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Glucose: A Review

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Abstract

Glucose is the most abundant monosaccharide (a type of carbohydrate) on the planet and the primary source of energy for all living things. It's the sugar made by plants from water and carbon dioxide with the help of sunshine, and it circulates in the blood of humans and other animals as a source of energy. The chemical formula of glucose is C6H12O6, and its empirical or simplest formula is CH2O, indicating that each carbon and oxygen atom in the molecule has two hydrogen atoms. Dextrose, blood sugar, maize sugar, grape sugar, and its IUPAC scientific name (2R,3S,4R,5R)-2,3,4,5,6-Pentahydroxyhexanal are all names for glucose. Glucose forms isomers, which are chemically similar but have various conformations, just like other sugars. Only D-glucose is found in nature. It is possible to synthesize L-glucose. The World Health Organization's List of Essential Medicines, which includes the safest and most effective medicines required in a health system, includes glucose as an intravenous sugar solution. It's also included on the list when combined with sodium chloride. The structure, physical characteristics, chemical properties, biological properties, and analysis of glucose and glucose-related biopolymers will be discussed in this paper.

Keywords: Glucose, carbohydrate, monosaccharide, oilgosaccharide, polysaccharide, starch, cellulose.

1. Introduction

D-glucose, the most abundant carbohydrate and organic component (when all of its forms are taken into account), belongs to the monosaccharide class of carbohydrates. Monosaccharides, often known as simple sugars, are carbohydrate molecules that cannot be broken down into simpler carbohydrate molecules by hydrolysis. They can be combined to form bigger structures, such as oligosaccharides and polysaccharides, which can then be hydrolyzed to provide monosaccharides.

It's found in fruits and honey, and it's the most common free sugar in higher animals' blood. It is the source of energy for cell function, and its metabolism must be carefully regulated (gluconeogenesis). Starch, a primary energy-reserve carbohydrate in plants, and cellulose molecules both contain thousands of glucose units. Glycogen, the reserve carbohydrate in most vertebrate and invertebrate animal cells, as well as fungi and protozoans, is also made up of glucose. Glucose provides around 3.75 kilocalories of energy per gram in the human body. It is broken down into carbon dioxide and water, yielding ATP, which is a molecular type of energy. While glucose is required for a variety of processes, it is particularly significant since it provides approximately all of the energy required by the human brain.

Because glucose includes six carbon atoms, it is referred to as hexose sugar. It is a type of aldohexose in particular. It's available in both linear and cyclic forms (most common). It has a six-carbon backbone and no branches in its linear shape. The carbon with the aldehyde group is C-1, while the other five carbons all have a hydroxyl group. Isomerization occurs when the hydrogen and -OH groups in glucose may rotate around the carbon atoms. D-glucose, the D-isomer, is found in nature and is used by plants and animals for cellular respiration.

2. Discussion of Glucose and Related Polymers

2.1. Glucose

Andreas Marggraf, a German chemist, extracted glucose for the first time in 1747 from raisins. Johann Tobias Lowitz found it in grapes in 1792, and it was recognized from cane sugar by its taste (sucrose). Jean Dumas invented the term glucose in 1838, derived from the Greek word gleucos, which meaning "sweet" or "sugar." In glucose, the -ose suffix denotes that the molecule is a carbohydrate. Emil Fischer was awarded the Nobel Prize in Chemistry in 1902 for his research into the structure and characteristics of the molecule. D-(+)-glucose, often known as dextrose, is a 2,3,4,5,6-pentahydroxyhexaldehyde with a molecular weight of 180.16 kDa and a molecular formula of C6H12O6. In powder form, glucose is easily soluble in water. -D-glucose hydrate is the stable form below 50 degrees Celsius; at 50 degrees Celsius, the anhydrous form is obtained; and at higher temperatures, -D-glucose is obtained. Glucose can also be found in foods as part of disaccharides such as sucrose (glucose and fructose), lactose (glucose and galactose), and maltose (glucose and maltose) (glucose).

D-glucose is an aldehyde and a polyalcohol. It's classed as an aldose, which refers to sugars with an aldehyde group. The suffix -ose denotes sugar, while -ald denotes an aldehyde group. C-2, C-3, C-4, and C-5 are the four chiral carbon atoms in glucose. The D-form, or D-glucose, is the most common type of glucose found in nature. The L-form, namely L-glucose, is its chemical mirror image. There are 2n arrangements for chiral carbon atoms because each one has a mirror counterpart. As a result, there are 24 or 16 alternative arrangements of carbon atoms with secondary hydroxyl groups in a six-carbon aldose, permitting the production of 16 different six-carbon sugars with an aldehyde end. Eight of these are from the D-series, while the other eight are from the L-series.

All sugars with the hydroxyl group on the highest numbered chiral carbon atom (C-5 in the case of glucose) positioned on the right-hand side are referred to as D-sugars, while those with the hydroxyl group on the highest numbered chiral carbon atom positioned on the left-hand side are referred to as L-sugars. Two structures of D-glucose in their open-chain, acyclic form (known as the Fischer projection) with carbon atoms numbered in the traditional way. Hexoses, the most frequent group of aldoses, including D-glucose and all other sugars with six carbon atoms. The category names are frequently combined, with an aldohexose sugar having six carbon atoms. Glucose is depicted in a specific configuration in the Fischer projection. The hydroxyls on C-2, C-4, and C-5 are on the right side of the carbon backbone, whereas the hydroxyl on C-3 is on the left.

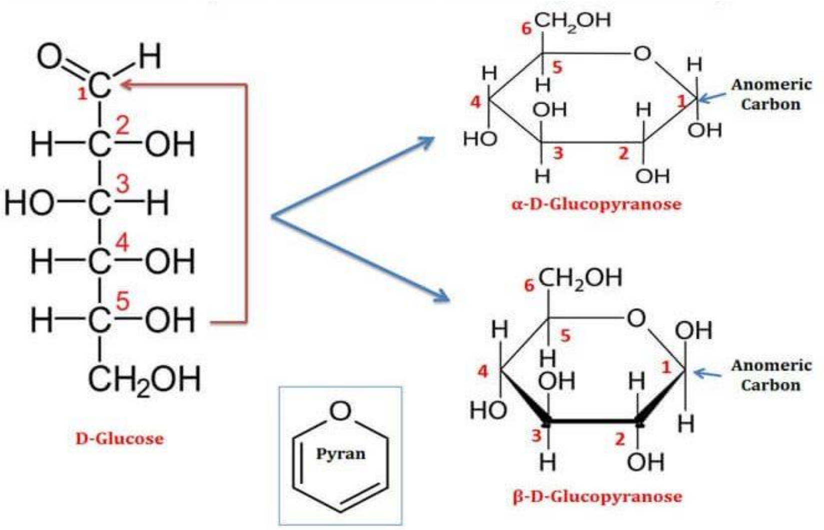

Fig 1: Open chain and cyclic structure of glucose

2.2. Glucose Oligosaccharides

Oligosaccharides (from the Greek oligo, 'few') are carbohydrate chains made up of three to ten sugar units. However, some authors include disaccharides and carbohydrates with up to 20 residues. Maltose, maltotriose, and maltotetraose are the dimer, trimer, and tetramer forms of glucose molecules connected by (1–4) links, respectively, because these compounds are the results of starch digestion in the malting process. Dietary disaccharides include sucrose, maltose, and lactose.

