Lecture-2

"Carbohydrates"

* chemically they are polyhydroxy aldehyde or ketone (carbonyl compounds) and their condensation products.

* $C_x(H_2O)_y$ ↓ Carbon hydrates of. — x may or may not equal to y

* means it is organic substance having C_H and 'O' in which ratio of H to O is 2:1 they are directly produced during photosynthesis of autotrophic plants.

* Carbohydrates are also called "saccharides" bic their basic components are sugars.

mono + oligo (small carbohydrate) (sweet taste) and called sugars — Carbohydrates (Hydrate of carbon) Poly (large quite tasteless)

Monosaccharides	Oligosaccharides	Polysaccharides
• [They can't be hydrolysed]	• [Can be hydrolysed to simpler components]	• [Can be hydrolysed to simpler components]
	• 2-9 monosaccharide units	• 10s many Saccharide units.
• Soluble in water	• Soluble in water	• Insoluble in water
		• They are also called "Glycans"

Monosaccharides :→ Small carbohydrates, soluble in water & sweet in taste. They can't be hydrolysed further. General formula is $C_nH_{2n}O_n$ depending on carbon atom they are of S-types.

(1) Triose (3C) → Glyceraldehyde, dihydroxy acetone

(2) Tetrose (4C) → Erythrose

(3) Pentose (5C) → Ribose, deoxyribose, Xylose, Ribulose

(4) Hexose (6C) → Glucose, Fructose, Galactose, Mannose

(5) Heptose (7C) → Sedoheptulose

Pentoses & Hexoses exists in both open chain as well as ring forms. There are two types of ring forms

Pyran — Furan

α- Below the plane of ring HO – CH2

α-ring form (Glucose)

β- above the plane of ring HO – CH2

β-ring form (Ribose)

* Fructose = Sweetest sugar also kia fruit sugar (Laevulose) — exist in nectar & Honey

* Glucose = Grape sugar or blood sugar (Dextrose)

* Galactose

= Derived monosaccharide :→ modified monosaccharides

(1) Deoxy sugar ⇒ deoxy ribose

(2) Aminosugar ⇒ Glucosamine, Galactosamine

(3) Sugar acid ⇒ Ascorbic acid, Glucuronic acid

(4) Sugar alcohol ⇒ Glycerol, mannitol

= Oligosaccharides :→ Contain 2 to 9 monomeric units.

(2) monomeric unit ⇒ Disaccharides

(3) —11— ⇒ Trisaccharides

(4) —0— ⇒ Tetrasaccharides

The smallest & commonest oligosaccharides are disaccharides. Example – Sucrose, Maltose, Lactose, Trehalose

* Sucrose :- kia cane sugar. ↓ "non-reducing sugar" — Glucose + Fructose (Acetal linkage)

* Maltose or malt sugar :- occur in malted grains of Barley (α-1-α linkage) ↓ "reducing sugar"

* Lactose or milk sugar :→ naturally found in milk (β-1-α linkage) ↓ "reducing sugar"

Reducing and Non-reducing Sugars :→

- Detect by using Fehling's solution and Benedict's Solution.
- Reducing Sugar converts $Cu^{2+} \longrightarrow Cu^{+}$ ↓ (Cuprous oxide) + red color (Cupric oxide) is colored substance

Polysaccharides :→ Formed by polymerisation of large number of monosaccharides monomer.

The right end of a polysaccharide is reducing end when as left end is named non-reducing end. overall polysaccharides is non-reducing.

Depending upon composition i.e. type of monomeric unit use to form polymer. broadly divided into ② Types

Homopolysaccharides or Homoglycans	Hetero polysaccharides or Heteroglycans
(made up of only one type of monomeric unit)	(made of more than one type of monomeric units)
Example :- cellulose, Chitin, Glycogen, Starch, Inulin	Example :- Hyaluronic acid, Chondroitin sulphate, Agar-Agar, Heparin

Polysaccharides are formed by many monomeric units, this process reduces the bulk, makes the polysaccharides almost insoluble & decreases its effect on water potential or osmotic potential of the cell, therefore, ideal for storage and as structural component

* not found in Taste, unable to pass through plasma-membrane.

* Depending on function polysaccharides are of three types.

1) Storage Polysaccharide :→ eg. glycogen, starch, Inulin
2) Structural polysaccharide :→ eg. Chitin, cellulose
3) Mucopolysaccharide :→ chondroitin sulphate, Hyluronic acid, Heparin

- Starch → storage polysaccharide in most of the plant. It is end product of photosynthesis It is stored in chloroplast as special leucoplast called amyloplast.

It consists of two components

(1) Amylose :- more soluble in water form 20-30% part of starch (linear polymer) — Unbranched chain polymer ↓ Branching at (α-1-6 linkage)

(2) Amylopectin :- (Main Body)

Chemically linked ↓ Glucose ↓ each form 6 glu unit (α-1-4 linkage)

Starch forms helical structure that can hold I_2 ∴ there form gives Blue black color with I_2 solution. while amylopectin fraction gives red-violet color with I_2.

It reduces the bulk, makes polysaccharide storage insoluble & have its effect on water potential or osmotic potential of cell. They are ∴ ideal for Storage and as structural component.

- Glycogen :→ Also kia animal starch. Storage form of glucose polymer in animal, bacteria and fungi

In our case it stored in liver & muscles (mainly skeletal)

It gives reddish color with I_2 solution white & more branching

- Insulin :- Polymer of fructose (fructan). Storage polysaccharide of roots & tubers of Dahlia

Not metabolized in Human body, readily filtered through kidney ∴ use to detect GFR

- Chitin :- It is the second most abundant organic substance. It is nitrogen containing complex polysaccharide (Homopolysaccharide – N-acetyl glucosamine)
  - It is also kia Fungal Cellulose
  - It is unbranched
  - Present in cell wall of fungus, chitinous teeth in gizzard of cockroach, chitinous exoskeleton of arthropods, chitinous rods in radulae of molluscs.

- Cellulose :- Homopolysaccharide of glucose with high tensile strength. Occur in cell wall of plants & cotton fruits. Paper made from plant pulp and cotton fibre is cellulosic.

Cellulose is the most abundant organic substance of biosphere forming 50% of carbon found in plants.

Cellulose is unbranched & linear chains. The adjacent glucose residues are joined together by β-1-4 linkage. The molecules of adjacent chains are held together by intermolecular hydrogen bond.

Polyuronic acid → Animal cement
Ca-Mg Pectate → Plant cement

Example of chemically modified sugar (amino sugar)

① Glucosamine
② N-acetyl galactosamine