Frequently Asked question

1. **Write on the chemical composition of carbohydrates in general.**

A carbohydrate is made up of carbon, hydrogen and oxygen. Their empirical formula is $C_6H_{12}O_6$ ($6C+6H_2O$).As monosaccharides carbohydrates exist in forms with number of carbon atoms ranging from 4 to 7. Carbohydrates are technically termed as 'hydrates of carbon' and structurally they are termed as polyhydroxy aldehydes or ketones depending on the functional group present. Monosaccharide units in the form of oligo and polysaccharides are bound together by a covalent bond also known as a 'glycosidic linkage'.

2. **Write on the form of carbohydrates in foods?**

Carbohydrates are common components of foods, both as natural components and as added ingredients. Carbohydrates exist mainly as monosaccharides, oligo-saccharides and polysaccharides. The monosaccharides, oligo-saccharides and some among the polysaccharides are digestible and thus become an important source of energy. Whereas, the non digestible cell wall polysaccharides provide protective benefits on long term health and can reduce the risk of certain non communicable diseases.The free sugars in foods especially glucose and disaccharides such as lactose, maltose etc are a source of energy and can rapidly digested, absorbed and utilized to yield energy.

3. **Write on the classification of carbohydrates.**

Carbohydrates can be classified based on various features, the common one being classified based on the number of sugar units they contain into the following three categories. Monosaccharides contain a single unit; oligosaccharides contain 2 to 20 sugar units and polysaccharides contain many sugar unitsas in polymers.Monosaccharides cannot be broken down to simpler carbohydrate molecules by hydrolysis, so they are sometimes referred to as 'simple sugars' (Ex: glucose). Depending on the number of monosaccharides, the oligosaccharides are classified as disaccharides (Ex: sucrose), trisaccharides (maltotriose), tetrasaccharides (Ex:stachyose). Polysaccharides are composed of a large number of monosaccharide units (200-15000) combined to form a polymer (Ex: starch, cellulose, glycogen etc).

4. **Write on D and L forms of carbohydrates with examples.**

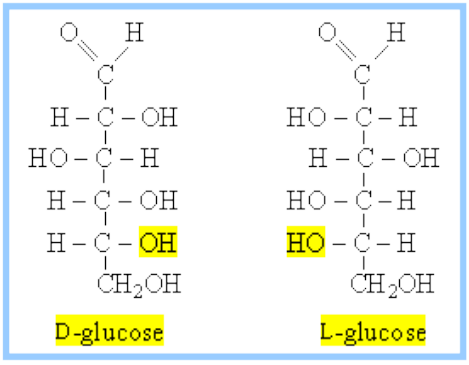
Carbohydrates contain chiral atoms thus can exist in two forms namely ‘D’ and ‘L’ forms. They are mirror images of each other. A monosaccharide is given D configurationwhen the hydroxyl group is situated to the right of the farthest asymmetric carbon atom, whereas L configuration is given if the hydroxyl group is situated to the left of the asymmetric carbon atom. Most naturally occurring sugars have D isomers. D & L sugars are mirror images of one another. For example, D-glucose and L-glucose as shown below.

5. **What are pyranose and furanose ring structures of sugars?**

The reaction of carbonyl groups of aldehydes and ketones produces end products with a cyclic structure referred to as hemiacetal. The pyranose ring is formed by the reaction of the hydroxyl group on carbon 5 (C-5) of a sugar with the aldehyde at carbon 1 resulting in the formation of a six membered ring structure (ex: D-glucose). The furanose ring is formed by the reaction of the hydroxyl group on carbon C-4 with the aldehyde at carbon 1 resulting in a five membered ring structure (ex: fructose). Further the anomeric carbon atom C-1, if the hydroxyl group located below the plane of the ring, the sugar will be said to be in alpha form (alpha D glucose) when the hydroxyl group located above the plane of the ring, it becomes the beta form (beta D glucose).

6. **Explain the features of common oligosaccharides found in foods/products.**

Some of the common disaccharides found in foods are lactose, sucrose, maltose and raffinose. Lactose is made up of glucose and galactose. It is found is mammalian milk and is the primary source of carbohydrate for an infant till 6 months of age. Hydrolysis occurs by the action of lactase in the gut. Sucrose is made up of glucose and fructose; and is generally termed ‘table sugar’ or sugar. It is hydrolysed into D-glucose and D-fructose on hydrolysis by the enzyme sucrase. Sucrose is used in bakery products and various commercial products. Maltose is made up of two unit of glucose and although not found naturally in foods, It is produced by hydrolysis of starch using the enzyme amylase and is used as a mild sweetener in foods.



7. Brief on the functions of sugar in food systems.

Sugars have numerous other functions apart from their nutritive value. Some of the important roles sugar plays when it is added to foods are as follows:

- As a Bulking agent – sugar contributes to the texture of foods such as biscuits.
- As a preservative – sugar helps to prevent or slow the growth of microbes in jams and other preserves. It also helps to prolong the shelf life of many foods by acting as a humectant by maintaining and stabilising the water content in foods. Sugars such as maltose and lactose have limited uptake of water and are used in confections and bakery toppings.
- As a colour enhancer – on heating in the presence of amino acids, sugar breaks down to produce the colour and desirable flavour that characterises many cooked foods such as muffins.
- Sugar provides optimum viscosity in beverages and semi-liquid foods like syrups, chutneys etc.

