

Chapter 1 : Carbohydrates - Chemical Structure (Page 1 of 3)

An important reaction of monosaccharides is the oxidation of the aldehyde group, one of the most easily oxidized organic functional groups. Aldehyde oxidation can be accomplished with any mild oxidizing agent, such as Tollens' reagent or Benedict's reagent.

Monosaccharides are known to be the simplest form of carbohydrates, and as such, they are considered to be their building blocks. In general, monosaccharides, share the same chemical formula of $C_6H_{12}O_6$, and because having six carbon atoms, they are also called as hexose. Being sugars, monosaccharides naturally have a sweet taste fructose is considered to be the sweetest among them and remain in their solid forms at room temperature. In spite of their very high molecular weights, they are very soluble in water as compared with other substances with the same molecular weight. The fact that there are a lot of OH groups in their structure makes this possible. Regarding their chemical composition, monosaccharides do not usually exhibit their open-chain structures. In this type of formation, an alcohol group can be readily added to the carbonyl group to create a pyranose ring that contains a stable conformation of a cyclic hemiacetal or hemiketal. Monosaccharides, in general, can be readily oxidized by certain chemicals. After this reaction, a formation of an orange precipitate of copper I oxide or Cu_2O will occur. All monosaccharides undergo this type of reaction and are called reducing sugars. The chemical reaction is shown above

Three Most Common Monosaccharides

There are three most common naturally occurring monosaccharides: Despite sharing the same chemical formula, they have different structural configurations, thus making them different regarding overall structure and function. Glucose Considered as the most critical monosaccharide, glucose is also known as dextrose or blood sugar. As it is, it serves as an immediate energy source during cellular respiration photosynthesis. Glucose is naturally occurring in plants and animals in its free form. It is synthesized in a process called gluconeogenesis from non-carbohydrate molecules like glycerol and pyruvate. At the same time, it can also come from the break-down of glycogen in the process called glycogenolysis. Fructose Also known as fruit sugar, fructose is the natural sugar that is found in fruits and honey. Overall, it is considered to be the sweetest among sugars. In chemical terms, fructose is also called as levulose. Care should be taken when consuming too much fructose as it is often associated with gastrointestinal problems and with somehow contributes to the increase in the fat content of blood. Galactose Last but not the least is the monosaccharide galactose that is derived from the hydrolysis of the disaccharide lactose milk-sugar. This lactose derived from milk is an essential energy source for many animals, including humans. Interestingly, the mammalian body can convert glucose to galactose for the mammary glands to produce the lactose in milk. Wikimedia Because monosaccharides and other carbohydrates have many OH groups, they can be joined to one another by covalent bonds. In particular, glycosidic bonds are the type of covalent bonds that join together carbohydrate molecules with other groups, which may or may not be of the same type. As their name suggests, they are involved with glycosides which are ring-shaped carbohydrate molecules that may either be a five-membered ring or a six-membered one. It should also be important to note that not all glycosidic bonds are the same: And just like what was alluded to above, the fact that monosaccharides contain many OH groups means that many linkages via glycosidic bonds are possible. Hence, the variety of these ties can be correlated with the vast array of monosaccharides, and their forms make more complex carbohydrates be packed with much information.

Polysaccharides

Long chains of polymeric saccharides that are formed via the glycosidic linkages of monosaccharides are known as polysaccharides. Polysaccharides that are made up of the same type of monosaccharides are referred to as homopolymers. There are two most common types of polysaccharides in animal and plant cells: They are described below. Glycogen In animals, the most common type of homopolymer is glycogen. Glycogen is a very large polysaccharide made of glucose monomers and is considered to be the storage form of carbohydrates in animal cells. Starch On the other hand, starch is the storage form of energy in plants. It comes in two forms: A special type of polysaccharide, called a disaccharide, is made up of just two monosaccharide units linked via a glycosidic bond. The most common disaccharides are sucrose glucose and fructose , lactose glucose and galactose , and maltose two glucose.

Function of Carbohydrates As alluded to earlier, carbohydrates serve as the immediate energy sources. In higher organisms, they serve to enable the metabolism of fats to avoid the breaking down of proteins for energy. Aside from that carbohydrates are also needed to metabolize fats. Apparently, if the body generates enough energy for its physiological functions, extra energy becomes stored as fat. In conclusion, monosaccharide as carbohydrate building blocks can be linked to a wide variety of stereochemistries which are essential in the formation of more complex structures. Because of these small units, living organisms are supplied with ample amount of energy that helps them survive. Indeed, small things make a big difference. Cite this article as: Accessed November 21, Building Blocks of Carbohydrates.

