BIOMOLECULES

Biomolecules : Chemical substances which form the basis of life and are responsible for growth, maintenance and then albility to reproduce eq. carbohydrate, proteins fats, enzymes, nucleic acids, hormones, ATP, Vitamens etc.

Carbohydrates (Hydrates of C): They are defined as optically active polyhydroxy aldehydes or polyhydroxy ketones or substances which give these on hydrolysis the ratio of H and O is same as is water they are represented by general formula $C_x(H_2O)_y$.

eq. $C_6H_{12}O_6$ or $C_6(H_2O)_6$ $x = y = 6$

$C_{12}H_{22}O_{11}$ or $C_{12}(H_2O)_{11}$ $x \neq y$

Rhamnose $C_6H_{12}O_5$ and Deoxyrebose $(C_5H_{10}O_4)$ are carbohydrate by chemical behaviour mole by formula $(C_x(H_2O)_y$.

* CH_3COOH (H_2O) and (CH_2O) and CH_3COOH $(C_2(H_2O)_2)$ are not carbohydrates but are represented by general formula $(C_x(H_2O)_y)$.

Classification of carbohydrates or (Saocharrides). (Sakcharen means sugar) : – Base behaviour towards hydrolysis.

TYPES OF CARBOHYDRATES

1. **Monosoccharrdes :** Simplest carbohydrates which cannot hydrolysed to smaller molecules formula $(CHO)_n$, n = 3 to 7
   Glucose, Fructose (Hexose)
   Ribose, Deoxyribose (Pentose)

2. **Oligosaccharides:** (Greek : Oligo means few) Carbohydrates which on hydrolysis give 2 – 10 molecules of monosacchandes. They are further classified as
   Disaccharides – Sucrose, Maltose, Lacrose,
   Trisaccharides – Raffiose,
   Tetrasecccharides – Stachyrose.

   Hydrolysis

   Sucrose + H_2O $\rightarrow$ Glucose + Fructose
   Maltose + H_2O $\rightarrow$ Glucose + Glucose
   Lactose + H_2O $\rightarrow$ Glucose + Galactose
   Raffinose + H_2O $\rightarrow$ Glucose + fructose + Galactose
   $C_{13}H_{32}O_{16}$
   Stadnyrose + H_2O $\rightarrow$ Glucose + Frctose + 2 Galactose
   $C_{24}H_{42}O_{21}$

   Disaccharides – Carbohydrates which upon hydrolysis give 2 molecules of same or different monosaccharides are called disaccharides.

3. **Polysaccharides:** Carbohydrates which give large no. of monosacchairdes on hydrolysis are called polysachharides.
   eq. Starch, Cellulose ,Glycogen
   General formula : $(C_6H_{10}O_5)_n$ where n = 100 – 3000.

Sugars and Non–Sugars

All the monosaccharides and oligosaccharides are crystallines solids, soluble in water and sweet in taste. These are collectively called Sugars

The polysaccharides are amorphous solids, insoluble in water and tasteless and thus are called **non-sugars.**

Reducing and non reducing sugars or carbohydretes.

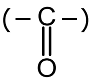
Those carbohydrates which contain aldehydic or ketonic group in the hemiactal or hemiketal form and reduce Tollens reagent or Fehling solution are called Reducing sugars, While others which do not reduce these reagents are called non-reducing sugars (carbohydrates).

All monosaccharides whether aldoses or Ketoses are reducing sugars eq. Glucose Fructose.

Disaccharides such as sucrose in which the two monosaccharides units (G and F) are liked through their reducing centes i.e. aldehyde or ketonic groups are non reducing. All polysaccharides (Starch, cellulose) glycogen dextrins etc.) are non reducing carbohydrates.

MONOSACCHARIDES ARE CLASSIFIED AS

1. **Aldoses :** Monosaccharides containing an – CHO group are called Aldoses – CHO group is present at C_1.
2. **Ketones :** Monosaccharides containing a keto



$(-\underset{\underset{O}{\|}}{C}-)$ Group are called ketoses.

Since keto group is divalent, it can be present anywhere along the 'c' chain however in all the naturally occurring ketones, ketogroup is always present at a 'C' atom next to Terminal C i.e., at C_2.

Glucose (or Dextrose) – $C_6H_{12}O_6$.

Glucose occurs in free as well as conbined state. It occurs in large (20%) quantities in ripe grapes, that is why it is called grape sugar. It also occurs in honey and sweet fruits (Mangoes, apples, Peaches, Pears etc.). In combined state, it occurs in glycosides, disaccharides and polysaccharides Glucose is most abundant compound on earth

PREPARATION OF GLUCOSE.