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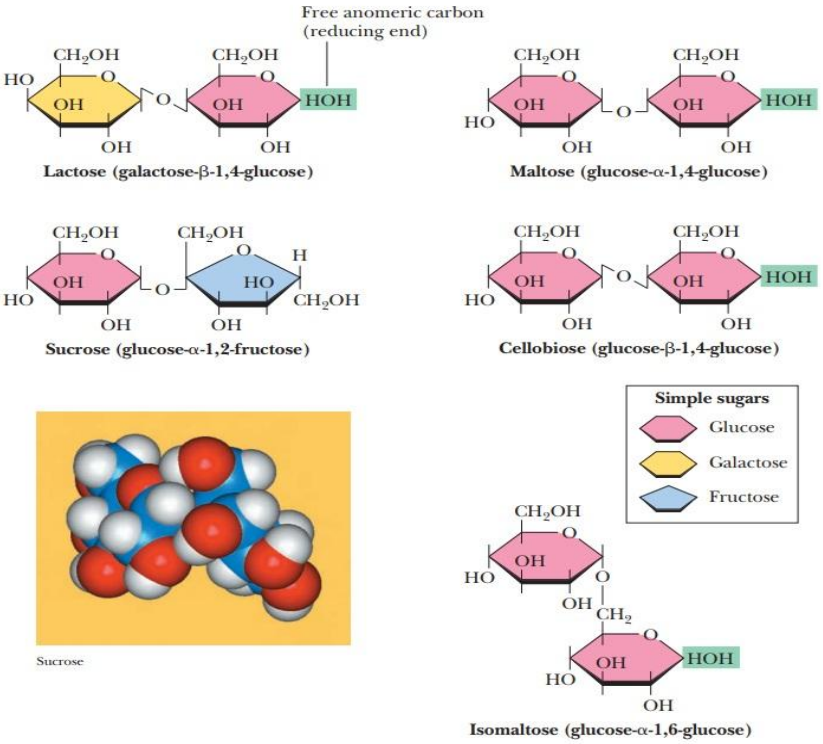

Fig 2: Structures of Different Oligosaccharides

2.3. Starch

Starch is a carbohydrate that may be found in nature and is one of the most important sources of energy for humans. Wheat, rice, potatoes, and other staple crops grown all over the world are consumed on a daily basis. Starch is one of the three basic types of carbohydrates, along with fiber and sugar. It is a glucose (C6H10O5)n -linked polymer with a significant molecular weight. The majority of starches have a mix of -(1-4) and -(1-6) connections. The linear shape of the -(1-4)-linked polymer allows for hydrogen bonding between polymer chains and a more compact starch structure. The addition of (1-6) linkages creates branch points and a more open structure, allowing the (1-4)-linked backbone with the hemiacetal bond in the alpha configuration to coil into a helical shape like a spring. Branched starches with the (1-6) linkage are more easily hydrated and digested than linear starches with the (1-4) linkage. Amylose starch is the (1-4)-linked starch, while amylopectin starch is the (1-6)-linked starch.

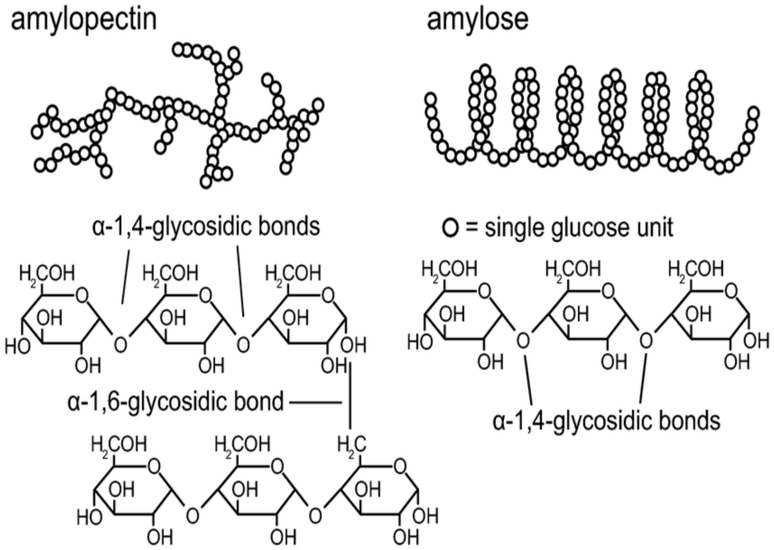

Fig 3: Structure of Amylose and Amylopectin (Starch)

2.4. Resistant Starch

A carbohydrate that resists digestion in the small intestine and ferments in the large intestine is known as resistant starch. The fibers function as a prebiotic, feeding the healthy bacteria in the gut as they ferment. Resistant starch comes in a variety of forms. They are categorized according to their structure or source. A single food can include multiple types of resistant starch. Resistant starches are divided into three types, according to one proposed classification: RS1, RS2, and RS3. The first class, RS1, is starch that, due to its food shape and insufficient enzymatic attack, escapes small intestine digestion (e.g., large particle size or compact nature of food or starch entrapment by dietary fiber). The second, RS2, contains more crystalline starches that are difficult to digest (e.g., high-amylose starches that resist gelatinization). The RS3 starches have been retrograded (e.g., high-amylose starches that upon cooling after cooking form a compact, hydrogen bonded crystalline structure that excludes water).

2.5. Cellulose

Cellulose is a polysaccharide made up of hundreds to thousands of (1-4) connected D-glucose units in a linear chain. Green plants, numerous types of algae, and oomycetes all have it as a structural component of their major cell walls. It's the most common organic polymer on the planet. Cotton fiber has a cellulose level of 90%, wood has a cellulose content of 40-50%, and dried hemp has a cellulose content of around 57 percent. In the same way as starch is a (1-4)-linked glucose polymer (C6H10O5)n, cellulose is a (1-4)-linked glucose polymer (C6H10O5)n, but the glucose molecules are -linked, allowing for the creation of a linear polymer with strong intrachain hydrogen bonding. As much as 10,000 glucose monomer units can be found in cellulose polymers. Cellulose is insoluble in cold or hot water, as well as most dilute acids and alkalis, and is resistant to minor intestine digestion. Colonic bacteria partially digest it; the amount degraded varies depending on the source, with cellulose from vegetables degrading more than cellulose from cereals like wheat.

