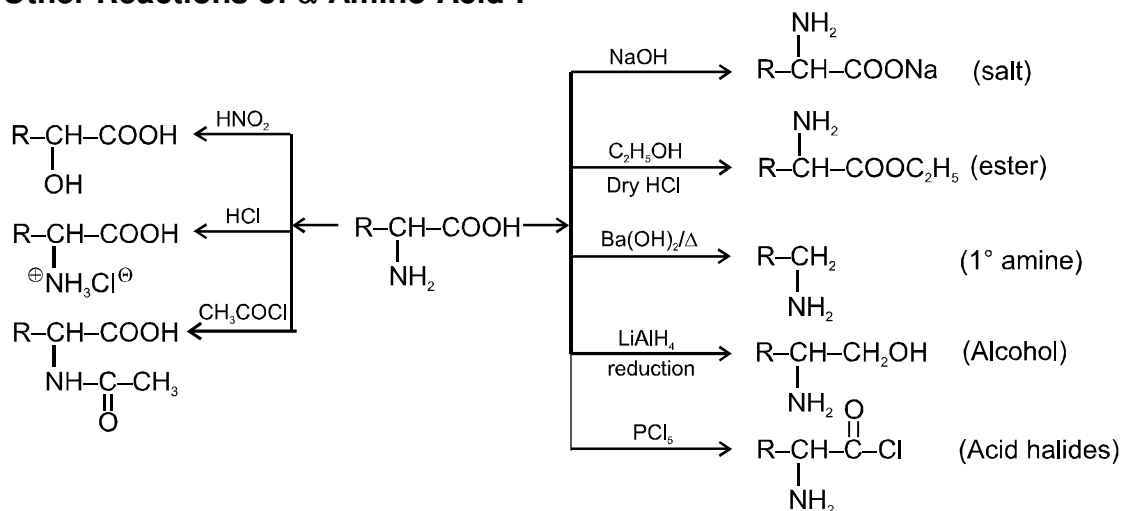




In case of ϵ -amino acid, intramolecular cyclisation would give a seven-membered ring, which is formed with difficulty. Hence, there is intermolecular polymerisation forming nylon-6.



(c) Other Reactions of α -Amino Acid :

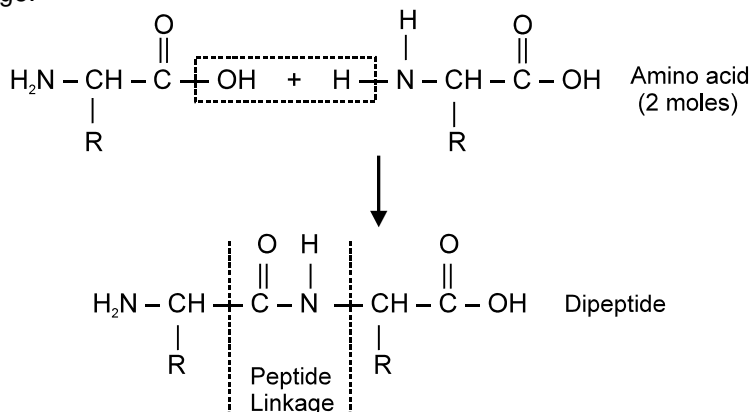


Peptides bonds and Proteins :

Peptides (Proteins) : Peptides are condensation polymers of α -amino acids formed by condensation of amino group of one α -amino acid with the carboxyl group of same or different α -amino acid by elimination of water. They are classified as di, tri, tetra, pentapeptides etc. according to two, three, four, five etc molecules of the same or different amino acid combining together. It determines their specific physiological functions in the living organism.

Structure of Proteins (Peptides)

Amino acids are bifunctional molecules with $-\text{NH}_2$ group at one end and $-\text{COOH}$ at the other. Therefore, $-\text{COOH}$ of one molecule and $-\text{NH}_2$ of another molecule interact by elimination of H_2O to form an amide-like linkage.



Peptide Linkage : The amino acid unit having free $-\text{NH}_2$ groups is called N-terminal end whereas the amino acid unit with free $-\text{COOH}$ group is called C-terminal end. The structure is written with N-terminal end to the left and C-terminal end to the right. At N-terminal or C-terminal further bond

formation take place and tri, tetra, pentapeptide are formed. $-\text{NH}-\text{CH}(\text{R})-\text{C}(=\text{O})-$ unit repeated in polypeptides.



Polypeptides : More than 10 amino acids join together is called polypeptides which is a linear chain natural polymer.

Naming of polypeptides : Naming of polypeptides starts from –N–terminal residue, and suffix -ine of amino acids is replaced by -yl for all except amino acid of C-terminal residue.

Example : Glycine → Glycyl, Alanine → Alanyl, Lysine → Lysyl

Alanylglycylphenylalanine means Ala-Gly-Phe or A-G-F.

Determining sequence of polypeptides by partial hydrolysis :

Q.1 Tripeptides

H ₃ O ⁺	Glycine, Alanine, Valine
Partial	Gly-Ala, Ala-Val
Hydrolysis	

Write the structure of tripeptide?

Ans. Gly-Ala-Val.

Q.2 Tripeptides

H ₃ O ⁺	Glycine, Valine, Lysine
Partial	Valine-Lysin & Glycine-Valine
Hydrolysis	

Write the structure of tripeptide?

Ans. Gly-Val-Lys.

PROTEINS

A polypeptide with more than 100 amino acid residues (mol. mass > 10,000) is called a protein but, a few polypeptide with lesser number of amino acid is also known.

Example : Insulin have 51 amino acids.

Classification of Proteins :

(I) On the basis of molecular structure : Proteins have been classified into two parts.

(i) Fibrous proteins (ii) Globular proteins

(i) Fibrous Proteins : When polypeptide chain run parallel and fiber like structure then it is called fibrous protein. In Fibrous protein chain are held together by hydrogen and disulphide bond. These are insoluble in water.

Ex. Keratin, myosin.

(ii) Globular proteins : When polypeptide chain is folded to form spheroidal shape it is called globular protein. Such folding is because of a folding of polypeptides in such a way that lipophilic (fat soluble) part are pushed inward and hydrophilic part is pushed outward. These are soluble in water and sensitive to small change in temperature and pH.

Ex. Albumins in egg, enzyme and some hormones, etc.

(II) On the basis of chemical composition :

(i) Simple proteins : Simple proteins on hydrolysis give only α-amino acids. For example albumin in the white portion of eggs, glutenin in wheat, oxygenin in rice, keratin in hair, nails horns etc.

(ii) Conjugated Proteins : In conjugated proteins, protein part is combined with non-protein part. On hydrolysis these give a non protein part in addition to the α-amino acids. This non protein portion is called PROSTHETIC GROUP. Its function is to control the biological function of the protein.

Prothetic groups may be carbohydrate, phosphate, lipids (ester of higher fatty acids) and so on.

Ex. Casein of milk, haemoglobin of blood are example of conjugated proteins.

(iii) Derived Proteins : Degradation products obtained by partial hydrolysis of simple or conjugated proteins with acids, alkalis or enzymes are called derived proteins. For example : proteoses peptones, and polypeptides

Protein → Proteoses → Peptones → Polypeptides



Structure of Proteins :

Structure and shape of proteins can be studied at four different levels i.e. primary, secondary, tertiary and quaternary, each level being more complex than the previous one.

(i) Primary structure of Proteins :

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. sequence of amino acids creates a different proteins.

Ex. Normal Haemoglobin : $-\text{Val} - \text{His} - \text{Leu} - \text{Thr} - \text{Pro} - \text{Glu} - \text{Lys}-$
 Sickle cell anemia Haemoglobin : $-\text{Val} - \text{His} - \text{Leu} - \text{Thr} - \text{Pro} - \text{Val} - \text{Lys}-$

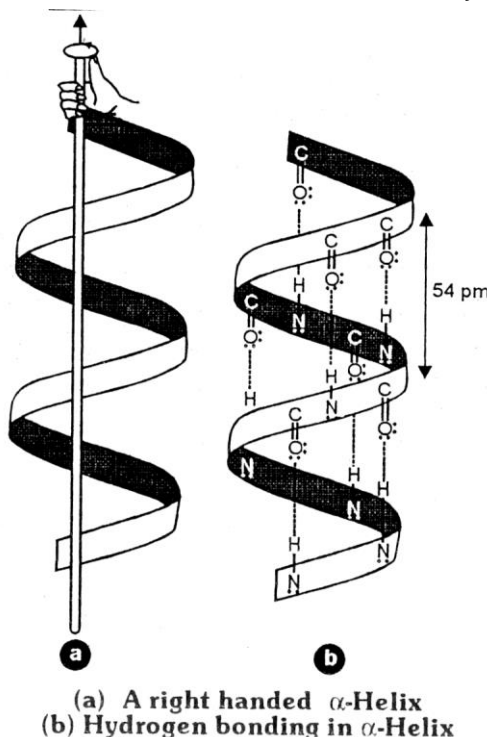
(ii) Secondary structure of Proteins :

The shape in which a long polypeptide chain can exist is called secondary structure of proteins. The following two different secondary structure are possible.

- (a) α -Helix structure (b) β -pleated sheet structure

(a) α -Helix structure :

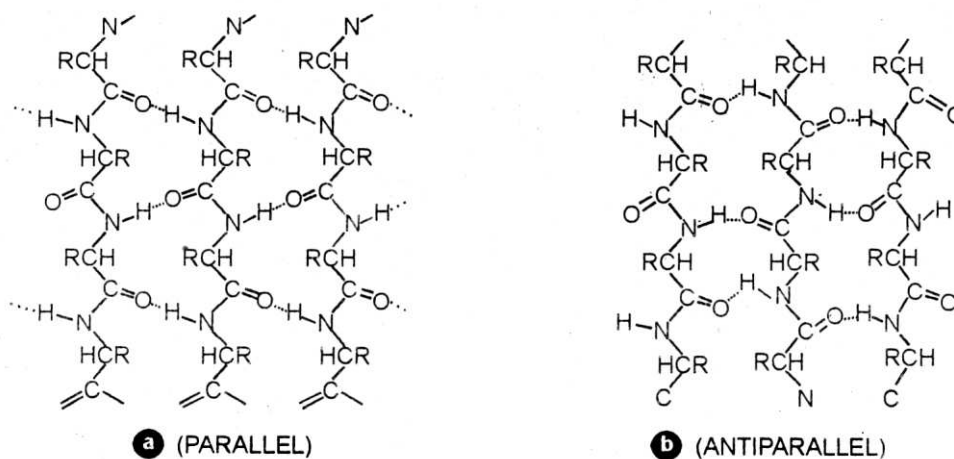
In α Helix a polypeptide chain forms all possible H-bonds by twisting into a right handed screw (helix) – NH group of each amino acid residue H-bond to the C=O of an adjacent turn of helix.



(b) β -pleated sheet structure or simply β -structure :

In β structure all peptide chains are stretched out to a nearly maximum extension and then laid side by side which are held together by inter molecular H-bond.

The poly peptide chains can link together in parallel and antiparallel sequence. These are represented as follows :-



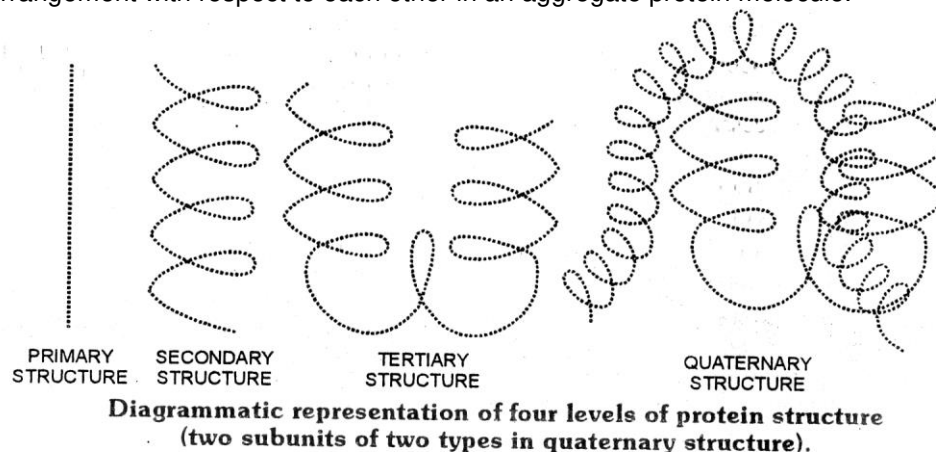
β -Conformation of proteins (a) Parallel (b) Anti-parallel.

(iii) Tertiary structure of proteins :

The tertiary structure of protein represent overall folding of the polypeptide chains i.e further folding of the secondary structure producing a 3D structure. **It gives rise to two major molecular shapes fibrous and globular.**

(iv) Quarternary structure of proteins :

There are certain proteins which are composed of two or more polypeptide chains referred to as sub-units or protomoss. The quarternary structure refers to the determination of the number of sub-units and their arrangement with respect to each other in an aggregate protein molecule.



Denaturation of proteins :

When protein in native form is subjected to a physical change like temperature or pH, the H-bonds are disturbed. As a result globules get unfold and helices get uncoiled therefore proteins loses its activity. During denaturation 2° and 3° structures get destroyed but 1° structure remain the same.

Ex: Coagulation of egg while on boiling and curdling of milk caused by bacteria present in milk.

Renaturation of proteins :

Denaturation may be reversible or irreversible. Coagulation of egg on boiling and curdling of milk are example of irreversible protein denaturation. But in some cases it may be reversible and this process of reversibility is called renaturation. Hence, When the temperature and pH of a denaturated protein are brought back 3° & 2° structures are restored.

Chemical Test :

(i) Biurate Test : $\text{CuSO}_4 + \text{alkaline solution} + \text{Protein} \rightarrow \text{Violet colour.}$

Biurate Test is for peptide linkage (Atleast two peptide linkage must be present; Dipeptide do not give this test).

(ii) Ninhydrin Test : Blue or violet colour with Ninhydrin.



Section (C) : Enzymes, Vitamins and Nucleic acids

Enzymes

Life is possible due to the coordination of various chemical reactions in living organisms. An example is the digestion of food, absorption of appropriate molecules and ultimately production of energy. This process involves a sequence of reactions and all these reactions occur in the body under very mild conditions. This occurs with the help of certain biocatalysts called **enzymes**. Almost all the enzymes are globular proteins. Enzymes are very specific for a particular reaction and for a particular substrate. The ending of the name of an enzyme is **-ase**.

Mechanism of Enzyme Action

Enzymes are needed only in small quantities for the progress of a reaction. Similar to the action of chemical catalysts, enzymes are said to reduce the magnitude of activation energy. For example, activation energy for acid hydrolysis of sucrose is 6.22 kJ mol^{-1} , while the activation energy is only 2.15 kJ mol^{-1} when hydrolysed by the enzyme, sucrase.

Examples of few enzymes and their catalysed reaction.

S.No.	Enzyme	Source	Reaction
1.	Diastase	Malt	Conversion of starch into maltose $2(\text{C}_6\text{H}_{10}\text{O}_5)_{n(\text{aq})} + n\text{H}_2\text{O}_{(\text{l})} \xrightarrow{\text{Diastase}} n\text{C}_{12}\text{H}_{22}\text{O}_{11(\text{aq})}$ $\text{Starch} \xrightarrow{\text{Diastase}} \text{maltose}$
2.	Maltase	Malt.	Conversion of maltose into glucose $\text{C}_{12}\text{H}_{22}\text{O}_{11(\text{aq})} + \text{H}_2\text{O}_{(\text{l})} \xrightarrow{\text{Maltase}} 2\text{C}_6\text{H}_{12}\text{O}_{6(\text{aq})}$ $\text{maltose} \xrightarrow{\text{Maltase}} \text{glucose}$
3.	Invertase	Yeast	Inversion of cane sugar $\text{C}_{12}\text{H}_{22}\text{O}_{11(\text{aq})} + \text{H}_2\text{O}_{(\text{l})} \longrightarrow \text{C}_6\text{H}_{12}\text{O}_{6(\text{aq})} + \text{C}_6\text{H}_{12}\text{O}_{6(\text{aq})}$ $\text{Sucrose} \longrightarrow \text{glucose} + \text{Fructose}$
4.	Zymase	Yeast	Conversion of glucose into ethanol $\text{C}_6\text{H}_{12}\text{O}_{6(\text{aq})} \xrightarrow{\text{Zymase}} 2\text{C}_2\text{H}_5\text{OH}_{(\text{aq})} + 2\text{CO}_{2(\text{g})}$ $\text{glucose} \xrightarrow{\text{Zymase}} \text{ethanol}$
5.	Mycoderma aceti	old vinegar	Manufacture of acetic acid from ethyl alcohol. $\text{CH}_3\text{CH}_2\text{OH}_{(\text{l})} + \text{O}_2 \xrightarrow[\text{aceti}]{\text{mycoderma}} \text{CH}_3\text{COOH}_{(\text{l})} + \text{H}_2\text{O}_{(\text{l})}$ Acetic acid
6.	Urease	soyabean	Decomposition of urea into $\text{NH}_3 + \text{CO}_2$ $\text{NH}_2\cdot\text{CONH}_{2(\text{aq})} + \text{H}_2\text{O}_{(\text{l})} \xrightarrow{\text{Urease}} 2\text{NH}_{3(\text{g})} + \text{CO}_{2(\text{g})}$
7.	Lactic bacilli	Curd	Conversion of milk into curd <div style="text-align: right;">_____</div>
8.	Pepsin	stomach	Conversion of proteins to peptides in the stomach. <div style="text-align: right;">_____</div>
9.	Trypsin	Intestines	conversion of protein into acids by hydrolysis in intestines. <div style="text-align: right;">_____</div>

Vitamins

It has been observed that certain organic compounds are required in small amounts in our diet but their deficiency causes specific diseases. These compounds are called **vitamins**. Most of the vitamins cannot be synthesised in our body but plants can synthesise almost all of them, so they are considered as essential food factors. However, the bacteria of the gut can produce some of the vitamins required by us. All the vitamins are generally available in our diet.

Different vitamins belong to various chemical classes and it is difficult to define them on the basis of structure. 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. B1, B2, B6, B12, etc. Excess of vitamins is also harmful and vitamin pills should not be taken without the advice of doctor.

The term "**Vitamine**" was coined from the word vital + amine since the earlier identified compounds had amino groups. Later work showed that most of them did not contain amino groups, so the letter 'e' was dropped and the term **vitamin** is used these days.



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 B12) in our body.

Exception : Biotin (Vitamin H) : It is neither soluble in water nor in fats.

Some important Vitamins, their Sources and their Deficiency Diseases

S.No.	Vitamins	Characteristics	Sources	Deficiency disease
1	A (Retinal)	Soluble in oils and fats, stable to heat. Promote growth, vision and increases resistance to diseases.	Milk, Butter, eggs, fish, liveroil, rice kidney, green vegetables, angoes sweet potatoes, carrots, tomatoes etc.	Xerophthalmia (hardening of eye) cornea night blindness and xerosis (drying of skin)
2	B ₁ Thiamine	Soluble in water destroyed by heat above 313 K.	Pulses, nuts, cereals (rice, wheat), yeast, egg yolk, milk, green vegetables and fruits.	Beriberi (paralysis of legs and general weakness) loss of appetite
3	B ₂ (Riboflavin or lactoflavin)	Soluble in water sensitive to light but stable to heat.	Milk, yeast, green vegetables, meat, liver, kidney, egg white etc.	Retards growth general inflammation of tongue i.e darkened tongue dermatitis and cheilosis (racking at corners of mouth and lips).
4	B ₆ (Pyridoxin or adermin)	Soluble in water.	Rice bran, yeast, molases, meat, fish, egg yolk etc.	Cause specific dermatitis and anaemia in man effects central nervous system.
5	B ₁₂ (cyanocobalamine)	Water soluble, stable to heat.	Milk, egg, liver of animals	Anemia (RBC deficient) inflammation of tongue and mouth
6	H (Biotin)	Neither soluble in water not in fats.	Yeast, liver, kidney and milk	Dermatitis, loss of hairs and paralysis
7	C (Ascorbic acid)	Soluble in water but destroyed by cooking.	Citrus fruits : Amla, tomatoes, green leafy vegetables. (Daily dosage 75 mg)	Cause scurvy (bleeding of gums pyorrhea bleeding of teeth)
8	D (Ergocalciferol)	Soluble in oil and fats, stable to heat and resistant to oxidation to controls calcium and phosphorus metabolism.	Milk, butter, eggs, liver & meat. (Daily dosage 0.025 mg)	Rickets (deformation of bones) osteomalacia (soft bones and joint pain)
9	E (It is mixture of 4-vitamins a, b, g, d tocoferols)	Soluble in oils and fats, stable to heat and oxidation.	Vegetable oil, wheat germ oil, cotton seed oil, peanut oil, soyabean, eggs, milk, fish. (Daily dosage 5 mg)	Loss of sexual power of reproduction (sterility) increased muscular weakness.
10	K (phyloquinone mixture of two vitamins K ₁ & K ₂)	Soluble in oils and fats, stable to heat, sensible to light and alkali.	Vitmain K ₁ affalfa leafs vegetables. Vitamin K ₂ occurs mainly in bacteria.	Haemorrhage lengthens the time of blood clotting. Excessive bleeding in injury. Vitamin K ₁ & K ₂ and alkali bacteria.





Nucleic Acids

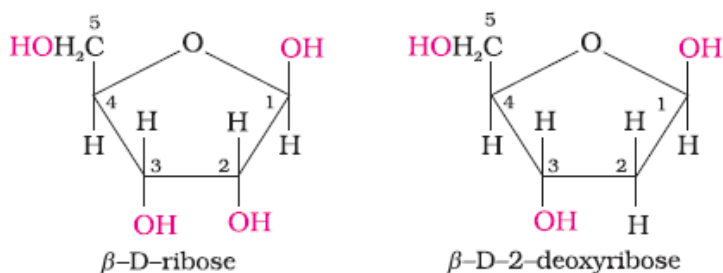
Every generation of each and every species resembles its ancestors in many ways. How are these characteristics transmitted from one generation to the next? It has been observed that nucleus of a living cell is responsible for this transmission of inherent characters, also called **heredity**. The particles 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.

Chemical Composition of Nucleic Acids

Complete hydrolysis of DNA (or RNA) yields a pentose sugar, phosphoric acid and nitrogen containing heterocyclic compounds (called bases).

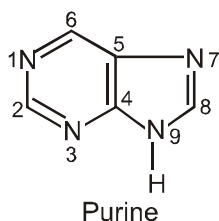
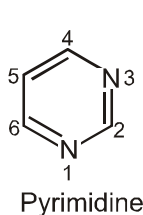
In DNA molecules, the sugar moiety is β -D-2-deoxyribose whereas in RNA molecule, it is β -D-ribose.



Nitrogenous bases have two categories

(a) Pyrimidine : It includes cytosine, thymine and uracil. Pyrimidine bases are made of only one ring of carbon and nitrogen.

(b) Purine: It includes adenine and guanine. Purine bases are made of two ring of carbon and nitrogen. 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).

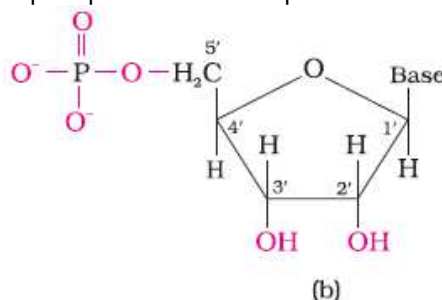
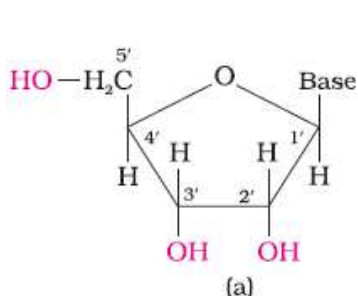


Pyrimidines			Purines	
Thymine (T)	Uracil (U)	Cytosine (C)	Adenine (A)	Guanine (G)

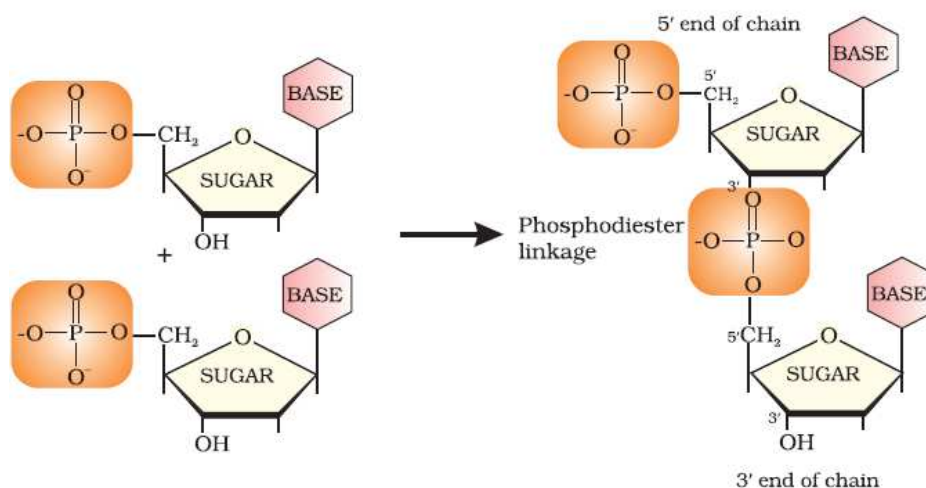


Structure of Nucleic Acids

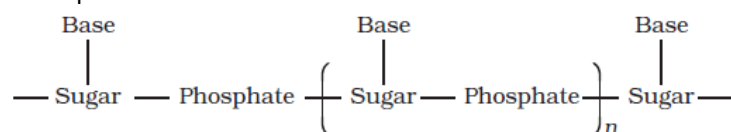
A unit formed by the attachment of a base to 1' position of sugar is known as **nucleoside**. In nucleosides, the sugar carbons are numbered as 1', 2', 3', etc. in order to distinguish these from the bases. When nucleoside is linked to phosphoric acid at 5'-position of sugar moiety, we get a nucleotide.