(I) From Cane sugar: (Sucrose) :

When sucrose is hydrolysed by boiling with dil HCl or dil H_2SO_4 in alcoholic solution

$$C_{12}H_{22}O_{11} + H_2O \xrightarrow{H^+} C_6H_{12}O_6 + C_6H_{12}O_6$$

Sucrose Glucose Fractose

(II) From Starch :

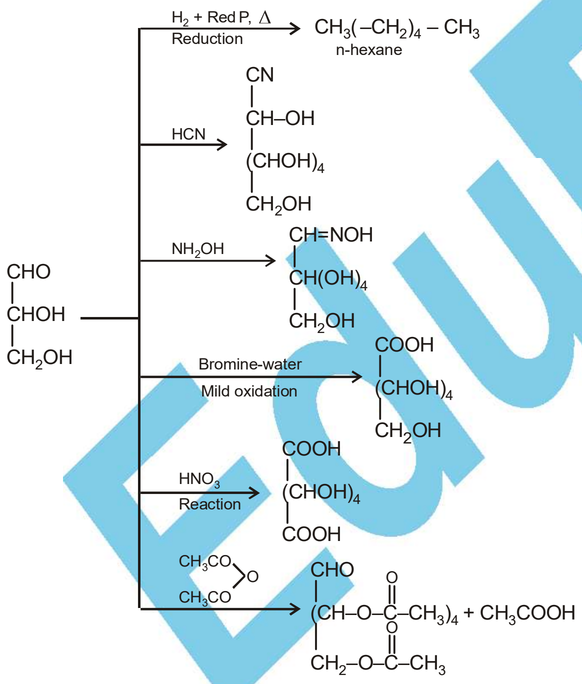
Commercially Glucose is obtained by hydrolysis of starch by boiling it with dil H_2SO_4 at 393 K under present $(C_6H_{10}O_5)_n + nH_2O \xrightarrow[393K,\ 2\text{-}3\ atm]{H^+} nC_6H_{12}O_6$

Starch Clucose

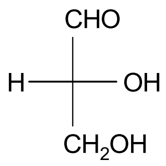
GLUCOSE (OPEN CHAIN STRUCTURE – BY BAEYER)

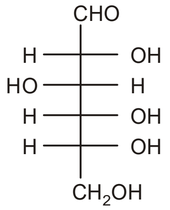
CHO ← One aldehyde group
|
$CH(OH)_4$ ← Four 2° alcoholic group
|
CH_2OH ← One 1° Alcoholic group

Above structure assigned on following bases molecular formula : $C_6H_{12}O_6$.



Glucose is correctly named as D(+) -glucose.





D–(+)–Glyceraldehyde

D–(+)–Glucose

Cyclic Structure of Glucose

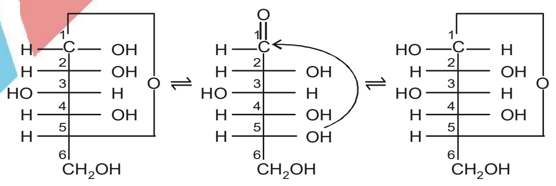
The structure of glucose explained most of its properties but the following reactions and facts could not be explained by this structure.

1. Despite having the aldehyde group, glucose does not give 2,4-DNP test, Schiffs test and it does not form the hydrogensulphite addition product with $NaHSO_3$.

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

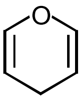
3. Glucose is found to exist in two different crystalline forms which are named as α and β. The α –form of glucose (m.p. 419 K) is obtained by crystallisation from concentrated solution of glucose at 303 K while the b-form (m.p. 423 K) is obtained by crystallisation from hot and saturated aqueous solution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

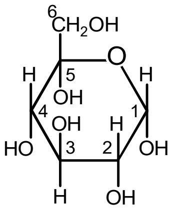
This behavior could not be explained by the open chain structure (I) for glucose. It was found that glucose forms a six-membered ring in which – OH at C-5 is involved in ring formation. This explains the absence of –CHO group and also existence of glucose in two forms as shown below. These two cyclic forms exist in equilibrium with open chain structure.

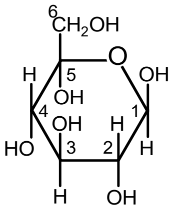


α–D–(+)–Glucose β – D – (+) – Glucose

The two cyclic hemiacetal forms of glucose differ only in the configuration of the hydroxyl group at C1, called anomeric carbon (the aldehyde carbon before cyclisation). Such isomers, i.e., α–form and β–form. are called **anomers.** The six membered cyclic structure of glucose is called **pyranose structure** (α–or β–), in analogy with pyran.







Pyran α–D–(+)–Glucopyranose

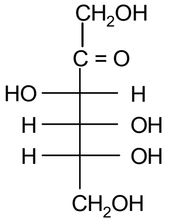
β–D–(+)–Glucoyranose

II Fructose

Fructose is an important detohexose.