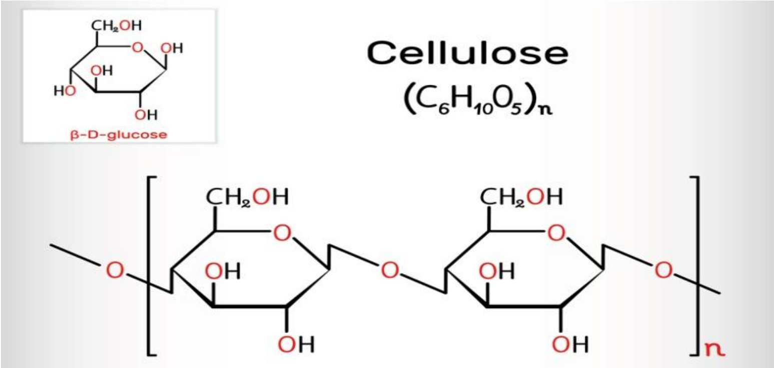

Fig 4: Structure of Cellulose

2.6. β-Glucans

β-glucans are soluble fibers that come from the cell walls of bacteria, fungi, yeasts and some plants. β-glucans might prevent the body from absorbing cholesterol from food. They might also stimulate the immune system by increasing chemicals that prevent infections. In many ways, these predominantly (1-4)-linked glucose polymers are the cellulose equivalent of the starch amylopectin. Here, it is the (1-3) linkages interspersed throughout the polymer that prevent the compact structure achieved with the cellulose polymer where only the (1-4) linkages exist. As a result of the more open molecular structure of the β-glucan, unlike cellulose, it is readily hydrated and soluble in water, forming a solution of high viscosity. The viscosity, in turn, is dependent on the molecular weight and the presence of the (1-3) linkages. The greater the molecular weight, the greater the viscosity. Thus, reduction of molecular weight by acid or enzymatic hydrolysis, which may also occur during food processing, may greatly reduce viscosity. The common feature shared by cellulose and the b-glucans is that both are resistant to digestion by small intestinal enzymes. However, whereas cellulose is only partially fermented by the colonic bacteria, β-glucans are completely fermented.

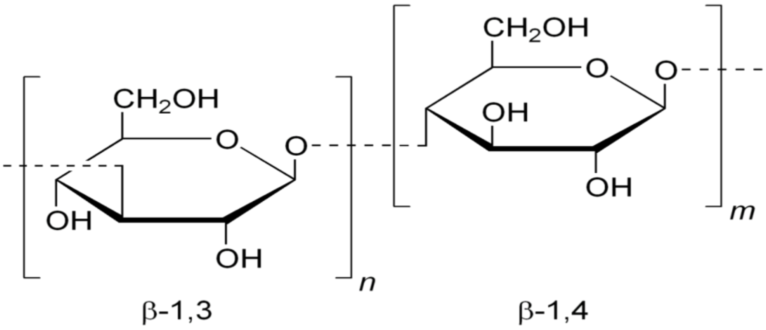

Fig 5: Structure of β-Glucans

2.7. Hemicellulose

Hemicellulose (also known as polyose) is a heteropolymer found in almost all terrestrial plant cell walls with cellulose. Hemicelluloses have a random, amorphous structure with limited strength, whereas cellulose is crystalline, robust, and resistant to hydrolysis. Dilute acid or base, as well as a variety of hemicellulase enzymes, can easily hydrolyze them. The name 'hemicellulose' does not refer to a group of glucose polymers with (1-4) links. The chemical structure of hemicellulose is identical to that of cellulose, but it is also insoluble in hot or cold water or hot dilute acid. However, it is soluble in dilute alkali. With two or more sugars (e.g., arabinoxylans present in cereals), the polymeric structure is heterosaccharitic and has a tiny molecular size (50-200 saccharide units).

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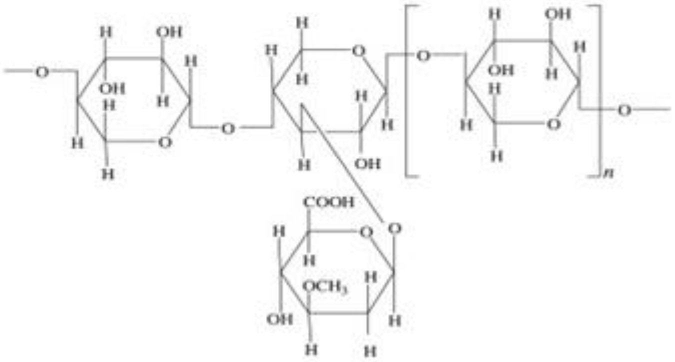


Fig 6: Structure of Hemicellulose

3. Occurrence

Glucose is a sugar synthesized by plants from water and carbon dioxide utilizing energy from sunlight during photosynthesis. It is vertebrates' principal carbohydrate energy source. Fasting blood glucose levels in healthy humans range from 3.5 to 5.5 mmol l^{-1} (depending on the laboratory) and rise to around 10 mmol l^{-1} (the renal threshold for full reabsorption, past which glucose'spills' into the urine) postprandially. One of the diagnostic criteria for diabetes is blood levels greater than 7.8 mmol l^{-1} 2 hours following a 75 g glucose load. Glycogen, α- -linked polymer, is mostly stored in the liver and muscles ('animal starch'). A 70 kg man can store 500 g of glycogen on average. Gluconeogenesis can also produce glucose from the gluconeogenic amino acids lactate, glycerol, and pyruvate. Glycogenolysis is the breakdown of glycogen into glucose. The energy source for erythrocytes, renal tissue, and nervous tissue is glucose. The glucose in erythrocytes and renal tissue is not oxidized, but rather recycled to the liver for glucose production as part of the Cori cycle. The brain requires 140 g of glucose each day to metabolize glucose. Despite this requirement, carbohydrate should account for 45 percent to 65 percent of total calories consumed. Glucose is found in fruits and vegetables, and while it is less sweet per gram than fructose or sucrose, it is responsible for the sweet taste of vegetables and fruit, together with fructose and sucrose. Foods containing glucose, fructose, and sucrose in various ratios comprise the major available (i.e., absorbable in the small intestine) carbohydrate sources, with the exception of fruit such as green bananas, seeds (grain and dried legumes), and tubers, in which starch is the major carbohydrate form.

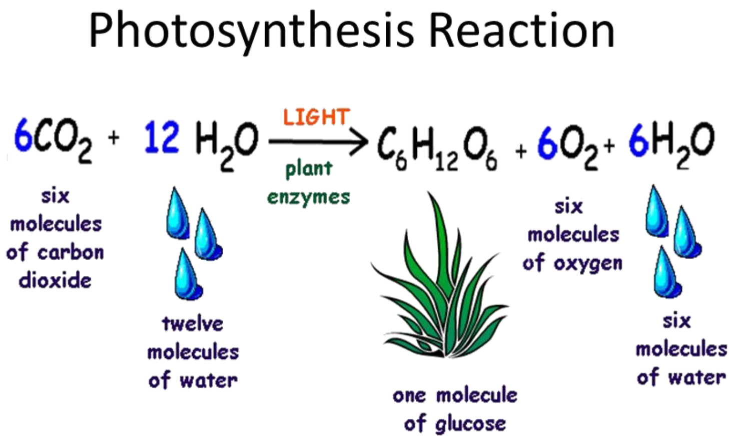


Fig 7: Photosynthesis of glucose

4. Physical Properties of Glucose

Pure glucose is a white crystalline powder with a density of 1.54 grams per cubic centimetre and a molar mass of 180.16 grams per mole. Whether a material is in the alpha or beta conformation determines its melting point. α-D-glucose has a melting point of 146 °C (295 °F; 419 K). β-D-glucose has a melting point of 150 °C (302 °F; 423 K). Table 1 lists some of the physical properties of glucose, such as melting point, solubility, and density.