Chapter 2 : Carbohydrates: Monosaccharides, Disaccharides and Polysaccharides

All monosaccharides are soluble in water. When they are dissolved in water, they would take up the ring-form. This is the cause for their solubility in water. (4) When monosaccharides are dissolved in water, they would initiate the lowering of water potential of the solution. (5) Optional The water solutions of monosaccharides are optically active.

The following points highlight the three types of carbohydrates. They are the sugar units that cannot be further hydrolysed into simpler units. Sugars containing an aldehydic group are known as aldoses, e. Sugars containing a ketonic group are known as ketoses. Depending upon the number of carbon atoms, aldoses and ketoses are further classified as: Physical Characters of Monosaccharides: A carbon atom substituted by four different groups or atoms is known as asymmetric carbon atom. All carbohydrates except dihydroxyacetone have one or more asymmetric carbon atoms. Two compounds having the same molecular formula but different structural formula are known as isomers. The number of isomers can be calculated from the number of chiral centres n . The general formula is 2^n . Glucose has four asymmetric carbon atoms, i. When sugars differ only in the configuration around one specific carbon atom they are called epimers. Non super-imposable mirror images are known as enantiomers. When white light which is a mixture of different wavelengths is passed through a Nichol prism, then the emerging light will be of a single wavelength and this is known as plane polarized light. When this plane polarized light is passed through a solution containing carbohydrate, the light is deflected either towards the right or left, which depends upon the configuration of atoms around the chiral centre. When the solution containing glyceraldehyde with the configuration in the figure given below around the chiral centre is taken, wherein the -OH group on the asymmetric carbon atom is towards right, when written on paper in the straight line projection form, then the light is deflected towards right. When the solution containing glyceraldehyde with the following configuration around the chiral centre is taken, wherein the -OH group on the asymmetric carbon atom is towards left, when written on paper in the straight line projection form, then the plane polarized light is rotated towards left. Hence this glyceraldehyde is known as levorotatory sugar or compound and is designated as l -sugar - sugar. In such cases the rotation of the plane polarized light is dependent upon many factors, viz. Under such circumstances there is no relation between the configurations of the sugar to the rotation of the plane polarized light. Hence other compounds sugars, amino acids, etc. D series compounds are those compounds that contain the reference group on the right side of the last chiral centre from the functional group. If glucose is taken, the functional group is the aldehydic group -CHO and the chiral centre furthest from it is the 5th carbon atom and the reference group -OH is present on the right side of the straight chain. Hence it is known as D-glucose. This glucose may or may not be dextrorotatory. It may also be levorotatory. L series compounds are those compounds that contain the reference group on the left side of the last chiral centre from the functional group. If the -OH group is present at the left side on 5th carbon of the straight chain form of glucose then it is known as L-glucose. This glucose may or may not be levorotatory. It may also be dextrorotatory. Sugars differing at the anomeric carbon atom are known as anomers. When an aldehydic group or carbonyl carbon reacts with an alcoholic group, then it results in the formation of a hemiacetal. Carbohydrates contain both aldehydic carbonyl and alcoholic groups within the molecule. Hence it is possible that the aldehydic group present at the 1st carbon atom of the sugars can react with any of the alcoholic groups present on the other carbon atoms, thus resulting in the creation of an additional chiral centre at the 1st carbon atom and this chiral centre is now known as the anomeric carbon atom. Sugars differing at this anomeric carbon atom are known as anomers. Two anomers for each of the sugars are possible. Ring structures of carbohydrates: This results in the formation of a cyclic ring structure. If the 1st and the 4th carbon atoms are involved in the hemiacetal formation, then the resultant ring structure is a five membered ring that resembles another compound known as furan. Hence the name of the resultant carbohydrate ring structure is furanose ring. If the 1st and the 5th carbon atoms of the same sugar are involved in the hemiacetal formation then the resultant ring structure is a five membered ring that resembles another compound known as pyran. Hence the name of the resultant carbohydrate ring structure is pyranose ring. Among the carbohydrates, trioses and tetroses do not involve in the ring formation owing to their short length.