Structure of Fructose

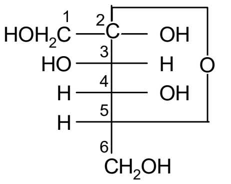
Fructose also has the molecular formula $C_6H_{12}O_6$ as a laevo rotateory compound.



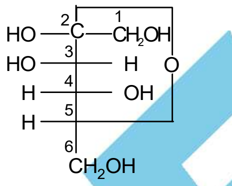
D – (–) – Fructose

It also exists in two cyclic forms which are obtained by the addition of –OH at C5 to the ($>C{=}O$) group. The ring, thus formed is a five membered ring and is named as furanose with analogy to the compound furan.

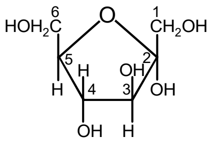
Furan



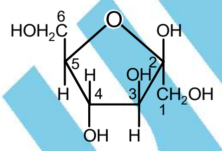
α–D–(–)–Fructofuranose



β–D–(–)–Fructofuranose



α –D–(–)–Fructofuranose



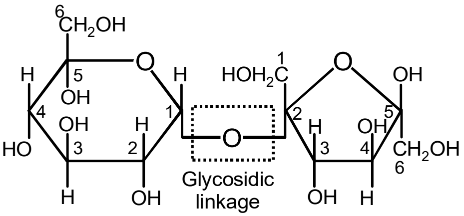
β –D–(–)–Fructofuranose

A linkage between two monosaccharide units through oxygen atom is called **glycosidic linkage.**

(i) Sucrose:

$$\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} + H_2 \rightarrow \underset{\text{d-(+)-Glucose}}{C_6H_{12}O_6} + \underset{\text{D-(–)-Fructose}}{C_6H_{12}O_6}$$

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

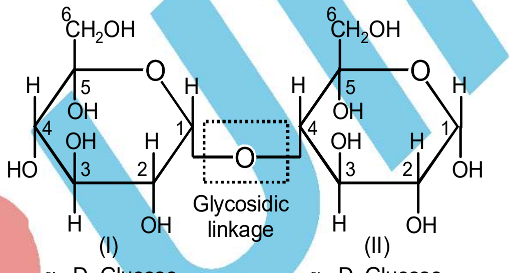


α –D–Fructose   β –D–Fructose

Sucrose

(ii) Maltose:

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

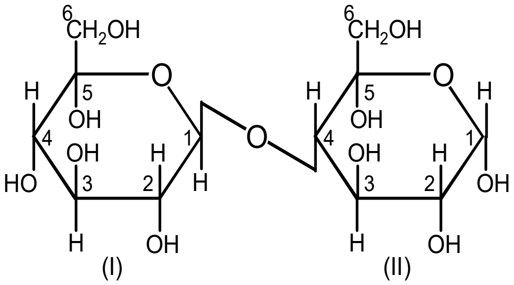


(I) α –D–Glucose   (II) α –D–Glucose

Maltose

(iii) Lactose :

Commonly known as milk sugar since this disaccharide is found in milk. It is composed of β-D-galactose and β-D-glucose. The linkage is between C1 of galactose and C4 of glucose. Hence it is also a reducing sugar.



(I) α –D–Glucose   (II) α –D–Glucose

Polysaccharides

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

(i) Starch: Starch is the main storage polysaccharide of plants. It is the most important dietary source for human beings. High content of starch is found in cereals, roots, tubers and some vegetables. It is a polymer of α–glucose and consists of two components–**Amylose** and **Amylopectin.** Amylose is water soluble component which constitutes about 15-20% of starch. Chemically amylose is a long unbranched chain with 200 - 1000 α-D-(+)-glucose units held by C 1 – C 4 glycosidic linkage.

Amylopectin is insoluble in water and constitutes about 80 - 85% of starch. It is a branched chain polymer of α -D- glucose units in which chain is formed by C 1 – C 4 glycosidic linkage whereas branching occurs by C 1 – C 6 glycosidic linkage.

(ii) Cellulose: Cellulose occurs exclusively in plants and it is the most abundant organic substance in plant kingdom. It is a predominant constituent of cell wall of plant cells. Cellulose is a straight chain polysaccharide composed only β -glucose units which are joined by glycosidic linkage between C 1 of one glucose unit and C 4 of the next glucose unit.

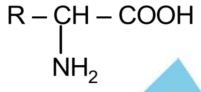
(iii) Glycogen: The carbohydrates are stored in animal body as glycogen. It is also known as animal starch because its structure is similar to amylopectin and is rather more highly branched. It is present in liver, muscles and brain. When the body needs glucose, enzymes break the glycogen down to glucose.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

Carbohydrates are found in biosystem in combination with many proteins and liqids.

PROTEINS are polymers of α-amino acids.