S. No.	Physical Properties	Characteristics
1	Appearance	White, Crystalline
2	Molecular weight	180.16 g mol^{-1}
3	Melting point	150 ^{o}C
4	Density	1.54 g cm^{-3} (at 18 ^{o}C)
5	Solubility in: Water Ethanol Diethyl ether Pyrimidine	 Soluble Slightly soluble Insoluble Soluble

Table 1: Physical Properties of Glucose

4.1. Structure

Glucose ($C_6H_{12}O_6$) contains six carbon atoms and an aldehyde group and is therefore referred to as an aldohexose. The glucose molecule can exist in an open-chain (acyclic) and ring (cyclic) form (in equilibrium), the latter being the result of an intramolecular reaction between the aldehyde C-atom and the C-5 hydroxyl group to form an intramolecular hemiacetal. As the ring contains five carbon atoms and one oxygen atom, which resembles the structure of pyran, the cyclic form of glucose is also referred to as glucopyranose. In this ring, each carbon is linked to a hydroxyl side group with the exception of the fifth atom, which links to a sixth carbon atom outside the ring, forming a CH_2OH group. The formation of pyranose and furanose rings (cyclic hemiacetals) of glucose has been presented in Figure 8.

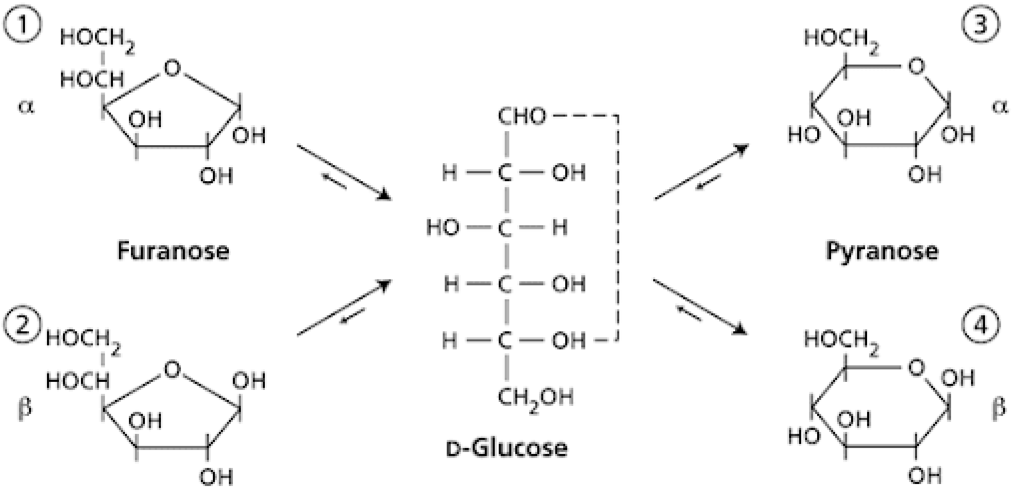


Fig 8: Acyclic and Cyclic Structure of Glucose

4.2. Solubility

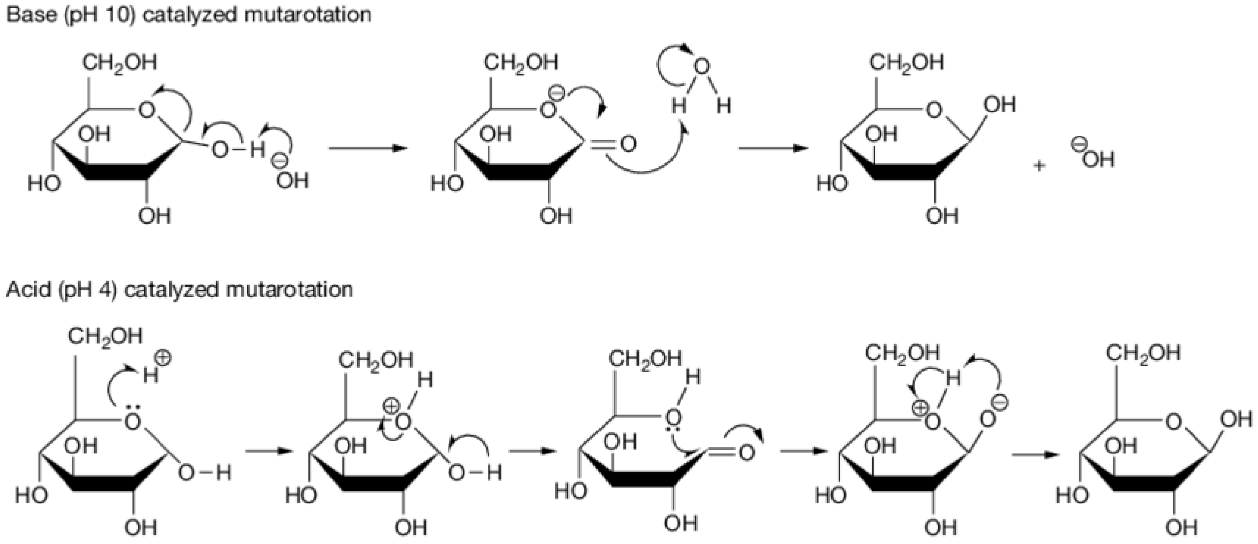
One of glucose's most essential physical features is its ability to dissolve in an aqueous (water-based) solution. Because the blood, extracellular fluid, and fluid inside cells are all made up of water, glucose must dissolve properly in water in order to travel through the bloodstream and into cells. Only carbon and hydrogen-based compounds have a low water solubility. Water solubility is aided by elements like oxygen and nitrogen, which are abundant in organic and bioorganic compounds. The six oxygen atoms in glucose improve its capacity to dissolve in water. Glucose dissolves rapidly in water because five of those oxygen atoms are provided in the form of alcohol groups, which allows it to easily establish hydrogen bonds with water molecules and making it particularly water-soluble. Glucose comes in a variety of colors and is soluble in water, acetic acid, and a variety of other solvents. In methanol and ethanol, they are just slightly soluble.

4.3. Solid State

Depending on conditions, three major solid forms of glucose can be crystallized from water solutions: α-glucopyranose, β-glucopyranose, and β-glucopyranose hydrate.

4.4. Mutarotation

The open-chain form is thermodynamically unstable, and it spontaneously isomerizes to the cyclic forms. When sugar molecules are dissolved in aqueous solutions, a series of reactions, involving molecular rearrangements around the C-1, take place. These rearrangements are associated with the change in optical rotation and lead to the formation of a mixture of products that are in equilibrium. This process, first observed for D-glucose, is called mutarotation. If one dissolves α-D-glucopyranose ($[\alpha]_D$ +112^o) or β-Dglucopyranose ($[\alpha]_D$ +19^o) in water, an equilibrium is formed with the $[\alpha]_D$ of the resultant solution being +52.7^o. Theoretically, the mixture contains five different structural forms of glucose: α-D-glucopyranose, β-D-glucopyranose, α-D-glucofuranose, β-D-glucofuranose, and open-chain free aldehyde (Figure 2). The four-ring structures are transformed into each other via the open-chain form. The process will take place if the starting material represents any of the five forms. The mutarotation process is slow (it may take several hours to reach equilibrium) if conducted in water at 20 ^{o}C. The rate of mutarotation increases, however, 1.5-3 times with each 10 ^{o}C increase in the temperature. Both acids and bases increase the rate of mutarotation. Certain enzymes, such as mutarotase, will also catalyze the mutarotation reactions. The rate and the relative amount of products are also affected by the polarity of the solvent, with less polar solvents decreasing the rate of mutarotation. The reaction begins upon dissolution of sugar molecule and an attack, by either acid or base, on the cyclic sugar. It involves the transfer of a proton from an acid catalyst to the sugar or the transfer of proton from the sugar to a base catalyst as shown in Figure 9.