Nucleotides are joined together by phosphodiester linkage between 5' and 3' carbon atoms of the pentose sugar. The formation of a typical dinucleotide is shown below



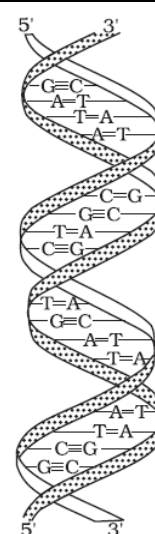
A simplified version of nucleic acid chain is as shown below.



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)**.





DNA Fingerprinting

It is known that every individual has unique fingerprints. These occur at the tips of the fingers and have been used for identification for a long time but these can be altered by surgery. A sequence of bases on DNA is also unique for a person and information regarding this is called DNA fingerprinting. It is same for every cell and cannot be altered by any known treatment. DNA fingerprinting is now used

- (i) in forensic laboratories for identification of criminals.
- (ii) to determine paternity of an individual.
- (iii) to identify the dead bodies in any accident by comparing the DNA's of parents or children.
- (iv) to identify racial groups to rewrite biological evolution.

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.

Differences between DNA and RNA

	DNA		RNA
1	It usually occurs inside nucleus and some cell organelles.	1	Very little RNA occurs inside nucleus. Most of it is found in the cytoplasm.
2	DNA is the genetic material.	2	RNA is not the genetic material except in certain viruses, e.g. Reovirus.
3	It is double stranded with the exception of it some viruses (e.g. $\phi \times 174$).	3	RNA is single stranded except reovirus where is double stranded.
4	DNA contains over a million nucleotides.	4	Depending upon the type, RNA contains 70-1200 nucleotides.
5	DNA is of only two types; intra-nuclear and extra-nuclear.	5	There are at least three types of RNAs-mRNA, rRNA and tRNA.
6	It contains deoxyribose sugar.	6	It contains ribose sugar.
7	Nitrogen base thymine occurs in DNA alongwith three others-adenine, cytosine and guanine.	7	Thymine is replaced by uracil in RNA The other three are similar-adenine, cytosine and guanine.
8	It replicates to form new DNA molecules.	8	It cannot normally replicate itself.
9	DNA transcribes genetic information to RNA.	9	RNA translates the transcribed message for forming polypeptides.
10	DNA controls metabolism and genetics including variations.	10	It only controls metabolism under instruction from DNA.
11	Purine and pyrimidine bases are in equal number.	11	There is no proportionality between number of purines and pyrimidine bases.





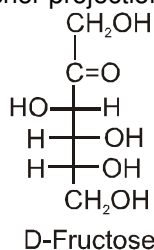
Exercise-1

Marked questions are recommended for Revision.

PART - I : SUBJECTIVE QUESTIONS

Section (A) : Carbohydrates

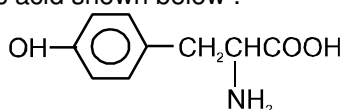
- A-1. What are monosaccharides ?
 A-2. Draw the Fischer projections for the open-chain structures of D-glucose and L-glucose ?
 A-3. The fischer projection of D-fructose is given below, write the fischer projection of L-fructose.



- A-4. Write the reaction of D-glucose with HNO_3 .
 A-5. Give reasons as the evidence in support of cyclic structure of glucose
 A-6. What is mutarotation ?
 A-7. What do you understand by glycosidic linkage ?
 A-8. What are reducing sugars ?
 A-9. What are the hydrolysis products of sucrose ?
 A-10. What is the basic structural difference between starch and cellulose ?
 A-11. Simple six membered ring compound (eg. Cyclohexane) are not soluble in water whereas glucose and sucrose are soluble in water. Explain why ?

Section (B) : Amino Acids & Proteins

- B-1. What do you mean by the following also give example
 (a) Non -essential amino acids (b) Essential amino acids
 B-2. Amino acids show amphoteric behaviour. Explain why ?
 B-3. Tyrosine is an α -amino carboxylic acid shown below :

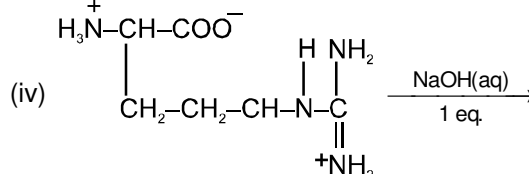
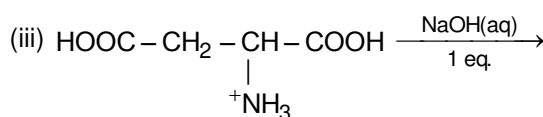
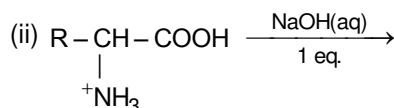
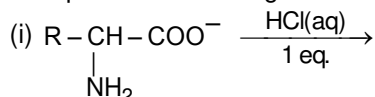


Write the most stable structural formula -

- (a) In it's cationic form (b) In it's anionic form
 (c) In it's dianionic form (d) In it's Zwitter ionic form

- B-4. How will you identify a basic amino acid ?

- B-5. Complete the following reactions :

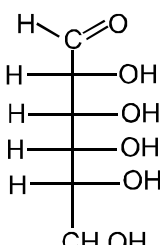
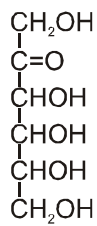




- B-6.** Why an amino acid is usually solid at room temperature.
- B-7.** The melting point and solubility (in H_2O) of amino acids are generally high. explain why ?
- B-8.** What is the product obtained when glycine hydrochloride reacts with two equivalents of $NaOH$? Write the chemical reactions involved.
- B-9.** What is the denaturation of proteins ?

PART - II : ONLY ONE OPTION CORRECT TYPE

Section (A) : Carbohydrates

- A-1.**  Allose, given monosaccharide is a/an ?
 (A) Aldopentose (B) Aldohexose (C) Ketopentose (D) Aldoheptose
- A-2.** The letter D in D-glucose signifies
 (A) dextrorotatory (B) mode of synthesis (C) its configuration (D) its diamagnetic nature
- A-3.**  For the structure, total possible optical isomers are
 (A) 12 (B) 4 (C) 16 (D) 8
- A-4.** Carbohydrates have :
 (A) $-OH$ group (B) $-CHO$ group (C) $>C=O$ group (D) All
- A-5.** Which of the following monosaccharide is pentose ?
 (A) Glucose (B) Fructose (C) Arabinose (D) Galactose
- A-6.** α -D-glucose and β -D-glucose differ from each other due to the difference in one of the carbon atoms, with respect to its
 (A) Number of $-OH$ groups (B) Configuration
 (C) Conformation (D) Size of hemiacetal ring
- A-7.** Which of the following pairs form the same osazone ?
 (A) Glucose and fructose (B) Glucose and galactose
 (C) Glucose and arabinose (D) Lactose and maltose
- A-8.** Glucose when treated with CH_3OH in presence of dry HCl gas gives α - and β -methylglucosides because it contains
 (A) an aldehydic group (B) a $-CH_2OH$ group
 (C) a cyclic structure (D) five $-OH$ group
- A-9.** α -D (+) glucopyranose is example of
 (A) acetal (B) ketal (C) hemiacetal (D) hemiketal
- A-10.** Which of the following indicates the presence of 5 $-OH$ groups in glucose
 (A) Penta-acetyl derivative of glucose (B) Cyanohydrin formation of glucose
 (C) Reaction with Fehling's solution (D) Reaction with Tollen's reagent



Section (B) : Amino Acids & Proteins

B-1. Which of the following is α -amino acid?

- (A) (B)
 (C) (D) $\text{CH}_3 - \text{CH}_2 - \underset{\text{COOH}}{\text{CH}} - \text{CH}_2 - \text{NH}_2$

B-2. Which of the following α -amino acids is not optically active ?

- (A) Alanine (B) Glycine (C) Phenylalanine (D) Cysteine

B-3. Which of the following is a basic amino acid?

- (A) (B)
 (C) (D)

B-4. The force of attraction between the neighbouring peptide chains is

- (A) Vander Waal's force (B) Covalent bond
(C) Hydrogen bond (D) Peptide linkage

B-5. The name of the given dipeptide is :



- (A) Gly-Gly (B) Gly-Ala (C) Ala-Ala (D) Ala-Gly

B-6. The three pK_a values of aspartic acid are 1.89, 3.65 and 9.60. The pI of the amino acid is

- (A) 2.77 (B) 6.62 (C) 5.74 (D) 7.0

Section (C) : Vitamins and Nucleic Acids

C-1. Which of the following is a vitamin -

- (A) Glucose (B) Keratin (C) Maltose (D) Riboflavin

C-2. Vitamin B₆ is known as

- (A) Pyridoxine (B) Thiamine (C) Tocopherol (D) Riboflavin

C-3. The best source of vitamin A is -

- (A) Oranges (B) Beans (C) Carrots (D) Wheat

C-4. Vitamin D is called -

- (A) Ascorbic acid (B) Calciferol or ergocalciferol
(C) Thiamine (D) Riboflavin

C-5. Which of the following is found in cod-liver oil ?

- (A) Vitamin C (B) Vitamin E (C) Vitamin A (D) Vitamin B₁

C-6. Vitamin E is also called :

- (A) Cyanocobalamin (B) Tocopherol (C) Lactoflavin (D) Ascorbic acid

C-7. The best source of vitamin C is :

- (A) Cod liver oil (B) Egg yolk (C) Citrus fruits (D) Fish liver oil



- C-8.** Milk contains vitamins :
 (A) A, D and E (B) A, B₁₂ and D (C) C, D and K (D) B₁, B₆ and D
- C-9.** Nervousness anaemia is caused by the deficiency of vitamin
 (A) B₁ (B) B₂ (C) B₆ (D) B₁₂
- C-10.** Deficiency of vitamin E causes
 (A) Scurvy (B) Loss of appetite
 (C) Loss of sexual power and reproduction (D) Beriberi
- C-11.** Which of the following is fat soluble vitamin ?
 (A) Vitamin A (B) Pyridoxine (C) Riboflavin (D) Thiamine
- C-12.** Which one of the following vitamin contains a metal atom ?
 (A) Vitamin A (B) Vitamin B₂ (C) Vitamin B₆ (D) Vitamin B₁₂
- C-13.** Identify the vitamin whose deficiency in our food decreases reproductive power :
 (A) vitamin A (B) vitamin C (C) vitamin D (D) vitamin E
- C-14.** Beri-beri is caused due to :
 (A) vitamin A (B) vitamin B (C) vitamin C (D) vitamin D
- C-15.** The sugar present in DNA is :
 (A) Glucose (B) Deoxyribose (C) Ribose (D) Fructose
- C-16.** The pentose sugar in DNA and RNA has the :
 (A) Open chain structure (B) Pyranose structure
 (C) Furanose structure (D) None of the above
- C-17.** Which of the following is not a pyrimidine base ?
 (A) Uracil (B) Guanine (C) Cytosine (D) Thymine
- C-18.** The relationship between the nucleotide triplets and the amino acids is called
 (A) Translation (B) Transcription (C) Replication (D) A genetic code
- C-19.** 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 2-deoxyribose pentose sugar.
- C-20.** Which of the following statements about RNA is not correct ?
 (A) It has a single strand (B) It does not undergo replication
 (C) It does not contain any pyrimidine base (D) It controls the synthesis of proteins
- C-21.** Oils and fats are esters of higher fatty acids with :
 (A) Ethanol (B) Glycol (C) Glycerol (D) Methanol
- C-22.** The chief constituents of cell membranes are :
 (A) Simple triglycerides (B) Waxes (C) Phospholipids (D) Proteins
- C-23.** The fats present in the body act as
 (A) Food storage only (B) Heat insulator only
 (C) Shock absorber only (D) All the three above
- C-24.** The most concentrated source of energy in the human body is
 (A) Fats (B) Sugars (C) Proteins (D) Nucleic acids



PART - III : MATCH THE COLUMN

1. Match **Column-I** with **Column-II**.

	Column-I		Column-II
	(polymer)		(monomer)
(A)	Sucrose	(p)	Linkage and hydrolysis product D(+) glucose
(B)	Maltose	(q)	Linkage and hydrolysis product D(-) fructose
(C)	Lactose	(r)	D(+) galactose
(D)	Cellulose	(s)	$\alpha(1 \rightarrow 4)$
		(t)	$\beta(1 \rightarrow 4)$

2. Match **Column-I** with **Column-II**.

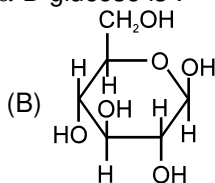
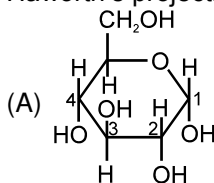
	Column-I		Column-II
(A)	$\begin{array}{c} \text{NH}_3^+ \\ \\ \text{CH}_3-\text{CH}-\text{COO}^- \end{array}$	(p)	Acidic amino acid
(B)	Arginine	(q)	Neutral amino acid
(C)	Valine	(r)	Zwitter ion
(D)	Aspartic acid	(s)	Basic amino acid

Exercise-2

Marked questions are recommended for Revision.

PART-I : ONLY ONE OPTION CORRECT TYPE

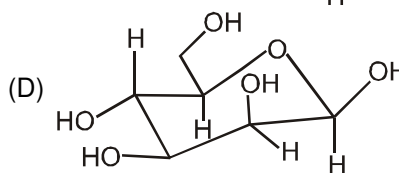
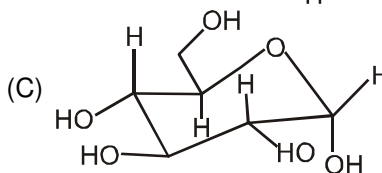
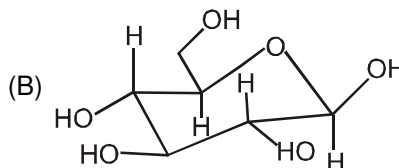
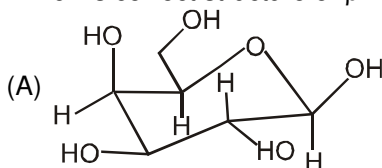
1. Haworth's projection of α -D glucose is :



(C) both

(D) none

2. Which is correct structure of β -D-glucopyranose.



3. 3 molecule of phenylhydrazine is used in Osazone formation. The correct statement about the use of phenylhydrazine is :

(A) All the three molecules react in similar manner.

(B) Two molecules reacts in similar manner whereas the third reacts in different way.

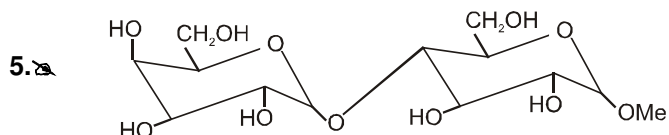
(C) All the three molecules react in different way.

(D) Only two react in same manner but the third molecule remains unreacted.



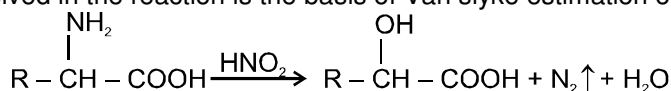


4. Ketones do not reduce Tollen's reagents, but fructose with a keto group reduces it. Which one of the following is a correct statement ?
 (A) Enolisation of keto group of fructose and transformation into aldehyde group in presence of OH^- , (which is present in Tollen's reagent).
 (B) $> \text{CHOH}$ group is also oxidised to keto group.
 (C) Both statements are correct.
 (D) None of the statement is correct.

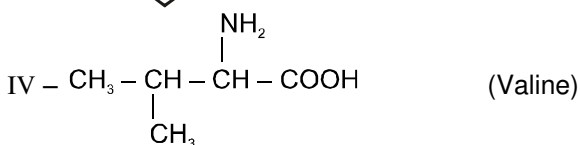
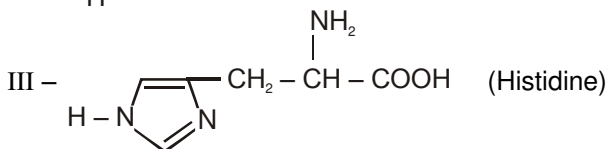
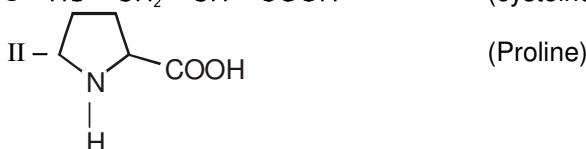
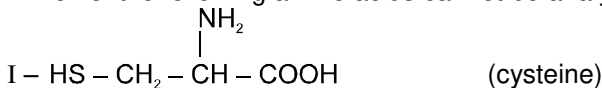


On acid hydrolysis of above disaccharide, we get

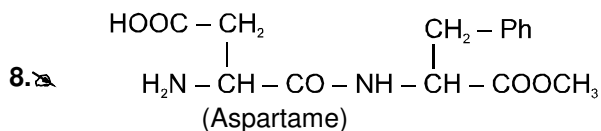
- (A) Two moles of glucose
 (B) one mole of glucose
 (C) One mole of galactose
 (D) one mole of glucose and one mole of galactose
6. Find the pair which is correctly matched
 (A) Sucrose : monosaccharide
 (B) Fructose : aldose sugar
 (C) Glucose : mutarotation
 (D) Sucrose : reducing sugar
7. Nitrous acid (HNO_2) converts amino acids into hydroxy acids with retention of configuration. Estimation of nitrogen gas evolved in the reaction is the basis of Van slyke estimation of amino acids.



Which of the following amino acids cannot be analysed by Van slyke method?



- (A) only I
 (B) only II
 (C) I and III
 (D) I, III, IV



Aspartame is 160 times as sweet as sucrose and is used as a sugar substitute.

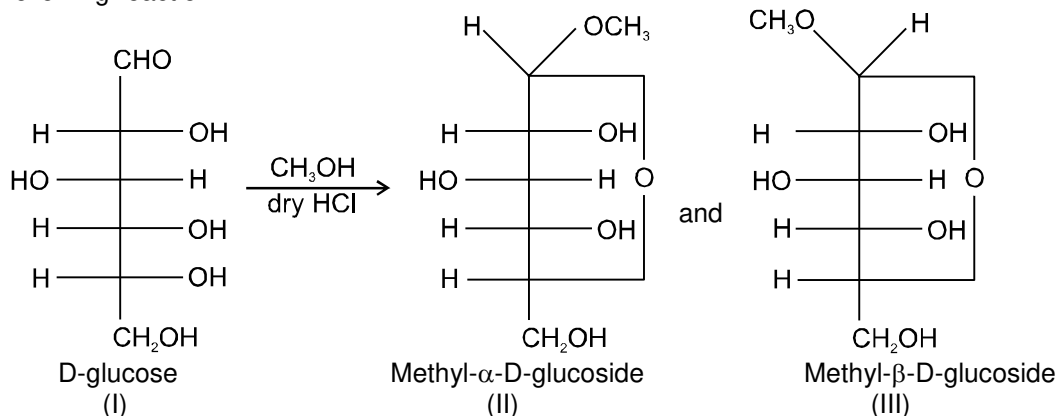
the correct statement (s) about aspartame is (are)

- I - It is an ester derivative of dipeptide
 II - It can be named as aspartyl phenylalanine methyl ester
 III - It is a tripeptide
 IV - It is having four functional groups.
 (A) I, II
 (B) I, II, IV
 (C) II, III, IV
 (D) only II



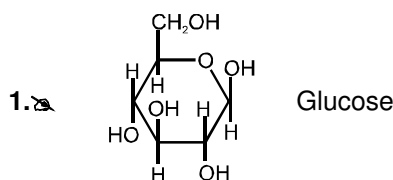
PART - II : SINGLE AND DOUBLE VALUE INTEGER TYPE

1. Consider an amylose chain of 4000 glucose unit. At how many cleavage require to lower the average length to 400 units.
2. How many statements are correct?
D-glucose, on treating with methanol in presence of dry HCl gives methyl glucosides according to the following reaction



- (i) The glucosides do not reduce fehling's solution
 (ii) The glucosides do not react with hydrogen cyanide or hydroxylamine
 (iii) Behaviour of glucosides as stated in S₁ and S₂ indicates the absence of free -CHO group.
 (iv) The two forms of glucosides are enantiomers.
 How many statements are correct ?
3. An octapeptide (Mol. wt. = 516 g) on complete hydrolysis given glycine and alanine (Mol. mass = 89 g). Alanine contributes 41.59% to total weight of hydrolysed product. How many number of alanine unit present in octapeptide.
4. Among the following amino acids no. of essential amino acids are
Glycine, Alanine, Valine, Cysteine, Leucine, Isoleucine, Serine, Threonine.
5. Calculate of pI of glutamic acid
 $\text{HOOCCH}_2\text{CH}_2\text{—CH—COOH} \leftarrow \text{pK}_a = 2.19$
 $\uparrow \qquad \qquad \qquad \downarrow$
 $\text{pK}_a = 4.25 \qquad \text{NH}_3^+ \leftarrow \text{pK}_a = 9.67$
 (report answer $\text{pI} \times 10$ upto two digit)
6. No of optical isomers possible for fructose $\text{CH}_2(\text{OH})\text{—CH}(\text{OH})\text{—CH}(\text{OH})\text{CH}(\text{OH})\text{—CO—CH}_2\text{—OH}$ is :

PART - III : ONE OR MORE THAN ONE OPTIONS CORRECT TYPE

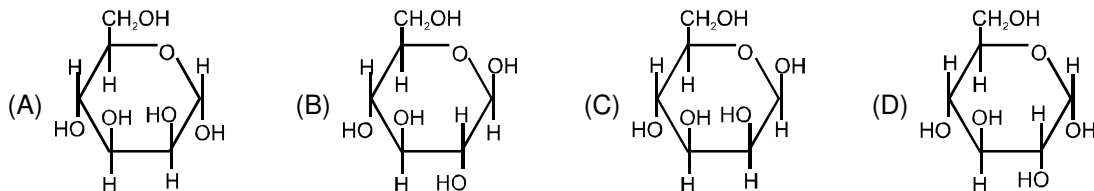


The correct statements about above structure of glucose are :

- (A) It is a Pyranose form
 (B) It is a furanose form
 (C) It is a β -anomer
 (D) It is a D -sugar



2. D-Mannose differs from D-glucose in its stereochemistry at C-2. The pyranose form of D-Mannose is

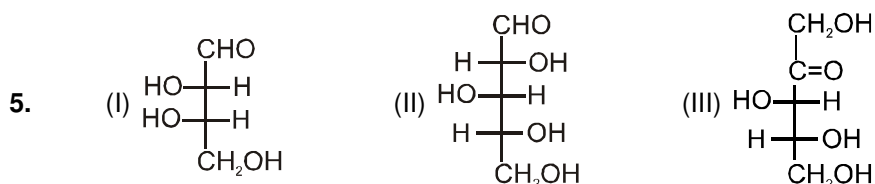


3. Which of the following is /are reducing sugar

(A) Sucrose (B) Glucose (C) Fructose (D) methylmaltoside

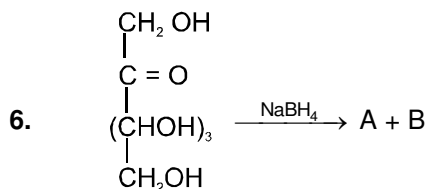
4. Which of these are polysaccharides of glucose ?

(A) Starch (B) Cellulose (C) Sucrose (D) Lactose



The correct statement about the sugars given above are

- (A) I and II are L-Sugars (B) II and III are D-Sugar
(C) I and III are D-sugars (D) I is L-sugar



Fructose

The product A and B in the a above reaction are

- (A) Diastereomers (B) Enantiomers
(C) Anomers (D) Optically active hexahydroxy compounds

7. The correct statements about peptides are :

- (A) A dipeptide has one peptide link between two amino acids.
(B) By convention N-Terminus is kept at left and C- terminus at right in the structure of a peptide
(C) If only one amino group and one carboxylic acid, group are available for reaction, then only one dipeptide can forms.
(D) A polypeptide with more than hundred amino acid residues (mol. mass > 10,000) is called a protein

8. Correct statement about peptide linkage in a protein molecule is/are correct ?

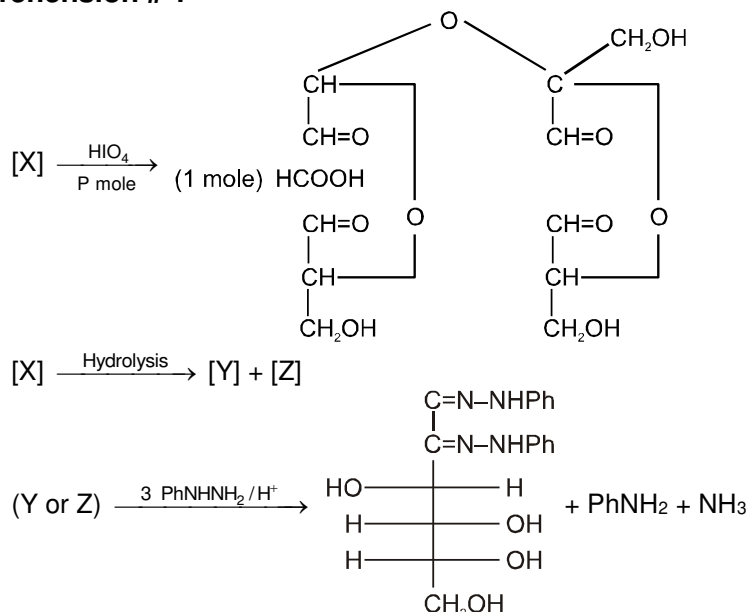
- (A) It is amide linkage
(B) It has partial double bond character.
(C) It is hydrophilic in nature
(D) It connects protein molecules through H-bonds.



