Compounds in Human Body Organic

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ABSTRACT

This research includes an introduction to organic chemistry in the human body, compounds, their importance, composition, types and presence , the functional group is a group of atoms linked by strong covalent bonds and tending to function in chemical reactions as a single unit. You can think of functional groups as tightly knit "cliques" whose members are unlikely to be parted. Five functional groups are important in human physiology; these are the hydroxyl, carboxyl, amino, methyl and phosphate groups

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Introduction

Organic compounds typically consist of groups of carbon atoms covalently bonded to hydrogen, usually oxygen, and often other elements as well. Created by living things, they are found throughout the world, in soils and seas, commercial products, and every cell of the human body. The four types most important to human structure and function are carbohydrates, lipids, proteins, and nucleotides. Before exploring these compounds, you need to first understand the chemistry of carbon.(1)

A functional group is a group of atoms linked by strong covalent bonds and tending to function in chemical reactions as a single unit. You can think of functional groups as tightly knit "cliques" whose members are unlikely to be parted. Five functional groups are important in human physiology; these are the hydroxyl, carboxyl, amino, methyl and phosphate groups (1)

Functional Groups Important in Human Physiology

1- Hydroxyl(OH):

Hydroxyl groups are polar. They are components of all four types of organic compounds discussed in this chapter. They are involved in dehydration synthesis and hydrolysis reactions.

2- Carboxyl(O-C-OH):

Carboxyl groups are found within fatty acids, amino acids, and many other acids.

3- Amino(-N-H2):

Amino groups are found within amino acids, the building blocks of proteins.

4- Methyl(-C-H3):

Methyl groups are found within amino acids.

5- Phosphate

$—P—O_4^{2-}$

Phosphate groups are found within phospholipids and nucleotides.(1)

The function of chemical elements in the body

Most chemical elements found in the human body play a vital role. Some trace elements, such as titanium and cesium, may be contaminants. Some, such as lead, mercury, arsenic, and cadmium are active toxins depending on the amount present.

The function of the essential elements in the human body, by order of percentage of mass, are as follows:

Oxygen

Oxygen is the most common element in the human body, comprising approximately 65.0% of body mass. Most of the oxygen present is found in the form of water. Oxygen plays a critical role in metabolism and respiration and the element is found in every major organic molecule in the body including proteins, carbohydrates, fats, and nucleic acids.

Hydrogen

Hydrogen is the most abundant element in the universe (about 75% of total mass) and makes up around 10% of the human body by mass. It is present in the form of water (along with oxygen) as well as being an important element in organic molecules.

Nitrogen

Nitrogen comprises 3% of the human body by mass. It is found in all organisms in molecules such as amino acids (which make up proteins), nucleic acids (DNA and RNA), and adenosine triphosphate (ATP), an essential energy transfer molecule.

Calcium

Calcium is the most abundant metal in the human body, at around 1.4% by mass. Arguably its most well-known function is in the formation of bones and teeth and lack of calcium in the diet can lead to a variety of degenerative conditions. Other important roles in the human body include protein synthesis, maintaining the potential difference across cell membranes, and acting as second messengers in signal transduction pathways.

Phosphorus

Phosphorus is highly reactive, and because of this property, it is never found as a free element on Earth. Phosphates are essential to life, and this bound form of phosphorus is a major component of essential organic molecules such as phospholipids, ATP, and nucleic acids. It comprises 1.1% of the total body mass of the human body.

Potassium

Potassium makes up less than 1% of body mass. It plays a vital role in nerve transmission via the transfer of potassium ions across nerve cell membranes.

Sulfur

The tenth most common element in the universe and the fifth most common on Earth, sulfur plays an essential role in the human body. It is found in the body almost always in the form of metal sulfides and organosulfur compounds. Sulfur is also a major structural element of the protein keratin, which is found in skin and hair.

Sodium

Sodium, an alkali metal, is commonly found in salt. Sodium ions contribute to osmotic pressure as they are the major cation in the extracellular fluid (ECF.) Sodium also plays a key role in nerve transmission.