Amino Acids

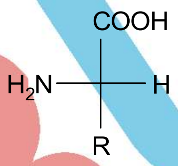
Amino acids contain amino ($-NH_2$) and carboxyl ($-COOH$) functional groups. Depending upon the relative position of amino group with respect to carboxyl group, the amino acids can be classified as α, β, γ, δ, and so on. Only α-amino acids are obtained on hydrolysis of proteins.



$$R-\underset{\displaystyle NH_2}{\underset{|}{CH}}-COOH$$

α-amino acid
(R= side chain)

Table : Natural Amino Acids



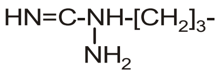
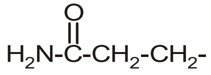
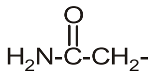
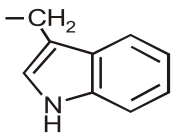
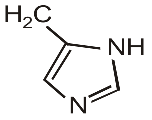
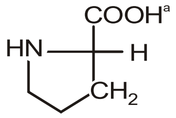
*** essential amino acid, a = entire structure**

Classification of Amino Acids

Amino acids are classified as acidic, basic or neutral depending upon the relative number of amino acid carboxyl groups in their molecule. Equal number of amino and carboxyl groups makes it neutral; more number of amino than carboxyl groups makes it basic and more carboxyl groups as compared to amino groups makes it acidic. The amino acids, which can be synthesised in the body, are known as ***non-essential amino acids.*** On the other hand, those which cannot be synthesised in the body and must be obtained through diet, are known as ***essential amino acids.***

Amino acids are usually colourless, crystalline solids. These are water-soluble, high melting solids and behave like salts rather than simple amines or carboxylic acids. This behavior is due to the presence of both acidic (carboxyl group) and basic (amino group) groups in the same molecule. In aqueous solution, the carboxyl group can lose a proton and amino group can accept a proton, giving rise to a dipolar ion known as **zwitter ion.** This is neutral but contains both positive and negative charges.

In zwitter ionic form, amino acids show amphoteric behavior as they react both with acids and bases.

Name of the amino acids	Characteristic feature of side chain, R	Three letter symbol	One letter code
1. Glycine	H	Gly	G
2. Alanine	$-CH_3$	Ala	A
3. Valine*	$(H_3C)_2CH-$	Val	V
4. Leucine*	$(H_3C)_2CH\text{-}CH_2\text{-}$	Leu	L
5. Isoleucine*		He	I
6. Arginine*	 $HN{=}\underset{\substack{\vert \\ NH_2}}{C}\text{-}NH\text{-}[CH_2]_3\text{-}$	Arg	R
7. Lysine*	$H_2N.(CH_2)_4\text{-}$	Lys	K
8. Glutamic acid	$HOOC\text{-}CH_2\text{-}CH_2\text{-}$	Glu	E
9. Aspartic acid	$HOOC - CH_2\text{-}$	Asp	D
10. Glutamine	 $H_2N\text{-}\overset{\substack{O \\ \Vert}}{C}\text{-}CH_2\text{-}CH_2\text{-}$	Gin	Q
11. Asparagine	 $H_2N\text{-}\overset{\substack{O \\ \Vert}}{C}\text{-}CH_2\text{-}$	Asn	N
12. Threonine*	$H_3C\text{-}CHOH\text{-}$	Thr	T
13. Serine	$HO\text{-}CH_2\text{-}$	Ser	S
14. Cysteine	$HS\text{-}CH_2\text{-}$	Cys	C
15. Methionine*	$H_3C\text{-}S\text{-}CH_2\text{-}CH_2\text{-}$	Met	M
16. Phenylalanine*	$C_6H_5\text{-}CH_2\text{-}$	Phe	F
17. Tyrosine	$(p)HO\text{-}C_6H_4\text{-}CH_2\text{-}$	Tyr	Y
18. Tryptophan*		Trp	W
19. Histidine*		His	H
20. Proline		Pro	P

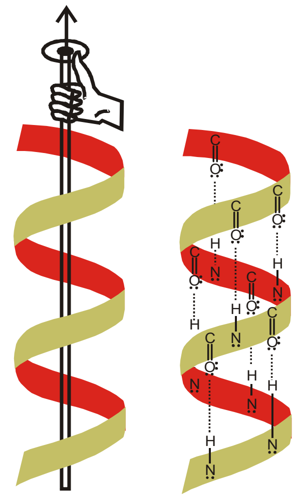
Except glycine, all other naturally occurring α-amino acids are optically active, since the α-carbon atom is asymmetric. These exist both 'D' and 'L' forms. Most naturaly occurring amino acids have L-configuration, L-Aminoacids are represented by writing the $-NH_2$ group on left hand side.

Structure of Proteins

The polymers of α-amino acids and they are connected to each other by **peptide bond** or **peptide linkage.** Chemically, peptide linkage is an amide formed between –COOH group and $-NH_2$ group. This results in the elimination of a water molecule and formation of a peptide bond –CO–NH–. The product of the reaction is called a dipeptide because it is made up of two amino acids. For example, when carboxyl group of glycine combines with the amino group of alanine we get a **dipeptide,** Glysylalanine.