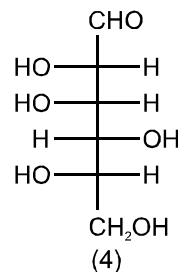
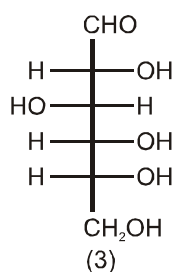
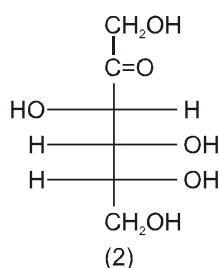
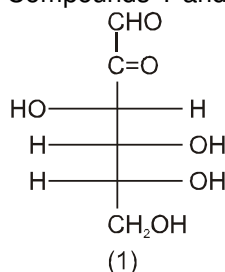
PART - IV : COMPREHENSION

Read the following passage carefully and answer the questions.

Comprehension # 1



1. Compounds Y and Z can be :



(A) 1 only

(B) 2, 3

(C) 1, 4

(D) 2, 3, 4

2. Number of moles (P) of HIO_4 used per moles of compound X is :

(A) 2

(B) 3

(C) 4

(D) 5

Comprehension # 2

Answer Q.3, Q.4 and Q.5 by appropriately matching the information given in the three columns of the following table.

Column-1		Column-2		Column-3	
(I)	Glucose	(i)	Disaccharide	(P)	Mutarotation
(II)	Sucrose	(ii)	Monosaccharide	(Q)	Reducing sugar
(III)	Starch	(iii)	Polysaccharide	(R)	Non-Reducing sugar
(IV)	Fructose	(iv)	Oligosaccharide	(S)	2,4-DNP test positive

3. Which combination is correct ?

(A) (I) (ii) (R)

(B) (III) (iii) (S)

(C) (II) (i) (R)

(D) (IV) (i) (Q)

4. Which of the following combination gives $\text{Br}_2/\text{H}_2\text{O}$ test ?

(A) (II) (iii) (R)

(B) (I) (ii) (Q)

(C) (IV) (ii) (Q)

(D) (III) (iii) (S)

5. Which of the following combination is correct set for invert sugar ?

(A) (II) (i) (Q)

(B) (III) (iii) (R)

(C) (II) (iv) (R)

(D) (II) (iii) (R)



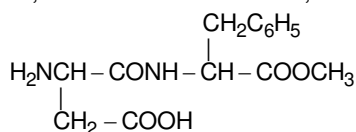


Exercise-3

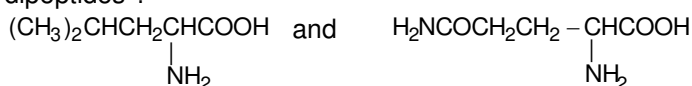
* Marked Questions may have more than one correct option.

PART - I : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

1. Aspartame, an artificial sweetener, is a peptide and has the following structure : [JEE-2001(M), 5/100]



- Identify the four functional groups
 - Write the zwitter ionic structure
 - Write the structures of the amino acids obtained from the hydrolysis of aspartame.
 - Which of these two amino acids, is more hydrophobic ?
2. Following two aminoacids leusine and glutamine form dipeptide linkage. What are two possible dipeptides ?

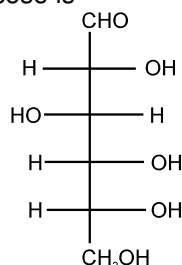


[JEE-2003(M), 2/60]

3. Which of the following pairs give positive Tollen's Test ? [JEE-2004(S), 3/84]

- (A) Glucose, sucrose (B) Glucose, fructose
(C) Hexanol, Acetophenone (D) Fructose, sucrose

4. The Fischer projection formula of D-glucose is [JEE 2004(M), 2/60]



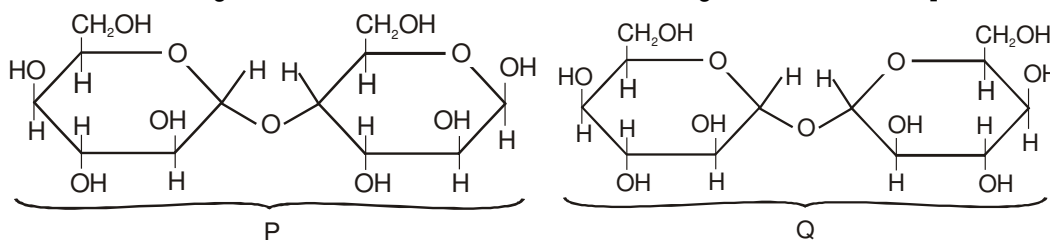
- Give Fischer projection formula of L-glucose.
- Give the product of reaction of L-glucose with Tollen's reagent.

5. The two forms of D-Glucopyranose obtained from solution of D-Glucose are known as :

[JEE-2005(S), 3/84]

- (A) Epimers (B) Anomers
(C) Enantiomers (D) Geometrical Isomers

6. Which of the following disaccharide will not reduce tollen's reagent. [JEE-2005(M), 2/60]





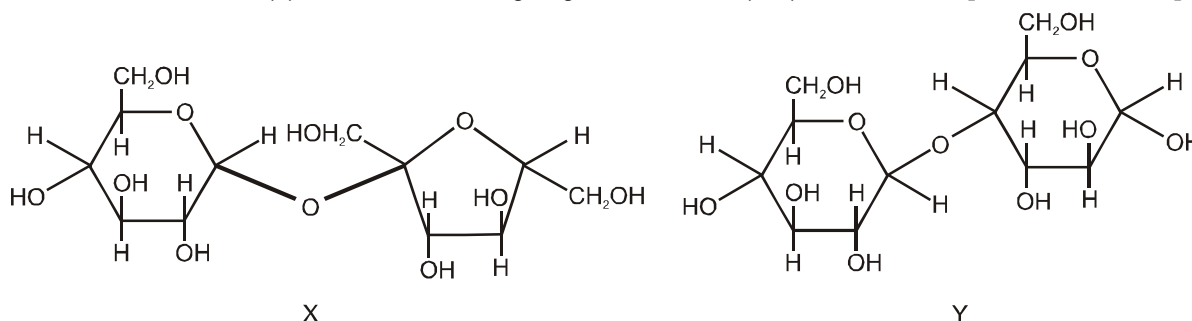
7. **Statement-1** : Glucose gives a reddish-brown precipitate with Fehling's solution. [JEE-2007, 3/162]
because

Statement-2 : Reaction of glucose with Fehling's solution gives CuO and gluconic acid.

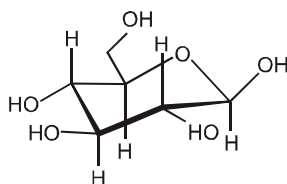
- (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

- 8.* The correct statement(s) about the following sugars **X** and **Y** is(are) :

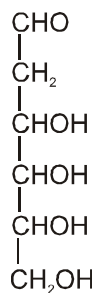
[JEE 2009, 4/160]



- (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.
9. A decapeptide (Mol. Wt. 796) on complete hydrolysis gives glycine (Mol. Wt. 75), alanine and phenylalanine. Glycine contributes 47.0 % to the total weight of the hydrolysed products. The number of glycine units present in the decapeptide is [JEE 2011, 4/180]
10. The following carbohydrate is [JEE 2011, 3/180]

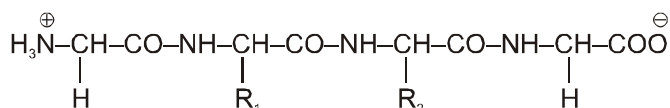


- (A) a ketohexose (B) an aldohexose (C) an α -furanose (D) an α -pyranose
11. When the following aldohexose exists in its D-configuration, the total number of stereoisomers in its pyranose form is : [JEE-2012, 4/136]





- 12.** The substituents R_1 and R_2 for nine peptides are listed in the table given below. How many of these peptides are positively charged at $\text{pH} = 7.0$? **[JEE-2012, 4/136]**

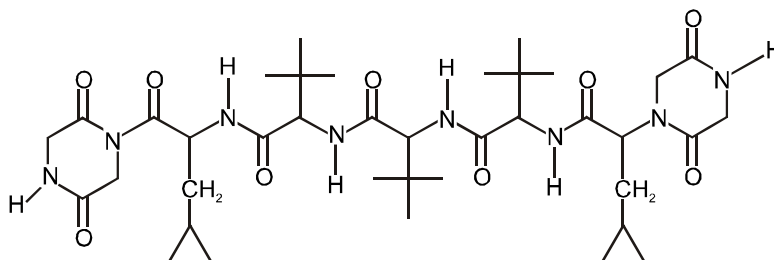


Peptide	R ₁	R ₂
I	H	H
II	H	CH ₃
III	CH ₂ COOH	H
IV	CH ₂ CONH ₂	(CH ₂) ₄ NH ₂
V	CH ₂ CONH ₂	CH ₂ CONH ₂
VI	(CH ₂) ₄ NH ₂	(CH ₂) ₄ NH ₂
VII	CH ₂ COOH	CH ₂ CONH ₂
VIII	CH ₂ OH	(CH ₂) ₄ NH ₂
IX	(CH ₂) ₄ NH ₂	CH ₃

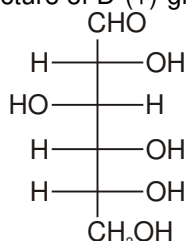
- 13.** A tetrapeptide has – COOH group on alanine. This produces glycine (Gly), valine (Val), phenyl alanine (Phe) and alanine (Ala), on complete hydrolysis. For this tetrapeptide, the number of possible sequences (primary structures) with – NH₂ group attached to a chiral center is :

[JEE(Advanced)-2013, 4/120]

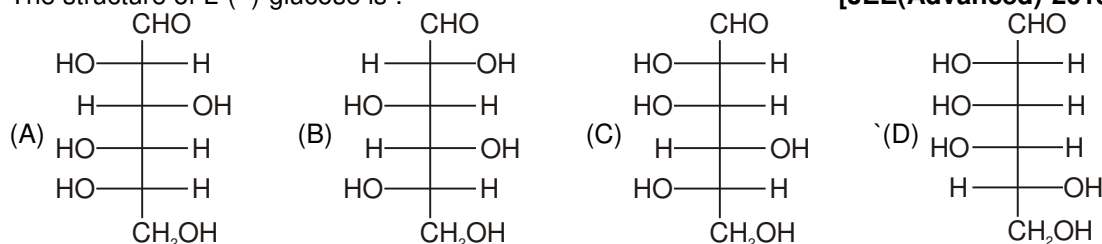
14. The total number of **distinct naturally occurring amino acids** obtained by complete acidic hydrolysis of the peptide shown below is : **[JEE(Advanced)-2014, 4/120]**



- 15.** The structure of D-(+)-glucose is



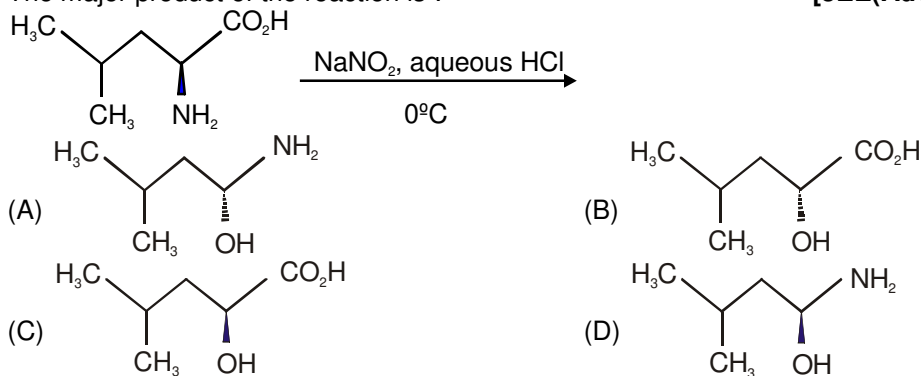
The structure of L-(–)-glucose is :





16. The major product of the reaction is :

[JEE(Advanced)-2015, 4/120]



17.* For 'invert sugar', the correct statement(s) is(are)

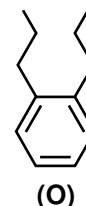
[JEE(Advanced)-2016, 3/124]

(Given : specific rotations of (+)-sucrose, (+)-maltose, L-(+)-glucose and L-(+)-fructose in aqueous solution are $+66^\circ$, $+140^\circ$, -52° and $+92^\circ$, respectively)

- (A) 'invert sugar' is prepared by acid catalyzed hydrolysis of maltose
 (B) 'invert sugar' is an equimolar mixture of D-(+)-glucose and D-(-)-fructose
 (C) specific rotation of 'invert sugar' is -20°
 (D) on reaction with Br_2 water, 'invert sugar' forms saccharic acid as one of the products

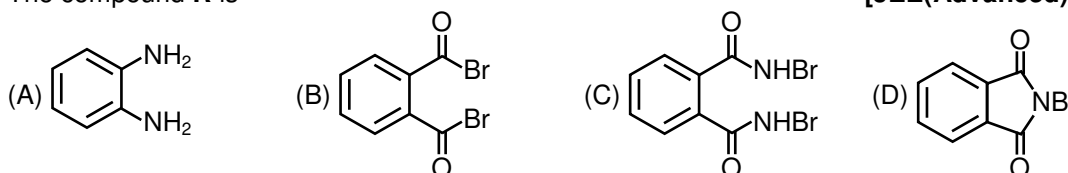
Comprehension # 2 (for 18 to 19)

Treatment of compound **O** with KMnO_4/H^+ gave **P**, which on heating with ammonia gave **Q**. The compound **Q** on treatment with Br_2/NaOH produced **R**. On strong heating, **Q** gave **S**, which on further treatment with ethyl 2-bromopropanoate in the presence of KOH followed by acidification, gave a compound **T**.



18. The compound **R** is

[JEE(Advanced)-2016, 3/124]



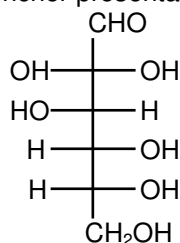
19. The compound **T** is

[JEE(Advanced)-2016, 3/124]

- (A) glycine (B) alanine (C) valine (D) serine

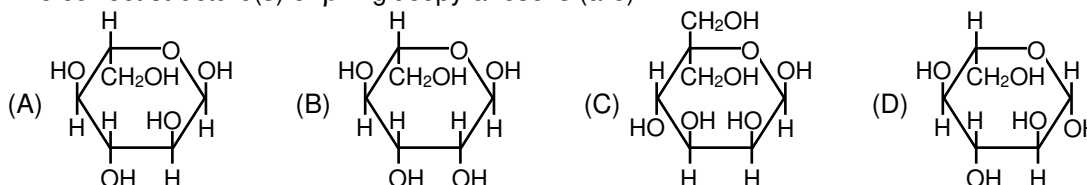
20.* The Fischer presentation of D-glucose is given below.

[JEE(Advanced)-2018, 4/120]



D-glucose

The correct structure(s) of β -L-glucopyranose is (are)





PART - II : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

JEE(MAIN) OFFLINE PROBLEMS

1. A substance forms zwitter ion. It can have functional group. [AIEEE-2002, 3/225]
 (1) $-\text{NH}_2$, $-\text{COOH}$ (2) $-\text{NH}_2$, $-\text{SO}_3\text{H}$
 (3) Both (1) and (2) (4) None of these
2. Complete hydrolysis of cellulose gives [AIEEE-2003, 3/225]
 (1) D-fructose (2) D-ribose (3) D-glucose (4) L-glucose
3. The reason for double helical structure of DNA is: [AIEEE-2003, 3/225]
 (1) van der Waal's forces. (2) dipole-dipole interaction.
 (3) hydrogen bonding. (4) electrostatic attractions.
4. Which base is present in RNA but not in DNA? [AIEEE-2004, 3/225]
 (1) uracil (2) cytosine (3) guanine (4) thymine
5. Insulin production and its action in human body are responsible for the level of diabetes. This compound belongs to which of the following categories? [AIEEE-2004, 3/225]
 (1) a co- enzyme (2) a hormone (3) an enzyme (4) an antibiotic
6. In both DNA and RNA, heterocyclic base and phosphate ester linkages are at : [AIEEE 2005, 3/225]
 (1) C_5' and C_2' respectively of the sugar molecule
 (2) C_2' and C_5' respectively of the sugar molecule
 (3) C_1' and C_5' respectively of the sugar molecule
 (4) C_5' and C_1' respectively of the sugar molecule.
7. The pyrimidine bases present in DNA are [AIEEE-2006, 3/165]
 (1) cytosine and guanine (2) cytosine and thymine
 (3) cytosine and uracil (4) cytosine and adenine
8. The term anomers of glucose refers to [AIEEE-2006, 3/165]
 (1) a mixture of (D)-glucose and (L)-glucose
 (2) enantiomers of glucose
 (3) isomers of glucose that differ in configuration at carbon one ($\text{C}-1$)
 (4) isomers of glucose that differ in configurations at carbons one and four ($\text{C}-1$ and $\text{C}-4$)
9. The secondary structure of protein refers to: [AIEEE-2007, 3/120]
 (1) α -helical backbone. (2) hydrophobic interactions.
 (3) sequence of α -amino acids. (4) fixed configuration of the polypeptide backbone.
10. α -D-(+)-glucose and β -D-(+)-glucose are [AIEEE-2008, 3/105]
 (1) epimers (2) anomers (3) enantiomers (4) conformers
11. The two functional groups present in a typical carbohydrate are : [AIEEE-2009, 4/144]
 (1) $-\text{CHO}$ and $-\text{COOH}$ (2) $>\text{C}=\text{O}$ and $-\text{OH}$ (3) $-\text{OH}$ and $-\text{CHO}$ (4) $-\text{OH}$ and $-\text{COOH}$
12. The presence or absence of hydroxy group on which carbon atom of sugar differentiates RNA and DNA. [AIEEE-2011, 4/120]
 (1) 1st (2) 2nd (3) 3rd (4) 4th
13. The change in the optical rotation of freshly prepared solution of glucose is known as: [AIEEE-2011, 4/120]
 (1) racemisation (2) specific rotation (3) mutarotation (4) tautomerism
14. Which one of the following statements is correct? [AIEEE-2012, 4/120]
 (1) All amino acids except lysine are optically active
 (2) All amino acids are optically active
 (3) All amino acids except glycine are optically active
 (4) All amino acids except glutamic acids are optically active



15. Synthesis of each molecule of glucose in photosynthesis involves : [JEE-Main 2013, 4/120]
 (1) 18 molecules of ATP (2) 10 molecules of ATP
 (3) 8 molecules of ATP (4) 6 molecules of ATP
16. Which one of the following bases is not present in DNA ? [JEE-Main 2014, 4/120]
 (1) Quinoline (2) Adenine (3) Cytosine (4) Thymine
17. Which of the vitamins given below is water soluble ? [JEE-Main 2015, 4/120]
 (1) Vitamin C (2) Vitamin D (3) Vitamin E (4) Vitamin K
18. Thiol group is present in : [JEE-Main 2016, 4/120]
 (1) Cystine (2) Cysteine (3) Methionine (4) Cytosine
19. Which of the following compounds will behave as a reducing sugar in an aqueous KOH solution? [JEE-Main 2017, 4/120]
- (1)

(2)
- (3)

(4)
20. Glucose on prolonged heating with HI gives : [JEE-Main 2018, 4/120]
 (1) Hexanoic acid (2) 6-iodohexanal (3) n-Hexane (4) 1-Hexene

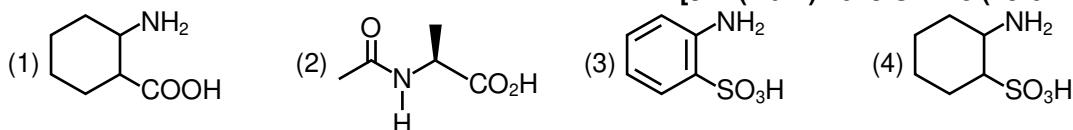
JEE(MAIN) ONLINE PROBLEMS

1. Which of the following will not show mutarotation? [JEE(Main) 2014 Online (12-04-14), 4/120]
 (1) Maltose (2) Lactose (3) Glucose (4) Sucrose
2. The reason for double helical structure of DNA is the operation of : [JEE(Main) 2014 Online (19-04-14), 4/120]
 (1) Electrostatic attractions (2) Vander Waals forces
 (3) Dipole-Dipole interactions (4) Hydrogen bonding
3. Complex hydrolysis of starch gives : [JEE(Main) 2015 Online (10-04-15), 4/120]
 (1) glucose only
 (2) glucose and fructose in equimolar amounts
 (3) galactose and fructose in equimolar amounts
 (4) glucose and galactose in equimolar amounts
4. Accumulation of which of the following molecules in the muscles occurs as a result of vigorous exercise? [JEE(Main) 2015 Online (11-04-15), 4/120]
 (1) Glycogen (2) Glucose (3) Pyruvic acid (4) L-lactic acid
5. Consider the following sequence for aspartic acid:
- $$\begin{array}{ccccccc}
 \text{CO}_2\text{H} & & \text{CO}_2^- & & \text{CO}_2^- & & \text{CO}_2^- \\
 | & & | & & | & & | \\
 \text{H}_3\text{N}^+ - \text{C} - \text{H} & \xrightleftharpoons[1.88]{\text{p}K_1} & \text{H}_3\text{N}^+ - \text{C} - \text{H} & \xrightleftharpoons[3.65]{\text{p}K_R} & \text{H}_3\text{N}^+ - \text{C} - \text{H} & \xrightleftharpoons[9.60]{\text{p}K_2} & \text{H}_2\text{N} - \text{C} - \text{H} \\
 | & & | & & | & & | \\
 \text{CH}_2\text{CO}_2\text{H} & & \text{CH}_2\text{CO}_2\text{H} & & \text{CH}_2\text{CO}_2^- & & \text{CH}_2\text{CO}_2^-
 \end{array}$$
- The pI (isoelectric point) of aspartic acid is: [JEE(Main) 2016 Online (09-04-16), 4/120]
 (1) 5.74 (2) 3.65 (3) 2.77 (4) 1.88
6. Among the following, the essential amino acid is : [JEE(Main) 2017 Online (08-04-17), 4/120]
 (1) Valine (2) Aspartic acid (3) Serine (4) Alanine

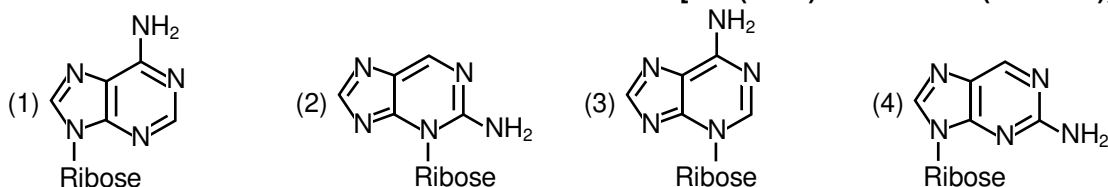


7. The **incorrect** statement among the following is : [JEE(Main) 2017 Online (09-04-17), 4/120]
- (1) α -D-glucose and β -D-glucose are anomers.
 - (2) The penta acetate of glucose does not react with hydroxyl amine.
 - (3) Cellulose is a straight chain polysaccharide made up of only β -D-glucose units.
 - (4) α -D-glucose and β -D-glucose are enantiomers.

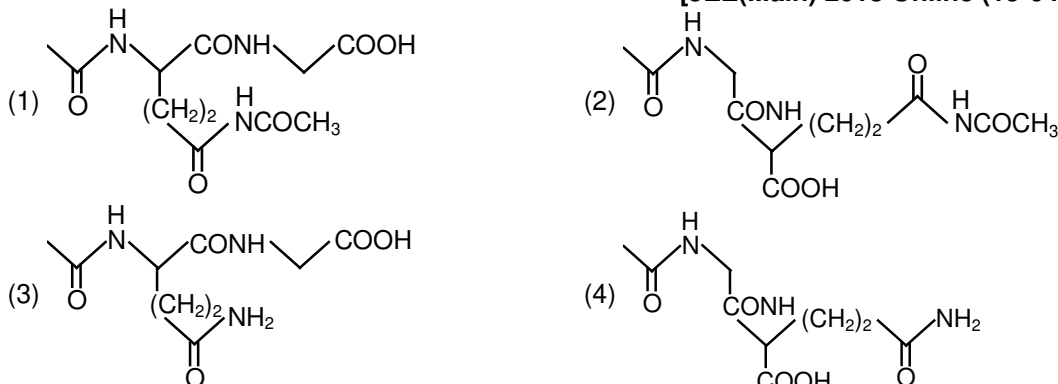
8. Which of the following will not exist in zwitter ionic form at pH = 7 ? [JEE(Main) 2018 Online (15-04-18), 4/120]



9. Which of the following is the correct structure of Adenosine ? [JEE(Main) 2018 Online (15-04-18), 4/120]



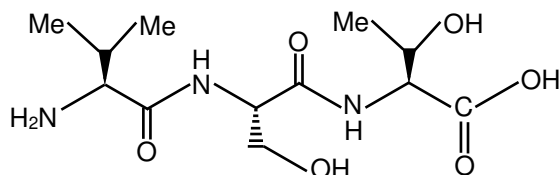
10. The dipeptide, Gln-Gly, on treatment with CH_3COCl followed by aqueous work up gives : [JEE(Main) 2018 Online (15-04-18), 4/120]



11. Among the following, the **incorrect** statement is : [JEE(Main) 2018 Online (16-04-18), 4/120]
- (1) Cellulose and amylose has 1,4-glycosidic linkage.
 - (2) Lactose contains β -D-galactose and β -D-glucose.
 - (3) Maltose and lactose has 1,4-glycosidic linkage.
 - (4) Sucrose and amylose has 1,2-glycosidic linkage.