Change in the specific rotation of an optically active compound without any change in its other properties is known as mutarotation. If it is dissolved in water, the specific rotation gradually changes with time and reaches a stable value. This change in specific rotation is known as mutarotation. When this is dissolved in water its rotation gradually changes and finally reaches a stable value. Chemical Reactions of Carbohydrates: Reducing action of sugars: In alkaline medium, the aldehydic or ketonic group of sugars can reduce a number of substances like metals like copper, silver, mercury and bismuth. Copper salts are reduced to cuprous hydroxide or oxide in solution. The sugars are identified in the urine and blood based upon this principle. Sugars having a free aldehydic or ketonic group are known as reducing sugars, e.g. Among disaccharides maltose and lactose are reducing sugars. This is a semi quantitative test most commonly used for the detection of the percentage of sugar in urine. Therefore, this test is very specific for glucose or other reducing sugars in urine. Upon confirmation that there is no formation of precipitate, 8 drops of urine is added to it and is heated for 2 more minutes. Formation of a coloured precipitate, after addition of urine is a positive indication. The colour of the precipitate depends upon the percentage of reducing sugar. Sugars that do not have a free aldehydic or ketonic group are called as non-reducing sugars, e.g. Though polysaccharides have at least one free aldehydic or ketonic group, but still they are non-reducing sugars owing to their larger molecular size and complexity of the structure. Hence the aldehydic or ketonic group is not available for the reducing action. Phenyl hydrazine reacts with reducing sugars to form osazones. It involves carbonyl carbon and the adjacent carbon. Osazone is a crystalline compound and is used as an identification test for sugars. Fructose and glucose forms a broom stick shaped crystal in 3 and 5 minutes respectively. Maltose forms star shaped crystals in 20 minutes whereas lactose forms puff shaped crystals in 30 minutes time. Galactose forms mucic acid, which is insoluble in water. This forms an identification test for galactose known as mucic acid test. Inside the cell, the enzymes oxidize both the aldehydic and primary alcoholic groups of the carbohydrates forming uronic acids. D-glucuronic acid is a component of structural materials like chondroitin sulphate, mucoitin sulphate and glycoproteins proteoglycans. It plays an important role in detoxification of bile pigments. L-glucose forms iduronic acid. Dehydration with strong acids: The hydroxyl group at the second carbon of a sugar is replaced by an amino group to form an amino sugar, e.g. These sugars are formed due to removal of one of the oxygen from the alcoholic group, e.g. It is present in DNA. Uronic acids and saccharic acids are also derived sugars. Formation of glycosides with alcohol: When two alcoholic groups react with each other, a glycoside is formed. Carbohydrates contain many alcoholic groups. Hence two carbohydrates can react with alcoholic groups of one another sugars, forming glycosides. Union of two carbohydrates is known as a disaccharide, three is trisaccharide and many is a polysaccharide. There are some glycosides, other than carbohydrates discussed in this article, that are medically important, some of them are: This is a cardiac glycoside. A plant glycoside used as an immuno-stimulating agent. Also a plant glycoside used in kidney functions. Sugars containing two monosaccharide units linked by glycosidic bond are known as disaccharides. The three most common disaccharides are discussed below: It is also known as malt sugar. It is the product of starch hydrolysis. It is a reducing sugar and forms star shaped osazone crystals. It is present in milk and hence called milk sugar. It is a reducing sugar and forms puff shaped osazone crystals. It is the common table sugar obtained from sugar cane hence the name cane sugar. As it is a non-reducing sugar it does not form osazones. It is also known as invert sugar. On hydrolysis by an enzyme "sucrase or invertase", it gives a mixture of glucose and fructose.

Chapter 3 : Chemical and Physical Properties of Polysaccharides used in cooking

Identify the physical and chemical properties of monosaccharides. Monosaccharides such as glucose and fructose are crystalline solids at room temperature, but they are quite soluble in water, each molecule having several OH groups that readily engage in hydrogen bonding.

