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Significance Patterns of Organic Chemistry in Real World

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Abstract

Organic compound, any of a large class of chemical compounds in which one or more atoms of carbon are covalently linked to atoms of other elements, most commonly hydrogen, oxygen, or nitrogen. Although organic compounds make up only a small percentage of the Earth's crust, they are of central importance because all known life is based on organic compounds. Living things incorporate inorganic carbon compounds into organic compounds through a network of processes (the carbon cycle) that begins with the conversion of carbon dioxide and a hydrogen source like water into simple sugars and other organic molecules by autotrophic organisms using light (photosynthesis) or other sources of energy. Most synthetically produced organic compounds are ultimately derived from petrochemicals consisting mainly of hydrocarbons, which are themselves formed from the high pressure and temperature degradation of organic matter underground over geological timescales. This ultimate derivation notwithstanding, organic compounds are no longer defined as compounds originating in living things, as they were historically

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Introduction

Although vitalism has been discredited, scientific nomenclature retains the distinction between organic and inorganic compounds. The modern meaning of organic compound is any compound that contains a significant amount of carbon—even though many of the organic compounds known today have no connection to any substance found in living organisms. The term carbogenic has been proposed by E. J. Corey as a modern alternative to organic, but this neologism remains relatively obscure [1].

The organic compound L-isoleucine molecule presents some features typical of organic compounds: carbon–carbon bonds, carbon–hydrogen bonds, as well as covalent bonds from carbon to oxygen and to nitrogen.

As described in detail below, any definition of organic compound that uses simple, broadly applicable criteria turns out to be unsatisfactory, to varying degrees. The modern, commonly accepted definition of organic compound essentially amounts to any carbon containing compound, excluding several classes of substances traditionally considered as 'inorganic'. However, the list of substances so excluded varies from author to author. Still, it is generally agreed upon that there are (at least) a few carbon containing compounds that should not be considered organic. For instance, almost all authorities would require the exclusion of alloys that contain carbon, including steel [2] (which contains cementite, Fe3C), as well as other metal and semimetal carbides (including "ionic" carbides, e.g, Al4C3 and CaC2 and "covalent" carbides, e.g. B4C and SiC, and graphite intercalation compounds, e.g. KC8). Other compounds and materials that are considered 'inorganic' by most authorities include: metal carbonates, simple oxides (CO, CO2, and arguably, C3O2), the allotropes of carbon, cyanide derivatives not containing an organic residue (e.g., KCN, (CN)2, BrCN, CNO−, etc.), and heavier analogs thereof (e.g., CP− 'cyaphide anion', CSe2, COS; although CS2 'carbon disulfide' is often classed as an organic solvent). Halides of carbon without hydrogen (e.g., CF4 and CClF3), phosgene (COCl2), carboranes, metal carbonyls (e.g., nickel carbonyl), mellitic anhydride ($C_{12}O_9$), and other exotic oxocarbons are also considered inorganic by some authorities [3].

Nickel carbonyl ($Ni(CO)_4$) and other metal carbonyls present an interesting case. They are often volatile liquids, like many organic compounds, yet they contain only carbon bonded to a transition metal and to oxygen and are often prepared directly from metal and carbon monoxide [4]. Nickel carbonyl is frequently considered to be organometallic [5]. Although many organometallic chemists employ a broad definition, in which any compound containing a carbon-metal covalent bond is considered organometallic, it is debatable whether organometallic compounds form a subset of organic compounds.[6]

Metal complexes with organic ligands but no carbon-metal bonds (e.g., $Cu(OAc)_2$) are not considered organometallic; instead they are classed as metalorganic. Likewise, it is also unclear whether metalorganic compounds should automatically be considered organic [7].

The relatively narrow definition of organic compounds as those containing C-H bonds excludes compounds that are (historically and practically) considered organic. Neither urea nor oxalic acid is organic by this definition, yet they were two key compounds in the vitalism debate. The IUPAC Blue Book on organic nomenclature specifically mentions urea[7] and oxalic acid.[8] Other compounds lacking C-H bonds but traditionally considered organic include benzenehexol, mesoxalic acid, and carbon tetrachloride. Mellitic acid, which contains no C-H bonds, is considered a possible organic substance in Martian soil.[9] Terrestrially, it, and its anhydride, mellitic anhydride, are associated with the mineral mellite ($Al_2C_6(COO)_6 \cdot 16H_2O$).

