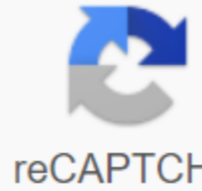


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Home » Biochemistry » Carbohydrates – Monosaccharides, Disaccharides, Polysaccharides Updated on February 24, 2020 by Sagar Aryal

Carbohydrate definition Carbohydrates are molecules containing carbon, hydrogen and oxygen. There are twice as many hydrogen atoms as carbon or oxygen atoms. The common formula for carbohydrate can be written as $C_x(H_2O)_y$. They act as the source of energy (e.g. glucose), as a storage of energy (e.g. starch and glycogen) and as structural units (e.g. cellulose in plants and chitins in insects). Most carbohydrates are polymers. Polymers are large, complex molecules consisting of long chains of monomers. Monomers are small, basic molecular units. Carbohydrates can be divided into three groups: monosaccharides, disaccharides and polysaccharides. Monosaccharides – Structure, Properties, and Samples Monosaccharides are simple sugars in which there is one oxygen atom and two hydrogen atoms for each carbon atom present in the molecule. They have common formula as $(CH_2O)_n$. Monosaccharides reduce sugars. The test for reducing sugar is called Benedict's test. They are sugars, which taste sweet, are soluble in water and are insoluble in non-polar solvents. They exist in straight chains or in the ring or cyclical shapes. They are classified according to the number of carbon atoms in each molecule as trioses (3C), tetroses (4C), pentoses (5C), hexoses (6C), heptoses (7) and so on. The names of all sugars end with -ose. Examples: Glyceraldehyde (triose), Eritrose (threose), Ribose (pentose), Glucose (hexose), Fructose (hexose), Galactose (hexose), Sedoheptulose (heptose), etc. They are used as a source of energy in breathing. They are important building blocks for large molecules. Disaccharides - Structure, Properties and Sample Disaccharides consist of two monosaccharides merged by a condensation reaction. The condensation reaction is the connection of two molecules with the formation of a new chemical bond and a water molecule released when the connection is formed. A glycosidic bond is formed between two monosaccharides. If carbon 1 on one monosaccharide joins carbon 4 on another monosaccharide, it is called a 1,4 glycosidic bond. Examples: Maltose is formed from two α glucose molecules merged by a glycosidic bond. Sucrose is formed from a condensation reaction between a glucose molecule and a fructose molecule. Lactose is formed from glucose and a galactose molecule. Sucrose is a non-reducing sugar. Disaccharides can be divided apart into two monosaccharides by breaking the glycosidic bond by adding water molecules, known as hydrolysis reaction. The water provides a hydroxy group (-OH) and hydrogen (-H), which helps to break the glycosidic bond. Sucrose is the transport sugar. Lactose is the sugar found in milk which is an important component of the diet of young mammals. Polysaccharides – Structure, Properties, and Examples Polysaccharides are polymers formed by the combination of many monosaccharide molecules (more than two) through condensation reactions. Molecules with 3-10 sugar units are known as oligosaccharides, while molecules that are 11 or more monosaccharides are true polysaccharides. Polysaccharides don't taste sweet. Because their molecules are so enormous, most polysaccharides do not dissolve in water. Polysaccharides are made exclusively from one kind of monosaccharide called homopolysaccharides (Starch) while those made of more than one monomer called heteropolysaccharides (Hyaluronic acid). Starch consists of long chains of α glucose (Amylose and Amylopectin). Glycogen is made of α glucose linked by glycosidic bonds. Cellulose is also made of many β -glucose molecules linked by glycosidic bonds between carbon 1 and carbon 4. Starch is the main energy storage material in plants. Glycogen is the main energy storage material in animals. Cellulose is the main component of cell walls in plants. The test for starch is called an Iodine test. References Ann Fullick, Jo Locke and Paul Bircher. 