Monosaccharides can be classified by the number x of carbon atoms they contain: The most important monosaccharide, glucose, is a hexose. Examples of heptoses include the ketoses, mannoheptulose and sedoheptulose. Monosaccharides with eight or more carbons are rarely observed as they are quite unstable. In aqueous solutions monosaccharides exist as rings if they have more than four carbons. Monosaccharides are the simplest units of carbohydrates and the simplest form of sugar. In that case, the compound is termed an aldose. Ketoses of biological interest usually have the carbonyl at position 2. The various classifications above can be combined, resulting in names such as "aldohexose" and "ketotriose". A more general nomenclature for open-chain monosaccharides combines a Greek prefix to indicate the number of carbons tri-, tetra-, pent-, hex-, etc. Open-chain stereoisomers[edit] Two monosaccharides with equivalent molecular graphs same chain length and same carbonyl position may still be distinct stereoisomers, whose molecules differ in the three-dimensional arrangement of the bonds of certain atoms. This happens only if the molecule contains a stereogenic center, specifically a carbon atom that is chiral connected to four distinct molecular sub-structures. Those four bonds can have any of two configurations in space distinguished by their handedness. In a simple open-chain monosaccharide, every carbon is chiral except the first and the last atoms of the chain, and in ketoses the carbon with the keto group. Therefore, it exists as two stereoisomers whose molecules are mirror images of each other like a left and a right glove. Monosaccharides with four or more carbons may contain multiple chiral carbons, so they typically have more than two stereoisomers. The number of distinct stereoisomers with the same diagram is bounded by 2^c , where c is the total number of chiral carbons. The Fischer projection is a systematic way of drawing the skeletal formula of an acyclic monosaccharide so that the handedness of each chiral carbon is well specified. Each stereoisomer of a simple open-chain monosaccharide can be identified by the positions right or left in the Fischer diagram of the chiral hydroxyls the hydroxyls attached to the chiral carbons. Most stereoisomers are themselves chiral distinct from their mirror images. In the Fischer projection, two mirror-image isomers differ by having the positions of all chiral hydroxyls reversed right-to-left. Mirror-image isomers are chemically identical in non-chiral environments, but usually have very different biochemical properties and occurrences in nature. While most stereoisomers can be arranged in pairs of mirror-image forms, there are some non-chiral stereoisomers that are identical to their mirror images, in spite of having chiral centers. In that case, mirroring is equivalent to a half-turn rotation. For this reason, there are only three distinct 3-ketopentose stereoisomers, even though the molecule has two chiral carbons. Distinct stereoisomers that are not mirror-images of each other usually have different chemical properties, even in non-chiral environments. Therefore, each mirror pair and each non-chiral stereoisomer may be given a specific monosaccharide name. For example, there are 16 distinct aldohexose stereoisomers, but the name "glucose" means a specific pair of mirror-image aldohexoses. In the Fischer projection, one of the two glucose isomers has the hydroxyl at left on C3, and at right on C4 and C5; while the other isomer has the reversed pattern. These specific monosaccharide names have conventional three-letter abbreviations, like "Glu" for glucose and "Thr" for threose. Generally, a monosaccharide with n asymmetrical carbons has 2^n stereoisomers. The number of open chain stereoisomers for an aldose monosaccharide is larger by one than that of a ketose monosaccharide of the same length. Configuration of monosaccharides[edit] Like many chiral molecules, the two stereoisomers of glyceraldehyde will gradually rotate the polarization direction of linearly polarized light as it passes through it, even in solution. The two stereoisomers are identified with the prefixes D.

Chapter 4 : Fructose | C₆H₁₂O₆ - PubChem

Like monosaccharides, disaccharides are soluble in water. Three common monosaccharides are sucrose, lactose and maltose. "Disaccharide" is one of the four chemical groupings of carbohydrates (monosaccharide, disaccharide, oligosaccharide, and polysaccharide).