12. The increasing order of pK_a of the following amino acids in aqueous solution is : [JEE(Main) 2019 Online (09-01-19), 4/120]
- (1) Asp < Gly < Lys < Arg
 - (2) Arg < Lys < Gly < Asp
 - (3) Asp < Gly < Arg < Lys
 - (4) Gly < Asp < Arg < Lys

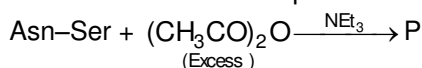
13. The correct sequence of amino acids present in the tripeptide given below is : [JEE(Main) 2019 Online (09-01-19), 4/120]



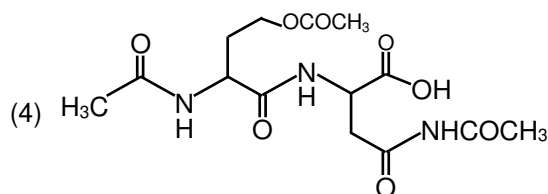
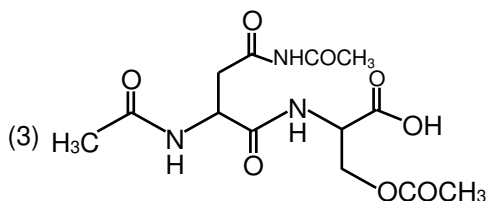
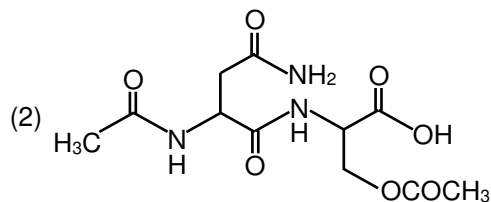
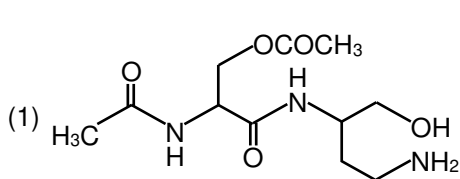
- (1) Val - Ser - Thr (2) Leu - Ser - Thr (3) Thr - Ser - Leu (4) Thr - Ser - Val



14. The correct structure of product 'P' in the following reaction is :



[JEE(Main) 2019 Online (10-01-19), 4/120]



15. The correct match between item 'I' and item 'II' is:

[JEE(Main) 2019 Online (10-01-19), 4/120]

Item 'I'
(Compound)

- (A) Lysine
(B) Furfural
(C) Benzyl alcohol
(D) Styrene

Item 'II'
(Reagent)

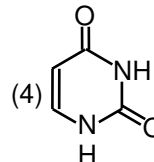
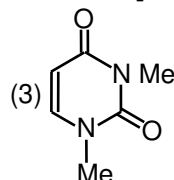
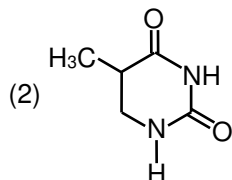
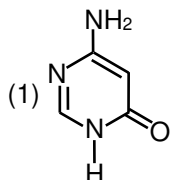
- (P) 1-Naphthol
(Q) Ninhydrin
(R) KMnO_4
(S) Ceric ammonium nitrate

- (1) (A)→(R), (B)→(P), (C)→(Q), (D)→(S)
(3) (A)→(Q), (B)→(R), (C)→(S), (D)→(P)

- (2) (A)→(Q), (B)→(P), (C)→(S), (D)→(R)
(4) (A)→(Q), (B)→(P), (C)→(R), (D)→(S)

16. Among the following compounds, which one is found in RNA?

[JEE(Main) 2019 Online (11-01-19), 4/120]



17. The correct match between Item I and Item II is : [JEE(Main) 2019 Online (11-01-19), 4/120]

Item I	Item II
(A) Ester test	(P) Tyr
(B) Carbylamine test	(Q) Asp
(C) Phthalein dye test	(C) Ser
	(D) Lys

- (1) (A) → (Q); (B) → (S); (C) → (R)
(3) (A) → (R); (B) → (S); (C) → (Q)

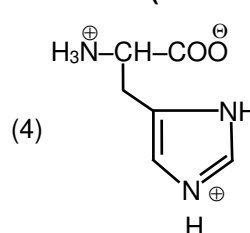
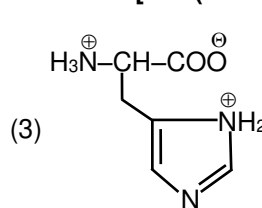
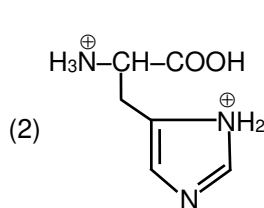
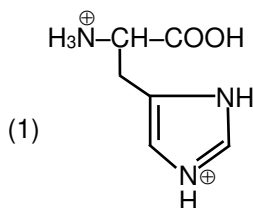
- (2) (A) → (R); (B) → (Q); (C) → (P)
(4) (A) → (Q); (B) → (S); (C) → (P)

18. Among the following compounds most basic amino acid is: [JEE(Main) 2019 Online (12-01-19), 4/120]

- (1) Asparagine (2) Serine (3) Histidine (4) Lysine

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

[JEE(Main) 2019 Online (12-01-19), 4/120]





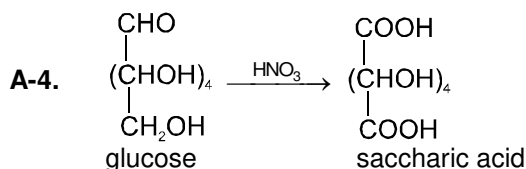
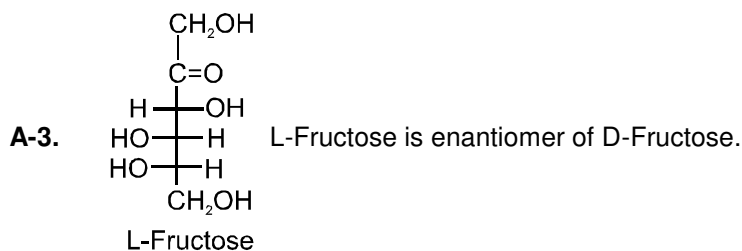
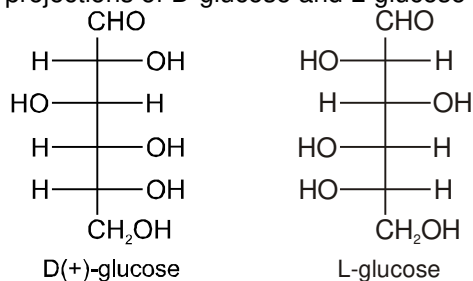
Answers

EXERCISE - 1

PART - I

A-1. Monosaccharide is a carbohydrate that cannot be hydrolysed further to give simpler unit of polyhydroxy aldehyde or ketone.

A-2. Fischer projections of D-glucose and L-glucose are respectively



A-5. (i) Though glucose has aldehyde group, it does not give 2,4-DNP test
 (ii) It does not form hydrogen sulphite addition product
 (iii) The pentacetate of glucose does not react with hydroxyl amine.
 Above facts indicate the absence of free $-\text{CHO}$ group in glucose.

A-6. The spontaneous change in specific rotation of an optically active compound in solution with time, to an equilibrium value, is called mutarotation

A-7. The oxide linkage between two monosaccharides, formed by loss of a water molecule is called glycosidic linkage.

A-8. Those carbohydrates which reduce fehling's solution and tollen's reagents are called reducing sugars.

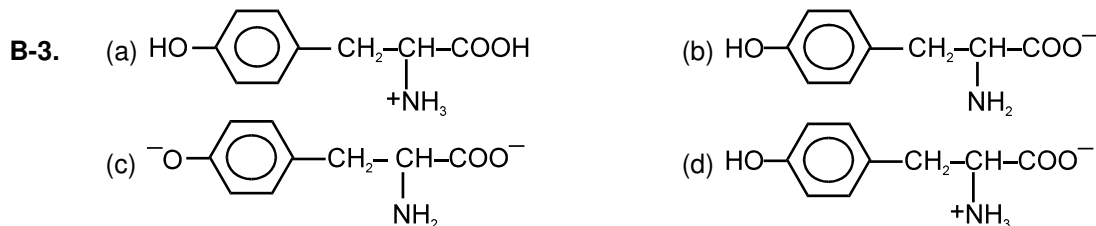
A-9. Glucose and fructose

A-10. Starch has (C_1-C_4) α glycosidic linkage between α -D glucose units, cellulose has (C_1-C_4) β glycosidic linkage between β -D glucose units.

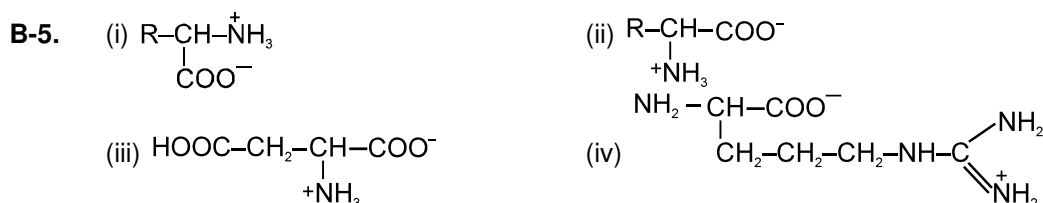
A-11. Glucose has five $-\text{OH}$ groups and sucrose has eight $-\text{OH}$ groups so they can form hydrogen bonding with H_2O molecules, hence soluble in water.



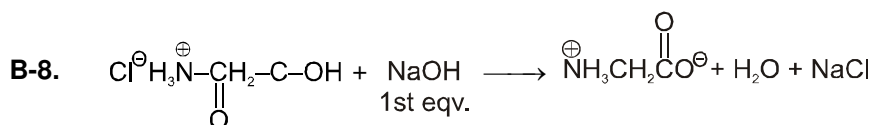
- B-1.** (a) The amino acids which can be synthesised in the body - non-essential ex. Glycine, Alanine.
 (b) The amino acids which cannot be synthesised and must be obtained through diet. ex. valine, leucine.
- B-2.** Due to the presence of both acidic and basic groups in the same molecule. In aqueous solution $-\text{COOH}$ group can lose a proton and $-\text{NH}_2$ group can accept a proton and forms zwitter ion. In zwitter ionic form amino acids show amphoteric behaviour.



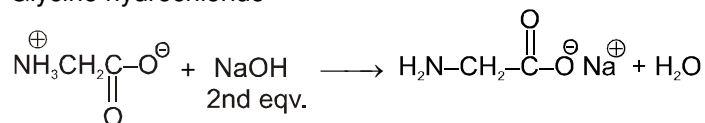
- B-4.** Number of amino groups is more than the number of carboxylic groups.



- B-6.** Due to its existence in the form of zwitter ion, there exist a very strong intermolecular attraction which is responsible for high melting point of amino acid.
- B-7.** Amino acids contain two functional groups which can make H-bonds that is the reason why they have high m.p. and solubility in water.



Glycine hydrochloride



- B-9.** When protein in native form is subjected to a physical change like temperature or pH, the H-bonds are disturbed. As a result globules get unfold and helices get uncoiled therefore proteins loses its activity. During denaturation 2° and 3° structures get destroyed but 1° structure remain the same.
 Ex: Coagulation of egg white on boiling and curdling of milk caused by bacteria present in milk.

PART – II

- | | | | | |
|------------------|------------------|------------------|------------------|------------------|
| A-1. (B) | A-2. (C) | A-3. (D) | A-4. (D) | A-5. (C) |
| A-6. (B) | A-7. (A) | A-8. (C) | A-9. (C) | A-10. (A) |
| B-1. (B) | B-2. (B) | B-3. (A) | B-4. (C) | B-5. (D) |
| B-6. (A) | C-1. (D) | C-2. (A) | C-3. (C) | C-4. (B) |
| C-5. (C) | C-6. (B) | C-7. (C) | C-8. (A) | C-9. (C) |
| C-10. (C) | C-11. (A) | C-12. (D) | C-13. (D) | C-14. (B) |
| C-15. (B) | C-16. (C) | C-17. (B) | C-18. (D) | C-19. (C) |
| C-20. (C) | C-21. (C) | C-22. (C) | C-23. (D) | C-24. (A) |



PART - III

1. $A \rightarrow (p,q) ; B \rightarrow (p,s) ; C \rightarrow (p,r,t) ; D \rightarrow (p,t)$
2. $(A - q,r) ; (B - s) ; (C - q) ; (D - p)$

EXERCISE - 2

PART - I

- | | | | | |
|--------|--------|--------|--------|--------|
| 1. (A) | 2. (B) | 3. (B) | 4. (A) | 5. (D) |
| 6. (C) | 7. (B) | 8. (B) | | |

PART - II

- | | | | | |
|--------------|------|------|------|-------|
| 1. 9 | 2. 3 | 3. 3 | 4. 4 | 5. 32 |
| 6. $2^3 = 8$ | | | | |

PART - III

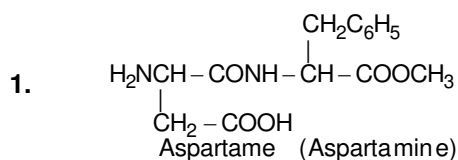
- | | | | | |
|----------|-----------|-----------|---------|---------|
| 1. (ACD) | 2. (AC) | 3. (BC) | 4. (AB) | 5. (BD) |
| 6. (AD) | 7. (ABCD) | 8. (ABCD) | | |

PART - IV

- | | | | | |
|--------|--------|--------|--------|--------|
| 1. (B) | 2. (B) | 3. (C) | 4. (B) | 5. (C) |
|--------|--------|--------|--------|--------|

EXERCISE - 3

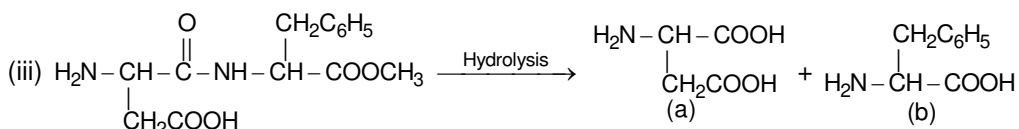
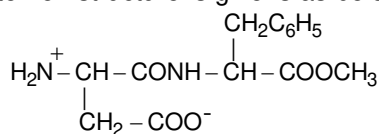
PART - I



- (i) In aspartame four functional groups are present which are
- | | |
|----------------------------|--------------------------------------|
| (a) $-\text{NH}_2$ (Amine) | (b) $-\text{COOH}$ (Carboxylic acid) |
|----------------------------|--------------------------------------|



- (ii) Zwitter ion structure is given as below :

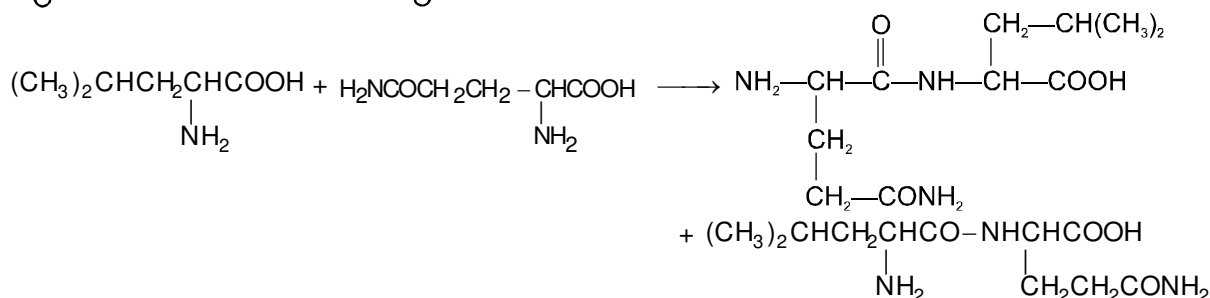
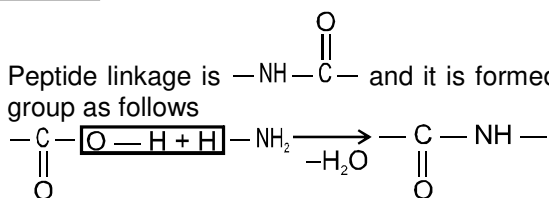


Hence on hydrolysis two amino acid (a) and (b) are obtained.

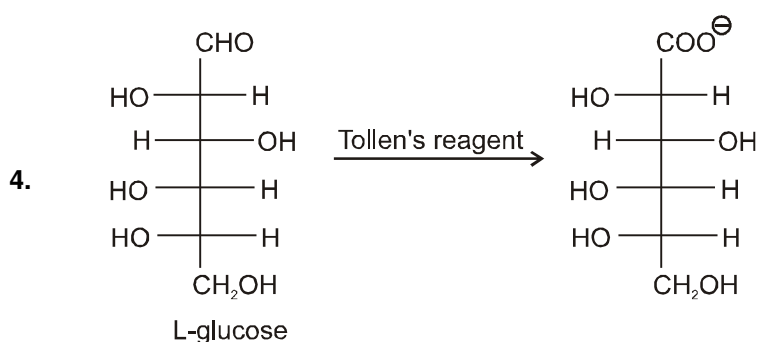
- (iv) In above two amino acids $\begin{array}{c} \text{NH}_2-\text{CH}-\text{COOH} \\ | \\ \text{CH}_2-\text{H}_5\text{C}_6 \end{array}$ is more hydrophobic due to presence of non-polar $\text{C}_6\text{H}_5-\text{CH}_2-$ or benzyl group.



2. Peptide linkage is $-\text{NH}-\overset{\text{O}}{\parallel}{\text{C}}-$ and it is formed by the condensation between $-\text{NH}_2$ group and $-\text{COOH}$ group as follows



3. (B)



5. (B)

6. P is a reducing sugar as one monosaccharide has free reducing group because glycosidic linkage is (1, 4). Whereas in Q both the reducing groups are involved in glycosidic bond formation

- | | | | | |
|-----------------------------------|----------|---------|---------|---------|
| 7. (C) | 8. (BC) | 9. 6 | 10. (B) | 11. 8 |
| 12. 4 [(iv), (vi), (viii) & (ix)] | 13. 4 | 14. 1 | 15. (A) | |
| 16. (C) | 17. (BC) | 18. (A) | 19. (B) | 20. (D) |

PART - II

JEE(MAIN) OFFLINE PROBLEMS

- | | | | | |
|---------|---------|---------|---------|---------|
| 1. (3) | 2. (3) | 3. (3) | 4. (1) | 5. (2) |
| 6. (3) | 7. (2) | 8. (3) | 9. (4) | 10. (2) |
| 11. (3) | 12. (2) | 13. (3) | 14. (3) | 15. (1) |
| 16. (1) | 17. (1) | 18. (2) | 19. (4) | 20. (3) |

JEE(MAIN) ONLINE PROBLEMS

- | | | | | |
|---------|---------|---------|---------|---------|
| 1. (4) | 2. (4) | 3. (1) | 4. (4) | 5. (3) |
| 6. (1) | 7. (4) | 8. (2) | 9. (1) | 10. (3) |
| 11. (4) | 12. (1) | 13. (1) | 14. (2) | 15. (2) |
| 16. (4) | 17. (4) | 18. (4) | 19. (1) | |



Additional Problems for Self Practice (APSP)

This Section is not meant for classroom discussion. It is being given to promote self-study and self testing amongst the Resonance students.

PART - I : PRACTICE TEST-1 (IIT-JEE (MAIN Pattern))

Max. Time : 1 Hr.

Max. Marks : 120

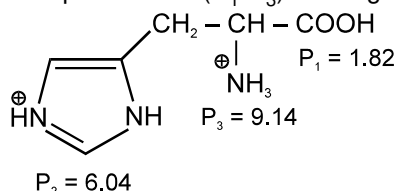
Important Instructions

- The test is of **1 hour** duration.
- The Test Booklet consists of **30** questions. The maximum marks are **120**.
- Each question is allotted **4 (four)** marks for correct response.
- Candidates will be awarded marks as stated above in Instructions No. 3 for correct response of each question. $\frac{1}{4}$ (**one fourth**) marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.
- There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instructions 4 above.

- Glucose on reduction with Na/Hg and water gives ?
(1) Sorbitol (2) Fructose (3) Saccharic acid (4) Gluconic acid
- Glucose or fructose is converted into C_2H_5OH in the presence of ?
(1) Diastase (2) Maltase (3) Invertase (4) Zymase
- Glucose cannot be classified as ?
(1) Hexose (2) Carbohydrate (3) Aldose (4) Oligosaccharide
- The common disaccharide has the molecular formula :
(1) $C_{10}H_{18}O_9$ (2) $C_{10}H_{20}O_{11}$ (3) $C_{18}H_{22}O_{11}$ (4) $C_{12}H_{22}O_{11}$
- Starch is changed into disaccharide in presence of ?
(1) Diastase (2) Maltase (3) Lactase (4) Zymase
- First member of aldose sugar is :
(1) aldotriose (2) aldotetrose (3) aldopentose (4) aldohexose
- How many optically active molecules are possible with structural formula $CH_2OHCHOHCHOHCHOHCHOHCHO$?
(1) 16 (2) 8 (3) 32 (4) 4
- Which carbohydrate is used in silvering of mirror ?
(1) Sucrose (2) Fructose (3) Glucose (4) Starch
- The charring process when $C_6H_{12}O_6$ is heated with conc. H_2SO_4 is due to ?
(1) Oxidation (2) Reduction (3) Dehydration (4) Dehydrogenation
- Which one of the following kinds of bonds are not broken during denaturation of a protein ?
(1) Peptide bond (2) Hydrogen bond (3) Disulphide bond (4) Ionic bond
- A hexapeptide with the composition Arg, Gly, leu, Pro has proline at both C-terminal and N-terminal position. The partial hydrolysis of the hexapeptide gives Gly-Pro-Arg, Arg-Pro, Pro-Leu-Gly.
(1) Pro-Gly-Leu-Pro-Arg-Pro (2) Pro-Leu-Gly-Pro-Arg-Pro
(3) Pro-Leu-Gly-Arg-Pro-Pro (4) Pro-Arg-Pro-Leu-Gly-Pro
- The function of proteins is to act as
(1) Structural materials of animal tissues (2) Enzymes and antibodies
(3) Metabolic regulators (4) All the three above

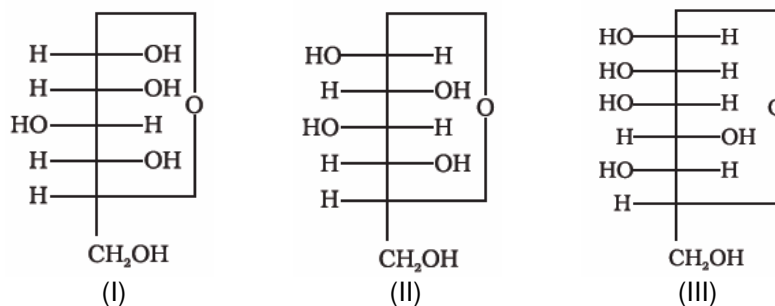


13. Observe the pKa values (P_1 - P_3) of the given amino acid.



Which form of this amino acid will exist in aqueous solution at pH = 8

- (1) as dication (2) as monocation (3) as zwitter ion (4) as monoanion
14. Carbohydrates have not been classified on the basis of :
 (1) sugars and non-sugars (2) reducing character
 (3) optical activity (4) hydrolysis (complexity of structure)
15. Which of the following statements about β -pleated sheet secondary structure of proteins is correct ?
 (1) Parallel β -pleated sheet structure is more stable than the antiparallel sheet structure.
 (2) Antiparallel β -pleated sheet structure is more stable than the parallel sheet structure.
 (3) Both parallel and antiparallel sheet structures have equal stability.
 (4) there is no clear relationship between the two in terms of stability.
16. The two forms of D-Glucopyranose obtained from solution of D-Glucose are known as
 (1) Epimers (2) Anomers (3) Enantiomers (4) Geometrical Isomers
17. Three cyclic structures of monosaccharides are given below which of these are anomers.

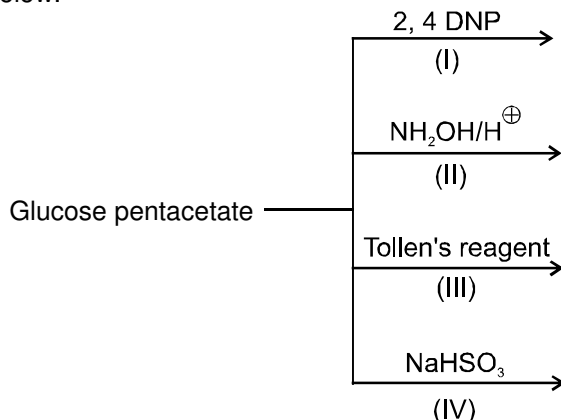


- (1) I and II (2) II and III (3) I and III (4) III is anomer of I and II
18. Glucose and fructose give same type of reactions :
 (1) with bromine water (2) on reduction with Na-Hg/ H_2O
 (3) with Fehling's solution (4) All are correct
19. The protein responsible for blood clotting is :
 (1) Albumins (2) Globulins (3) Fibroin (4) Fibrinogen
20. Hydrolysis of sucrose into (+) glucose and (-) fructose is known as
 (1) Mutarotation (2) Inversion (3) Pyrolysis (4) None of these
21. The term inverted sugar refers to an equimolar mixture of :
 (1) D-Glucose and D-galactose (2) D-Glucose and D-fructose
 (3) D-Glucose and D-mannose (4) D-Glucose and D-ribose
22. Glycoside linkage is
 (1) an acetal linkage (2) an ether linkage
 (3) an ester linkage (4) an amide linkage
23. Sucrose on hydrolysis yields a mixture which is
 (1) optically inactive (2) dextrorotatory (3) laevorotatory (4) racemic
24. Cellulose on hydrolysis yields
 (1) β -D-Fructose (2) α -D-Glucose (3) β -D-Glucose (4) α -D-Fructose



25. Find true and False from the following statements regarding carbohydrates
 S_1 : All monosaccharides whether aldoses or ketoses are reducing sugars.
 S_2 : Bromine water can be used to differentiate between aldoses and ketoses
 S_3 : A pair of diastereomeric aldoses which differ only in configuration at C-2 are anomers.
 S_4 : Osazone formation destroys the configuration at C-2 of an aldose, but does not affect the configuration of the rest of the molecule.
 (1) TTTT (2) TTFT (3) TTFT (4) FTTT

26. Observe the following laboratory tests for glucose pentacetate and mention +ve or -ve from the code given below.



- (1) + + + + (2) - - - - (3) + - + - (4) + + - -

27. The non-protein portion of a protein is called :
 (1) Functional group (2) Characteristic group (3) Prosthetic group (4) Enolic group
28. Glucose and fructose are :
 (1) Optical isomers (2) Tautomers (3) Functional isomers (4) Chain isomers.
29. In a protein molecule various amino acids are linked together by :
 (1) dative bond (2) α -glycosidic bond (3) β -glycosidic bond (4) peptide bond
30. The correct corresponding order of names of four aldoses with configuration given below respectively, is
 (1) D-erythrose, D-threose, L-erythrose, L-threose (2) L-erythrose, L-threose, L-erythrose, D-threose
 (3) D-threose, D-erythrose, L-threose, L-erythrose (4) L-erythrose, L-threose, D-erythrose, D-threose

Practice Test-1 (IIT-JEE (Main Pattern))

OBJECTIVE RESPONSE SHEET (ORS)

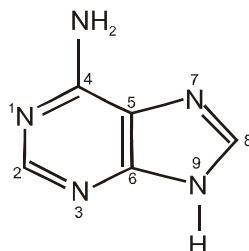
Que.	1	2	3	4	5	6	7	8	9	10
Ans.										
Que.	11	12	13	14	15	16	17	18	19	20
Ans.										
Que.	21	22	23	24	25	26	27	28	29	30
Ans.										