If a third amino acid combines to a dipeptide, the product is called a **tripeptide.** When the number of such amino acids is more than ten, then the products are called **polypeptides.** A polypeptide with more than hundred amino acid residues, having molecular mass higher than 10000u is called a protein. However, the distinction between a polypeptide and a protein is not very sharp. Polypeptides with fewer amino acids are likely to be called proteins if they ordinarily have a well defined conformation of a protein such as insulin which contains 51 amino acids.

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



α-Helix structure of proteins

(a) Fibrous proteins

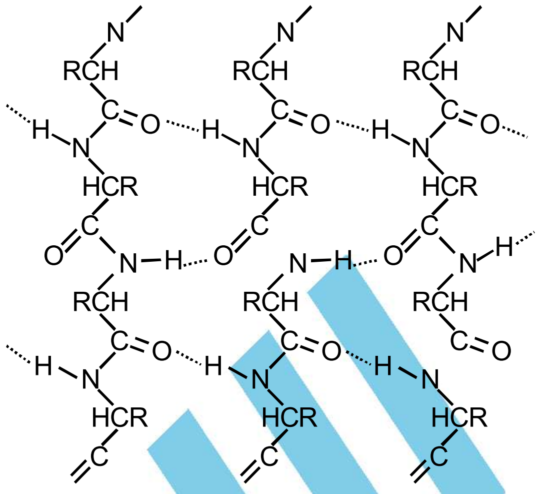
When the polypeptide chains run parallel and are held together by hydrogen and disulphide bonds, then fibre–like structure is formed. Such proteins are generaly insoluble in water. Some common examples are keratin (present in hair, wool, silk) and myosin (present in muscles), etc.

(b) Globular proteins

this structure results when the chains of polypeptides coil around to give spherical shape. These are usually soluble in water. Insulin and albumins are the common examples of globular proteins.

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

(ii) Secondary structure of proteins: The secondary structure of protein refers to the shape in which a long polypeptide chain can exist. They are found to exist in two different types of structures viz. α-helix and β-pleated sheet structure. These structures arise due to the regular folding of the backbone of the polypeptide chain due to hydrogen bonding between $-\overset{\overset{O}{\|}}{C}-$ and –NH –Groups of the peptide bond.



β -Pleated sheet structure of proteins

α-Helix is one of the most common ways in which a polypeptide chain forms all possible hydrogen bonds by twisting into a right handed screw (helix) with the –NH group of each amino acid residue hydrogen bonded to the $\rangle C = O$ of an adjacent turn of the helix. In β-structure all peptide chains are stretched out to nearly maximum extension and then laid side by side which are held together by intermolecular hydrogen bonds. The structure resembles the pleated folds of drapery and therefore is known as β-pleated sheet.

(iii) Tertiary structure of proteins: The tertiary structure of proteins represents overall folding of the polypeptide chains i.e., further folding of the secondary structure. It gives rise to two major molecular shapes viz. Fibrous and globular. The main forces which stabiles the 2^o and 3^o structures of proteins are hydrogen bonds, disulphide linkages, van der Waals and electrostatic forces of attraction.

(iv) Quaternary structure of proteins: Some of the proteins are composed of two or more polypeptide chains referred to as sub-units. The spatial arrangement of these subunits with respect to each other is known as quaternary structure.

Denaturation of Proteins

Protein found in a biological system with a unique three-dimensional structure and biological activity is called a native protein. When a protein in its native form, is subjected to physical change like change in temperature or chemical change like change in pH, the hydrogen bonds are disturbed. Due to this, globules unfold and helix get uncoiled and protein loses its biological activity. This is called **denaturation** of protein. During denaturation 2º and 3º structures are destroyed but 1º structure remains intact. The coagulation of egg white on boiling is a common example of denaturation. Another example is curdling of milk which is caused due to the formation of lactic acid by the bacteria present in milk.

Biocatalysis

Enzymes are very specific for a particular reaction and for a particular substrate. They are generally named after the compound or class of compounds upon which they work. For example, the enzyme that catalyses hydrolysis of maltose into glucose in named as **maltase.**

$$\underset{\text{Maltose}}{C_{12}H_{22}O_{11}} \xrightarrow{\text{Maltase}} \underset{\text{Glucose}}{2C_6H_{12}O_6}$$

The enzymes which catalyse the oxidation of one substrate with simultaneous reduction of another substrate are named as **oxidoreductase** enzymers. The ending of the name of an enzyme is –**ase.**

Vitamins

Organic compounds required in the diet in small amounts to perform specific biological functions for normal maintenance of opotimum growth and health of the organism. Vitamins are designated by alphabets A, B, C, D, etc. Some of them are further named as sub-groups e.g. B_1, B_2, B_6, B_{12}, etc. Excess of vitamins is also harmful.