All monosaccharides have the following physical properties. When they are dissolved in water, they would take up the ring-form. This is the cause for their solubility in water. That means that the water solution of a monosaccharide can rotate the plane of polarized light. This is called the Optical activity. What is optic activity? Light wave is a transverse wave. That is, the direction of vibration is perpendicular to the direction of propagation, just like the sine wave. The plane in which the light wave vibrates is the same as its plane of propagation. So, there is one plane for one light ray. A light beam consists of many light rays in various planes. A beam of polarized light consists of parallel light rays. If a water solution can rotate the plane of polarized light by an angle, the solute is said to be optical active. The water solutions of monosaccharides can rotate the angles of polarized light, so, monosaccharides are optical active. The angles they rotate are dependent on the type of chemicals, concentration of the chemical in water solution, types of solvents and temperature. The instrument measuring the optical rotation of a solution is called the polarimeter. If a solution rotates the plane of light clockwise, it is said to be dextrorotatory. An alphabet, "d", would be put in front of its name. Otherwise, the chemical is levorotatory, and is marked "l". In fact, nobody knows what is the real direction of rotation of polarized light of the aqueous solution of the chemical with structural formula drawn. So, scientists set the definitions of dextrorotatory and levorotatory according to their structural formulae of glyceraldehyde. Any chemical, if its structural formulae can be expressed similar to that of the D-glyceraldehyde can be defined as dextrorotatory and a "D" will be put in front of its chemical name, as D-glucose, D-fructose, etc. Otherwise, it would be defined as the levorotatory and its chemical name would have an "L" in front, as L-glycine etc. This is the absolute definition. This absolute definitions cannot solve the problem, because the structural formulae are such sophisticate. Sometimes a dextrorotatory chemical will rotate the plane of polarized light anti-clockwisely and such occasions are not odd. Therefore, the angles of rotation can be positive or negative. Below is a list of optical rotations of some sugars.

Chapter 5 : Building Blocks of Carbohydrates | Types, Properties & Functions

Nomenclature of Monosaccharides: The nomenclature of monosaccharides is at present regulated by international rules. Generally, the common name of the carbohydrate is used together with indications relative to the nature of the anomers, form of the cycle, D-series or L-series and the rotatory power: for example, α -D(+)-gluco- pyranose.

In this article we will discuss about: Isomerism of Monosaccharides 2. Cyclic Structure of Monosaccharides 3.

The monosaccharides or simple sugars are molecules containing several alcohol groups as well as a reducing group, either aldehyde or ketone. Monosaccharides are classified according to the number of carbon atoms of their molecules trioses, tetroses, pentoses, hexoses, heptoses, etc. The simplest monosaccharides have three carbon atoms; they include an aldotriose " glycerinaldehyde " and a ketotriose " dihydroxyacetone see fig. These 2 forms are mirror images of each other; they represent a couple of optical isomers or enantiomers , the physical and chemical properties of which are all practically identical. The spatial structure of other monosaccharides having a larger number of carbon atoms derives from that of glycerinaldehyde, and we will have aldoses of the D- or L-series depending on whether the hydroxyl carried by the asymmetric carbon next to the primary alcohol group is in a configuration identical to that of the D- or L-glycerinaldehyde i. In the case of ketoses which possess a primary alcohol group at each end, this definition may lead to confusion. For the definition to be more general, it may be stated that it is the configuration of the secondary alcoholic hydroxyl carried by the asymmetric carbon farthest from the reducing group aldehyde or ketone which determines whether the monosaccharide belongs to the D- or L- series again by analogy with the D- or L-glycerinaldehyde. Let us examine the case of aldotetroses aldoses with 4 carbon atoms. We can apply the rule we have just enunciated, but the situation is somewhat complicated by the fact that there are two asymmetric carbon atoms. We will have the 2 configurations D and L of erythrose E1 and E2 forming a couple of enantiomers because they are mirror images of each other, and we will also have the 2 configurations D and L of threose forming a couple of enantiomers T1 and T2. On the contrary, E1 and T1, E1 and T2, E2 and T1, E2 and T2 do not form couples of enantiomers; they are diastereo-isomers; their physical and chemical properties are distinctly different, so that it is easier to separate 2 diastereo-isomers than 2 enantiomers see fig. Now considering aldopentoses, one finds 3 asymmetric carbon atoms, and therefore 8 possible stereo-isomers. Only the 4 D-forms are shown in figure to each one of them corresponds a L-form, i. As regards aldohexoses, which have 4 asymmetric carbon atoms, there are 16 possible stereo-isomers i. Figure shows only the 3 isomers most frequently found in living organisms. It is observed that these 3 isomers are all of the D-series. In fact, natural monosaccharides, whether aldoses or ketoses, are mostly of the D-series the only notable exceptions are L-arabinose and L-fucose. Regarding the D- or L-configuration of ketoses, the same rule " given earlier " applies. Figure shows the structure of some ketoses which play an important role in carbohydrate metabolism. It will be observed that they all have the ketone group in position 2 and " excepting fructose " their names are appended with the suffix -ulose which is characteristic of ketoses. It may be noted that the 2 ketopentoses represented, D-ribulose and D- xylulose differ only by the configuration of a single carbon atom carbon 3 , they are epimers. D-glucose and D-galactose see fig. Cyclic Structure of Monosaccharides: We have, so far, written the formula of monosaccharides in the form of a Linear chain. But this representation is not satisfactory because it does not explain some observations. Glucose and other aldoses, contrary to most aldehydes, do not restore the colour of fuchsine decolorized by SO₂ Schiff s fuchsine. The rotatory power of a freshly prepared glucose solution changes when it is observed in the polarimeter this has been called mutarotation. Besides, two stereo-isomers or anomers of glucose were isolated: When an aldehyde is treated by methanol in acid medium, 2 molecules of methanol react with one molecule of aldehyde to form an acetal. This cyclization between the aldehyde group and the alcoholic group of carbon 5 is easier than what is suggested by the linear representation of glucose; these two groups can readily react because they are in fact close to one another in space, as shown by the construction of molecular models taking into considerations the atomic distances and valence angles. This cyclization may involve either carbon 5 or carbon 4 of glucose. In the case of the oxide bridge , one has a hexagonal cycle containing 5 carbon atoms and one oxygen atom; it is