A slightly broader definition of organic compound includes all compounds bearing C-H or C-C bonds. This would still exclude urea. Moreover, this definition still leads to somewhat arbitrary divisions in sets of carbon-halogen compounds. For example, CF_4 and CCl_4 would

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be considered by this rule to be "inorganic", whereas CF_3H, $CHCl_3$, and C_2Cl_6 would be organic, though these compounds share many physical and chemical properties [10].

Classification

Organic compounds may be classified in a variety of ways. One major distinction is between natural and synthetic compounds. Organic compounds can also be classified or subdivided by the presence of heteroatoms, e.g., organometallic compounds, which feature bonds between carbon and a metal, and organophosphorus compounds, which feature bonds between carbon and a phosphorus [11].

Another distinction, based on the size of organic compounds, distinguishes between small molecules and polymers.

Natural compounds

Natural compounds refer to those that are produced by plants or animals. Many of these are still extracted from natural sources because they would be more expensive to produce artificially. Examples include most sugars, some alkaloids and terpenoids, certain nutrients such as vitamin B12, and, in general, those natural products with large or stereoisometrically complicated molecules present in reasonable concentrations in living organisms [12].

Further compounds of prime importance in biochemistry are antigens, carbohydrates, enzymes, hormones, lipids and fatty acids, neurotransmitters, nucleic acids, proteins, peptides and amino acids, lectins, vitamins, and fats and oils [13].

Compounds that are prepared by reaction of other compounds are known as "synthetic". They may be either compounds that already are found in plants or animals or those that do not occur naturally.

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Most polymers (a category that includes all plastics and rubbers) are organic synthetic or semi-synthetic compounds.

Many organic compounds—two examples are ethanol and insulin—are manufactured industrially using organisms such as bacteria and yeast. Typically, the DNA of an organism is altered to express compounds not ordinarily produced by the organism. Many such biotechnology-engineered compounds did not previously exist in nature.[citation needed]

The CAS database is the most comprehensive repository for data on organic compounds. The search tool SciFinder is offered. The Beilstein database contains information on 9.8 million substances, covers the scientific literature from 1771 to the present, and is today accessible via Reaxys. Structures and a large diversity of physical and chemical properties is available for each substance, with reference to original literature. PubChem contains 18.4 million entries on compounds and especially covers the field of medicinal chemistry. A great number of more specialized databases exist for diverse branches of organic chemistry.

Animal tissues, plant tissues, bacteria, and fungi contain organic molecules; horns and nails, fallen leaves, eggs, fruits and vegetables contain organic compounds; wood, milk, paper, petroleum and gasoline contain organic compounds. In summary, all living matter, parts or products of living matter and remains of living matter contain organic compounds. Organic molecules associated with living organisms are also called biomolecules.

Organic compounds are molecules that contain carbon atoms covalently bonded to hydrogen atoms (C-H bonds). Many organic compounds are formed from chains of covalently-linked carbon atoms with hydrogen atoms attached to the chain (a hydrocarbon backbone). This means that all organic compounds have in common the presence of carbon atoms and hydrogen atoms. In addition, different organic compounds may contain oxygen, nitrogen, phosphorous, and other elements. Carbon dioxide (CO2) does not have hydrogen; then, it is not an organic compound. Water (H2O) has no carbon; then, it is not an organic compound.

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Sodium chloride has neither carbon nor hydrogen; then, it is not an organic compound. Generally, gases, and mineral salts (inorganic substances found in soil, or bodies of water or watercourses) are not organic.

Conclusion

Most organic compounds making up our cells and body belong to one of four classes: carbohydrates, lipids, proteins, and nucleic acids. These molecules are incorporated into our bodies with the food we eat. In general, molecules in these four classes are very large, and we often call large molecules macromolecules. Number of carbons that form the backbone of an organic compound, and shape of it (long chain, branched chain, ring) are not the only features that determine organic compounds properties. Groups of atoms of other elements associated to the carbon backbone give unique properties to the millions of different types of organic molecules. A specific group of atoms linked by strong covalent bonds is called a functional group.

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