Chlorine

Chlorine plays an essential role in maintaining the acid-base balance of blood, along with the formation of tendons, teeth, and bones. It is commonly found in salts and in combination with potassium and sodium in the body. It also contributes to liver function and helps to eliminate organic waste.

Magnesium

Magnesium is the least common of the essential elements in the human body. Some 300 or so enzymes require magnesium ions to function properly, and magnesium ions interact with compounds such as DNA, RNA, and ATP .(2)(3)(4)(5)

Carbohydrates

The term carbohydrate means “hydrated carbon.” Recall that the root hydro- indicates water. A **carbohydrate** is a molecule composed of carbon, hydrogen, and oxygen; in most carbohydrates, hydrogen and oxygen are found in the same two-to-one relative proportions they have in water. In fact, the chemical formula for a “generic” molecule of carbohydrate is (CH2O)n.

Carbohydrates are referred to as saccharides, a word meaning “sugars.” Three forms are important in the body: monosaccharides, disaccharides, and polysaccharides. Monosaccharides are the monomers of carbohydrates. Disaccharides (di- = “two”) are made up of two monomers. **Polysaccharides** are the polymers, and can consist of hundreds to thousands of monomers.

Monosaccharides

A **monosaccharide** is a monomer of carbohydrates. Five monosaccharides are important in the body. Three of these are the hexose sugars, so called because they each contain six atoms of carbon. These are glucose, fructose, and galactose, shown in Figure .(2)**a**. The remaining monosaccharides are the two pentose sugars, each of which contains five atoms of carbon. They are ribose and deoxyribose, shown in Figure(2)**b**.

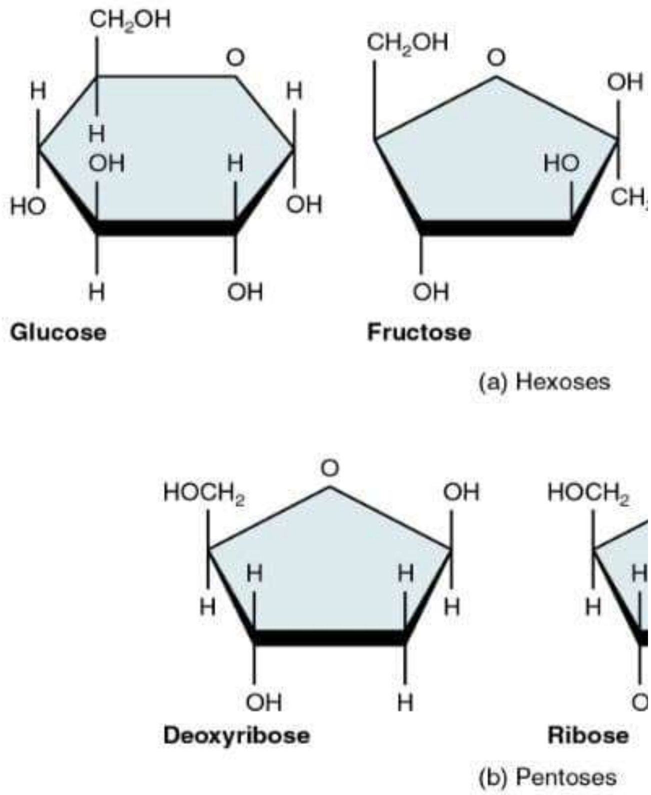
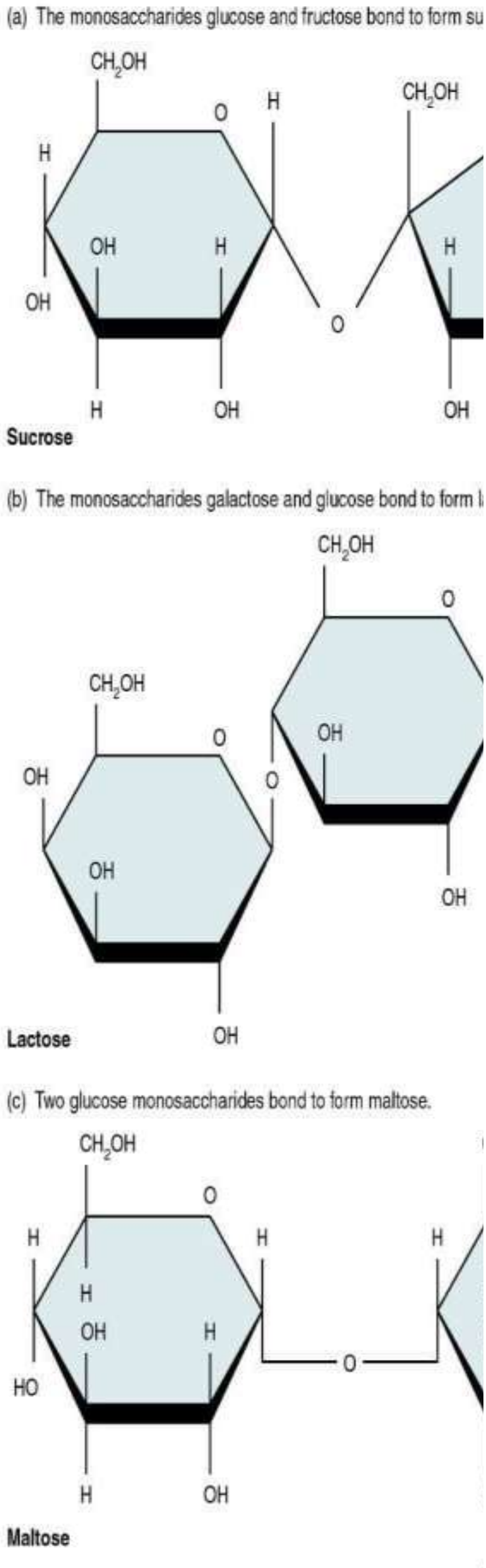