a pyranose ring. In the case of the oxide bridge, the pentagonal cycle contains 4 carbon atoms and one oxygen atom; it is a furanose ring. In both cases the reducing group is in the hemiacetal or pseudo-aldehyde form. The same cyclic forms pyranose and furanose rings exist for ketoses, particularly for fructose; in this case, one speaks of a pseudo-ketone group for the hemiacetal form. Monosaccharides in solution in water mainly adopt the pyran form. On the contrary in numerous cases where they are combined, they are found in the furan form see for example, the formulae of sucrose and nucleotides, figs. They have been named anomers, because they differ only by the configuration of substituents on the hemiacetal asymmetric carbon atom. The representation proposed by Haworth is increasingly used at present: Inversely, if the oxide bridge is on the left of the chain, the excess carbon atoms are represented downwards. These two rules are illustrated by some examples see fig. In reality the hexagonal cycle is not plane: The Different Types of Monosaccharides: Monosaccharides are divided into four categories: D-glucose, D-galactose, D-mannose, D-xylose, etc. This group also comprises the deoxyoses, which are monosaccharides having lost 1 or 2 oxygen atoms. Among them, can be mentioned the 6-deoxyhexoses which may be considered, either as aldohexoses, the terminal "CH₂OH" of which is replaced by a "CH₃", or as aldopentoses in which one hydrogen of carbon 5 is replaced by a methyl examples: L-rhamnose or 6-deoxy-L-mannose, L-fucose or 6-deoxy-L-galactose. The most important is a pentose, the 2-deoxy-D-ribose, which is the monosaccharide found in deoxyribonucleic acids and derives from D-ribose see fig. They derive from the neutral monosaccharides by replacement of a hydroxyl generally the one carried by carbon 2 by an amine group. They are often found in polysaccharides which are described in the following. The amino group is frequently acetylated. Figure shows the structure of the 4 most common hexosamines the structures of glucosamine and muramic acid are represented in the N-acetylated form. Uronic acids derive from aldoses by oxidation of the primary-alcohol group into a carboxylic group and therefore maintain the aldehyde group. Its structure is shown in figure Sialic or neuraminic acids are derivatives generally acetylated of neuraminic acid which itself consists of a molecule of pyruvic acid carbons 1, 2,3 condensed with a molecule of D-mannosamine carbons 4 to 9. N-acetyl-neuraminic acid see fig. The other acetylations, leading to various sialic acids, occur on hydroxyls especially in positions 4 and 7. Sialic acids are constituents of various glycoproteins and glycolipids. There are also N-glycolyl-neuraminic acids the OH of which can also be acetylated. Compounds Derived from Monosaccharides: L-Ascorbic Acid Vitamin C: A study of its structure see fig. It is further characterised by a double bond between 2 carbon atoms, each carrying a hydroxyl ene-diol. Polyalcohols are obtained by reduction of the aldehyde or ketone group to alcohol group. For example, by reduction, D-glucose gives D-glucitol usually known as sorbitol, D-galactose gives D-galactitol usually known as dulcitol, D-mannose gives mannitol, D-ribose gives ribitol found in the molecule of riboflavin, see fig. The compound with 3 carbon atoms, glycerol, which may be considered as the reduction product of glyceraldehyde or dihydroxyacetone and which in fact, derives from the latter is a trialcohol which has a considerable metabolic importance. Lastly, let us mention the existence of cyclic polyalcohols, called cyclitols. The representative of this group most frequently found in nature is myo-inositol see fig. Generally, the common name of the carbohydrate is used together with indications relative to the nature of the anomerism, form of the cycle, D-series or L-series and the rotatory power: Lastly, initials have been adopted in order to facilitate the writing; the following are the most common: N-acetyl-glucosamine; Mur NAc: N-acetylmuramic acid; Glc AU: The nature of the cycle and of the D- or L-series are also indicated: Chemical Properties of Monosaccharides: As mentioned above, monosaccharides are polyhydroxyaldehydes or poly-hydroxyketones: As will be seen in the following, phosphoric esters of monosaccharides are of very great importance in the metabolism of carbohydrates. In most cases the primary alcohol group is esterified, giving for example, glucosephosphate, fructosephosphate, fructosephosphate, fructose- 1,6-bisphosphate, ribosephosphate, ribulosephosphate, glyceraldehydephosphate, dihydroxyacetone-phosphate, etc. The hemiacetal group can also be esterified example: In presence of alkaline agents sodium hydroxide, silver oxide, dimethyl-formamide and methyl sulphate or iodide, the free hydroxyls of monosaccharides are replaced by methoxy groups OCH₃. Alkylation does not take place on the blocked OH, like the one involved in the oxide bridge or those engaged in a glycoside linkage, in oligo- or polysaccharide molecules. This property is utilized in the determination of the modes of linkage between the molecules of monosaccharides in

