BIOMOLECULES

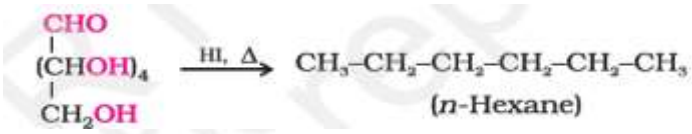
- ***carbohydrates*** *may be defined as optically active polyhydroxy aldehydes or ketones or the compounds which produce such units on hydrolysis*.

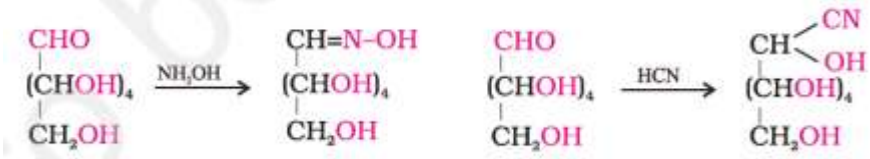
Some of the carbohydrates, which are sweet in taste, are also called sugars. e.g. common sugar

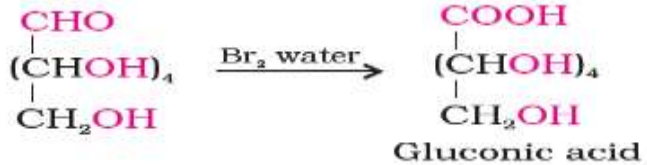
- **Classification of Carbohydrates**

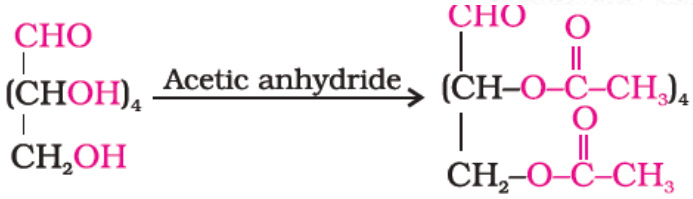
1. **Monosaccharides** : cannot be hydrolysed further to give simpler unit of polyhydroxy aldehyde or ketone.
2. **oligosaccharides :** yield two to ten monosaccharide units, on hydrolysis.
3. **Polysaccharides:** yield a large number of monosaccharide units on hydrolysis.

- **Reducing sugars**: All those carbohydrates which reduce Fehling's solution and Tollens' reagent are referred to as reducing sugars. sugars in which aldehyde & ketones functional groups are free, are called reducing sugars,

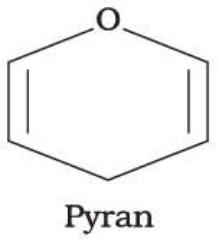


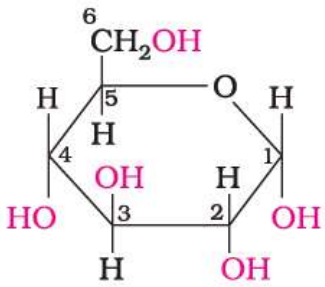




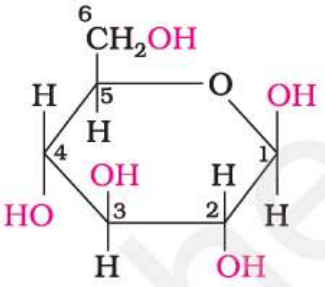


- The two cyclic hemiacetal forms of glucose differ only in theconfiguration of the hydroxyl group at C1, called *anomeric carbon*(the aldehyde carbon before cyclisation). Such isomers, i.e., α-formand β-form, are called **anomers**.
- Haworth structure of glucose