Base (pH 10) catalyzed mutarotation

Acid (pH 4) catalyzed mutarotation

Fig 9: Mechanism of base and acid-catalyzed mutarotation reactions

4.5. Enolization and Isomerization

Sugars are relatively easily interconverted in the presence of alkali. Aldose and ketose epimerization, as well as aldose-ketose isomerization, are all part of the process. Figure 10 depicts the mechanism of the reaction. The enolization reaction occurs when a carbonyl molecule with a -hydrogen atom undergoes a general reaction. The 1,2 enediol is generated first from aldehydo-D-glucose, which can then be transformed into another aldose (with the opposite configuration at C-2) and the equivalent ketose. D-glucose, D-mannose, and D-fructose can all be easily interconverted through enolization and isomerization. Isomerization can be catalyzed by a base or an enzyme, and it can happen in acid or neutral circumstances, though at a considerably slower pace.

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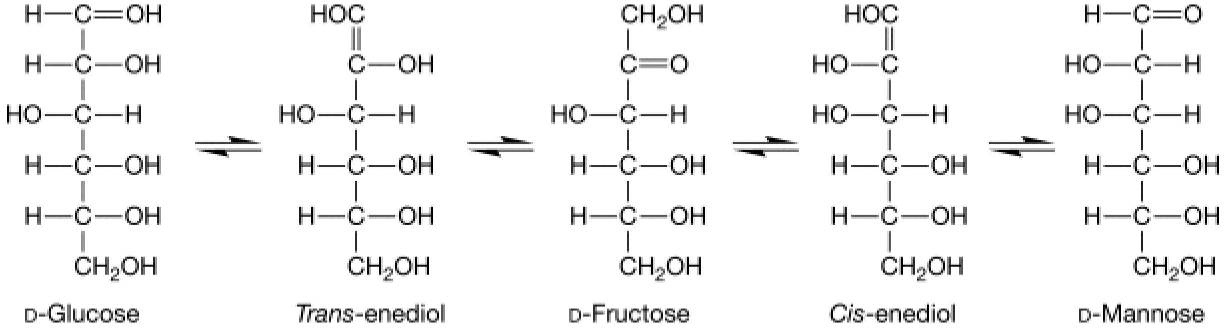


Fig 10: Enolization and Isomerization Reactions

4.6. Optical Activity

D-glucose is dextro-rotatory, meaning it rotates the direction of polarized light clockwise whether in solution or solid form. The chirality of the molecules causes the effect, and the mirror-image isomer, L-glucose, is also laevo-rotatory (rotates polarized light counter clockwise) by the same amount. The D- prefix has nothing to do with the compound's optical characteristics. It means that the C-2 chiral center is the same handedness as D-chiral glyceraldehyde's center (which was so labeled because it is dextro-rotatory). D-dextro-rotatory glucose's property is due to a combination of its four chiral centers, not only C-2; in fact, several of the other D-aldohexoses are laevo-rotatory.

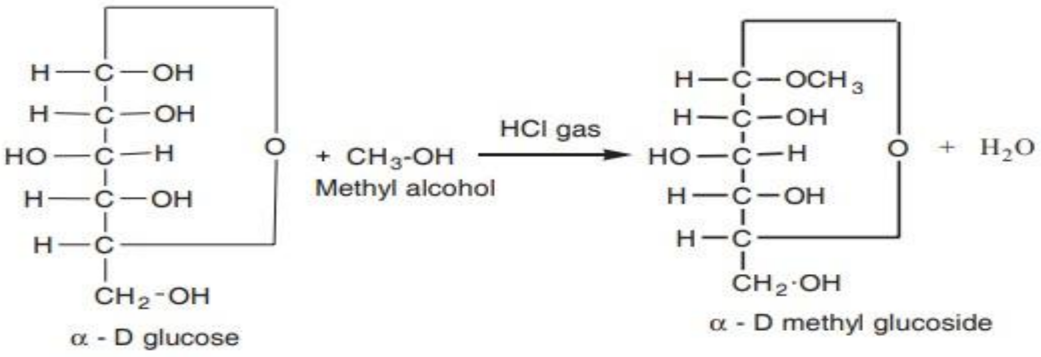
5. Chemical Properties of Glucose

Alcohol, ester (in ring form), and aldehyde (in linear form) are the functional groups found in glucose, and they are responsible for the bulk of the chemical processes it undergoes. In glucose, there are three different types of active groups:

1) The –OH group of glycosidic sugars
2) Group of alcoholics –OH
3) Aldehyde – group CHO

5.1. Glucoside formation

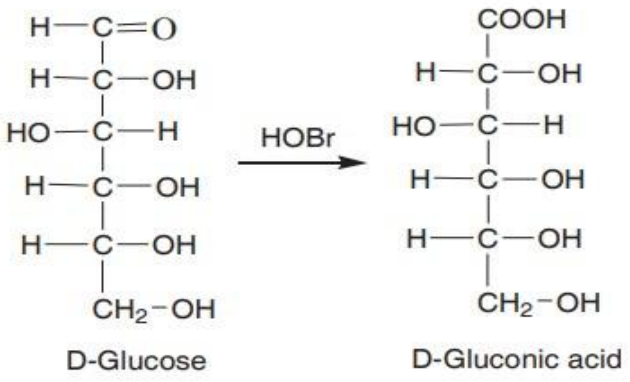
Glucose reacts with methanol in the presence of HCl and gives α- and β-glucoside. Glucoside formation is due to the reaction of alcohol with anomeric -OH group of glucose.



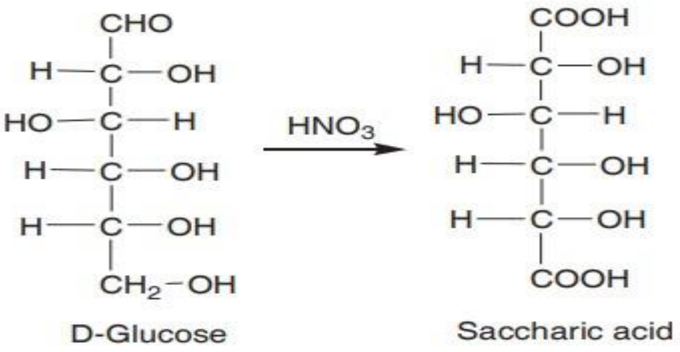
5.2. Oxidation

Glucose when treated with bromine water, forms gluconic acid. The aldehyde group is oxidised to carboxylic group. First, bromine forms hypobromous acid (HOBr), with water and oxidises the glucose to gluconic acid.