polysaccharides. The aldehyde or ketone group of monosaccharides can be oxidized; aldoses and ketoses will therefore behave like reductants and in particular, they will be able to reduce metal salts in alkaline solution up to the metal stage or up to a lower degree of oxidation. Since the medium is alkaline, we obtain: This reaction will be produced by all molecules of aldoses and ketoses which have, if not a free aldehyde or ketone group, at least a pseudo-aldehyde or pseudo-ketone group capable of yielding a free group as the equilibrium existing in the solution is displaced by the reaction. On the contrary, the molecules whose pseudo-aldehyde or pseudo ketone group is involved in an oside linkage will not have any reducing character except if this linkage is hydrolyzed. Examples will be given in the following while referring to heterosaccharides, disaccharides and polysaccharides. Action of Concentrated Acids: Under the effect of a concentrated acid and in heat, aldoses and ketoses give furfural in the case of pentoses, a hydroxymethylated derivative of furfural in the case of hexoses, or furoic acid in the case of uronic acids. In the case of glucose the reaction is as follows see fig. Furfural and its derivatives can condense with various phenols naphthol, orcinol, etc. In a first step, a molecule of phenylhydrazine reacts with a molecule of aldose or ketose to form a hydrazone. Then, an osazone is obtained in presence of an excess of phenylhydrazine. Osazones are crystallized products whose characteristics form of crystals, melting point can allow the identification of monosaccharides. Two epimer aldoses which differ only by the configuration of the hydroxyl carried by carbon 2; this is the case of glucose and mannose see fig. An aldose and a ketose isomers having the same configuration of the carbon atoms carrying secondary alcohol groups; this is the case of glucose and fructose see fig.

Chapter 6 : Monosaccharide - Wikipedia

5 Monosaccharide Reactions, cont. Esterification The -OH groups of monosaccharides can behave as alcohols and react with acids (especially phosphoric acid) to form esters.

Chapter 7 : Properties of Monosaccharides - Chemistry LibreTexts

(1) All disaccharides are soluble in water and give a sweet taste. the sweetness of sucrose is taken as 1, the sweetness of other carbohydrates is listed in below.

Chapter 8 : Disaccharide - Wikipedia

Chemical properties of monosaccharides Reaction with hydrazines to form osazones. Reduction to form sugar alcohols Name of monosaccharide Sugar derivative GI Slideshare uses cookies to improve functionality and performance, and to provide you with relevant advertising.

Chapter 9 : Food Carbohydrates: Chemistry, Physical Properties, and Applications - CRC Press Book

Best Answer: in general, monosaccharides and disaccharides are highly soluble compounds in polar solvents (as water) due to the presence of abundant hydroxyl groups in those molecules.