Classification of Vitamins

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

(ii) Water soluble vitamins: Water soluble vitamins must be supplied regularly in diet because they are readily excreted in urine and cannot be stored (except vitamin B_{12}) in our body. eg. - vitamins B & C .

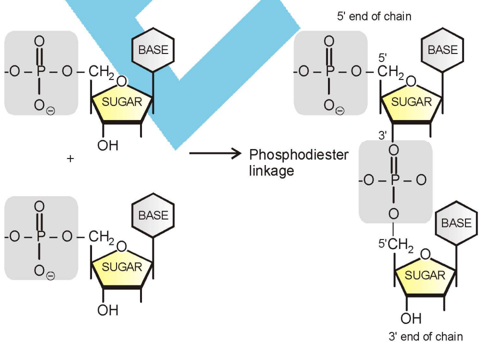
Table : Some important Vitamins, their Sources and their Deficiency Diseases

NUCLEIC ACIDS are the polymers of nucleotides which in turn consist of a base, a pentose sugar and phosphate moiety. Nucleic acids are respeonsible for the transfer of characters from parents to offsprings. There are two types of nucleic acids – **DNA** and **RNA.** DNA contains a five carbon sugar molecule called **2-deoxyribose** whereas RNA contains ribose. Both DNA and RNA contain adenine, guanine and cytosine. The fourth base is thymine in DNA and uracil in RNA. The structure of DNA is a double strand whereas RNA is a single strand molecule. DNA is the chemical basis of heredity and have the coded message for proteins to be synthesised in the cell. There are three types of RNA – mRNA, rRNA and tRNA which actually carry out the protein synthesis in the cell.

S1/ No.	Name of Vitamins	Sources	Deficiency diseases
1	Vitamin A	Fish liver oil, carrots, butter and milk	Xerophthalmia (hardening of cornea of eye) Night blindness
2	Vitamin B_1 (Thiamine)	Yeast, milk, green vegetables and cereals	Beri beri (loss of appetite, retarded growth)
3	Vitamin B_2 (Riboflavin)	Milk, eggwhite, liver, kidney	Cheilosis (fissuring at corners of mouth and lips), digestive disorders and burning sensation of the skin.
4	Vitamin B_6 (Pyridoxine)	Yeast, milk, egg yolk, cereals and grams	Convulsions
5	Vitamin B_{12}	Meat, fish, egg and curd	Pernicious anaemia (RBC deficient in haemoglobin)
6	Vitamin C (Ascrobic acid	Citrus fruits, amla and green leafy vegetables	Scurvy (bleeding gums)
7	Vitamin D	Exposure to sunlight, fish and egg yolk	Rickets (bone deformities in children) and osteomalacia (soft bones and joint pain in adults)
8	Vitamin E	Vegetable oils like wheat germ oil, sunflower oil, etc,	Increased fragility of RBCs and muscular weakness
9	Vitamin K	Green leafy vegetables	Increased blood clotting time

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 in 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. The sequence of nucleotides in the chain of a nueleic acid is caled its primary structure. Nucleic acids have a secondary structure also. James Watson and francis Crick gave a double strand helix structure of 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.

SOLVED PROBLEMS

Q.1 The melting points and solubility in water of amino acids are generally higher than that of the corresponding holo acids. Explain.

Sol. Amino acid molecules are dipolar (Zwitter ion) and so have strong intermolecular electrostatic forces between them. This makes their melting points and solubility in water higher than corresponding halo acids because in halo acids there is only hydrogen bonding between their molecules.

Q.2 Where does the water present in the egg go after boiling the egg?

Sol. After boiling, the water soluble gobular protein of egg white gets denatured and it coagulates into hard and rubbery insoluble mass.

Q.3 Why vitamin C cannot be strored in our body?

Sol. Vitamin C is water soluble vitamin and so it is readily excreted through urine and hence cannot be stored in our body.

Q.4 What products would be formed when a nucleotide from DNA containing thymine is hydrolysed?

Sol. Complete hydrolysis of a nucleotide from DNA containing thymine will yield.

(i) Phosphoric acid
(ii) β-D-2-Deoxyribose sugar
(iii) Thymine, cystosine (Pyrimidines)
(iv) Adenine and guanine.

Q.5 What are reducing sugars?

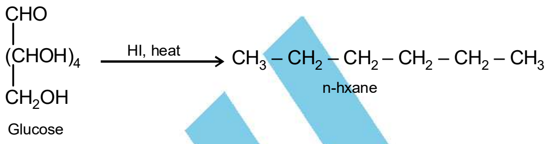
Sol. All those carbohydrates which reduce Felling's solution and Tollen's reagent are referred to as reducing sugars. All monosacchrides whether aldoses or ketoses are reducing sugars. Disaccharides other than sucrose in which aldehydic or ketonic groups are free, are called reducing sugars for example maltose and lactose.