Figure .1 Five Important Monosaccharides

disaccharide

A disaccharide is a pair of monosaccharides. Disaccharides are formed via dehydration synthesis, and the bond linking them is referred to as a glycosidic bond (glyco- = "sugar"). Three disaccharides (shown in Figure .3) are important to humans. These are sucrose, commonly referred to as table sugar, lactose, or milk sugar, and maltose, or malt sugar. As you can tell from their common names, you consume these in your diet, however, your body cannot use them directly. Instead, in the digestive tract, they are split into their component monosaccharides via hydrolysis.



Polysaccharides

Polysaccharides can contain a few to a thousand or more monosaccharides. Three are important to the body (Figure .3):

 Starches are polymers of glucose. They occur in long chains called amylose or branched chains called amylopectin, both of which are stored in plant-based foods and are relatively easy to digest.

 Glycogen is also a polymer of glucose, but it is stored in the tissues of animals, especially in the muscles and liver. It is not considered a dietary carbohydrate because very little glycogen remains in animal tissues after slaughter, however, the human body stores excess glucose as glycogen, again, in the muscles and liver.

 Cellulose, a polysaccharide that is the primary component of the cell wall of green plants, is the component of plant food referred to as “fiber”. In humans, cellulose/fiber is not digestible, however, dietary fiber has many health benefits. It helps you feel full so you eat less, it promotes a healthy digestive tract, and a diet high in fiber is thought to reduce the risk of heart disease and possibly some forms of cancer.(1)

 Cellulose, a polysaccharide found in the cell walls of all plants, is one of the main components of insoluble dietary fiber. Although it is indigestible in humans (generally rumination, and some insects—particularly termites, have more complex digestions and can digest cellulose), cellulose and insoluble dietary fiber generally help maintain a healthy digestive tract (6)by facilitating movement through the large part of the colon (ie defecation). Other sugars contained in dietary fiber include resistant starch and inulin, which some types of bacteria feed on in the flora of the large intestine, and are metabolized by these bacteria to produce short-chain fatty acids.(7)(8)

Functions of Carbohydrates

The body obtains carbohydrates from plant-based foods. Grains, fruits, and legumes and other vegetables provide most of the carbohydrate in the human diet, although lactose is found in dairy products.