2015. A Level Biology for OCR-A. Oxford University Press. (Buy this book) Michael McCarthy 2015. Edexcel AS/A level Biology 1. 2nd Edition. Pearson Education Limited. C.G.P. 2015. A-Level Biology Examination Board: AQA. Complete Review and Practice. Original material by Richard Parsons, Glenn Toole and Susan Toole. 2015. AQA Biology for A-Level. 2nd Edition. Oxford University Press. Mary Jones, Richard Fosbery, Jennifer Gregory and Dennis Taylor. 2014. Cambridge International AS and a Shallow Biology Course Book. 4th Edition. Cambridge University Press. Mary Jones. 2010. Cambridge International A/AS-Level Biology Review Guide. Hodder Education. Sue Hocking, Frank Sochacki and Mark Winterbottom. 2015. OCR AS / A level Biology A. 2nd Edition. Pearson Education Limited. Carbohydrate- Monosaccharides, Disaccharides, Polysaccharides Carbohydrates are the most abundant bio-macro molecules on earth. They are commonly known as sugars because most of them have a sweet taste. Chemically all carbohydrates are polyhydroxy (contain many hydroxyl, -OH, groups) aldehydes or ketones. All carbohydrates are hydrated from carbon and it contains C, H and O. The ratio of hydrogen and oxygen in the majority of carbohydrates will be in 2:1 as in water. Some carbohydrates also contain nitrogen, phosphorus and sulphur. Majority of carbohydrates, not all, have the empirical formula $(CH_2O)_n$. In biochemistry, carbohydrates are considered saccharides. The term saccharide is derived from a Greek word 'sakkharon' meaning sugar. Green plants solve the energy of sunlight through photosynthesis. In photosynthesis, the light energy is converted into the chemical energy and it is stored in some carbohydrates such as glucose, fructose, sucrose, starch. The oxidative breakdown of these carbohydrates releases the energy stored in them and this energy is used for the different metabolic activities of the cells. Carbohydrates are classified into three large categories based on the number of monomer units and the extent of their polymerization. They are: (1). Monosaccharides (2). Oligosaccharides (3). Polysaccharides (1). Monosaccharide Monosaccharides, also called simple sugars, are the basic unit of carbohydrates. They are the fundamental unit of carbohydrates and they cannot be further hydrated to yield smaller carbohydrate units. All monosaccharides consist of a single polyhydroxy aldehyde or ketone unit. Most of the monosaccharides have the empirical formula $C(H_2O)_n$. Monosaccharides exist as colorless, crystalline and water-soluble solids. Most of the monosaccharides have a sweet taste. All monosaccharides reduce sugars. Based on the number of carbon atoms, the monosaccharides may be triose (with 3C), tetroses (4C), pentoses (5C) or hexoses (6C). Monosaccharides with four or more carbon atoms tend to have cyclic structures in nature. The scientific nomenclature of monosaccharides is very complex. However, the common names of most of the monosaccharides end with a suffix '-ose'. The most abundant monosaccharide in nature is a six-carbon sugar called glucose. Examples of monosaccharides: 3 Carbon – Dihydroxy acetone 4 Carbon - Eritrose 5 Carbon - Ribose 6 Carbon - Glucose, Fructose (2). Oligosaccharides The oligosaccharides are sugar polymers comprising short chains of monosaccharide units (remnants). The monosaccharide units in the polysaccharide chain are linked by a distinctive bond called glycosidic bonding. The number of monomer units in the oligosaccharides usually ranges from 2-20. All oligosaccharides on hydrolysis deliver individual monosaccharide units due to the cleavage of the glycosidic bonds. The most common oligosaccharides in nature are disaccharides. A disaccharide consists of two units of monosaccharide units. The most abundant naturally occurring disaccharide is sucrose (table sugar). Sucrose consists of a glucose molecule and a fructose molecule connected α -1-2 glycosidic linkage. Oligosaccharides with three or more units do not occur freely in nature. They are usually found associated with non-sugar molecules such as proteins and lipids