PART - II : NATIONAL STANDARD EXAMINATION IN CHEMISTRY (NSEC) STAGE-I

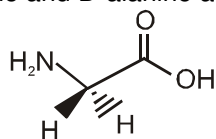
1. Prosthetic group in Glycoprotein is : [NSEC-2001]
(A) vitamins (B) fats (C) carbohydrates (D) nucleic acid
2. The chemical in DNA molecule that could lead to synthesis of protein with an altered amino acid sequence is called [NSEC-2001]
(A) cellular membrane (B) lipid formation (C) replication (D) mutation
3. Formation of peptide bond is accompanied by release of one molecule of [NSEC-2002]
(A) oxygen (B) hydrogen (C) water (D) none of these
4. Amino acid at its isoelectric point when placed in an electric field exhibits which of these properties ? [NSEC-2002]
(A) moves toward cathode (B) moves toward anode
(C) no movement (stationary) (D) none of these
5. The number of hydrogen bonds present in the sequence of a stretch of a double helical DNA 5' ATGCCTAA3' is [NSEC-2003]
(A) 16 (B) 19 (C) 24 (D) 20.
6. Metal ions are known to interact with amino acid residues of proteins. The amino acid with larger number of metal binding sites are [NSEC-2003]
(A) cysteine, alanine (B) methionine, tryptophan
(C) glutamic acid, cysteine (D) arginine, isoleucine.
7. Glycogen, a storage form of carbohydrate, in liver [NSEC-2003]
(A) acts as a reservoir or antioxidant activity (B) helps in digestion by secreting enzymes
(C) acts as a source of energy during starvation (D) acts as a reservoir to neutralise acidic food.
8. One among the following classes of compounds is not a biopolymer [NSEC-2004]
(A) proteins (B) steroids (C) nucleic acids (D) glycogens.
9. Insulin, a hormone secreted by the pancreas is a [NSEC-2004]
(A) carbohydrate (B) steroid (C) protein (D) nucleic acid
10. An enzymatic partial hydrolysis of starch and cellulose give disaccharides maltose and cellobiose respectively. Hence, maltose and cellobiose differ with respect to [NSEC-2004]
(A) molecular mass (B) configuration at the glycoside linkage
(C) placement of the glycoside linkage (D) ring sizes of the constituent sugar residues.
11. The structure representing the Zwitter ion form of glycine is [NSEC-2004]
(A) $\text{CH}_2\text{—COOH}$ (B) $\text{CH}_2\text{—COOH}$ (C) $\text{CH}_2\text{—COO}^-$ (D) $\text{CH}_2\text{—COO}^-$
 | | | |
 NH_2 NH_3^+ NH_3^+ NH_2
12. The simplest carbohydrate capable of exhibiting optical isomerism is [NSEC-2005]
(A) glucose (B) fructose (C) sucrose (D) glyceraldehyde.
13. Long chain fatty acid esters of glycerol may be converted to soap by [NSEC-2005]
(A) trans-esterification (B) reduction (C) acid hydrolysis (D) alkaline hydrolysis
14. Secondary structure of proteins can be destabilized by [NSEC-2005]
(A) treating it with β -mercaptoethanol (B) treating it with iodoacetate
(C) treating it with 0.001 M KCl (D) heat.
15. Tertiary structure of proteins depends on [NSEC-2005]
(A) number and type of amino acids (B) number and sequence of amino acids
(C) type and sequence of amino acids (D) type of amino acids only.
16. The peptide bond in proteins is [NSEC-2005]
(A) planar and usually found in a trans conformation.
(B) planar, but rotates to three preferred dihedral angles.
(C) non-polar and fixed in a trans conformation.
(D) non-polar, but rotates to three preferred dihedral angles.



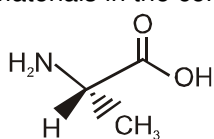
17. The property of replication is associated with (A) RNA and DNA (B) DNA and protein (C) only DNA (D) only RAN. [NSEC-2005]
18. Identify the biomolecules which is not a polymer. (A) glycogen (B) sucrose (C) haemoglobin (D) DNA. [NSEC-2005]
19. Structure of adenine is shown below,



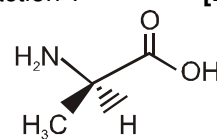
- Nitrogen atoms involved in Watson-Crick base pairing with thymine are (A) N1 and nitrogen of NH_2 (B) N1 and N3 (C) N7 and nitrogen of NH_2 (D) N1 and N9. [NSEC-2006]
20. Test by which starch and cellulose can be distinguished from each other is (A) reducing sugar test (B) analysis of products of hydrolysis (C) iodine test (D) Molisch test. [NSEC-2006]
21. A positive Biuret test confirms the presence of (A) ester (B) carboxylic acid (C) amide (D) amine. [NSEC-2006]
22. Bonds responsible for the helical structure of proteins are (A) peptide bonds (B) hydrophobic interactions (C) intermolecular H bonds (D) intramolecular H bonds [NSEC-2006]
23. Glucose and fructose react with phenylhydrazine to give identical yellow osazones because (A) carbon atoms 3, 4 and 5 in both have same configuration (B) both are hexoses (C) both are reducing sugars (D) all the above. [NSEC-2006]
24. In a nucleoside, nitrogen base is linked to pentose sugar by (A) peptide linkage (B) N-glycosidic linkage (C) phosphodiester bond (D) H-bonds. [NSEC-2006]
25. Which of the following statements is not correct for glycine? (A) It contains amino group. (B) It is a constituent of proteins. (C) It contains a carboxylate group. (D) It is optically active. [NSEC-2006]
26. Which of the following term is applicable for glucose - galactose pair? (A) isomers (B) epimers (C) anomers (D) none of these. [NSEC-2006]
27. What is true about both DNA and RNA? (A) both are genetic materials (B) both have same nitrogen bases (C) both have located inside cell (D) both have hydrogen bonds to stabilize its secondary structure. [NSEC-2006]
28. When an α -amino acid contains a substituent, there is possibility of optical isomers. For example, L-alanine and D-alanine are two enantiomers. What is the number of all possible linear tripeptides (repetitions of amino acids permitted) that can be formed from the following three amino acids: glycine, L-alanine and D-alanine as the starting materials in the condensation reaction ? [NSEC-2006]



glycine(Gly)



L-alanine(L-Ala)



D-alanine(D-Ala)

(A) 3C_2

(B) 3!

(C) 8

(D) 27.

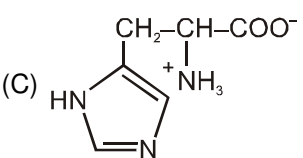


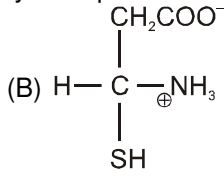


29. Titration of the amino acid lysine has three pK_a values viz., pK_{a1} (2.18), pK_{a2} (8.95) and pK_{a3} (10.53). The pH at which this amino acid will show no net migration in an electric field is [NSEC-2007]
(A) 5.57 (B) 9.74 (C) 6.35 (D) 7.22
30. Proteins present inside the cell membrane are stabilized by [NSEC-2007]
(A) hydrogen bond (B) disulfide bond (C) hydrophobic force (D) phospho-diester bond
31. The amino acid prolin allows bending of a polypeptide in secondary structure of protein. This is possible due to [NSEC-2008]
(A) Presence of peptide bond (B) Absence of hydrogen bond
(C) Presence of hydrogen bond (D) Steric hindrance
32. Which of the amino acid stabilizes tertiary structure of protein through formation of covalent bond ? [NSEC-2008]
(A) Tyrosine (B) Methionine (C) Cysteine (D) Valine
33. A mixture of three amino acids glycine (Gly), lysine (Lys) and glutamic acid (Glu) was separated by an anion exchange chromatography process. The order of elution of amino acids from the column is [NSEC-2008]
(A) Glu, Lys, Gly (B) Lys, Glu, Gly (C) Gly, Lys, Glu (D) Glu, Gly, Lys
34. Ten DNA molecules undergo replication 2 times. The total number DNA molecules produced are : [NSEC-2008]
(A) 10 (B) 20 (C) 30 (D) 40
35. Enzymatic hydrolysis of starch leads to release of [NSEC-2008]
(A) Fructose (B) Mannose (C) Glucose (D) Xylose
36. During alcoholic fermentation of sugars, the enzyme which converts glucose (or fructose) into ethanol is: [NSEC-2009]
(A) zymase (B) invertase (C) maltase (D) urease
37. The nucleic acid which bears a condon in its structure is – [NSEC-2009]
(A) r-RNA (B) t-RNA (C) m-RNA (D) DNA
38. Protein synthesis does not involve – [NSEC-2009]
(A) ammino acids (B) t-RNA (C) m-RNA (D) DNA
39. The most likely change occurring in a protein sample when treated with 6 M HCl is – [NSEC-2009]
(A) formation of disulphide bond (B) formation of peptide bond
(C) hydrolysis of peptide bond (D) oxidation of disulphide bond
40. The order of the energy released by biological oxidation of equal amounts (moles) of glucose, sucrose and starch is – [NSEC-2009]
(A) starch > sucrose > glucose (B) starch > glucose > sucrose
(C) sucrose > glucose > starch (D) glucose > sucrose > starch
41. Enzymatic breakdown of cellulose will yield monomers of – [NSEC-2009]
(A) Galactose (B) Glucose (C) Fructose (D) Ribose
42. The trend of isoelectric point (pI) of the amino acids glycine, lysine and aspartic acid is – [NSEC-2009]
(A) glycine > lysine > aspartic acid (B) aspartic acid > lysine > glycine
(C) aspartic acid > glycine > lysine (D) lysine > aspartic acid > glycine
43. The chemical substance which can be used to isolate a protein present inside the cell membrane is – [NSEC-2009]
(A) Chelating agent (B) Dilute acid (C) Detergent (D) Urea solution
44. The chemical force playing an important role in binding of codon to anticodon is – [NSEC-2009]
(A) covalent bond (B) co-ordinate bond (C) hydrogen bond (D) hydrophobic bond
45. In a DNA molecule [NSEC-2010]
(A) $A = C$ (B) $A + G = C + T$ (C) $T = G$ (D) $A/T = 2$



46. When an apple is cut, the exposed part begins to turn brown. Often the browning action can be arrested by adding a few drops of lemon juice to the exposed area. The basis for this treatment is: [NSEC-2010]
 (A) lemon juice is an antioxidant.
 (B) denaturation of proteins of the enzymes.
 (C) decolourization due to lemon juice.
 (D) activation of decolourizing enzymes under acidic medium.
47. A nonapeptide in rat on hydrolysis gave the following identifiable tripeptides: [NSEC-2010]
 Gly-Ala-Phe, Ala-Leu-Val, Gly-Ala-Leu, Phe-Glu-His, and His-Gly-Ala.
 The sequence of the nonapeptide is
 (A) Gly-Ala-Leu-Val-Phe-Glu-His-His-Gly (B) Ala-Phe-Leu-Val-Gly-Leu-Phe-Glu-His
 (C) Gly-Ala-Phe-Glu-His-Gly-Ala-Leu-Val (D) Phe-Ala-Leu-Val-Gly-Glu-His-Gly-Ala
48. Denaturation of protein due to change in pH could be due to [NSEC-2011]
 (A) loss of van der Waal's interaction (B) hydrophobic interaction
 (C) change in ionic interaction (D) breaking of covalent bonds
49. If titration of an amino acid present in the solution yielded pI (isoelectric point) value of 10.80, the amino acid present in the solution may be [NSEC-2011]
 (A) glycine (B) arginine (C) histidine (D) prolin
50. Semipermeable nature of the cell membrane can be attributed to the presence of [NSEC-2011]
 (A) protein and DNA (B) lipid and protein
 (C) polysaccharide and lipid (D) DNA and lipid
51. Secondary structures could be formed in nucleic acid similar to protein due to formation of : [NSEC-2011]
 (A) covalent bond (B) ionic bond (C) co-ordinate bond (D) hydrogen bond
52. α -D(+) glucose and β -D(+) glucose are [NSEC-2012]
 (A) Enantiomers (B) Geometrical isomers
 (C) Epimers (D) Anomers
53. The genetic material of a cell is made of [NSEC-2012]
 (A) nucleic acids (B) proteins (C) carbohydrates (D) fats
54. The amino acid that cannot be obtained by hydrolysis of protein is [NSEC-2012]
- (A) $\text{HOOCCH}_2\text{CH}(\text{NH}_3^+)\text{COO}^-$

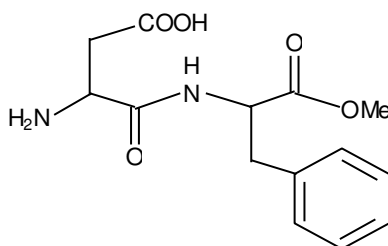
(C) 

(B) 

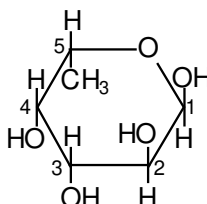
(D) $\text{NH}_3^+(\text{CH}_2)_4\text{CH}(\text{NH}_2)\text{COO}^-$
55. Protein and DNA being charged molecule, can be separated by [NSEC-2012]
 (A) Electrophoresis (B) Centrifugation (C) Filtration (D) Spectrophotometry
56. The biomolecule which does not have a secondary structure is [NSEC-2012]
 (A) Protein (B) Lipid (C) DNA (D) RNA
57. What is NOT true for both cellulose and DNA? [NSEC-2013]
 (A) Both are long chain polymers (B) Both contains similar monomers
 (C) Both have glycosidic Linkages (D) Both can break down by enzymatic hydrolysis
58. How much chemical energy is fixed in the form of ATP upon complete oxidation of one mole of glucose ? (Hydrolysis of ATP yields 7.5 kcal/mole) [NSEC-2013]
 (A) 360 (B) 300 (C) 270 (D) 200
59. In animals, the stored carbohydrates is [NSEC-2013]
 (A) Starch (B) Glycogen (C) Sucrose (D) Fructan



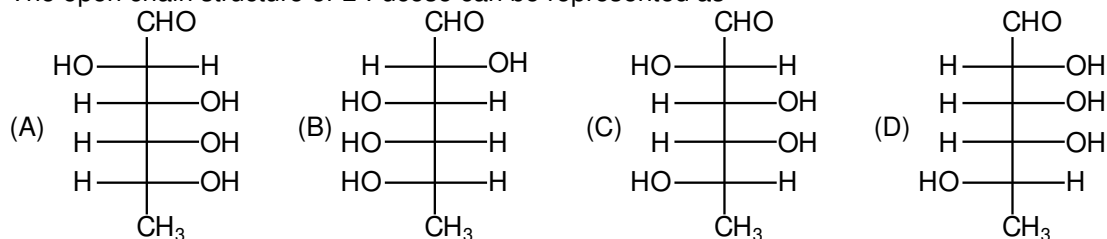
60. The isoelectric point of an amino acid is : [NSEC-2013]
 (A) The pH at which it exists in the acidic form (B) The pH at which exists in the basic form
 (C) The pH at which it exists in the Zwitterion form (D) The pH which is equal to its pK_a value
61. The minimum number of H^+ ions that can be released by an amino acid is [NSEC-2013]
 (A) 1 (B) 2 (C) 3 (D) 4
62. Amylose and cellulose are polymers of glucose in which glucose units are joined to each other respectively by linkages of the type [NSEC-2014]
 (A) α, β (B) β, β (C) β, α (D) $\alpha\beta, \beta$
63. 50 g of sucrose is hydrolysed to a mixture of glucose and fructose. Sucrose is dextrorotatory, however the mixture formed is laevorotatory. This is because [NSEC-2014]
 (A) more amount of β -D-fructose is formed than that of β -D-glucose
 (B) β -D-glucose undergoes inversion of configuration
 (C) β -D-fructose and β -D-glucose undergo inversion to their α -anomers
 (D) laevorotation of β -D-fructose is more than dextrorotation of β -D-glucose.
64. The sugars that are produced on hydrolysis of DNA and RNA are [NSEC-2014]
 (A) epimers (B) two different sugars (C) positional isomers (D) diastereomers
65. Many protein-based biomaterials, such as waste hair and feathers, can absorb heavy metal ions from wastewater. It has been observed that metal uptake by these materials increases in alkaline condition. The enhanced uptake in alkaline conditions is due to [NSEC-2015]
 (A) generation of many ligand sites in the protein molecules due to removal of H^+
 (B) availability of a high concentration of OH^- ions as ligands
 (C) Increased cross – linkages in the protein chains by formation of amide bonds
 (D) increase in solubility of the proteins
66. Aspartame (X) is an artificial sweetening agent and is 200 times sweeter than sugar. It is an ester of the dipeptide of : [NSEC-2016]



- (A) alanine and phenylalanine (B) aspartic acid and alanine
 (C) phenylalanine and glycine (D) aspartic acid and phenylalanine
67. L-Fucose with the following planar representation is a sugar component of the determinants of the A, B, O blood group typing [NSEC-2016]



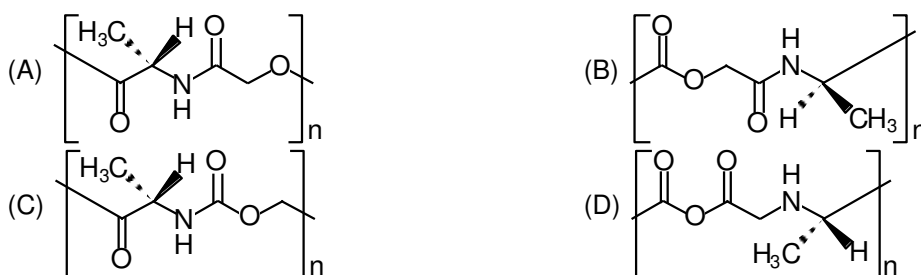
The open chain structure of L-Fucose can be represented as





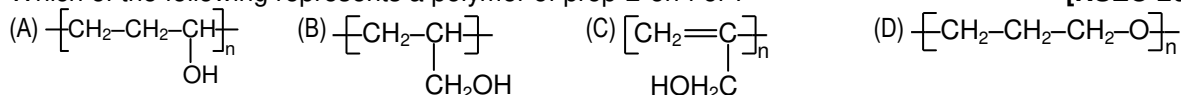
68. A biodegradable alternating copolymer of L-alanine and glycolic acid ($\text{HO}-\text{CH}_2-\text{COOH}$) is :

[NSEC-2016]



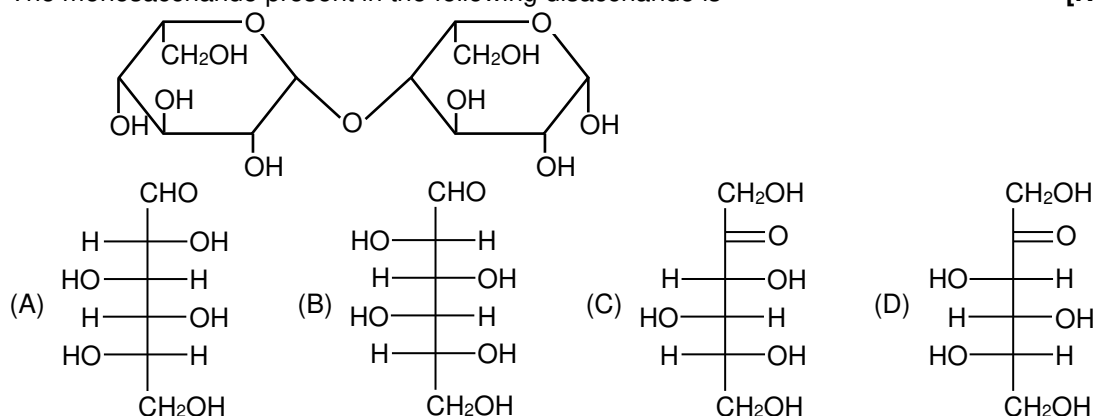
69. Which of the following represents a polymer of prop-2-en-1-ol ?

[NSEC-2017]



70. The monosaccharide present in the following disaccharide is

[NSEC-2018]



PART - III : PRACTICE TEST-2 (IIT-JEE (ADVANCED Pattern))

Max. Time : 1 Hr.

Max. Marks : 54

Important Instructions

A. General :

- The test is of 1 hour duration.
- The Test Booklet consists of 18 questions. The maximum marks are 54.

B. Question Paper Format

- Each part consists of five sections.
- Section-1 contains 7 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONE is correct.
- Section-2 contains 5 multiple choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONE OR MORE THAN ONE are correct.
- Section-3 contains 2 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9 (both inclusive).
- Section-4 contains 1 paragraphs each describing theory, experiment and data etc. 3 questions relate to paragraph. Each question pertaining to a particular passage should have only one correct answer among the four given choices (A), (B), (C) and (D).
- Section-5 contains 1 multiple choice questions. Question has two lists (list-1 : P, Q, R and S; List-2 : 1, 2, 3 and 4). The options for the correct match are provided as (A), (B), (C) and (D) out of which ONLY ONE is correct.

C. Marking Scheme

- For each question in Section 1, 4 and 5 you will be awarded 3 marks if you darken the bubble corresponding to the correct answer and zero mark if no bubble is darkened. In all other cases, minus one (-1) mark will be awarded.



10. For each question in Section 2, you will be awarded 3 marks. If you darken all the bubble(s) corresponding to the correct answer(s) and zero mark. If no bubbles are darkened. No negative marks will be answered for incorrect answer in this section.
11. For each question in Section 3, you will be awarded 3 marks if you darken only the bubble corresponding to the correct answer and zero mark if no bubble is darkened. No negative marks will be awarded for incorrect answer in this section.

SECTION-1 : (Only One option correct Type)

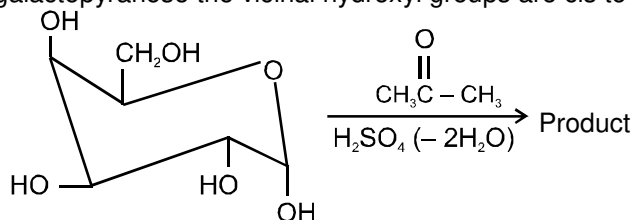
This section contains 7 multiple choice questions. Each questions has four choices (A), (B), (C) and (D) out of which Only ONE option is correct.

1. Two hexoses form the same osazone. Find the correct statement about these hexoses.
 (A) Both of them must be aldoses
 (B) They are epimers at C-3
 (C) The carbon atoms 1 and 2 in both have the same configuration
 (D) The carbon atoms 3, 4 and 5 in both have the same configuration
2. Consider following reagent :
 I. Br₂ water II. Tollen's reagent III. Fehling's solution
 which can be used to make distinction between an aldose and a ketose ?
 (A) I, II and III (B) II and III (C) I only (D) II only
3. Alanine $\text{CH}_3\text{-CH}(\text{NH}_2)\text{-COOH}$ in aqueous solution is found as $\text{CH}_3\text{-CH}(\text{NH}_3^+)\text{-COO}^-$, then Tryptophan $\text{CH}_2(\text{Indol-3-yl})\text{-CH}(\text{NH}_2)\text{-COOH}$ and Aspartic acid $\text{HO-C(=O)-CH}_2\text{-CH}(\text{NH}_2)\text{-COOH}$ is found in neutral aqueous solution as
- (A) $\text{CH}_2(\text{Indol-3-yl})\text{-CH}(\text{NH}_2)\text{-COOH}$ and $\text{HO-C(=O)-CH}_2\text{-CH}(\text{NH}_2)\text{-COOH}$
- (B) $\text{CH}_2(\text{Indol-3-yl})\text{-CH}(\text{NH}_2)\text{-COO}^-$ and $\text{HO-C(=O)-CH}_2\text{-CH}(\text{NH}_3^+)\text{-COO}^-$
- (C) $\text{CH}_2(\text{Indol-3-yl})\text{-CH}(\text{NH}_3^+)\text{-COO}^-$ and $\text{HO-C(=O)-CH}_2\text{-CH}(\text{NH}_3^+)\text{-COO}^-$
- (D) $\text{CH}_2(\text{Indol-3-yl})\text{-CH}(\text{NH}_3^+)\text{-COO}^-$ and $\text{O}^-\text{-C(=O)-CH}_2\text{-CH}(\text{NH}_3^+)\text{-COO}^-$



4. $\text{CH}_3 - \overset{\text{NH}_2}{\underset{|}{\text{CH}}} - \text{COOH} \xrightarrow{(\text{X})} \text{CH}_3 - \overset{\text{NH}_2}{\underset{|}{\text{CH}}} - \text{CH}_2\text{OH}$
 The reagent (X) can be :
 (A) $\text{H}_2 / \text{Pd/BaSO}_4/\text{quinoline}$ (B) NaBH_4 (C) LiAlH_4 (D) CH_3MgI

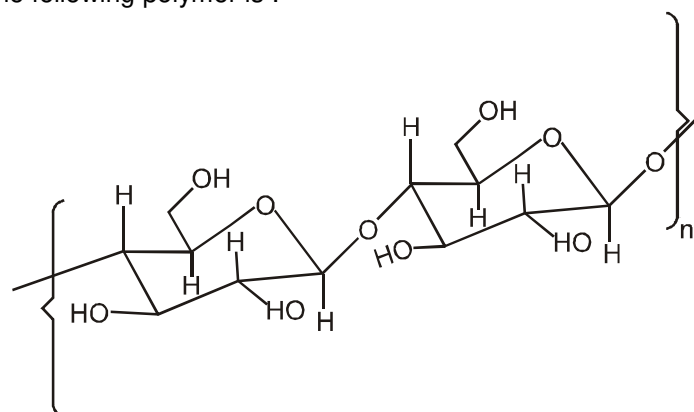
5. In α -D-galactopyranose the vicinal hydroxyl groups are cis to each other -



The product may be :

- (A) (B)
 (C) CH_3COOH (D) $\text{CH}_3 - \underset{\text{OH}}{\text{CH}} - \text{CH}_3$

6. The structure of the following polymer is :



- (A) Starch (B) Sucrose (C) Cellulose (D) Maltose
7. It is best to carry out reaction with sugars in neutral or acidic medium and not in alkaline medium because in alkaline medium sugars undergo ?
 (A) Racemisation (B) Decomposition (C) Inversion (D) Rearrangement

Section-2 : (One or More than one options correct Type)

This section contains 5 multipole choice questions. Each question has four choices (A), (B), (C) and (D) out of which ONE or MORE THAN ONE are correct.