Although most body cells can break down other organic compounds for fuel, all body cells can use glucose. Moreover, nerve cells (neurons) in the brain, spinal cord, and through the peripheral nervous system, as well as red blood cells, can only use glucose for fuel. In the breakdown of glucose for energy, molecules of adenosine triphosphate, better

known as ATP, are produced. **Adenosine triphosphate (ATP)** is composed of a ribose sugar, an adenine base, and three phosphate groups. ATP releases free energy when its phosphate bonds are broken, and thus supplies ready energy to the cell. More ATP is produced in the presence of oxygen (O2) than in pathways that do not use oxygen. The overall reaction for the conversion of the energy in glucose to energy stored in ATP can be written:(1)

$C6H12O6 + 6\ O2 \rightarrow 6\ CO2 + 6\ H2O + ATP$

In addition to being a critical fuel source, carbohydrates are present in very small amounts in cells' structure. For instance, some carbohydrate molecules bind with proteins to produce glycoproteins, and others combine with lipids to produce glycolipids, both of which are found in the membrane that encloses the contents of body cells(1)

Carbohydrates play many roles in living organisms. Polysaccharides serve to store energy (such as starch and glycogen), and as structural components (such as cellulose in plants and chitin in arthropods). The 5-carbon monosaccharide ribose is an important component of coenzymes (such as ATP, FAD, and NAD) and the backbone of a genetic molecule known as RNA. The related deoxyribose is a component of DNA. Polysaccharides and their derivatives contain many other important biomolecules that play key roles in the immune system, fertilization, disease prevention, blood clotting, and growth.(9)

Lipid

In biology and biochemistry, a lipid is a macro biomolecule that is soluble in nonpolar solvents.[10] Non-polar solvents are typically hydrocarbons used to dissolve other naturally occurring hydrocarbon lipid molecules that do not (or do not easily) dissolve in water, including fatty acids, waxes, sterols, fat-soluble vitamins (such as vitamins A, D, E, and K), monoglycerides, diglycerides, triglycerides, and phospholipids The functions of lipids include storing energy, signaling, and acting as structural components of cell membranes.(11)(12)

Scientists sometimes define lipids as hydrophobic or amphiphilic small molecules; the amphiphilic nature of some lipids allows them to form structures such as vesicles, multilamellar/unilamellar liposomes, or membranes in an aqueous environment. Biological lipids originate entirely or in part from two distinct types of biochemical subunits or "building-blocks": ketoacyl and isoprene groups. Using this approach, lipids may be divided into eight categories: fatty acids, glycerolipids, glycerophospholipids, sphingolipids, saccharolipids, and polyketides (derived from condensation of ketoacyl subunits); and sterol lipids and prenol lipids (derived from condensation of isoprene subunits).(13)

Triglycerides

A triglyceride is one of the most common dietary lipid groups, and the type found most abundantly in body tissues. This compound, which is commonly referred to as a fat, is formed from the synthesis of two types of molecules (Figure 6): A glycerol backbone at the core of triglycerides, consisting of three carbon atoms.

Three fatty acids, long chains of hydrocarbons with a carboxyl group and a methyl group at opposite ends, extending from each of the carbons of the glycerol.

Triglycerides form via dehydration synthesis. Glycerol gives up hydrogen atoms from its hydroxyl groups at each bond, and the carboxyl group on each fatty acid chain gives up a hydroxyl group. A total of three water molecules are thereby released.

Fatty acid chains that have no double carbon bonds anywhere along their length and therefore contain the maximum number of hydrogen atoms are called saturated fatty acids. These straight, rigid chains pack tightly together and are solid or semi-solid at room temperature (Figure 7.a). Butter and lard are examples, as is the fat found on a steak or in your own body. In contrast, fatty acids with one double carbon bond are kinked at that bond (Figure 7.b). These monounsaturated fatty acids are therefore unable to pack together tightly, and are liquid at room temperature. Polyunsaturated fatty acids contain two or more double carbon bonds, and are also liquid at room temperature. Plant oils such as olive oil typically contain both mono- and polyunsaturated fatty acids

Whereas a diet high in saturated fatty acids increases the risk of heart disease, a diet high in unsaturated fatty acids is thought to reduce the risk. This is especially true for the omega-3 unsaturated fatty acids found in cold-water fish such as salmon. These fatty acids have their first double carbon bond at the third hydrocarbon from the methyl group (referred to as the omega end of the molecule.