Q.6 What is the basic structural difference between starch and cellusose?

Sol. Starch is a mixture of amylose (linear polymer of α-glucose) and amylopectin (branched chain polymer of α-glucose) whereas cellulose is a linear polymer of β–glucose.

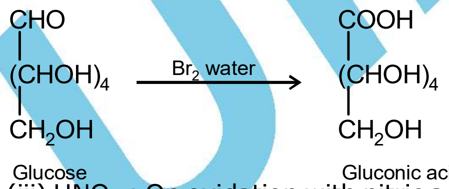
Q.7 What happens when D-glucose is treated with the following reagents?
(i) HI (ii) Bromine water (iii) HNO_3

Sol. (i) HI : On prolonged heating with HI, glucose forms n-hexane.



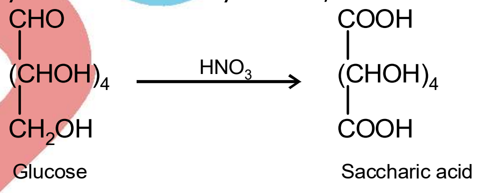
$$\begin{matrix}CHO\\ |\\ (CHOH)_4\\ |\\ CH_2OH\end{matrix} \xrightarrow{\text{HI, heat}} CH_3-CH_2-CH_2-CH_2-CH_2-CH_3$$

(ii) Br_2 water : Glucose gets oxidised to six carbon carboxylic acid (gluconic acid) on reaction with a mild oxidising agent like bromine water.



$$\begin{matrix}CHO\\ |\\ (CHOH)_4\\ |\\ CH_2OH\end{matrix} \xrightarrow{Br_2\text{ water}} \begin{matrix}COOH\\ |\\ (CHOH)_4\\ |\\ CH_2OH\end{matrix}$$

(iii) HNO_3 : On oxidation with nitric acid, glucose yields a dicarboxylic acid, saccharic acid.



$$\begin{matrix}CHO\\ |\\ (CHOH)_4\\ |\\ CH_2OH\end{matrix} \xrightarrow{HNO_3} \begin{matrix}COOH\\ |\\ (CHOH)_4\\ |\\ COOH\end{matrix}$$

Q.8 Enumerate the reactions of D-glucose which cannot be explained by its open chain structure.

Sol. (i) Glucose does not give 2,4-DNP test, Schiff's reagent test and does not react with sodium hydrogen sulphite and ammonia. These reactions indicate that glucose does not contain – CHO group.

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

(iii) Glucose exists in two different crystalline forms which are known as α and β.

Q.9 What type of bonding helps in stabilising the α-helix structure of proteins?

Sol. In a α-helix structure, polypeptide chains of amino acids coil as a right handed screw because of the formation of all possible hydrogen bonds between – NH group of each amino and > C = O group of adjacent turn of the helix.

Q.10 Differentiate between globular and fibrous proteins.

Sol.

	GlobularProteins	FibrousProteins
1.	Globular proteins have more or less spherical Shape (compact structure), because α - helix are tightly held up by weak attractive forces of various types : Hydrogen bonding, disulphide bridges, ionic or salt bridges.	Fibrous proteins are made up of polypeptide chains that run parallel to the axis and are held together by strong hydrogen and disulphide bonds. They can be stretched and contracted like a thread.
2.	Globular proteins are usually soluble in water.	Fibrous proteins are usually insolube in water.
3.	Examples : Insulin, thyroglobin, albumins, haemoglobin.	Examples : Keratins (hair, wood, silk, nails), myosins, elastins.

Q.11 What is the difference between a nucleoside and a nucleotide?

Sol. (i) Nucleotide: It is the phosphate ester of nucleoside. It is made up of three parts: Phosphoric acid, pentose sugar, heterocyclic compounds (Purines and Pyrimidines).

Nucleotide on hydrolysis gives nucleoside and phosphate groups.

(ii) Nucleoside : It is a glucoside like complex of a carbohydrates and nitrogen containing bases like purines and pyrimidines. Nucleoside on hydrolysis gives a sugar, two purines and two pyrimidines.

Q.12 The two strands in DNA are not identical but complementary. Exaplain.

Sol. The two strands are complementary to each other because the hydrogen bonds are formed between specific Pairs of bases. Adenine forms two hydrogen bonds with thymine whereas cystosine forms three hydrogen bonds with guanine.

Due to this base pairing principle, the sequence of bases in one strand automatically fixes the sequence of bases in the other stand. Thus, the two strands are complementary and not identical.

Hydrogen bonds are formed between complementary base pairs.

Q.13 Write important structural and functional differences between DNA and RNA.

Sol.