8. The correct statement(s) about starch :
 (A) It is a pure single compound.
 (B) It is a mixture of two polysaccharides of glucose.
 (C) It involves the $(\text{C}_1 - \text{C}_4)$ α - glycosidic linkage between two α - D glucose units.
 (D) It involves branching by $(\text{C}_1 - \text{C}_6)$ glycosidic linkage.



9. Which of the following pairs is (are) correctly matched ?
 (A) α -D (+) glucose and β -D(+) glucose \rightarrow C-2 epimers
 (B) Glucose and fructose \rightarrow C-3 epimers
 (C) Glucose \rightarrow mutarotation
 (D) Sucrose \rightarrow Glucose + fructose
10. D-Glucose and D-Mannose are :
 (A) Anomers (B) Enantiomers (C) Geometrical Isomers (D) Epimers
11. The correct structure of glycine at given pH are :
 (A) $\text{H}_3\text{N}^+\text{CH}_2\text{C}(=\text{O})\text{OH}$ at pH = 2.0 (B) $\text{H}_3\text{N}^+\text{CH}_2\text{C}(=\text{O})\text{O}^-$ at pH = 6.0
 (C) $\text{H}_2\text{NCH}_2\text{C}(=\text{O})\text{O}^-$ at pH = 9 (D) $\text{H}_2\text{NCH}_2\text{C}(=\text{O})\text{OH}$ at pH = 12
12. The correct statements about anomers are :
 (A) Anomers have different stereochemistry at C-1 (anomeric carbon).
 (B) α -D-glucopyranose and β -D-glucopyranose are anomers.
 (C) Both anomers of D-glucopyranose can be crystallised and purified.
 (D) When pure α -D-glucopyranose is dissolved in water its optical rotation slowly changes.

Section-3 : (One Integer Value Correct Type.)

This section contains 2 questions. Each question, when worked out will result in one integer from 0 to 9 (both inclusive)

13. For Aspartic acid $\left[\text{HO}-\overset{\text{C}}{\parallel}-\text{CH}_2-\underset{\substack{+\text{NH}_3 \\ \text{PK}_{a3}}}{\text{CH}}-\overset{\text{O}}{\parallel}-\text{C}-\text{OH} \right]$, the pK_{a1} , pK_{a2} and pK_{a3} are 2, 4 and 10 respectively
 and for Arginine $\text{NH}_2-\underset{\substack{\text{NH}_2+\text{PK}_{a3}}{\parallel}}{\text{C}}-\text{NH}-\text{CH}_2-\text{CH}_2-\underset{\substack{+\text{NH}_3 \\ \text{PK}_{a2}}}{\text{CH}}-\overset{\text{O}}{\parallel}-\text{C}-\text{OH}$, the pK_{a1} , pK_{a2} and pK_{a3} are 2, 9 and 13 respectively. If pI of aspartic acid is x and of arginine is y then x + y is :
14. Allose and Glucose are isomeric structures with similar structural formula but different configurations. If D-Allose and (L)-Glucose differs in configuration along C_i no. of carbons ($C_i = C_1, C_2, C_3, \dots$), then $\sum C_i$ is

SECTION-4 : Comprehension Type (Only One options correct)

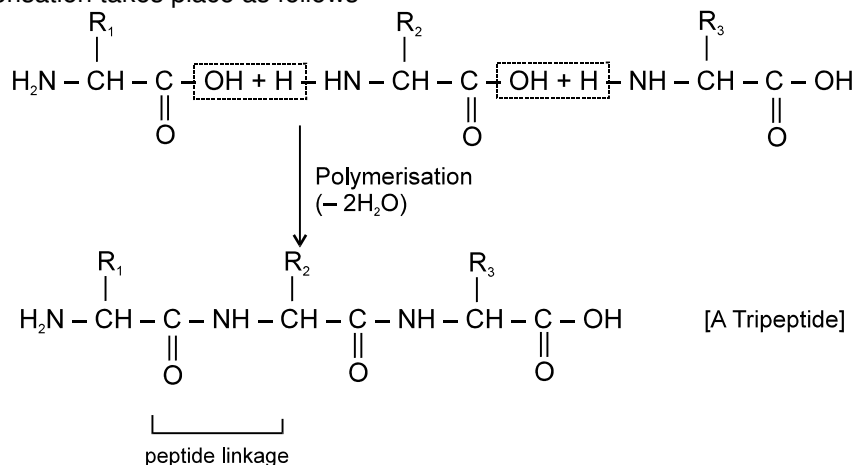
This section contains 1 paragraphs, each describing theory, experiments, data etc. 3 questions relate to the paragraph. Each question has only one correct answer among the four given options (A), (B), (C) and (D)

Paragraph For Questions 15 to 17

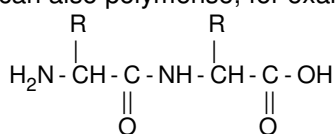
Proteins are biomolecules composed of α -amino acids. An α -amino acid has a general formula $\text{R}-\underset{\substack{| \\ \text{NH}_2}}{\text{CH}}-\text{COOH}$. The amino acids polymerise and form an amide linkage (peptide linkage) between two monomeric amino acid units.



The polymerisation takes place as follows



Two or more similar amino acids can also polymerise, for example a dimer will be like

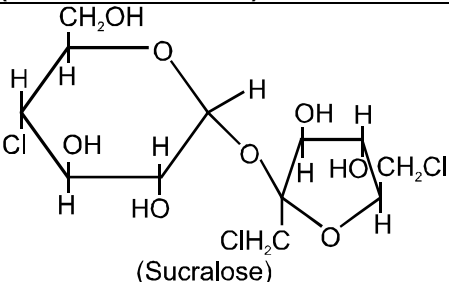


15. In the above trimer, if $R_1 = H$; $R_2 = CH_3$ & $R_3 = Ph$ then total number of optically active stereoisomers will be :
 (A) 8 (B) 6 (C) 4 (D) 2
16. In the given trimer if $R_1 = H$; $R_2 = CH_3$ and $R_3 = CH_2Ph$ then the amino acids present in the trimer are :
 (A) Glycine, Alanine & Phenyl Alanine
 (B) Glycine, Leucine & Phenyl Alanine
 (C) Alanine, Valine & Phenyl Alanine
 (D) Alanine, Leucine & Lysine
17. Which statement is incorrect about the given trimer.
 (A) it will liberate CO_2 with $NaHCO_3$.
 (B) It will liberate N_2 with $NaNO_2 / HCl$
 (C) It will give yellow precipitate with 2, 4-Dinitrophenylhydrazine
 (D) It will rotate plane polarized light.

SECTION-5 : Matching List Type (Only One options correct)

This section contains 1 questions, each having two matching lists. Choices for the correct combination of elements from List-I and List-II are given as options (A), (B), (C) and (D) out of which one is correct

18. Match the Following :

	Column I (Artificial sweetners)		Column II (Characteristics)
(P)	 <p>(Sucralose)</p>	(1)	A derivative of dipeptide



(Q)	$ \begin{array}{ccccccc} & \text{O} & \text{H} & \text{H} & \text{O} & \text{H} & \text{H} & \text{O} \\ & \parallel & & & \parallel & & & \parallel \\ \text{HO} & - \text{C} & - \text{C} & - \text{C} & - \text{C} & - \text{N} & - \text{C} & - \text{C} - \text{OCH}_3 \\ & & & & & & & \\ & & \text{H} & \text{NH}_2 & & \text{H} & \text{C} & \\ & & & & & & & \\ & & & & & & \text{C}_6\text{H}_5 & \\ & & & & & & \text{(Aspartame)} & \end{array} $	(2)	A derivative of disaccharide
(R)	$ \begin{array}{c} \text{COOH} \\ \\ \text{H} - \text{C} - \text{OH} \\ \\ \text{HO} - \text{C} - \text{H} \\ \\ \text{HO} - \text{C} - \text{H} \\ \\ \text{H} - \text{C} - \text{OH} \\ \\ \text{COOH} \\ \text{(Galactonic)} \\ \text{(Aldaric acid)} \end{array} $	(3)	Reduction product of an aldopentose
(S)	$ \begin{array}{c} \text{CH}_2\text{OH} \\ \\ \text{H} - \text{C} - \text{OH} \\ \\ \text{HO} - \text{C} - \text{H} \\ \\ \text{H} - \text{C} - \text{HO} \\ \\ \text{CH}_2\text{OH} \\ \text{(Xylitol)} \end{array} $	(4)	Oxidation product of aldohexose

Code :

	P	Q	R	S		P	Q	R	S
(A)	2	1	4	3	(B)	1	2	4	3
(C)	3	1	2	4	(D)	2	3	1	4

Practice Test-2 ((IIT-JEE (ADVANCED Pattern))
OBJECTIVE RESPONSE SHEET (ORS)

Que.	1	2	3	4	5	6	7	8	9	10
Ans.										
Que.	11	12	13	14	15	16	17	18		
Ans.										



APSP Answers

PART - I

1.	(1)	2.	(4)	3.	(4)	4.	(4)	5.	(1)
6.	(1)	7.	(1)	8.	(3)	9.	(3)	10.	(1)
11.	(2)	12.	(4)	13.	(3)	14.	(3)	15.	(3)
16.	(2)	17.	(1)	18.	(3)	19.	(4)	20.	(2)
21.	(2)	22.	(1)	23.	(3)	24.	(3)	25.	(3)
26.	(2)	27.	(3)	28.	(3)	29.	(4)	30.	(1)

PART - II

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

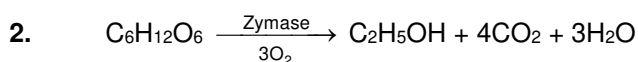
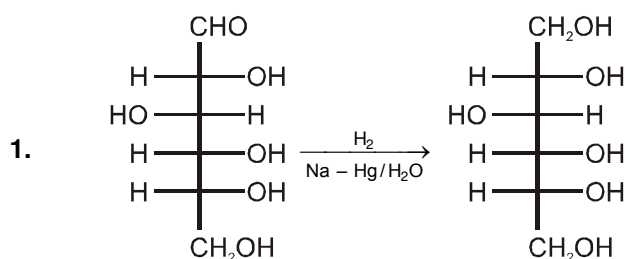
PART - III

1.	(D)	2.	(C)	3.	(D)	4.	(C)	5.	(A)
6.	(C)	7.	(D)	8.	(BCD)	9.	(CD)	10.	(D)
11.	(ABC)	12.	(ABCD)	13.	14	14.	11	15.	(C)
16.	(A)	17.	(C)	18.	(A)				

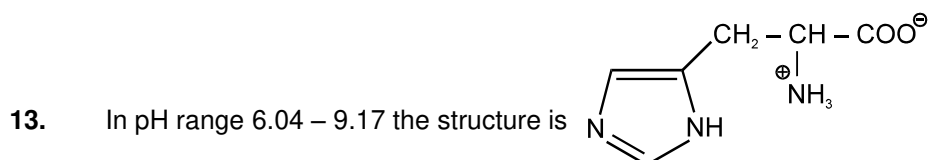


APSP Solutions

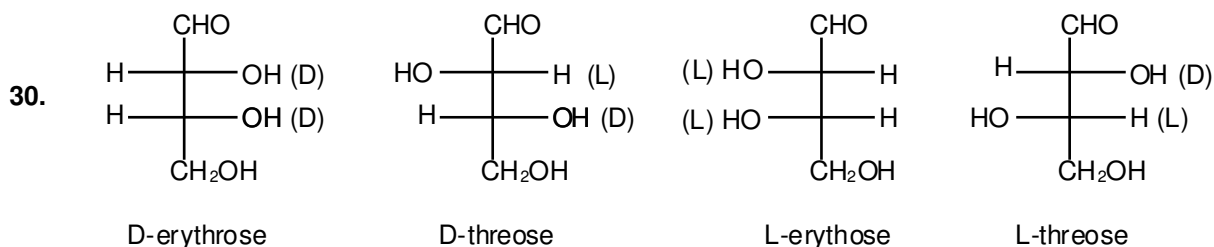
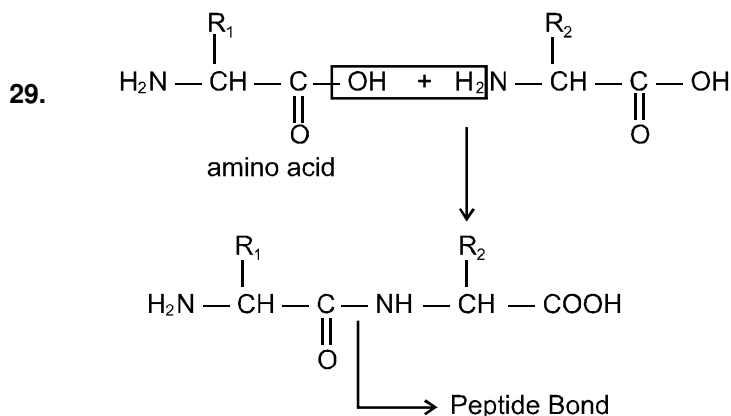
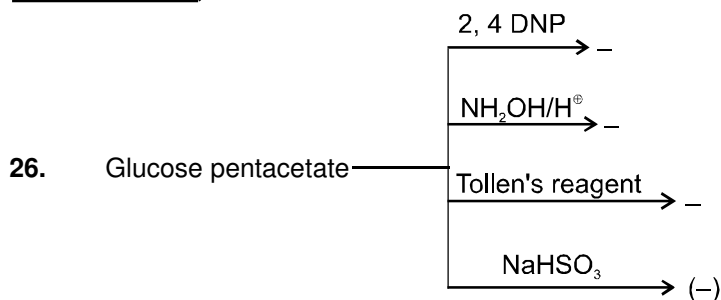
PART - I



3. Glucose is a monosaccharide where as oligosaccharides are those which have 2-10 monosaccharide units
4. Commonest disaccharide (sucrose) has molecular formula $\text{C}_{12}\text{H}_{22}\text{O}_{11}$.
5. Starch is hydrolysed by the enzyme diastase (also called β -amylase) to maltose
7. Total no. of optical isomers $= 2^4 = 16$
8. Glucose contain - CHO group so used for silvering of mirror.
9. Glucose is a hydrate of carbon $\text{C}_6(\text{H}_2\text{O})_6$ and dehydration on heating with conc, H_2SO_4
10. Factual
12. Self explanatory.



14. Carbohydrates have been classified on the basis of sugars and non-sugars, reducing character, hydrolysis (complexity of structure).
16. α -D-Glucopyranose and β -D-Glucopyranose are anomers.
18. Glucose and fructose both reduce fehling's solution.
19. Fibrinogen is protein responsible for blood clotting.
20. Hydrolysis of sucrose (dextrorotatory) into (+) glucose and (–) fructose gives overall levorotatory mixture of products, hence the process is known as "inversion of sugar".
21. Inverted sugar is 1 : 1 mixture of glucose and fructose.
22. Glycosidic linkage is an acetal linkage as it connects two (hemiacetal) monosaccharide units.
23. Sucrose \longrightarrow Glucose + Fructose
 $+ 65^\circ \quad + 52.5^\circ \quad - 90^\circ$
 the product mixture is overall leavorotatory.
24. Cellulose on hydrolysis yields β -D-glucose, because β -D-glucose units are polymerised in cellulose.
25. S_1 , S_2 and S_4 are correct. S_3 is incorrect because anomers are those which have difference in configuration at C-1.



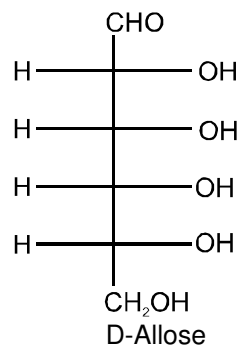
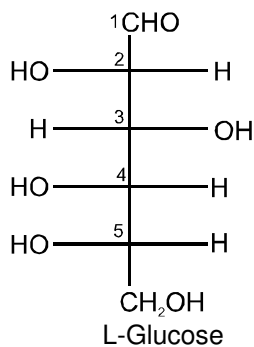
PART - III

- In the formation of osazone C-1 and C-2 react with phenyl hydrazine to form phenyl hydrazone. If C-3, C-4, C-5 have same configuration the carbohydrates will form same osazone even if they differ in configuration at C-1 or C-2.
- Tollen's reagent and fehling's solution can not be used to distinguish between aldose and ketose
- $$\begin{array}{c} \text{NH}_2 \\ | \\ \text{CH}_3 - \text{CH} - \text{COOH} \end{array} \xrightarrow{\text{LiAlH}_4} \begin{array}{c} \text{NH}_2 \\ | \\ \text{CH}_3 - \text{CH} - \text{CH}_2\text{OH} \end{array}$$
 hence X is LiAlH_4
- Cyclic acetals are commonly used to protect vicinal cis hydroxyl groups of sugars while reactions are carried out on the other parts of the molecule.
- In alkaline medium sugar undergo rearrangement
- Starch is the mixture of two polysaccharides - Amylose and amylopectin
- Glucose shows mutarotation, sucrose gives glucose and fructose on hydrolysis.
- At acidic pH, glycine will convert to cation and at basic pH glycine will convert to anion.
- Carbohydrate having different stereochemistry at C-1 are termed as Anomers, whereas when stereochemistry at any other carbon is different then those carbohydrates are known as epimers.
- $$x = \frac{2+4}{2} = 3 \quad ; \quad y = \frac{9+13}{2} = 11$$

$$x + y = 14.$$



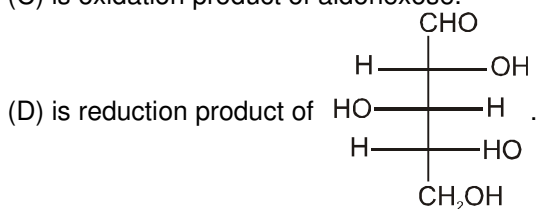
14. D-Allose and L-Glucose differ in configuration along C_2 , C_4 and C_5 therefore $\sum C_i = 2 + 4 + 5 = 11$.



15. The trimer will have structure $\text{H}_2\text{N} - \text{CH}_2 - \text{C}(=\text{O}) - \text{NH} - \overset{\text{CH}_3}{\underset{*}{\text{CH}}} - \text{C}(=\text{O}) - \text{NH} - \overset{\text{Ph}}{\underset{*}{\text{CH}}} - \text{C}(=\text{O}) - \text{OH}$. It has two dissimilar asymmetric atoms, so its total number of stereoisomers will be $2^2 = 4$.

17. The trimer is chiral, it has free COOH group and free primary NH_2 group, so statement A, B, D are correct. It does not have $\text{C} = \text{O}$ group.

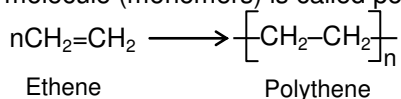
18. (A) has one acetal linkage thus is a disaccharide.
 (B) has one amide linkage.
 (C) is oxidation product of aldohexose.





Polymers

Polymers are very high molecular mass substances where each molecule is derived from very large number of simple molecules joined together in a regular way. Polymers are formed by repeated combination of simplest units called monomers and the process of formation of polymers from simple molecule (monomers) is called polymerization.

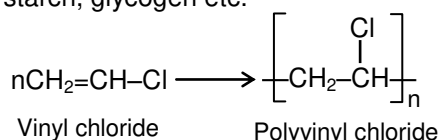


Polymers can be classified in following ways :

(A) Classification based on type of monomer units :

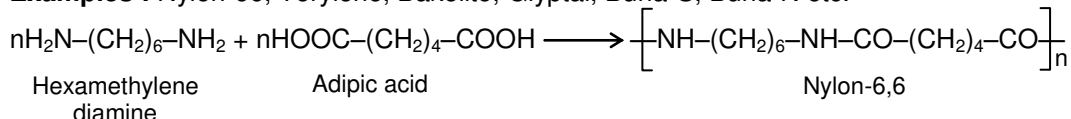
(i) **Homopolymers** : Polymers in which repeating structural units are derived from only one type of monomer units are called homopolymers.

Examples: Polyethylene, polyvinyl chloride (PVC), polyisoprene, neoprene (polychloroprene) polyacrylonitrile (PAN), nylon-6, polybutadiene, teflon (polytetrafluoroethylene), cellulose, starch, glycogen etc.



(ii) **Copolymers** : Polymers in which repeating structural units are derived from two or more types of monomer units are called copolymers.

Examples : Nylon-66, Terylene, Bakelite, Glyptal, Buna-S, Buna-N etc.

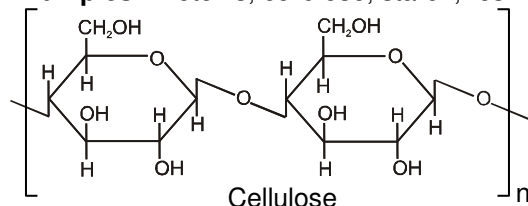


Nylon - Polymers which have amide linkage.

(B) Classification based on source of origin :

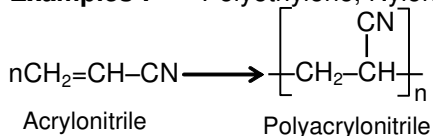
(i) **Natural polymers** : These polymers are found in plants and animals.

Examples: Proteins, cellulose, starch, resins and rubber.

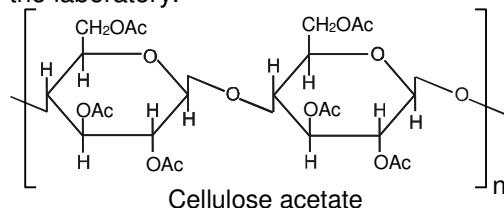


(ii) **Synthetic polymers** : These polymers are prepared in the laboratory.

Examples : Polyethylene, Nylon-6,6, Dacron & Polyacrylonitrile (PAN).



(iii) **Semi-synthetic polymers** : These polymers are found in plants and animals then modified in the laboratory.



Examples : Cellulose acetate (rayon) & Cellulose nitrate.



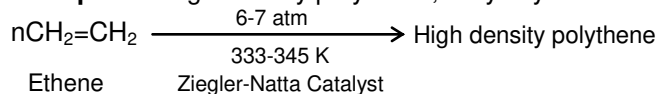


(C) Classification based on structure of polymers :

- (i) **Linear polymers** : These polymers consist of long and straight chains.



Examples : High density polythene, Polyvinyl chloride.

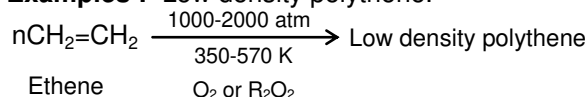


**** Ziegler Natta Catalyst** : $(\text{C}_2\text{H}_5)_3\text{Al} + \text{TiCl}_4$

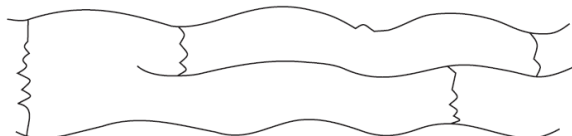
- (ii) **Branched chain polymers** : These polymers contain linear having some branches.



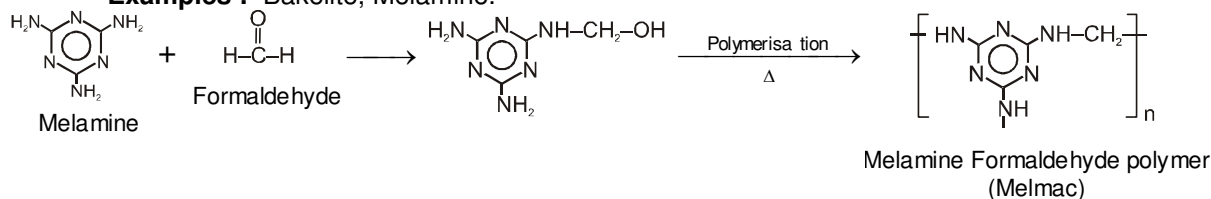
Examples : Low density polythene.



- (iii) **Cross linked or Network polymers** : These are usually formed from bi-functional and tri-functional monomers and contain strong covalent bonds between various linear polymer chain.



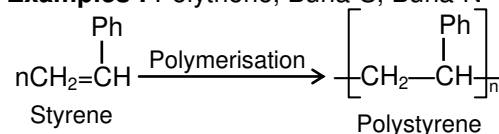
Examples : Bakelite, Melamine.