as glycoproteins (Glycoproteins, Proteoglycans and Glycolipids). Examples of oligosaccharides: (a). Sucrose: a disaccharide of glucose and fructose (b). Lactose: a disaccharide of galactose and glucose (c). Maltose: a disaccharide of two glucose molecules (d). Trehalose: a disaccharide of two α linked glucose residues (s). Raffinose: a trisaccharide of galactose, glucose, and fructose (3). Polysaccharides They are sugar polymers with more than 20 monosaccharide units. Most of the naturally occurring polysaccharides have more than 1000 monosaccharide units. Like oligosaccharides, the monomer units in the polysaccharides are also linked by glycosidic bonds. Polysaccharides on hydrolysis release the individual building monosaccharide units. Some polysaccharide chains are unbranched, while another is heavily branched. Polysaccharides are further classified into two categories based on the composition of monosaccharides in the chain. They are: (1). Homopolysaccharides: They consist of only a single type of monosaccharide unit. (2). Heteropolysaccharides: They consist of more than one type of unit. Examples of polysaccharides: Homopolysaccharides: Starch, Glycogen and Cellulose (monosaccharide units in all three are glucose) Heteropolysaccharide: Peptidoglycan, Chondroitin, Heparin Biological meaning / functions of carbohydrates: \rightarrow Source of energy: Carbohydrates are the primary source of energy. They are the food reserve (energy store molecules) in microbes, animals and plants. \rightarrow Source of C, H, and O: Carbohydrates also act as the source of C, H and O in the cells for the synthesis of other macromolecules. \rightarrow Sweetener: Some sugars are sweet in taste. They offer sweetness and flavor to a variety of food stuffs. \rightarrow Glycemics: Carbohydrate contains lipids (called glycolipids) is one of the important categories of plasma membrane lipids. \rightarrow Diet fibers: Carbohydrates are also the source from dietary fiber. \rightarrow Ribose sugar: A monosaccharide (ribose) is an essential component in the genetic material (DNA and RNA). \rightarrow Cell wall and exoskeleton: Some carbohydrates are the structural framework of the cells. For example, cellulose of the cell wall of plants, Peptidoglycan forms the cell wall of bacterial cells and chitin forms the cell wall of fungi and the exoskeleton of arthropods. \rightarrow Recognition: Some carbohydrates on the surface of cell membrane have recognition roles. \rightarrow Protein trade: The glycosylation (seizure of sugar moieties) of other macromolecules such as proteins of proteins is used in protein trading by the cell. Example: a protein marked with mannose 6 phosphate is destined to lysosomes. \rightarrow Anticoagulant: Heparin, The anticoagulant of the blood, is a carbohydrate that prevents the blood clotting. \rightarrow Blood Group: The ABO blood groups are determined by the carbohydrates and therefore carbohydrates also function as antigens. \rightarrow Industrial uses: Some carbohydrates are the raw material for many industries. Example: cellulose in the paper industry, starch, glucose, fructose etc. in fermentation and brewing industry. \rightarrow Back to Biochemistry Reading Notes Study Offline (Without Internet) Now you can download the PDF from this post absolutely free! Please click the Download Link / button below to save the mail as a single PDF file. The PDF file will be opened in a new window in the browser itself. Right-click on the and select 'Save As' option to save the file to your computer. Please share the PDF with your friends, family, students and colleagues... You can also like... @. Monosaccharides: Properties, Structure and Classification @. Oligosaccharides @. Polysaccharides @. Difference between reduction and non-sugars @. Glycoconjugates: (Glycoprotein, Proteoglycan and Glycolipids) @. Glycosylation @. Membrane Lipids: Properties, Structure and Classification @. MCQ on Carbohydrates: Part 1 | Part 2 | Part 3 | More Biochemistry Reading Notes... Sharing is caring... 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