Frequently Asked Questions

1. **Write on the oxidation of carbohydrates.**

Carbohydrates get oxidised in neutral or mild alkaline media. For instance, aldoses are oxidized to aldonic acids with bromine water in buffered neutral or alkaline media. Beta pyranose forms are more susceptible to oxidation than the alpha forms. Acids are obtained by the oxidation of aldonic acids by fehling's solution, which is an alkaline solution of copper that gets reduced in the process. The products of this reaction are termed as aldonic acids. Example : D-glucose on oxidation yields D-gluconic acid. When the hydroxymethyl groups are oxidised, uronic acids are formed. These can further take form as pyranose or furanose ringed structures. Example: D-galactose on oxidation yield D-galacturonic acids.

2. **Write on the reduction reaction of carbohydrates.**

Carbohydrates get reduced or gains hydrogen atom on hydrogenation. The addition of hydrogen takes place between the carbon and oxygen atom of the carbonyl group of an aldose or a ketose resulting in the formation of a sugar alcohol with suffix 'itol'. The hydrogenation of D-glucose leads to the formation of D-glucitol, commonly known as sorbitol. D-Mannitol is obtained by hydrogenation of D-mannose and Xylitol is produced from hydrogenation of D-xylose. The reducing is carried out using sodium borohydride or by catalytic hydrogenation. The sugar alcohols are widely used as humectants, artificial sweetners and softeners in dehydrated foods.

3. **How are esters of carbohydrates formed?**

Esters of carbohydrates are formed when the hydroxyl group of the carbohydrate reacts with an activated form of a carboxylic acid from an organic or inorganic acid. Esterification is the reverse process of hydrolysis. The end products have at least one hydroxyl group replaced by an alkyl group. Carbohydrates occur in nature as esters of acetates, succinates and carboxylic acid. They are especially found as components of polysaccharides such as potato and corn starch.

4. **What is Caramelization?**

Caramelization is the process of oxidation of sugar, which is one of the types of non-enzymatic browning reactioncharacterised by the absence of amino acid. In this process, volatile chemicals are released producing the characteristic caramel flavour. The reaction involves the removal of water (as steam) followed by break down of the sugar. The reaction depends on the type of sugar used. Sucrose and glucose caramelize around 160^{o}C and fructose caramelizes at 110^{o}C.This reaction is facilitated by small amounts of acids and certain salts. The final product is also termed as 'caramel' contains a complex mixture of polymeric compounds which are made up of unsaturated cyclic compounds.

5. **Explain the Maillard reaction.**

Maillard reaction is the browning of foods commonly seen on heating or on storage. It is due to a chemical reaction between reducing sugars, mainly d-glucose and a primary amino group (a free amino acid or amino group on a side chain of a protein molecule.) It is a complex series of reactions that usually occurs at increased temperatures usually above 140^{o}C. The overall process and termed as *Maillard browning*. The absence of enzymes in this process places it under the category of non-enzymatic browning reaction.The Maillard reaction is responsible for many colours and flavours in foodstuffs such as caramel made from milk and sugar, bread toast, beer, chocolate, coffee, roasted meat etc.

6. **What is an Amadori product?**

The Maillard reaction involves a chemical reaction between a sugar with a protein where, the aldehyde group of a glucose molecule will combine with the amino group of a lysine molecule (in a protein) to form an imine or Schiff base, which is a double bond between the carbon atom of the glucose and the nitrogen atom of lysine. On continued exposure, the Schiff base which is a glucose-protein complex undergoes rearrangement into a more stable compound known as an Amadori product which has less reversibility. This is further dehydrated, fragmented and polymerized to form end products with distinctive flavour.

7. **What are acrylamides and how are they formed?**

Acrylamide is derived primarily from the reaction between reducing sugars and the α-amino group of free L-asparagine. Foods with free L aspargine and reducing sugars are

susceptible to the formation of acrylamides on heating to a high temperature in processes such as frying, roasting, and baking. Although present naturally in some foods, the amount is insufficient to pose a risk of toxicity and larger amounts are formedonly on cooking.Acrylamide is a known neurotoxicant and a weak carcinogen in humans.Longer cooking times and cooking at higher temperatures can increase the amount of acrylamide in foods further.Acrylamide is found in foods such as potato products, grain products and coffee. Foods such as French fries and potato chips have the highest levels of acrylamide.

8. **How is hydrolysis of starch carried out?**

Starch is hydrolysed by means of acid hydrolysis and enzyme hydrolysis.The acid hydrolysis of starch hada widespread use, which is largely now replaced by enzymatic processes. Starch molecules undergo depolymerization by hot acids similar to other polysaccharide molecules. Hydrolysis of the glycosidic linkage occurs initially to produce very large fragments. On continued hydrolysis, dextrins are produced. Cooked starch hydrolysis can yield maltodextrins.Enzymes used for starch hydrolysis are α-Amylase, that cleaves both amylose and amylopectin molecules producing oligosaccharides. Glucoamylase (amyloglucosidase) is another enzyme used commercially in combination with α-amylase for the production of d-glucose (dextrose) syrups and crystalline d-glucose.