Finally, trans fatty acids found in some processed foods, including some stick and tub margarines, are thought to be even more harmful to the heart and blood vessels than saturated fatty acids. Trans fats are created from unsaturated fatty acids (such as corn oil) when chemically treated to produce partially hydrogenated fats.

As a group, triglycerides are a major fuel source for the body. When you are resting or asleep, a majority of the energy used to keep you alive is derived from triglycerides stored in your fat (adipose) tissues. Triglycerides also fuel long, slow physical activity such as gardening or hiking, and contribute a modest percentage of energy for vigorous physical activity. Dietary fat also assists the absorption and transport of the nonpolar fat-soluble vitamins A, D, E, and K. Additionally, stored body fat protects and cushions the body's bones and internal organs, and acts as insulation to retain body heat.

Fatty acids are also components of glycolipids, which are sugar-fat compounds found in the cell membrane. Lipoproteins are compounds in which the hydrophobic triglycerides are packaged in protein envelopes for transport in body fluids

Phospholipids

As its name suggests, a phospholipid is a bond between the glycerol component of a lipid and a phosphorous molecule. In fact, phospholipids are similar in structure to triglycerides. However, instead of having three fatty acids, a phospholipid is generated from a diglyceride, a glycerol with just two fatty acid chains (Figure 8). The third binding site on the glycerol is taken up by the phosphate group, which in turn is attached to a polar "head" region of the molecule. Recall that triglycerides are nonpolar and hydrophobic. This still holds for the fatty acid portion of a phospholipid compound. However, the head of a phospholipid contains charges on the phosphate groups, as well as on the nitrogen atom. These charges make the phospholipid head hydrophilic. Therefore, phospholipids are said to have hydrophobic tails, containing the neutral fatty acids, hydrophilic heads, the charged phosphate groups, and nitrogen atom

Steroid

A steroid compound (referred to as a sterol) has as its foundation a set of four hydrocarbon rings bonded to a variety of other atoms and molecules (see Figure8.b). Although both plants and animals synthesize sterols, the type that makes the most important contribution to human structure and function is cholesterol, which is synthesized by the liver in humans and animals and is also present in most animal-based foods. Like other lipids, cholesterol's hydrocarbons make it hydrophobic, however, it has a polar hydroxyl head that is hydrophilic. Cholesterol is an important component of bile acids and compounds that help emulsify dietary fats. In fact, the word's root chole- refers to bile. Cholesterol is also a building block of many hormones, signaling molecules that the body releases to regulate processes at distant sites. Finally, like phospholipids, cholesterol molecules are found in the cell membrane, where their hydrophobic and hydrophilic regions help regulate the flow of substances into and out of the cell

Prostaglandins

Like a hormone, a prostaglandin is one of a group of signaling molecules, but prostaglandins are derived from unsaturated fatty acids (see Figure 8.c). One reason that the omega-3 fatty acids found in fish are beneficial is that they stimulate the production of certain prostaglandins that help regulate aspects of blood pressure and inflammation, and thereby reduce the risk for heart disease. Prostaglandins also sensitize nerves to pain. One class of pain-relieving medications called nonsteroidal anti-inflammatory drugs (NSAIDs) works by reducing the effects of prostaglandins(1).

REFERENCE

1- Anatomy & Physiology by Lindsay M. BIga, Sierra Dawson, Amy Harwell, Robin Hopkins, Joel Kaufmann, Mike LeMaster, Philip Matern, Katie Morrison-Graham, Devon Quick & Jon Runyeon is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License, except where otherwise noted.

2- Chemical-Elements-are-Found-in-the-Human-Body

3- Salm, Sarah; Allen, Deborah; Nester, Eugene; Anderson, Denise (9 January 2015). Nester's Microbiology: A Human Perspective. p. 21. ISBN 978-0-07-773093-2. Retrieved 19 June 2016.