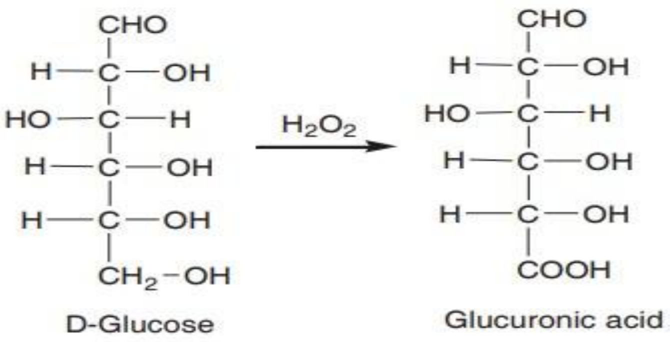
$$Br_2 + H_2O \longrightarrow HOBr + HBr$$



When glucose is oxidised with nitric acid, saccharic acid is formed.

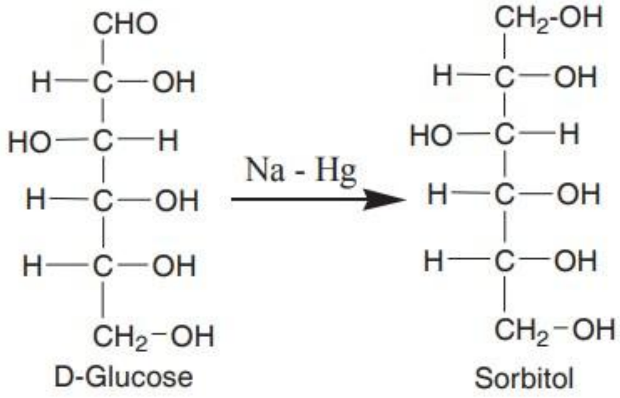


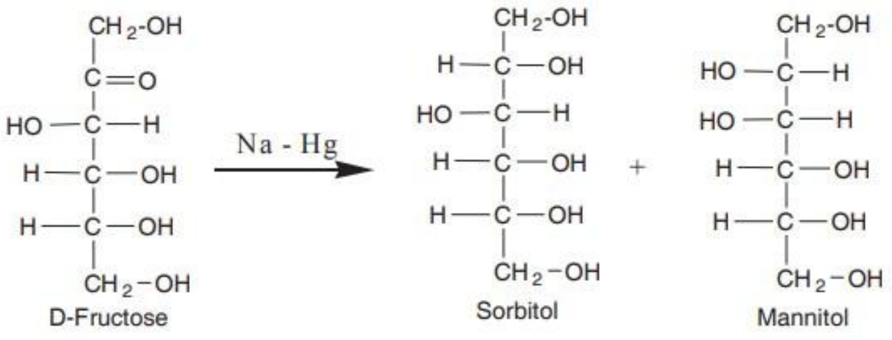
When glucose is oxidised with hydrogen peroxide (H_2O_2), glucuronic acid is formed. In this reaction only the primary alcohol is converted into carboxylic group, whereas the aldehyde remains unchanged.



5.3. Reduction

Monosaccharides can be reduced using a variety of reducing chemicals, including sodium-amalgam or hydrogen at high pressure in the presence of catalysts. The presence of an aldehyde or ketone group causes the reduction. They produce alcohols when reduced.





Sorbitol is generated when glucose is reduced by sodium amalgam. Because of the synthesis of a new asymmetric carbon C_2 in fructose, mannose yields mannitol while fructose yields a combination of sorbitol and mannitol.

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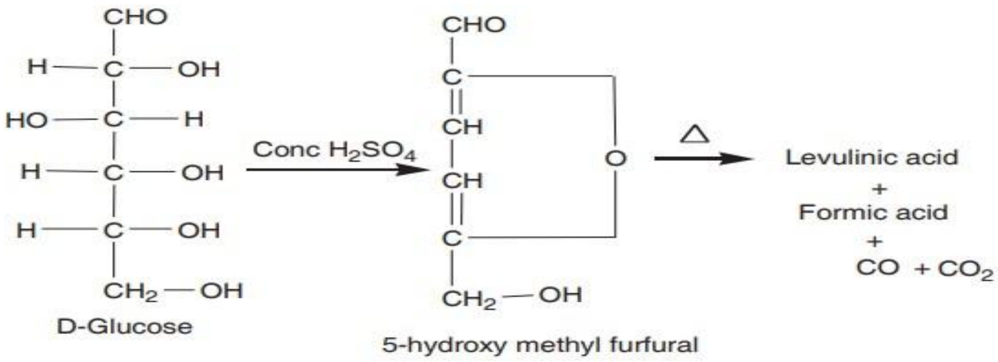
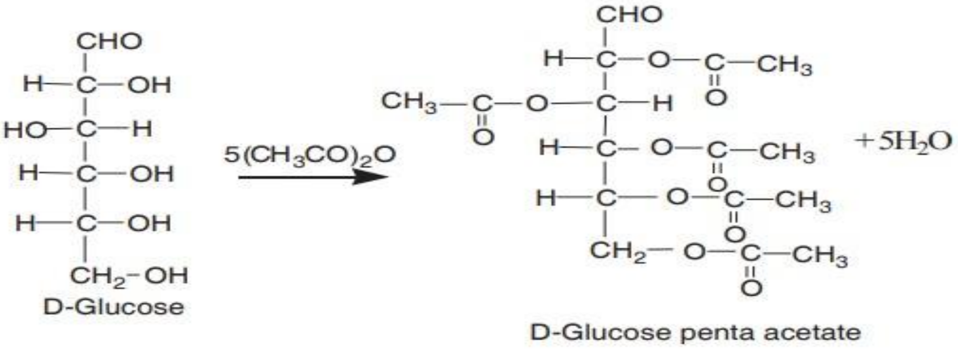
5.4. Reaction with concentrated H_2SO_4

When glucose is treated with concentrated H_2SO_4 or HCl then it forms 5-hydroxymethyl furfural which on further heating yields levulinic acid and formic acid. This reaction is the basis of the colour test, known as **Molish test** for sugars. When pentoses are treated with mineral acids furfural is obtained on heating.



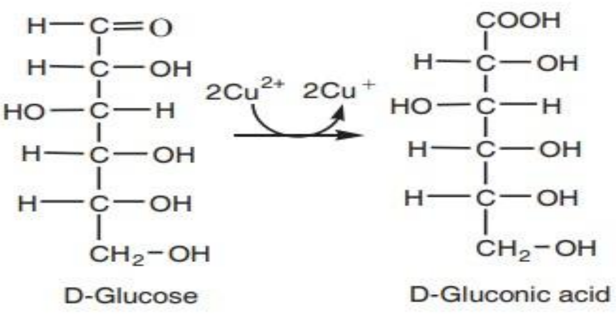
5.5. Ester formation

Monosaccharides can form esters with carboxylic acids due to the presence of -OH groups. For eg. glucose reacts with five molecules of acetic anhydride to form penta acetate derivative. It obviously indicates that the glucose contain five -OH groups.