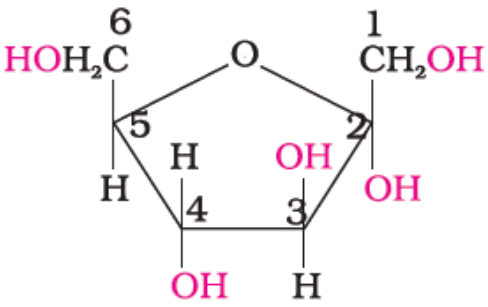


α – D – (+) – Glucopyranose

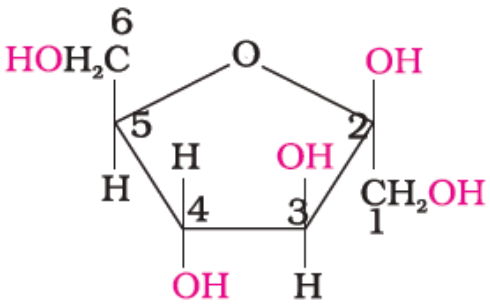


β – D – (+) – Glucopyranose

Haworth structure for fructose



α – D – (–) – Fructofuranose



β – D – (–) – Fructofuranose

Disaccharides : on hydrolysis with dilute acids or enzymes yield two molecules of either the same or different monosaccharides.

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

Invert sugar: Sucrose is dextrorotatory but after hydrolysis givesdextrorotatory glucose and laevorotatory fructose. Since the laevorotation of fructose (–92.4°) is more than dextrorotation of glucose (+ 52.5°), the mixture is laevorotatory. Thus, hydrolysis of sucrose brings about a change in the sign of rotation, from dextro(+) to laevo (–) and the product is named as **invert sugar**.

disaccharides	Hydrolysis product	
Sucrose	α-D-glucose & β-D-fructose	Non reducing sugar
Maltose	Two α-D-glucose	Reducing sugar
Lactose	β-D-galactose and α-D-glucose.	Reducing sugar

Polysaccharides

Starch:

- main storage polysaccharide of plants & the most important dietary source for human beings.
- a polymer of ⟨-glucose and consists of two components—**Amylose** and **Amylopectin**.
- Amylose is water soluble component which constitutes about 15-20% of starch.it is long unbranched chain with 200-1000 ⟨-D-(+)-glucose units held by C1– C4 glycosidic linkage.
- Amylopectin is insoluble in water and constitutes about 80-85% of starch. It is a branched chain polymer of ⟨-D-glucose units in which chain is formed by C1–C4 glycosidic linkage whereas branching occurs by C1–C6 glycosidic linkage.

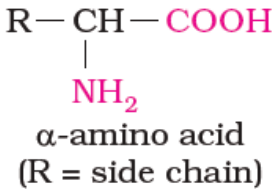
Cellulose

- constituent of cell wall of plant cells.
- β-D-glucose units which are joined by glycosidic linkage between C1 of one glucose unit and C4 of the next glucose unit.

Glycogen

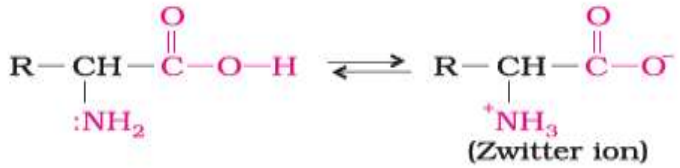
- known as *animal starch* because its structure is similar to amylopectin and is rather more highly branched. It is present in liver, muscles and brain.

PROTEINS (polymers of α-amino acids.)



α-amino acid
(R = side chain)

- Amino acids are classified as acidic, basic or neutral depending upon the relative number of amino and 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.
- synthesised in the body, are known as **non essential amino acids.**
- those which cannot be synthesised in the body and must be obtained through diet, are known as **essential amino acids**
- Zwitter ion: In aqueous solution, the carboxyl group can lose a proton and amino group can accept a proton, giving rise to a dipolar ion known as *zwitter ion*.



(Zwitter ion)

- peptide linkage is an amide formed between –COOH group and –NH_2 group
- Structure and shape of proteins

Primary structure: polypeptide chains.

Secondary structure: due to hydrogen bonding between >CO and –NH– groups of the peptide bond

Tertiary structure: hydrogen bonds, disulphide linkages, van der Waals and electrostatic forces of attraction.

Quaternary structure: The spatial arrangement of these subunits with respect to each other is known as quaternary structure.

- Denaturation of proteins: 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 proteins.
- During denaturation 2° and 3° structures are destroyed but 1º structure remains intact.