9. **What are the important by products of starch hydrolysis? Brief on their uses.**

The important products of starch hydrolysis used in food industry are as follows:

- Maltodextrin, which is a lightly hydrolyzed starch product with dextrose equivalent (DE) value of 10-20 and is used as a thickener and source of carbohydrates in commercial nutritional supplements.
- Various glucose syrups with DE ranging from 30–70, also called as ‘corn syrups’are formed. These are viscous solutions commonly used as sweeteners and thickeners in many kinds of processed foods.
- Dextrose with a DE of 100 which is also known as commercial glucose

- High fructose syrup, which is obtained by treating dextrose solutions with the enzyme glucose ‘isomerase’.It is the principal sweetener used in processed foods and beverages in the Western countries.

10. **What are modified starches? List the types of modified starches.**

The alteration of the properties of native starch present in foods can be achieved by physical and chemical methods. This is carried out with an intention to improve the physic-chemical properties of starch. The native starches on cooking produce rubbery pastes which form gels with undesirable consistency when the pastes are cooled. In order to overcome this and to improve the characteristics of gels and pastes obtained, the starch is modified and the products are termed as modified starches. Chemical modifications lead to the formation of crosslinked, stabilized, oxidized, and depolymerized products. Physical modifications lead to the formation of pre-gelatinized and cold-water-swelling products.

11. **What is pre-gelatinizedstarch? Write on its application.**

Pre-gelatinized starch is a starch that has been pre-cooked, dried and ground into flake or powder form.Heating of starch suspensions followed by drying results in the formation of end products that have the ability to swell in cold water and can form gels on heating. This type of modified starch dissolves easily and rapidlyin cold liquids and allows products to develop full viscosity without cooking.Pre-gelatinized starch is used to thicken instant desserts, allowing the food to thicken with the addition of cold water or milk. Other uses are in pizza toppings and dry mixes such as instant pudding mixes.

12. **Write on the nature and uses of cold water swelling starch.**

Cold water-swelling starch is a modified starch that remains as an intact granule. It is made by heating corn starch in 75–90% ethanol or by spray-drying process. The granules remain intact and on addition to water, they swell similar to cooked starch granules. Such starch is dispersible in sugar solutions or in corn syrups by rapid stirring. The resulting dispersion can be poured into molds, where it sets to a rigid gel that can be sliced easily. This gel can be sliced and is used in making desserts and muffins. Thus cold water swelling starch is used in preparation of

desserts and muffin batters. They are used as thickeners puddings, pie fillings, sauces, gravies and dips.

13. **Write on stabilized starches and its applications.**

Starch is stabilized which is also termed as substitution or stabilization process with an aim to primarily prevent the retrogradation of cooked starch, especially in the frozen and refrigerated food products containing cooked starch. The starch is stabilized by adding mono-functional reagentsthat act on the starch backbone to prevent inter chain associations, thus preventing the original starch molecules from re-associating.Stabilized products have lower gelatinization and pasting temperatures. They have a greater stability, improved freeze–thaw stability and greater clarity as compared to the untreated starch.

14. **How is Carboxymethylcellulose produced? Write on its uses.**

Carboxy methycellulose is obtained by treating alkaline cellulose with choloroacetic acid; the alkaline cellulose is obtained by the treatment of wood pulp with sodium hydroxide. Carboxymethylcellulose is widely used as a food gum. Other uses of Carboxymethylcellulose are as emulsifier stabilizer in foods such as beverages (soya milk, peanut milk etc), enhancer of solubility of proteins in cakes and soups, used in baked foods to avoid syneresis, to preserve the texture of pulp used in fruit juices and as binding and thickening agent in jellies, paste fillings, cheeses, salad dressings, cake fillings and icings.

15. **What are Methylcelluloses and Hydroxypropylmethylcelluloses? Write on their uses.**

Methylcelluloses and Hydroxypropylmethylcelluloses are the products of reaction of cellulose with methyl chloride or propylene oxide in the presence of a strong alkali that results in introduction of methyl or hydroxymethyl groups into the native cellulose structure. The nature of the substituent used, the degree of substitution decides the swelling capacity and solubility of the products. Methyl cellulose is used as a thickener, emulsifier, gel forming agent and clinical uses include as a tear substitute and as a laxative. Hydroxypropylmethyl cellulose is used as a thickener in sauces, flavour enhancer in fruit syrups, to enhance swelling of starch in baked goods and as fat replacers in food products.