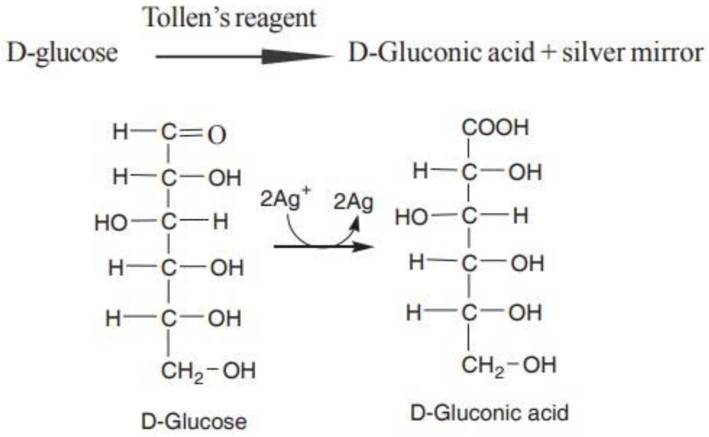


5.6. Reducing property

Monosaccharides act as the best reducing agents. They readily reduce oxidizing agents such as ferric cyanide, H_2O_2 and cupric ion. In such reactions, the sugar is oxidized at the carbonyl group and the oxidising agent becomes reduced. Glucose and other sugar capable of reducing certain compounds are called reducing sugars. Glucose reduces Tollen’s reagent, Fehling’s reagent, Benedict’s reagent etc. At the same time glucose is oxidized to gluconic acid.

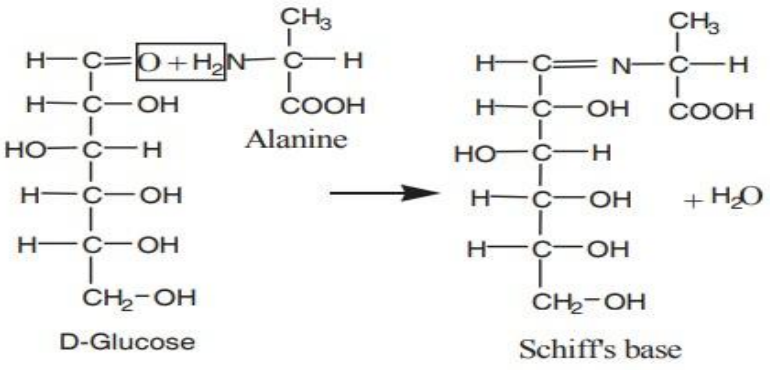


This property is the basis of Fehling's reaction (ammoniacal cupric sulphate), a qualitative test for the presence of reducing sugar. Cu^{2+} is reduced into Cu^{+} and at the same time glucose is oxidised to gluconic acid. During this reaction the blue colour of the reagent changes to reddish orange colour. Benedict's reagent contains cupric ions which are reduced to cuprous ions by the reducing sugar and the colour change from blue to orange or red. It indicates the presence of reducing sugar. A standard test for the presence of reducing sugar is the reduction of Ag+ in ammonia solution (Tollen's reagent) to yield a metallic silver mirror lining on the sides of the test tube.



5.7. Reaction with alanine

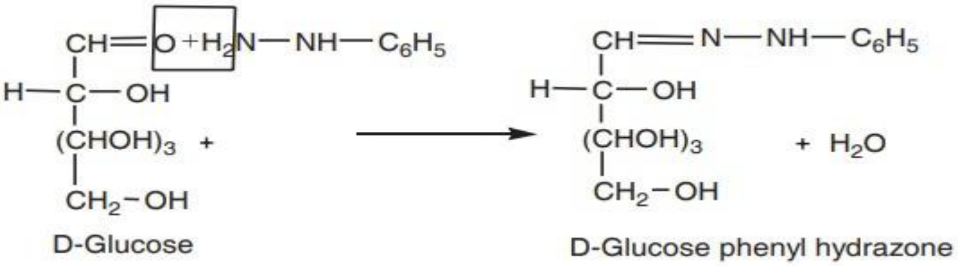
The aldehyde group of glucose condenses with the amino group of alanine to form **Schiff's base**. The browning reaction occurs during baking of bread and other mixtures of carbohydrates and proteins is believed to be due to the formation of Schiff's base between the amino groups of proteins and the aldehyde groups of carbohydrates.



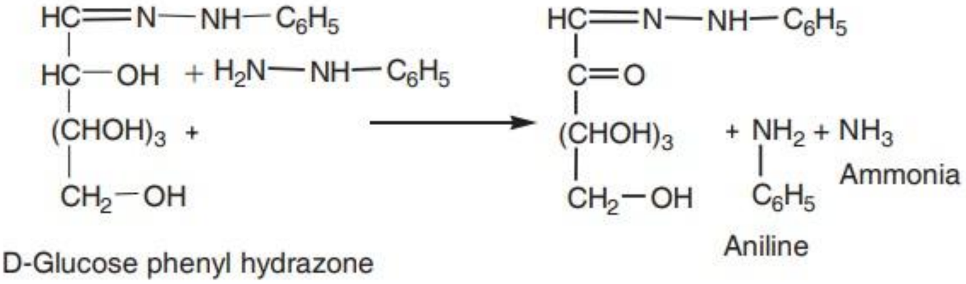
5.8. Osazone formation

The action of reducing sugars (monosaccharides and disaccharides) containing potential aldehyde or ketone groups on phenylhydrazine to generate phenyl hydrazones is an important reaction. Only two carbon atoms are involved in the reaction with phenylhydrazine: the carbonyl carbon atom and the one next to it.

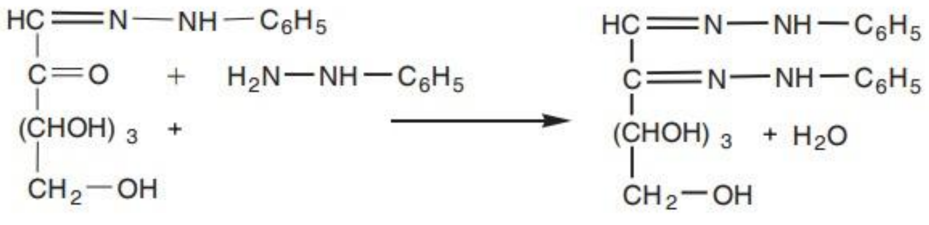
I. One molecule of glucose condenses with one molecule of phenyl hydrazine to create soluble glucose phenylhydrazone in phenylhydrazine processes.



ii) When there is an excess of phenylhydrazine, another phenylhydrazine molecule joins the process.



iii) The third molecule of phenylhydrazine now enters the process, producing yellow crystals known as phenyl glucosazone. For different sugars, the shape of the crystals and the time it takes for osazone to develop change.

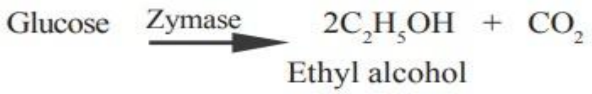


Phenyl gucosazone

Phenyl hydrazine reacts with fructose in a similar way as glucose. In this case, three molecules of phenyl hydrazine are involved in the process. Fructosazone is made from fructose. Osazone formation is also a characteristic of disaccharides like maltose and lactose. Sucrose, on the other hand, does not generate osazone because it lacks the free CHO and CO groups that are responsible for the reducing characteristic.