Vitamins : **organic compounds required in the diet in small amounts to perform specific biological functions for normal maintenance of optimum growth and health of the organism.**

Fat soluble vitamins: A, D, E and K.

Water soluble vitamins: B group vitamins and vitamin C

Sl. 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 (Ascorbic 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

Nucleic acid: 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**

- **deoxyribonucleic acid (DNA) and ribonucleic acid(RNA).**
- nucleic acids are long chain polymers of **nucleotides,** so they are also called polynucleotides.
- 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).
- A unit formed by the attachment of a base to 1' position of sugar is known as **nucleoside.**

Questions

1. What is meant by reducing sugars?

   Ans . those sugar which have free aldehyde group and give brick red precipitate with fehling's solution.

2. Amino acids may be acidic, alkaline or neutral. How does this happen? What are essential and non-essential amino acids? Name on of each type.

   Ans. Amino acids are classified as acidic, basic or neutral depending upon the relative number of amino and 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.

- Acidic-aspartic acid
- Basic – arginine
- Neutral -glycine

Those amino acids synthesised in the body, are known as **non essential amino acids.e.g leucine**
Those amino acids which cannot be synthesised in the body and must be obtained through diet, are known as **essential amino acids.**e.g. serine

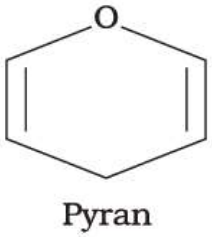
3. Define the following :

   (a) A peptide linkage (b) Glycosidic linkage (c) zwitter ion

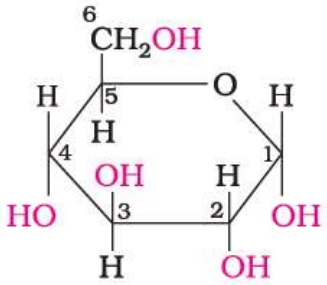
- Ans. (a) peptide linkage is an amide formed between –COOH group and $–NH_2$ group of two amino acids.
- (b)peptide linkage is an amide formed between –COOH group and $–NH_2$ group
- (c) In aqueous solutionof amino acids, the carboxyl group can lose a proton and amino group can accept a proton, giving rise to a dipolar ion known as *zwitter ion*

4. What is essentially the difference between α- glucose and β-glucose? What is meant by pyranose structure of glucose?

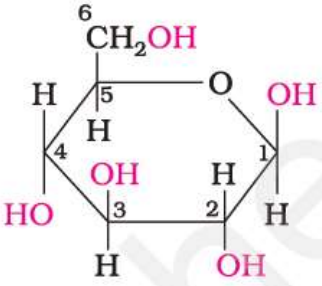
   Ans. Both are anomers of each other. First having optical rotation of $+111^0$ and the second $+19.5^0$



Pyran



α – D – (+) – Glucopyranose



β – D – (+) – Glucopyranose

5. What do you mean by invert sugar ?

   Ans. Sucrose is dextrorotatory but after hydrolysis givesdextrorotatory glucose and laevorotatory fructose. Since the laevorotation of fructose (–92.4°) is more than dextrorotation of glucose (+ 52.5°), the mixture is laevorotatory. Thus, hydrolysis of sucrose brings about a change in the sign of rotation, from dextro(+) to laevo (–) and the product is named as **invert sugar.**

6. Write the full form for DNA and RNA.
   Ans. deoxyribonucleic acid (DNA) and ribonucleic acid(RNA).

7. Write two difference between DNA and RNA.

DNA	RNA
Deoxy ribose sugar	Ribose sugar
Guanine cytosine thymine adenine bases	Guanine cytosine uracil adenine bases

8. Name the bases present in DNA and RNA.

   DNA :Guanine cytosine thymine adenine bases

   RNA: Guanine cytosine uracil adenine bases

9. What do you mean by denaturation of proteins?

Ans. 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 proteins.

10. Write the product of hydrolysis of:
    (a)sucrose
    (b)lactose
    (C) maltose
    Ans.

Sucrose -α-D-glucose & β-D-fructose
Maltose- Two α-D-glucose
Lactose-β-D-galactose and α-D-glucose.