(D) Classification based on mode of Polymerisation :

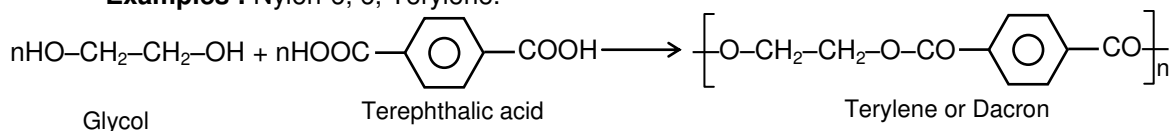
- (i) **Addition polymers** : The addition polymers are formed by the repeated addition of monomer molecules possessing double or triple bond.

Examples : Polythene, Buna-S, Buna-N



- (ii) **Condensation polymers** : The condensation polymers are formed by repeated condensation reaction between two different bi-functional or tri-functional monomeric units. In these polymerisation reactions, the elimination of small molecules such as water, alcohol, hydrogen chloride, etc.

Examples : Nylon-6, 6, Terylene.



Polyester – Polymers which have ester linkage.

(E) Classification based upon molecular force :

- (i) **Elastomers** : These are rubber like solids with elastic properties. In these elastomeric polymers, the polymer chains are held together by the weakest intermolecular forces.

Examples: Buna-S, Buna-N, Neoprene, etc.



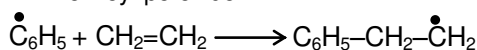
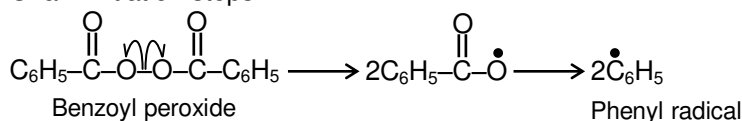
- (ii) **Fibres** : Fibres are the thread forming solids which possess high tensile strength and high modulus. Polymers in which the intermolecular forces of attraction are the strongest are called fibers. These forces are either due to H-bonding or dipole-dipole interactions. In case of nylon (polyamides), the intermolecular forces are due to H-bonding while in polyesters (terylene, dacron etc.) and polyacrylonitrile (orlon, acrylin etc.) Dipole-dipole interactions between the polar carbonyl (C = O) groups and, between carbonyl and cyano (– C ≡ N) groups respectively.
Examples: Polyamides (Nylon 6,6), polyesters (terylene), etc
- (iii) **Thermoplastics** : These are the linear or slightly branched long chain molecules capable of repeatedly softening on heating and hardening on cooling. These polymers possess intermolecular forces of attraction intermediate between elastomers and fibres.
Examples : Polythene, polystyrene, polyvinyls, etc.
- (iv) **Thermosetting polymers** : These polymers are cross linked or heavily branched molecules, which on heating undergo extensive cross linking in moulds and again become infusible. These cannot be reused.
Examples : Bakelite, urea-formaldehyde resins, etc.

(F) **Classification based on Mechanism of polymerisation:**

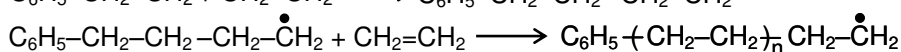
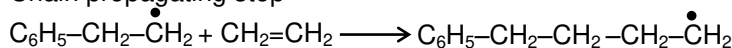
- (i) **Chain growth polymerisation** : Additional polymers are chain growth polymers. Chain growth polymerisation takes place by-

(a) **Free radical mechanism** : A variety of alkenes, dienes and their derivatives are polymerised in the presence of a free radical generating initiator (catalyst) like benzoyl peroxide, acetyl peroxide, tert-butyl peroxide, etc.

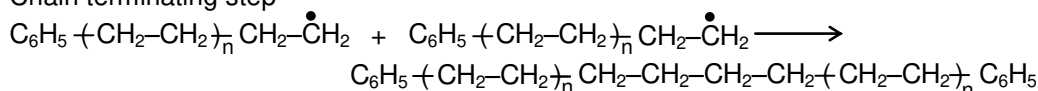
Chain initiation steps



Chain propagating step



Chain terminating step



Examples : CH₂=CH₂, CH₂=CH-CH₃, CH₂=CH-CH=CH₂, etc.

(b) **Cationic mechanism** : Alkenes having electron releasing group are polymerised by cationic mechanism.

Examples : CH₂=CH-O-CH₃

(c) **Anionic mechanism** : Alkenes having electron withdrawing group are polymerised by anionic mechanism.

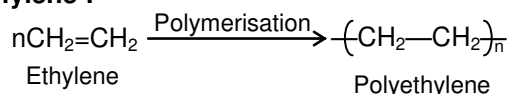
Examples : CH₂=CH-CN

- (ii) **Step growth polymerisation** : Condensation polymers are step growth polymer. This polymerisation progresses through step by step.

Examples : Nylon, bakelite, dacron, etc.

Examples of polymers :

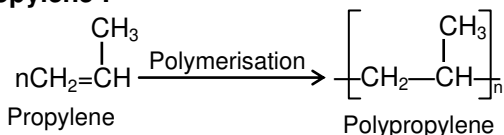
- (1) **Polyethylene** :



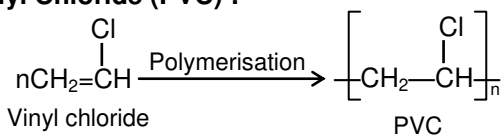
Low density polythene is used in the insulation of electricity carrying wires and manufacture of squeeze bottles, toys and flexible pipes.

High density polythene is used for manufacturing buckets, dustbins, bottles, pipes, etc.

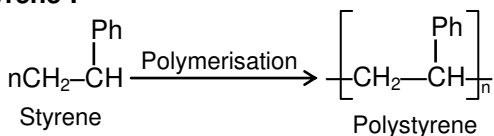


(2) **Polypropylene :**

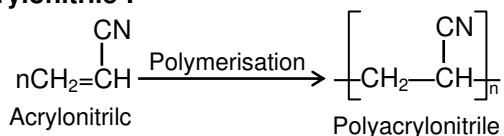
Polypropylene is used for manufacture of ropes, toys, pipes, fibres, etc.

(3) **Polyvinyl Chloride (PVC) :**

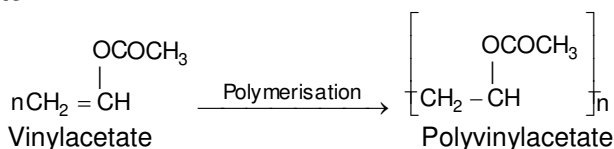
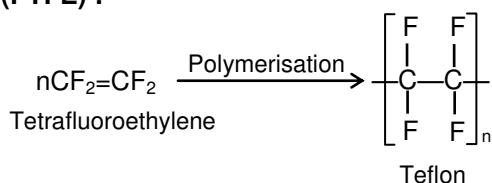
PVC is used in the manufacturing of rain coats, hand bags, vinyl flooring, water pipes, imitation leather, floor covering and gramophone records.

(4) **Polystyrene :**

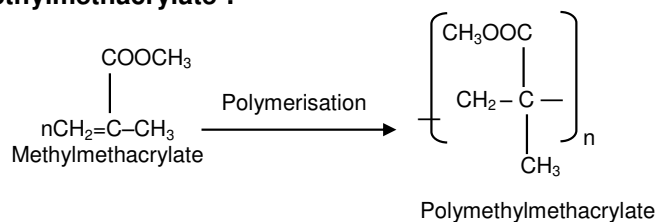
Polystyrene is used as insulator, wrapping material, manufacture of toys, radio and television cabinets.

(5) **Polyacrylonitrile :**

Polyacrylonitrile is used as a substitute for wool in making commercial fibres as orlon or acrilan.

(6) **Polyvinylacetate :**(7) **Teflon (PTFE) :**

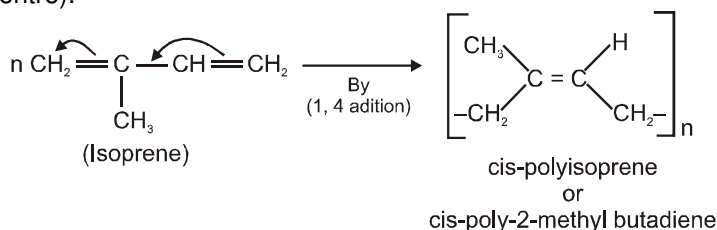
Teflon is used in making oil seals, valves and gaskets and it is also used for non-stick surface coated utensils. Because of its low chemical reactivity, excellent toughness, electrical and heat resistance, teflon is used as insulation for electrical items.

(8) **Polymethylmethacrylate :**



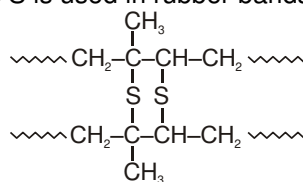
(9) Rubbers :

- (a) **Natural Rubber** : Rubber is a natural polymer and possesses elastic properties. It is also termed as elastomer and has a variety of uses. It is manufactured from rubber latex which is a colloidal dispersion of rubber in water. This latex is obtained from the bark of rubber tree and is found in India, Srilanka, Indonesia, Malaysia and South America. Natural rubber is a linear polymer of isoprene (2-methyl-1,3-butadiene) and is also called as cis-1, 4-polyisoprene. Natural Rubber is isotactic polymer (polymers which have same configuration at all stereocentre).

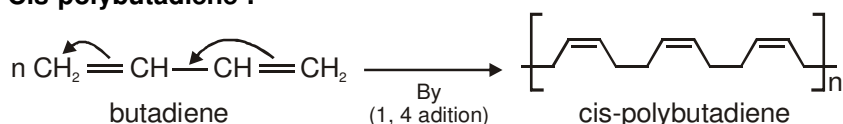
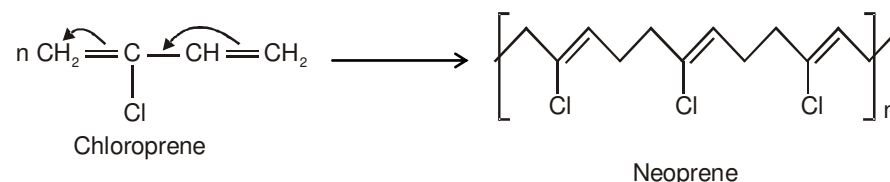


* **Gutta parcha**, has isoprene unit in trans-form (dentist used it in the filling of teeth).

Vulcanization : Raw rubber does not possess the characteristic of the rubber with which we are familiar. In order to give it strength & elasticity it is vulcanised. **In the vulcanization process, raw rubber is mixed with small amount of sulphur and heated.** Use of external sulphur increases the cross-linking and toughness. 1-3 % S is used in rubber bands and 5% S is used in tyre rubber.



- (b) **Synthetic Rubber** : Synthetic rubber is rubber like polymers, which is capable of getting stretched to twice its length. However, it returns to its original shape and size as soon as the external stretching force is released. Thus, synthetic rubbers are either homopolymers of 1,3-butadiene derivatives or copolymers of 1, 3-butadiene or its derivatives with another unsaturated monomers.

(i) **Cis-polybutadiene** :(ii) **Neoprene** :

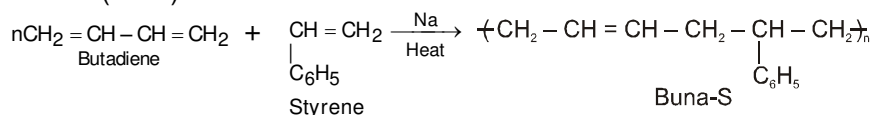
Neoprene has superior resistance to vegetable and mineral oils. It is used for manufacturing conveyor belts, gaskets and hoses.

(iii) **Buna-N** :

Buna-N is resistant to the action of petrol, lubricating oil and organic solvents. It is used in making oil seals, tank lining etc.



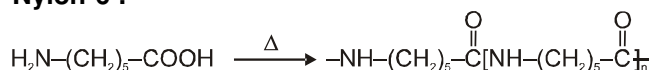
- (iv) **Buna-S** : It is obtained by the polymerization of butadiene and styrene in the ratio of 3 : 1 in the presence of sodium. It is also known as styrene butadiene rubber (SBR).



Buna-S is used for the manufacture of autotyres, floortiles, footwear components, cable insulation, etc.

(10) **Polyamides :**

(a) **Nylon-6 :**

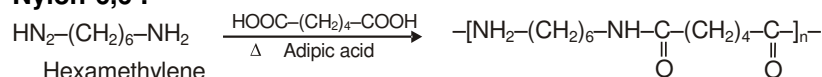


6-Aminohexanoic acid

Nylon-6

Nylon-6 is used for the manufacture of tyre cords, fabrics and ropes.

(b) **Nylon-6,6 :**

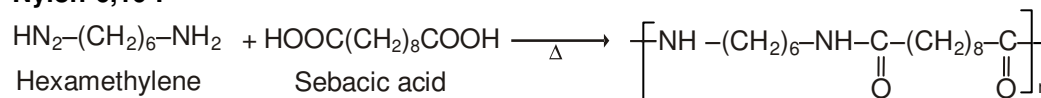


Hexamethylene
Diamine

Nylon 6, 6

Nylon-6, 6 is used in making sheets, bristles for brushes and in textile industry.

(c) **Nylon-6,10 :**



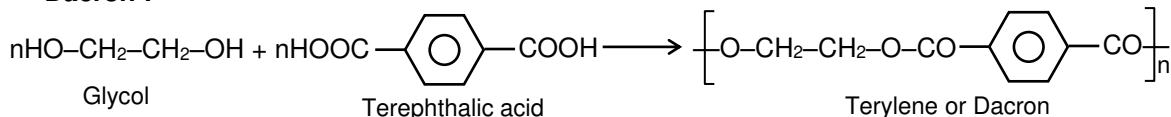
Hexamethylene
Diamine

Sebacic acid

Nylon 6, 10

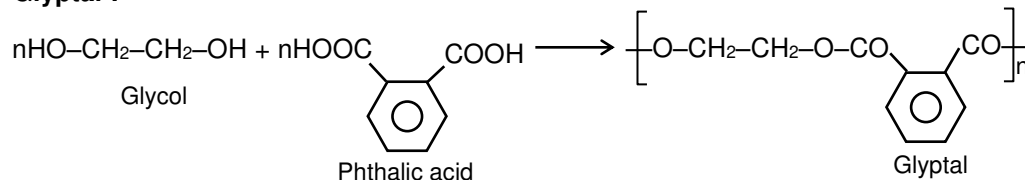
(11) **Polyesters :**

(a) **Dacron :**



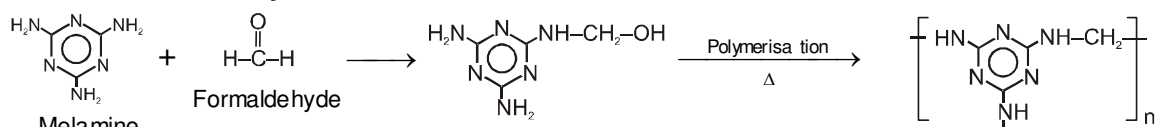
Dacron fibre (terylene) is crease resistant and is used in blending with cotton and wool fibres and also as glass reinforcing materials in safety helmets, etc.

(b) **Glyptal :**



Glyptal is used as manufacture of paints and lacquers.

(12) **Melamine formaldehyde Resin :**



Melamine Formaldehyde polymer
(Melmac)

Melamine formaldehyde resin is used in the manufacture of unbreakable crockery.

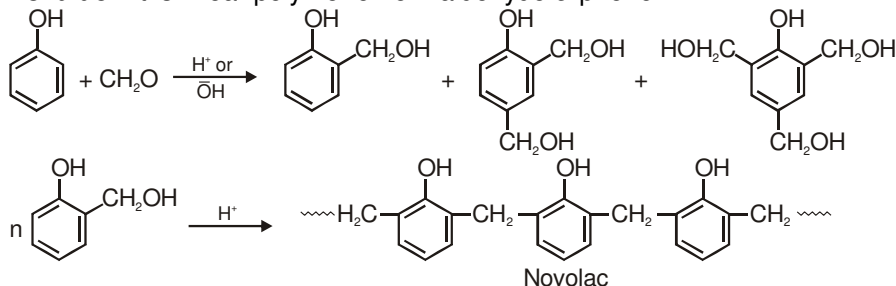




(13) **Phenol formaldehyde polymers :**

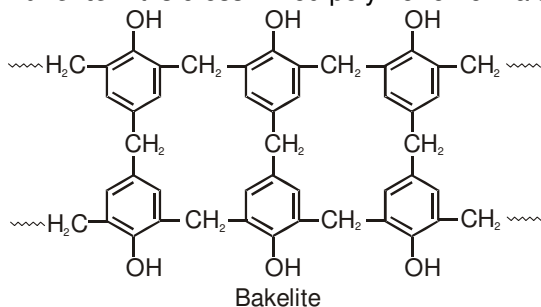
Phenol formaldehyde polymers are the oldest synthetic polymers. These are obtained by the condensation reaction of phenol with formaldehyde in the presence of either an acid or a base catalyst.

(a) **Novolac :** It is linear polymer of formaldehyde & phenol.



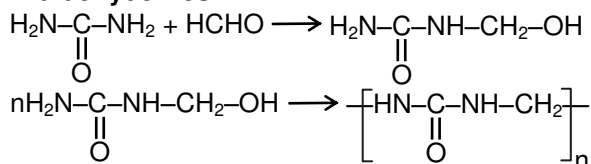
Novolac is used in paints.

(b) **Bakelite :** It is cross linked polymer of formaldehyde & phenol.



Bakelite is used for making combs, phonograph records, electrical switches, handles of various utensils & computer discs.

(14) **Urea formaldehyde Resin :**



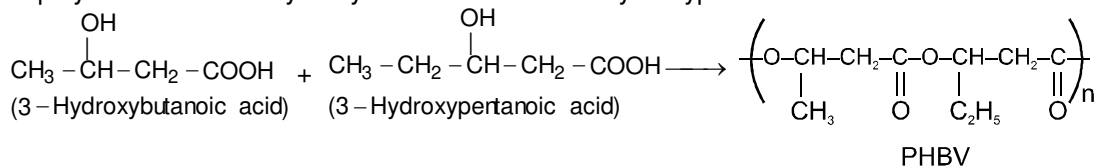
Urea formaldehyde Resin is used for making unbreakable cups and laminated sheets.

(15) **Biodegradable Polymers :**

A large number of polymers are quite resistant to the environmental degradation processes and are thus responsible for the accumulation of polymeric solid waste materials. These solid wastes cause acute environmental problems and remain undegraded for quite a long time. In view of the general awareness and concern for the problems created by the polymeric solid wastes, certain new biodegradable synthetic polymers have been designed and developed. These polymers contain functional groups similar to the functional groups present in biopolymers.

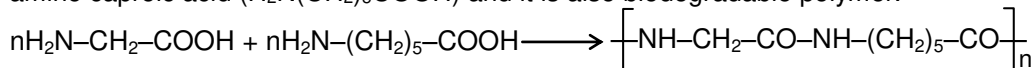
Aliphatic polyesters are one of the important classes of biodegradable polymers. Some examples are given below :

(a) **Poly β -hydroxybutyrate-co- β -hydroxy valerate (PHBV) :** It is obtained by the copolymerisation of 3-hydroxybutanoic acid and 3-hydroxypentanoic acid.



PHBV is used in speciality packaging, orthopaedic devices and in controlled release of drugs. PHBV undergoes bacterial degradation in the environment.

(b) **Nylon-2-nylon-6 :** It is an alternating polyamide copolymer of glycine ($\text{H}_2\text{N}-\text{CH}_2-\text{COOH}$) and amino caproic acid ($\text{H}_2\text{N}(\text{CH}_2)_5\text{COOH}$) and it is also biodegradable polymer.





Some common addition polymers/chain growth polymer				
S. No.	Name(s)	Formula	Monomer	Uses
1.	Polyethylene (low density (LDPE))	$-(CH_2-CH_2)_n-$	$CH_2=CH_2$ (ethylene)	Film wrap, Plastic Bags
2.	Polyethylene (high density (HDPE))	$-(CH_2-CH_2)_n-$	$CH_2=CH_2$ (ethylene)	Electrical insulation bottles, toys
3.	Polypropylene (PP) different grades	$\begin{array}{c} CH_3 \\ \\ -[CH-CH_2]_n \end{array}$	$CH_2=CHCH_3$ (propylene)	Manufacture of ropes, toys, pipes, fibres etc.
4.	Poly vinyl chloride (PVC)	$\begin{array}{c} Cl \\ \\ -[CH-CH_2]_n \end{array}$	$CH_2=CHCl$ (vinyl chloride)	Manufacture of rain coats, hand bags, vinyl flooring, water Pipes etc.
5.	Poly vinylidene chloride (Saran A)	$\begin{array}{c} Cl \\ \\ -[C-CH_2]_n \\ \\ Cl \end{array}$	$CH_2=CCl_2$ (vinylidene chloride)	Seat covers, films & fibers
6.	Polystyrene (Styron)	$\begin{array}{c} -[CH_2-CH]_n \\ \\ \text{C}_6\text{H}_5 \end{array}$	$CH_2=CHC_6H_5$ (styrene)	As insulator, wrapping material, manufactures of toys, radio and Television cabinets
7.	Polyacrylonitrile (PAN, Orlon, Acrilan)	$\begin{array}{c} [CN] \\ \\ -[CH-CH_2]_n \end{array}$	$CH_2=CHCN$ (acrylonitrile)	Rugs, Blankets clothing
8.	Polytetrafluoroethylene (PTFE, Teflon)	$-(CF_2-CF_2)_n-$	$CF_2=CF_2$ (tetrafluoroethylene)	Non-stick surfaces electrical insulation
9.	Poly methyl methacrylate (PMMA, Lucite, Plexiglas, perspex)	$-[CH_2C(CH_3)CO_2CH_3]_n-$	$CH_2=C(CH_3)CO_2CH_3$ (methylmethacrylate)	Lighting covers, signs skylights
10.	Poly vinyl acetate (PVAc)	$-(CH_2-CHOCOCH_3)_n-$	$CH_2=CHOCOCH_3$ (vinyl acetate)	Latex paints, Adhesives
11.	Natural Rubber	$-[CH_2-CH=C(CH_3)-CH_2]_n-$ (cis)	$CH_2=CH-C(CH_3)=CH_2$ (isoprene)	Requires vulcanization for practical use
12.	Neoprene	$-[CH_2-CH=CCl-CH_2]_n-$	$CH_2=CH-CCl=CH_2$ (chloroprene)	Synthetic rubber, oil resistant seal, gaskets, hoses & conveyor belts
13.	SBR styrene butadiene rubber (Buna-S)	$\begin{array}{c} -[CH_2-CH-CH_2-CH=CH-CH_2]- \\ \\ Ph \end{array}$	$H_2C=CHC_6H_5$ and $H_2C=CH-CH=CH_2$	Tyres, floortiles, foot wear & cable insulation
14.	Nitrile Rubber (Buna-N)	$\begin{array}{c} -[CH_2-CH-CH_2-CH=CH-CH_2]- \\ \\ CN \end{array}$	$H_2C=CHCN$ and $H_2C=CH-CH=CH_2$	Making oil seals, tank lining and hoses



Some condensation polymers/step growth polymers				
S. No.	Name(s)	Formula	Monomer	Uses
1.	Polyester/Dacron/Terylene/Mylar		HO ₂ C C ₆ H ₄ CO ₂ H (Terephthalic acid) HO-CH ₂ CH ₂ -OH Ethylene glycol	Fabric, Tyrecord
2.	Glyptal or Alkyds resin		HO ₂ C-C ₆ H ₄ -CO ₂ H (Phthalic acid) HO-CH ₂ CH ₂ -OH	Paints and Lacquers
3.	Polyamide (Nylon 6,6)	$\sim[\text{CO}(\text{CH}_2)_4\text{CO}-\text{NH}(\text{CH}_2)_6\text{NH}]_n\sim$	HO ₂ C-(CH ₂) ₄ -CO ₂ H H ₂ N-(CH ₂) ₆ -NH ₂	Parachutes & Clothing
4.	Nylon 6,10		HOOC-(CH ₂) ₈ -COOH H ₂ N-(CH ₂) ₆ -NH ₂	
5.	Polyamide Nylon 6, Perlon-L	$\sim[\text{CO}(\text{CH}_2)_5\text{NH}]_n\sim$	 Caprolactam	Rope & Tyrecord
6.	Bakelite		PhOH + HCHO in (excess)	Electrical Switch, combs, Handle of Utensils, computer discs and Bowling Balls
7.	Urea-formaldehyde resin	$(-\text{NH}-\text{CO}-\text{NH}-\text{CH}_2-)_n$	H ₂ N-CO-NH ₂ (Urea) HCHO (Formaldehyde)	Making unbreakable cups and laminated sheets.
8.	Melamine formaldehyde resin		 (melamine) + HCHO (formaldehyde)	Unbreakable crockery
9.	Polyamide Kevlar		Para HO ₂ C-C ₆ H ₄ -CO ₂ H Para H ₂ N-C ₆ H ₄ -NH ₂	Tyre
10.	Polyamide Nomex		Meta HO ₂ C-C ₆ H ₄ -CO ₂ H Meta H ₂ N-C ₆ H ₄ -NH ₂	
11.	Polyurethane Spandex		HOCH ₂ CH ₂ OH H ₃ C-C ₆ H ₃ (NCO) ₂	Foams, Shoes, Automobile seats and components
12.	Polycarbonate Lexan		(HO-C ₆ H ₄ -) ₂ C(CH ₃) ₂ (Bisphenol A) X ₂ C=O (X = OCH ₃ or Cl)	Bike helmet, goggles, bullet proof glass





Exercise-1

Marked questions are recommended for Revision.