5.9. Fermentation

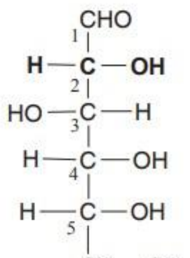
In an anaerobic environment, fermentation is the process of turning a larger complex molecule into simple molecules using enzymes. Alcohol and CO_2 are the end products of the process.



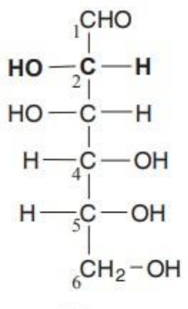
$$\text{Glucose} \xrightarrow{\text{Zymase}} \underset{\text{Ethyl alcohol}}{2C_2H_5OH} + CO_2$$

5.10. Epimerisation

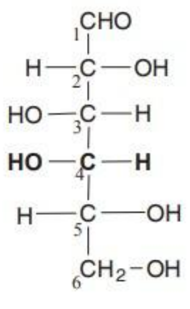
Epimers are two sugars that differ only in their arrangement around a single carbon atom. For example, glucose and mannose are epimers in terms of C_2. Only in terms of C_4 do glucose and galactose differ. Epimerization is the process of converting one epimer to another, and it requires the enzyme epimerases in living organisms. In human bodies, galactose is turned to glucose in this way



Glucose



Mannose



Galactose

6. Biochemical Properties

The most abundant monosaccharide is glucose. In most living organisms, glucose is the most commonly used aldohexose. One probable explanation is that glucose, unlike other aldohexoses, has a lesser tendency to react nonspecifically with protein amine groups. Glycation inhibits or eliminates the function of numerous proteins, as seen in glycated hemoglobin. The low rate of glycation of glucose is due to the fact that it has a more stable cyclic form than other aldohexoses, which means it spends less time in its reactive open-chain form. Because its hydroxy groups are in the equatorial position (with the exception of the hydroxy group on the anomeric carbon of D-glucose), glucose has the most stable cyclic form of all the aldohexoses. Because glucose is less glycated with proteins than other monosaccharides, it is most likely the most prevalent natural monosaccharide. Another theory is that because glucose is the only D-aldohexose with all five hydroxy substituents in the equatorial position in the form of -D-glucose, it is more easily accessible to chemical reactions like esterification and acetal production. As a result, D-glucose is a very popular building block in natural polysaccharides (glycans). Glucans are polysaccharides that are entirely made up of glucose.

Plants make glucose by photosynthesis, which involves the utilization of sunlight, water, and carbon dioxide, and it may be used as an energy and carbon source by all living things. However, most glucose is found in the form of its polymers, such as lactose, sucrose, starch, and other energy reserve compounds, as well as cellulose and chitin, which are components of plant, fungal, and arthropod cell walls, respectively. When ingested by mammals, fungi, and bacteria, these polymers are reduced to glucose by enzymes. When the need for glucose arises, all species can manufacture it themselves from certain precursors. Glucose is required for the energy synthesis of neurons, renal medulla cells, and erythrocytes. Adult people have roughly 18 g of glucose in their bodies, including about 4 g in their blood. In a 24-hour period, an adult's liver produces approximately 180 to 220 g of glucose. The glycation of proteins or lipids is likely to be the cause of many of the long-term consequences of diabetes (e.g., blindness, renal failure, and peripheral neuropathy). Glycosylation, on the other hand, is the enzyme-controlled addition of sugars to proteins and is required for the function of many proteins..

7. Commercial Production

Industrially, glucose is made from starch through enzymatic hydrolysis with glucose amylase or with the application of acids. Acid-catalyzed hydrolysis has mostly been replaced by enzymatic hydrolysis. Glucose syrup (enzymatically with more than 90% glucose in the dry matter) is the result, with a global annual manufacturing volume of 20 million tonnes (as of 2011). This is why it was previously known as "starch sugar." Bacillus licheniformis or Bacillus subtilis (strain MN-385) are the most commonly utilized amylases because they are more thermostable than the previously employed enzymes. Pullulanases from Aspergillus niger have been employed in the manufacturing of glucose syrup since 1982 to convert amylopectin to starch (amylose), boosting glucose output. The reaction is carried out at a temperature of 55-60 °C and a pH of 4.6-5.2. The dry matter of corn syrup contains between 20% and 95% glucose. Mizuame, a type of glucose syrup created in Japan, is made from sweet potato or rice starch. Maltodextrin contains approximately 20% glucose. Starch can be obtained from a variety of plants. In different parts of the world, maize, rice, wheat, cassava, potato, barley, sweet potato, corn husk, and sago are all used. Corn starch (from maize) is nearly entirely utilized in the United States. Some commercial glucose is found in invert sugar, a sucrose-derived combination of glucose and fructose that is roughly 1:1. Although cellulose may theoretically be hydrolyzed to glucose, this technology is not yet commercially viable.

8. Analysis of Glucose

Chemical, enzymatic, electrochemical, and high-performance liquid chromatography (HPLC) technologies may be used to analyze glucose. Chemical approaches based on the reducing ability of glucose, such as copper sulfate procedures, were common prior to the introduction of enzyme-based studies. Other reducing sugars and reducing chemicals, such as uric acid and vitamin C, affected these procedures. Concanavalin is used in nuclear magnetic resonance (NMR) spectroscopy, X-ray crystallography research, or lectin immunostaining when a glucose molecule needs to be recognized at a certain site in a bigger molecule. A conjugate of a reporter enzyme (that binds only glucose or mannose). Chromatographic technologies such as high performance liquid chromatography (HPLC) and gas chromatography are frequently employed in tandem with mass spectrometry for the examination of complex mixtures containing glucose, such as honey. These methods can also accurately detect honey adulteration by additional sugars when isotope ratios are taken into account. The use of silylation reagents for derivatization is frequent. It is also possible to quantify the proportions of di- and trisaccharides.

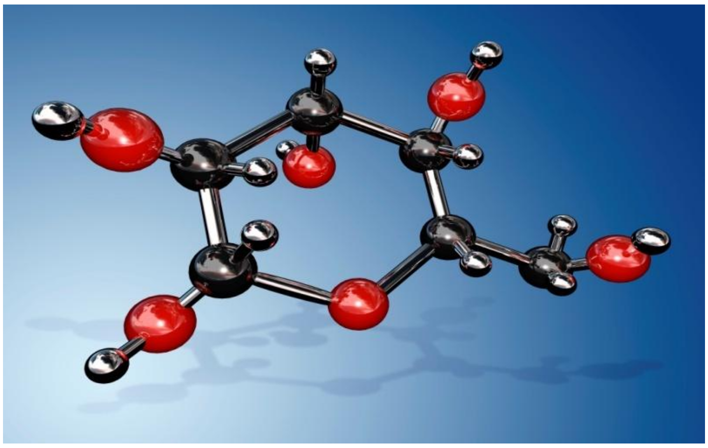


Fig 11: Ball stick model of glucose

9. Acknowledgement

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