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It is important to note that the linear form of glucose makes up less than 0. The rest is one of two cyclic forms of glucose that are formed when the hydroxyl group on carbon 5 (C5) bonds to the aldehyde carbon 1 (C1). Cyclic forms of glucose. From left to right: The open-chain form is limited to about 0. The terms "glucose" and "D-glucose" are generally used for these cyclic forms as well. The ring arises from the open-chain form by an intramolecular nucleophilic addition reaction between the aldehyde group at C-1 and either the C-4 or C-5 hydroxyl group, forming a hemiacetal linkage, $-C(OH)H-O-$. The reaction between C-1 and C-5 yields a six-membered heterocyclic system called a pyranose, which is a monosaccharide sugar hence "ose" containing a derivatised pyran skeleton. The much rarer reaction between C-1 and C-4 yields a five-membered furanose ring, named after the cyclic ether furan. The ring-closing reaction makes carbon C-1 chiral, too, since its four bonds lead to $-H$, to $-OH$, to carbon C-2, and to the ring oxygen. Therefore, the open-chain isomer D-glucose gives rise to four distinct cyclic isomers: These five structures exist in equilibrium and interconvert, and the interconversion is much more rapid with acid catalysis. The rings are not planar, but are twisted in three dimensions. Similarly, the glucofuranose ring may assume several shapes, analogous to the "envelope" conformations of cyclopentane. In the solid state, only the glucopyranose forms are observed, forming colorless crystalline solids that are highly soluble in water and acetic acid but poorly soluble in methanol and ethanol. Rotational isomers Each glucose isomer is subject to rotational isomerism. Mutarotation consists of a temporary reversal of the ring-forming reaction, resulting in the open-chain form, followed by a reforming of the ring. Thus, though the open-chain form is barely detectable in solution, it is an essential component of the equilibrium. The open-chain form is thermodynamically unstable, and it spontaneously isomerizes to the cyclic forms. Although the ring closure reaction could in theory create four- or three-atom rings, these would be highly strained, and are not observed in practice. In solutions at room temperature, the four cyclic isomers interconvert over a time scale of hours, in a process called mutarotation. The strength of the effect is different for each of the five tautomers. Note that the D - prefix does not refer directly to the optical properties of the compound. It indicates that the C-5 chiral center has the same handedness as that of D -glyceraldehyde which was so labeled because it is dextrorotatory. The fact that D -glucose is dextrorotatory is a combined effect of its four chiral centers, not just of C-5; and indeed some of the other D -aldohexoses are levorotatory. The equilibration takes place via the open-chain aldehyde form. Isomerisation In dilute sodium hydroxide or other dilute bases, the monosaccharides mannose, glucose and fructose interconvert via a Lobry de Bruyn-van Ekenstein transformation, so that a balance between these isomers is formed. This reaction proceeds via an enediol: Biochemical properties Metabolism of common monosaccharides and some biochemical reactions of glucose Glucose is the most abundant monosaccharide. Glucose is also the most widely used aldohexose in most living organisms. One possible explanation for this is that glucose has a lower tendency than other aldohexoses to react nonspecifically with the amine groups of proteins. Presumably, glucose is the most abundant natural monosaccharide because it is less glycosylated with proteins than other monosaccharides. Polysaccharides that are composed solely of Glucose are termed glucans. Glucose is produced by plants through the photosynthesis using sunlight, water and carbon dioxide and can be used by all living organisms as an energy and carbon source. However, most glucose does not occur in its free form, but in the form of its polymers, i. These polymers are degraded to glucose during food intake by animals, fungi and bacteria using enzymes. All animals are also able to produce glucose themselves from certain precursors as the need arises. Nerve cells, cells of the renal medulla and erythrocytes depend on glucose for their energy production. This complex of the proteins T1R2 and T1R3

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makes it possible to identify glucose-containing food sources. In humans, the breakdown of glucose-containing polysaccharides happens in part already during chewing by means of amylase, which is contained in saliva, as well as by maltase, lactase and sucrase on the brush border of the small intestine. Glucose is a building block of many carbohydrates and can be split off from them using certain enzymes. Glucosidases, a subgroup of the glycosidases, first catalyze the hydrolysis of long-chain glucose-containing polysaccharides, removing terminal glucose. In turn, disaccharides are mostly degraded by specific glycosidases to glucose. The names of the degrading enzymes are often derived from the particular poly- and disaccharide; inter alia, for the degradation of polysaccharide chains there are amylases named after amylose, a component of starch, cellulases named after cellulose, chitinases named after chitin and more. Furthermore, for the cleavage of disaccharides, there are maltase, lactase, sucrase, trehalase and others. In humans, about 70 genes are known that code for glycosidases. They have functions in the digestion and degradation of glycogen, sphingolipids, mucopolysaccharides and poly ADP-ribose. Humans do not produce cellulases, chitinases and trehalases, but the bacteria in the gut flora do. In order to get into or out of cell membranes of cells and membranes of cell compartments, glucose requires special transport proteins from the major facilitator superfamily. With the help of glucosephosphatase, glucosephosphate is converted back into glucose exclusively in the liver, if necessary, so that it is available for maintaining a sufficient blood glucose concentration. In other cells, uptake happens by passive transport through one of the 14 GLUT proteins. Gluconeogenesis and Glycogenolysis In plants and some prokaryotes, glucose is a product of photosynthesis. The cleavage of glycogen is termed glycogenolysis, the cleavage of starch is called starch degradation. The smaller starting materials are the result of other metabolic pathways. Ultimately almost all biomolecules come from the assimilation of carbon dioxide in plants during photosynthesis. In the liver about g of glycogen are stored, in skeletal muscle about g. Unlike for glucose, there is no transport protein for glucosephosphate. Gluconeogenesis allows the organism to build up glucose from other metabolites, including lactate or certain amino acids, while consuming energy. The renal tubular cells can also produce glucose. Glucose Degradation Glucose metabolism and various forms of it in the process Glucose-containing compounds and isomeric forms are digested and taken up by the body in the intestines, including starch, glycogen, disaccharides and monosaccharides. Glucose is stored in mainly the liver and muscles as glycogen. It is distributed and used in tissues as free glucose. Glycolysis and Pentose phosphate pathway In humans, glucose is metabolised by glycolysis [55] and the pentose phosphate pathway. If there is not enough oxygen available for this, the glucose degradation in animals occurs anaerobic to lactate via lactic acid fermentation and releases less energy. Muscular lactate enters the liver through the bloodstream in mammals, where gluconeogenesis occurs Cori cycle. With a high supply of glucose, the metabolite acetyl-CoA from the Krebs cycle can also be used for fatty acid synthesis. These processes are hormonally regulated. In other living organisms, other forms of fermentation can occur. The bacterium *Escherichia coli* can grow on nutrient media containing glucose as the sole carbon source. The first step of glycolysis is the phosphorylation of glucose by a hexokinase to form glucose 6-phosphate. The main reason for the immediate phosphorylation of glucose is to prevent its diffusion out of the cell as the charged phosphate group prevents glucose 6-phosphate from easily crossing the cell membrane. At physiological conditions, this initial reaction is irreversible. In anaerobic respiration, one glucose molecule produces a net gain of two ATP molecules four ATP molecules are produced during glycolysis through substrate-level phosphorylation, but two are required by enzymes used during the process.

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