	DNA	RNA
1.	Deoxy - ribose sugar.	Ribose sugar.
2.	Pyrimidine base is thymine.	Pyrimidine base is uracil.
3.	One type of DNA.	Three types of RNA, messenger-RNA, ribosomal -RNA and transfer-RNA.
4.	Found in the nucleus of the cell.	Found in the fluid outside the cell (cytoplasm)
5.	Very large polmers.	Comparatively smaller molecules.
6.	Double helix structure.	Single helix structure.
7.	Base pairing is A-T and C-G.	Base pairing is A-U and C-G.
8.	Responsible for transmission of hereditary	Responsible for synthesis of

EXERCISE-I UNSOLVED PROBLEMS

Q.1 Classify the following into monosaccharides and disaccharides. Ribose, 2-deoxyribose, maltose, galactose, fructose and lactose.

Q.2 What do you understand by the term glycosidic linkage?

Q.3 What is glycogen? How it is different from starch?

Q.4 What are essential and non-essential amino acids? Give two examples of each type

Q.5 Define the following as selected to proteins

(i) Peptide linkage (ii) Primary structure

Q.6 How do you explain the amphoteric behaviour of amino acids?

Q.7 What are enzymes?

Q.8 What is the effect of denaturation on the structure of proteins ?

Q.9 How are vitamins classified? Name the vitamin responsible for the coagulation of blood.

Q.10 Why vitamin A and vitamin C essential to us? Give their important sources.

Q.11 What are nucleic acids ? Mention their two important functions.

Q.12 What are anomers?

Q.13 How is excess glucose stored in our body?

Q.14 What is peptide bond?

Q.15 What are monosaccharides?

EXERCISE-II BOARD PROBLEMS

Q.1 Name the products obtained on complete hydrolysis of DNA. Enumerate the structural differences between DNA and RNA. in what way is a nucleotide different from a nucleoside ? Illustrate with examples.

Q.2 Define and classify vitamins. Name the diseases caused due to lack of any three of them.

Q.3 How does DNA replicate? Describe the mechanism of replication. How is the process responsible for preservation of heredity?

Q.4 What deficiency diseases are caused due to lack of vitamins A, B, B_6 and K in human diet?

Q.5 State the consititutional difference between DNA and RNA. Write down the names of the bases produced on hydrolysis of DNA.

Q.6 (a) Write reactions to show how glucose separately reacts with
(i) NH_2OH (ii) HNO_3
(iii) Ammonical $AgNO_3$
(b) What do you understand by
(i) Denaturation and
(ii) Renaturation of Proteins?

Q.7 (a) Define vitamins and state their classification. List two vitamins of each class.
(b) What are enzymes ? state the activity of an enzyme.

Q.8 Name the food sources and the deficiency diseases caused due to lack of any two of vitamins A, C, E and K.

Q.9 (a) State the composition and functional differences between DNA and RNA. Describe the mechanism of relication of DNA.
(b) Define 'Mutation'

Q.10 State two main differences between globular proteins and fibrous proteins.

Q.11 Name the main disease caused due to lack of vitamin and it source in each of the following: A, B_6 and E.

Q.12 Write the major classes in which the carbohydrates are divided depending upon whether these undergo hydrolysis, and it so on the number of products formed.

Q.13 What are essential and non-essential amino acids? Give two examples of each.

Q.14 (a) Define the following terms:

(i) Coenzymes (ii) Nucleotides
(b) List four main functions of carbohydrates in organisms.

Q.15 (a) Name the three major classes of carbohydrates and give an example of each of these classes.
(b) Answer the following:
(i) What type of linkage is responsible for the primary structure of proteins?
(ii) Name the location where protin synthesis occurs in our body.

Q.16 Answer the following questions briefly:
(i) What are reducing sugars?
(ii) What is meant by denaturation of a protein
(iii) define enzymes.

Q.17 Answer the following questions briefly:
(i) What are any two good sources of vitamin A ?
(ii) What are nucleotides?
(iii) How are carbohydrates classified?

Q.18 Name the four bases present in DNA. Which one of these is not present in RNA?

Q.19 What are the following substance ? Give one example of each of them.
(i) Cationic detergents
(ii) Enzymes
(iii) Sweetening agents

Q.20 What is meant by 'reducing sugars'

Q.21. Essenntial and non-essential amino acids ? With example only each.

Q.22 Amino acids may be acidic, alkaline or neutral. How does this happen? What are essential and non-essential amino acids. ? Name one of each types.

Q.23 What are the products of hydrolysis of lactose

Q.24 Shanti, a domestic helper of Mrs. Anuradha, fainted while mopping the floor. Mrs. Anuradha immediately took her to her to the nearby hospital where she was diagnosed to be severely 'anaemic'. The doctor prescribed an iron rich diet and multivitamins supplement to her. Mrs. Anuradha supported her finanically to get the medicines. After a month, Shanti was diagnosed to be normal.
After reading the above passage, answer the following questions :