8. **Define polysaccharides. How are they different from oligosaccharides?**

Polysaccharides are polymeric forms of carbohydrates composed of long chains of monosaccharide units bound by glycosidic linkages. The number of monosaccharide in a polysaccharide varies and degree of polymerisation is a term used to understand the number of monosaccharides. Majority of them have degree of polymerisation in the range of 200–3000. Cellulose has a value of 7,000–15,000. The monosaccharides can be arranged in both linear and branched forms.Polysaccharides commonly found in foods are starch, dextrins, glycogen, cellulose, hemicellulose and pectin. Polysaccharides found in plants such as cellulose, hemicellulose and pectin provide structural material (cell walls, fibres, seed coats, peels and husks). The large number of monosaccharide units compared to oligosaccharides (2-20 units) makes polysaccharides distinct.

9. **What role do polysaccharides have in food systems?**

Polysaccharides have the ability to modify and control the movement of water in food systems and water also can influence the physical and functional properties of polysaccharides. This interplay controls many functional properties mainly texture. Some polysaccharides disperse rapidly in water, some as swollen particles and some remian

insoluble. Polysaccharides can form either translucent or opaque gels at low and high concentration with the exception of some that do not form gels. Variations in the functionality among polysaccharides are attributed to the nature of monosaccharide, type of linkages, hydrogen bonding and ionic interaction between polymers. Pectins, alginates, carrageenans, and galactomannans are important based on their structure, stability and interactions.

10. **How are polysaccharides related to optimum health?**

Starch and other storage form of carbohydrates serve as major sources of energy in all types of diets around the world.The indigestible cell wall polysaccharides are considered as the major components of dietary fiber.They form bulk in the diet and aid in excretion of faecal matter. They are known to possess mood boosting properties by increasing the amount of feel-good chemicals in the brain. They also support healthy blood sugar levels in people with diabetes where control of the rate of digestion is of utmost importance. Another benefit is in themaintenance of cardiovascular health and immunity. Polysaccharides have a great effect in the intestine, and are known to improve the intestinal health for instance reducing the risk of colon cancer.

11. **Explain the chemical composition of starch**.

The basic chemical formula of the starch molecule is $(C_6H_{10}O_5)n$. Starch is a polysaccharide comprising of glucose monomers joined together by alpha 1,4 linkages. Starch granules are composed of a mixture of two polymers: a linear polysaccharide called amylose and a highly branched polysaccharide called amylopectin. Amylose consists of glucose units linked by alpha 1-4 linkages with varying chain length and molecular weight ranging from 1.1 -1.9 million. Glucose units in amylopectin are linked in a linear way with alpha (1→4) glycosidic bonds but the branching takes place with alpha (1→6) bonds every 24 to 30 glucose units, resulting in a branched structure. The molecular weight of amylopectin is 10 million.

.12. **Explain thenature of cellulose.**

Cellulose is a beta 1,4 linked linear polymer made of glucose units. It is insoluble in water, dilute acidic solutions and dilute alkaline solutions. The degree of polymerisation ranges from 1000 to 14,000, thus making it a high molecular weight compound. Although the

structure and composition of the cell walls of plants vary widely, the cellulose content is found to be 35–50 % of dry weight except for cotton where it is found up to 100% of the total carbohydrate. The linkages are also termed as ‘beta acetal’ linkages.

13. **Write on the uses of pectins.**

Pectin is a polysaccharide made up of a mixture of galactose, arabinose and galacturonic acid and is widely distributed in plants, more specifically found in cell walls of terrestrial plants. Pectin is capable of forming gels with sugar and acids. Use of pectin is predominantly because of its ability to form gels.Pectin is used in jams, jellies, frozen foods, and also in low-calorie foods as a fat and/or sugar replacer and in nutritional/health products.It is also used in fillings, medicines, sweets, as a stabilizer in fruit juices and milk drinks, and as a source of dietary fiber.

14. **What are gums?**

Gums are polysaccharides most often found in the woody elements of plants or in seeds. Gums are polysaccharidesthat produce a gel of a viscous solution when dispersed in water at low concentrations. Examples include agar, guar gum, xanthan gum, gum arabic and carboxymethyl cellulose. Gums are derived from land based plants, seaweeds or by bacterial fermentation. Based on their gel forming ability by binding water, they are used as thickening agents, gelling agents, emulsifiers and stabilizers in food industry. Most of the gums are polysaccharides which include starches, pectins and some of their derivatives. Seed gums and seaweed gums are other naturally occurring gums.

15.**Differentiate between aldoses and ketoses.**

Carbohydrates are termed as polyhydroxyaldehydes or ketones as they yield poly hydroxyl aldehydes and ketones on hydrolysis. Monosaccharides are classified into aldehydes or ketones based on the functional group present in the structure. Monosaccharides containing aldehyde group are known as ‘aldoses’ (name ending with ‘ose’) for example glucose and those containing ketones are known as ‘ketoses’ (name ending with ‘ulose’) for example fructose. Carbon with the ketone group is always found in the carbon atom number two whereas the carbon atom with the aldehyde group is always assigned as first carbon atom.