4- Subcommittee on the Tenth Edition of the Recommended Dietary Allowances, Food and Nutrition Board; Commission on Life Sciences, National Research Council (1 February 1989). "9-10". Recommended Dietary Allowances: 10th Edition. National Academies Press. ISBN 978-0-309-04633-6. Retrieved 18 June 2016.
Role of Oxygen in a Human Body. Environmental Protection Promoters Initiative. Available from: https://enviroppi.org/role-of-oxygen-in-a-human-body

6- USDA National Nutrient Database, 2015.
7- Cummings, John H. (2001). The Effect of Dietary Fiber on Fecal Weight and Composition (3rd ed.). Boca Raton, Florida: CRC Press. p. 184. ISBN 978-0-8493- 2387-4.
8- Cummings, John H. (2001). The Effect of Dietary Fiber on Fecal Weight and Composition (3rd ed.). Boca Raton, Florida: CRC Press. p. 184. ISBN 978-0-8493- 2387-4.
9- Maton A, Hopkins J, McLaughlin CW, Johnson S, Warner MQ, LaHart D, Wright JD (1993). Human Biology and Health. Englewood Cliffs, New Jersey: Prentice Hall. pp. 52–59. ISBN 978-0-13-981176-0.

10- ^ IUPAC, Compendium of Chemical Terminology, 2nd ed. (the "Gold Book") (1997). Online corrected version: (2006–) "lipids". doi:10.1351/goldbook.L03571
11- Fahy E, Subramaniam S, Murphy RC, Nishijima M, Raetz CR, Shimizu T, Spener F, van Meer G, Wakelam MJ, Dennis EA (April 2009). "Update of the LIPID MAPS comprehensive classification system for lipids". Journal of Lipid Research. 50 (S1): S9-14. doi:10.1194/jlr.R800095-JLR200. PMC 2674711. PMID 19098281.
12- Subramaniam S, Fahy E, Gupta S, Sud M, Byrnes RW, Cotter D, Dinasarapu AR, Maurya MR (October 2011). "Bioinformatics and systems biology of the lipidome". Chemical Reviews. 111 (10): 6452–90. doi:10.1021/cr200295k. PMC 3383319. PMID 21939287.
13- Fahy E, Subramaniam S, Murphy RC, Nishijima M, Raetz CR, Shimizu T, Spener F, van Meer G, Wakelam MJ, Dennis EA (April 2009). "Update of the LIPID MAPS comprehensive classification system for lipids". Journal of Lipid Research. 50 (S1): S9-14. doi:10.1194/jlr.R800095-JLR200. PMC 2674711. PMID 19098281.
14-Proteins. (2020). Gsu.Edu. http://hyperphysics.phy-astr.gsu.edu/hbase/Organic/protein.html
15-How many calories are in one gram of fat, carbohydrate, or protein? | Food and Nutrition Information Center| NAL | USDA. (2016). Usda.Gov. https://www.nal.usda.gov/fnic/how-many-calories-are-one-gram-fat-carbohydrate-or-protein-
16-Nelson DL, Cox MM (2005). Principles of Biochemistry (4th ed.). New York: W. H. Freeman. ISBN 0-7167-4339-6.
17-Böck A, Forchhammer K, Heider J, Baron C (December 1991). "Selenoprotein synthesis: an expansion of the genetic code". Trends in Biochemical Sciences. 16 (12): 463–7. doi:10.1016/0968-0004(91)90180-4. PMID 1838215.
18- Clark, Jim (August 2007). "An introduction to amino acids". chemguide. Retrieved 4 July 2015.
19- Jakubke H, Sewald N (2008). "Amino acids". Peptides from A to Z: A Concise Encyclopedia. Germany: Wiley-VCH. p. 20. ISBN 9783527621170 – via Google Books.
20- Pollegioni L, Servi S, eds. (2012). Unnatural Amino Acids: Methods and Protocols. Methods in Molecular Biology. 794. Humana Press. p. v. doi:10.1007/978-1-61779-331-8. ISBN 978-1-61779-331-8. OCLC 756512314. S2CID 3705304.