PART - I : SUBJECTIVE QUESTIONS

Section (A) : Polymers

- A-1.** Differentiate between a homopolymer and a copolymer. Give one example of each type.
- A-2.** What is meant by vulcanisation of rubber ? Why is rubber vulcanised ? Give an important application of vulcanised rubber.
- A-3.** The partial structure of neoprene, a polymer is given below. Identify the monomer unit.
- $$\begin{array}{ccccccc} & & \text{Cl} & & \text{Cl} & & \text{Cl} \\ & & | & & | & & | \\ \text{CH}_2 & - & \text{C} = \text{C} & - & \text{CH}_2 & - & \text{CH}_2 & - & \text{C} = \text{C} & - & \text{CH}_2 & - & \text{CH}_2 & - & \text{C} = \text{C} & - & \text{CH}_2 \\ & & | & & | & & | \\ & & \text{H} & & \text{H} & & \text{H} \end{array}$$
- A-4.** Classify the following as addition and condensation polymer
polymers : Terylene, Bakelite, polyvinyl chloride, polythene
- A-5.** What is the difference between Buna-N and Buna-S
- A-6.** Arrange the following in the increasing order of their intermolecular forces
Nylon-6, Neoprene, Polyvinyl chloride
(I) (II) (III)

PART - II : ONLY ONE OPTION CORRECT TYPE

Section (A) : Polymers

- A-1.** Monomer of given polymer $\left[\begin{array}{c} \text{CH}_3 \\ | \\ -\text{C}-\text{CH}_2- \\ | \\ \text{CH}_3 \end{array} \right]_n$ is :
- (A) 2-Methylpropene (B) Styrene (C) Propylene (D) Ethene
- A-2.** Starch is polymer of
(A) α -D-Glucose (B) β -D-Glucose
(C) α -D-Glucose and β -D-Glucose (D) α -D-Fructose
- A-3.** Polymer which has amide linkage is
(A) Nylon -6,6 (B) Terylene (C) Teflon (D) Bakelite
- A-4.** Nylon-6,6 is made by using
(A) Phenol (B) Benzaldehyde (C) Adipic acid (D) Succinic acid
- A-5.** Which of the following is a nitrogen containing polymer ?
(A) Polyvinyl chloride (B) Bakelite (C) Nylon (D) Terylene
- A-6.** Buna-S is a polymer of :
(A) Butadiene only (B) Butadiene and nitril
(C) Styrene only (D) Butadiene and styrene
- A-7.** Condensation product of caprolactum is :
(A) nylon-6 (B) nylon-6,6 (C) nylon-60 (D) nylon-6, 10





- A-8. Ziegler-Natta catalyst is :
 (A) $K[PtCl_3(C_2H_4)]$ (B) $(Ph_3P)_3RhCl$ (C) $Al_2(C_2H_5)_6 + TiCl_4$ (D) $Fe(C_5H_5)_2$

PART - III : MATCH THE COLUMN

1. Match **Column-I** with **Column-II**.

	Column-I (polymer)		Column-II (monomer)
(A)	Bakelite	(p)	ϵ -caprolactum
(B)	Polypropylene	(q)	Ethylene glycol + phthalic anhydride
(C)	Glyptal	(r)	propene
(D)	Nylon-6	(s)	Phenol + formaldehyde

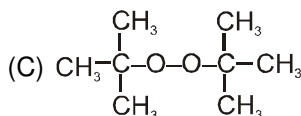
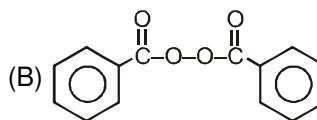
Exercise-2

Marked questions are recommended for Revision.

PART - I : ONLY ONE OPTION CORRECT TYPE

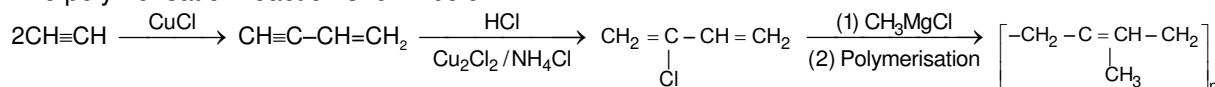
- Which of the following contains isoprene unit ?
 (A) Natural rubber (B) Polyethylene (C) Nylon-6,6 (D) Dacron
- Which of the following is condensation polymer ?
 (A) Polystyrene (B) PVC (C) Polyester (D) Teflon
- Which of the following polymerises most easily ?
 (A) $CH_3CH_2C\equiv CH$ (B) $CH_2=CH-CH=CH_2$
 (C) $CH_3CH_2-CH=CH_2$ (D) $CH\equiv C-C\equiv CH$
- Which of the following is radical initiator

(A) $R-N=N-R$



(D) All

5. The polymerisation reaction shown below



would produce :

- (A) PVC (B) neoprene (C) chloroprene (D) Rubber

PART - II : SINGLE AND DOUBLE VALUE INTEGER TYPE

- Among the following no. of condensation polymer
 Nylon-6, Buna-N, Buna-S, Nylon-6,6, Nylon-6,10, PVC, Polystyrene, Teflon.
- How many of the following polymers are addition polymer
 (i) Polyvinyl chloride (ii) Terylene (iii) Teflon (iv) Neoprene
 (v) Buna-S (vi) Nylon-6,6 (vii) Natural rubber (viii) Bakelite





PART - III : ONE OR MORE THAN ONE OPTIONS CORRECT TYPE

- Which of the following are polyamide polymer ?
(A) Protein (B) Nylon-6,6 (C) Nylon-6 (D) Polystyrene
- Preparation of nylon from hexamethylene diamine and adipic acid is an example of :
(A) addition polymerisation (B) homopolymerisation
(C) condensation polymerisation (D) copolymerisation
- Which of the following are condensation polymer ?
(A) Terylene (B) Bakelite (C) Polyvinyl chloride (D) Nylon-6,6

Exercise-3

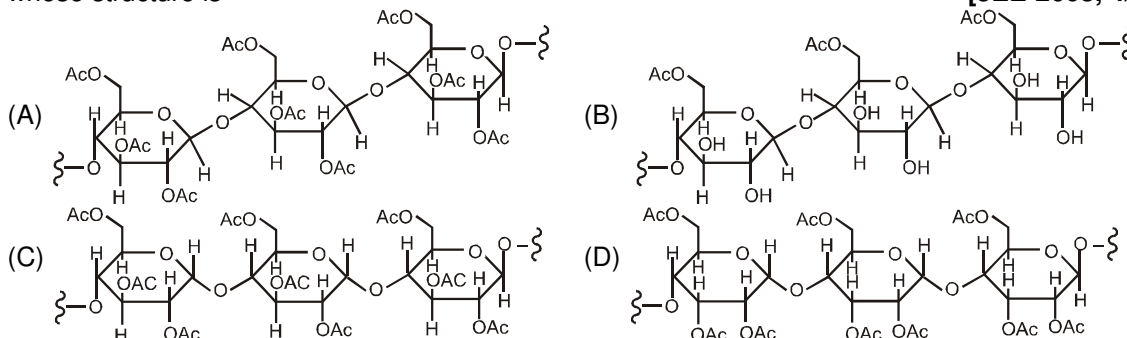
* Marked Questions may have more than one correct option.

PART - I : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

- Write down the heterogenous catalyst involved in the polymerisation of ethylene. [JEE-2003, 2/60]
- Match the chemical substances in **Column-I** with type of polymers/type of bonds in **Column-II**.
[JEE-2007, 6/162]

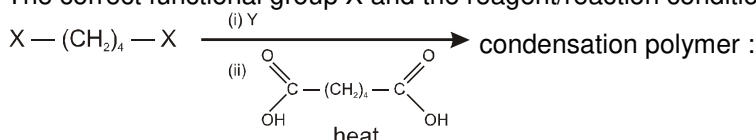
	Column-I		Column-II
(A)	cellulose	(p)	natural polymer
(B)	nylon-6,6	(q)	synthetic polymer
(C)	protein	(r)	amide linkage
(D)	sucrose	(s)	glycoside linkage

- Cellulose upon acetylation with excess acetic anhydride/H₂SO₄ (catalytic) gives cellulose triacetate whose structure is
[JEE-2008, 4/163]



- Among cellulose, poly vinyl chloride, nylon and natural rubber, the polymer in which the intermolecular force of attraction is weakest is :
[JEE 2009, 3/160]
(A) Nylon (B) Poly vinyl chloride (C) Cellulose (D) Natural Rubber

- The correct functional group X and the reagent/reaction conditions Y in the following scheme are



[JEE 2011, 4/180]

- (A) X = COOCH₃, Y = H₂/Ni/heat
- (B) X = CONH₂, Y = H₂Ni/heat
- (C) X = CONH₂, Y = Br₂/NaOH
- (D) X = CN, Y = H₂/Ni/heat

- The total number of lone-pairs of electrons in melamine is
[JEE(Advanced)-2013, 4/120]





7. On complete hydrogenation, natural rubber produces [JEE(Advanced)-2016, 3/124]
 (A) ethylene-propylene copolymer (B) vulcanised rubber
 (C) polypropylene (D) polybutylene

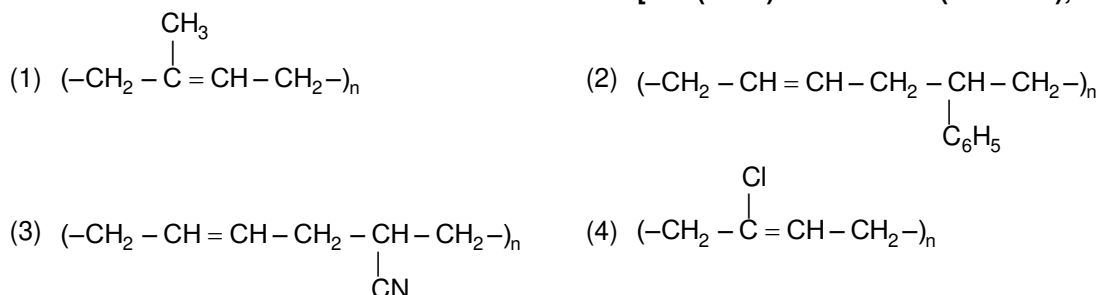
PART - II : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

JEE(MAIN) OFFLINE PROBLEMS

- Monomers are converted to polymers by [AIEEE-2002, 3/225]
 (1) Hydrolysis of monomer (2) Condensation between monomers
 (3) Protonation of monomers (4) none
- Complete hydrolysis of cellulose gives [AIEEE-2003, 3/225]
 (1) D-fructose (2) D-ribose (3) D-glucose (4) L-glucose
- Nylon threads are made up of [AIEEE-2003, 3/225]
 (1) Polyvinyl polymer (2) Polyester polymer (3) Polyamide polymer (4) Polyethylene polymer
- Which of the following is a polyamide ? [AIEEE-2005, 1½/225]
 (1) Bakelite (2) Terylene (3) Nylon-6,6 (4) Teflon
- Which of the following is fully fluorinated polymer [AIEEE-2005, 3/225]
 (1) PVC (2) Thiokol (3) Teflon (4) Neoprene
- Bakelite is obtained from phenol by reacting with [AIEEE-2008, 3/105]
 (1) CH₃CHO (2) CH₃COCH₃ (3) HCHO (4) (CH₂OH)₂
- Buna-N synthetic rubber is a copolymer of : [AIEEE-2009, 4/144]
 (1) H₂C=CH-CH=CH₂ and H₅C₆-CH=CH₂ (2) H₂C=CH-CN and H₂C=CH-CH=CH₂
 (3) H₂C=CH-CN and H₂C=CH-C(CH₃)=CH₂ (4) H₂C=CH-CN and H₂C=CH-C(Cl)=CH₂
- The polymer containing strong intermolecular forces e.g. hydrogen bonding is [AIEEE-2010, 4/144]
 (1) teflon (2) nylon-6,6 (3) polystyrene (4) natural rubber
- Which one is classified as a condensation polymer ? [JEE (Main)-2014, 4/120]
 (1) Dacron (2) Neoprene (3) Teflon (4) Acrylonitrile
- Which polymer is used in the manufacture of paints and lacquers ? [JEE(Main) 2015, 4/120]
 (1) Bakelite (2) Glyptal (3) Polypropene (4) Poly vinyl chloride
- Which of the following statements about low density polythene is FALSE? [JEE(Main) 2016, 4/120]
 (1) It is a poor conductor of electricity.
 (2) Its synthesis required dioxygen or a peroxide initiator as a catalyst.
 (3) It is used in the manufacture of buckets, dust-bins etc.
 (4) Its synthesis requires high pressure.
- The formation of which of the following polymers involves hydrolysis reaction? [JEE(Main) 2017, 4/120]
 (1) Bakelite (2) Nylon 6,6 (3) Terylene (4) Nylon 6

JEE(MAIN) ONLINE PROBLEMS

1. Structure of some important polymers are given. Which one represents Buna-S ? [JEE(Main) 2014 Online (09-04-14), 4/120]





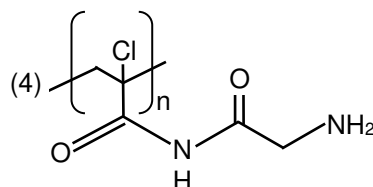
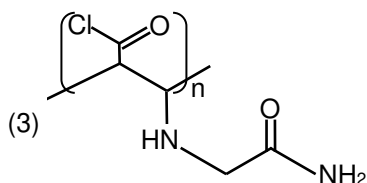
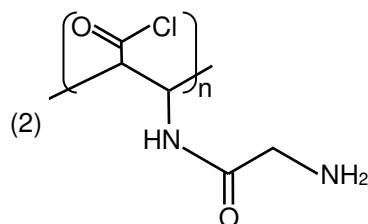
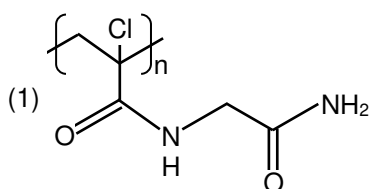
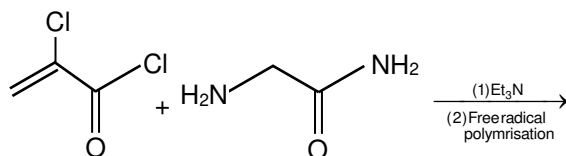
2. Which one of the following class of compounds is obtained by polymerization of acetylene ?
[JEE(Main) 2014 Online (09-04-14), 4/120]
 (1) Poly-yne (2) Poly-ene (3) Poly-ester (4) Poly-amide
3. Which one of the following is an example of thermosetting polymers ?
[JEE(Main) 2014 Online (19-04-14), 4/120]
 (1) Neoprene (2) Buna-N (3) Nylon 6, 6 (4) Bakelite
4. Match the polymers in column-A with their main uses in column-B and choose the correct answer :
[JEE(Main) 2015 Online (10-04-15), 4/120]
- | Column-A | Column-B |
|---|--|
| (A) Polystyrene | (i) Paints and lacquers |
| (B) Glyptal | (ii) Rain coats |
| (C) Polyvinyl chloride | (iii) Manufacture of toys |
| (D) Bakelite | (iv) Computer discs |
| (1) (A) - (iii), (B) - (i), (C) - (iii), (D) - (iv) | (2) (A) - (iii), (B) - (i), (C) - (ii), (D) - (iv) |
| (3) (A) - (ii), (B) - (iv), (C) - (iii), (D) - (i) | (4) (A) - (iii), (B) - (iv), (C) - (ii), (D) - (i) |
5. Which one of the following structures represents the neoprene polymer ?
[JEE(Main) 2015 Online (11-04-15), 4/120]
- | | |
|---|--|
| (1) $\left[\text{CH}_2 - \underset{\text{C}_6\text{H}_5}{\text{CH}} \right]_n$ | (2) $\left[\text{CH}_2 - \underset{\text{CN}}{\text{CH}} \right]_n$ |
| (3) $\left[\text{CH}_2 - \underset{\text{Cl}}{\text{C}} = \text{CH} - \text{CH}_2 \right]_n$ | (4) $\left[\text{CH}_2 - \underset{\text{Cl}}{\text{CH}} \right]_n$ |
6. **Assertion :** Rayon is a semisynthetic polymer whose properties are better than natural cotton.
Reason : Mechanical and aesthetic properties of cellulose can be improved by acetylation.
[JEE(Main) 2016 Online (09-04-16), 4/120]
 (1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion.
 (2) Both assertion and reason are incorrect.
 (3) Assertion is incorrect statement, but the reason is correct.
 (4) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion.
7. Which of the following polymers is synthesized using a free radical polymerization technique ?
[JEE(Main) 2016 Online (10-04-16), 4/120]
 (1) Teflon (2) Melamine polymer (3) Nylon 6,6 (4) Terylene
8. Which of the following is a biodegradable polymer ?
[JEE(Main) 2017 Online (09-04-17), 4/120]
- | | |
|---|--|
| (1) $\left[\text{HN} - (\text{CH}_2)_6 \text{NHCO} - (\text{CH}_2)_4 - \overset{\text{O}}{\parallel} \text{C} \right]_n$ | (2) $\left[\text{HN} - (\text{CH}_2)_5 \text{CONH} - \text{CH}_2 - \overset{\text{O}}{\parallel} \text{C} \right]_n$ |
| (3) $\left[\text{HN} - (\text{CH}_2)_5 - \overset{\text{O}}{\parallel} \text{C} \right]_n$ | (4) $\left[\overset{\text{O}}{\parallel} \text{C} - \text{C}_6\text{H}_4 - \text{COO} - (\text{CH}_2)_2 - \text{O} \right]_n$ |
9. The copolymer formed by addition polymerization of styrene and acrylonitrile in the presence of peroxide is :
[JEE(Main) 2018 Online (15-04-18), 4/120]
- | | |
|--|--|
| (1) $\left[\begin{array}{c} \text{H}_5\text{C}_6 \quad \text{CN} \\ \quad \\ -\text{C}-\text{CH}-\text{CH}_2- \\ \\ \text{CH}_3 \end{array} \right]_n$ | (2) $\left[\begin{array}{c} \text{CH}_2-\text{CH}-\text{CH}_2-\text{CH} \\ \quad \\ \text{C}_6\text{H}_5 \quad \text{CN} \end{array} \right]_n$ |
| (3) $\left[\begin{array}{c} \text{H}_5\text{C}_6 \quad \text{CN} \\ \quad \\ -\text{CH}_2-\text{CH}-\text{CH}-\text{CH}_2- \\ \quad \\ \text{CH}_3 \quad \text{CN} \end{array} \right]_n$ | (4) $\left[\begin{array}{c} \text{CH}-\text{CH}_2-\text{CH}_2-\text{CH} \\ \quad \\ \text{C}_6\text{H}_5 \quad \text{CN} \end{array} \right]_n$ |



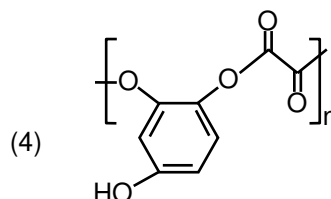
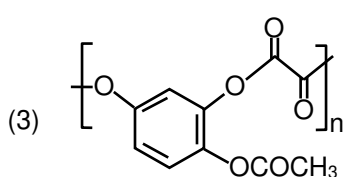
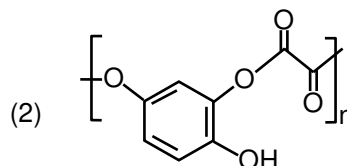
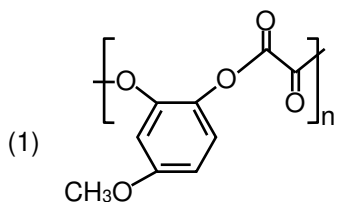
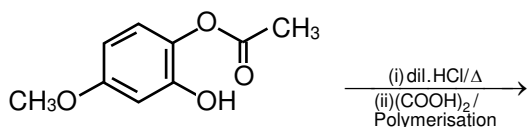
10. Which of the following statements is not true? [JEE(Main) 2018 Online (15-04-18), 4/120]

- (1) Step growth polymerization requires a bifunctional monomer.
- (2) Nylon 6 is an example of step-growth polymerization.
- (3) Chain growth polymerization includes both homopolymerisation and copolymerisation.
- (4) Chain growth polymerization involves homopolymerisation only.

11. Major product of the following reaction is : [JEE(Main) 2019 Online (09-01-19), 4/120]

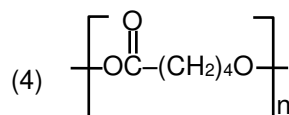
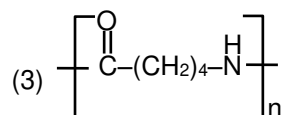
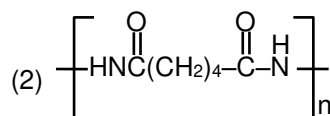
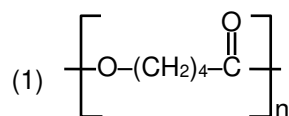
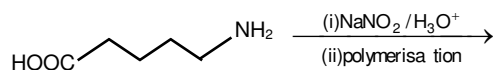


12. The major product of the following reaction is : [JEE(Main) 2019 Online (10-01-19), 4/120]

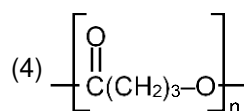
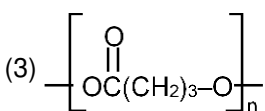
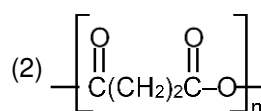
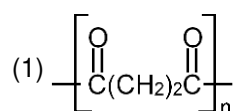




13. The polymer obtained from the following reactions is: [JEE(Main) 2019 Online (11-01-19), 4/120]



14. The homopolymer formed from 4-hydroxy-butanoic acid is: [JEE(Main) 2019 Online (11-01-19), 4/120]



15. Poly-β-hydroxybutyrate-co-β-hydroxyvalerate (PHBV) is a copolymer of

[JEE(Main) 2019 Online (12-01-19), 4/120]

- (1) 3-hydroxybutanoic acid and 2-hydroxypentanoic acid
- (2) 3-hydroxybutanoic acid and 4-hydroxypentanoic acid
- (3) 2-hydroxybutanoic acid and 3-hydroxypentanoic acid
- (4) 3-hydroxybutanoic acid and 3-hydroxypentanoic acid

16. The two monomers for the synthesis of Nylon-6,6 are: [JEE(Main) 2019 Online (12-01-19), 4/120]

- (1) $\text{HOOC}(\text{CH}_2)_4\text{COOH}$ & $\text{H}_2\text{N}-(\text{CH}_2)_6-\text{NH}_2$
- (2) $\text{HOOC}(\text{CH}_2)_6\text{COOH}$ & $\text{H}_2\text{N}(\text{CH}_2)_4\text{NH}_2$
- (3) $\text{HOOC}(\text{CH}_2)_6\text{COOH}$ & $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$
- (4) $\text{HOOC}(\text{CH}_2)_4\text{COOH}$, $\text{H}_2\text{N}-(\text{CH}_2)_4\text{NH}_2$



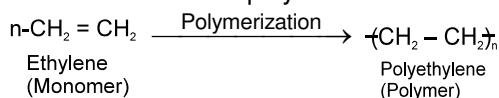


Answers

EXERCISE - 1

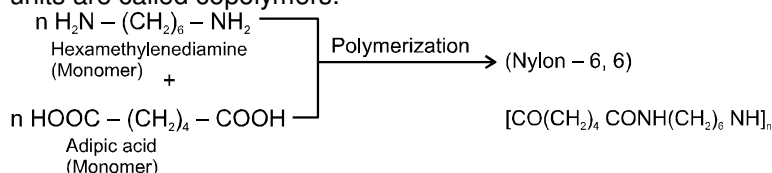
PART - I

- A-1. (i) Homopolymers :** Polymers in which repeating structural units are derived from only one type of monomer units are called homopolymers.



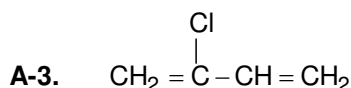
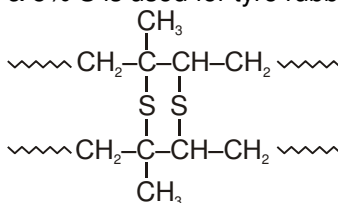
Other examples polypropylene, polyvinyl chloride (PVC), polyisoprene, neoprene (polychloroprene) polyacrylonitrile (PAN), nylon-6, polybutadiene, teflon (polytetrafluoroethylene), cellulose, starch, glycogen etc.

- (ii) Copolymers :** Polymers in which repeating structural units are derived from two or more types of monomer units are called copolymers.



- A-2.** Raw rubber does not possess the characteristic of the rubber with which we are familiar in order to give it strength & elasticity it is vulcanised. **In the vulcanization process, raw rubber is mixed with small amount of sulphur and heated.**

1-3 % S is used for rubber bands & 5% S is used for tyre rubber.



- A-4. Addition polymer :** Polyvinyl chloride, polythene
Condensation polymer : Bakelite, terylene

- A-5.** Buna-N → Copolymer of 1, 3-butadiene and acrylnitrile
Buna-S → Copolymer of 1, 3-butadiene and styrene

- A-6.** II < III < I

PART - II

- A-1.** (A) **A-2.** (A) **A-3.** (A) **A-4.** (C) **A-5.** (C)
A-6. (D) **A-7.** (A) **A-8.** (C)

PART - III

1. A → s, B → r, C → q D → p



EXERCISE – 2

PART – I

1. (A) 2. (C) 3. (B) 4. (D) 5. (D)

PART – II

1. 3 2. 5

PART – III

1. (ABC) 2. (CD) 3. (ABD)

EXERCISE – 3

PART – I

1. Ziegler Natta catalyst. ($R_3Al + TiCl_4$) 2. (A - p, s); (B - q, r); (C - p, r); (D - s) 3. (A)
4. (D) 5. (CD) 6. 6 7. (A)

PART – II

JEE(MAIN) OFFLINE PROBLEMS

1. (2) 2. (3) 3. (3) 4. (3) 5. (3)
6. (3) 7. (2) 8. (2) 9. (1) 10. (2)
11. (3) 12. (4)

JEE(MAIN) ONLINE PROBLEMS

1. (2) 2. (1) 3. (4) 4. (2) 5. (3)
6. (1) 7. (1) 8. (2) 9. (2) 10. (4)
11. (1) 12. (1) 13. (1) 14. (4) 15. (4)
16. (1)

