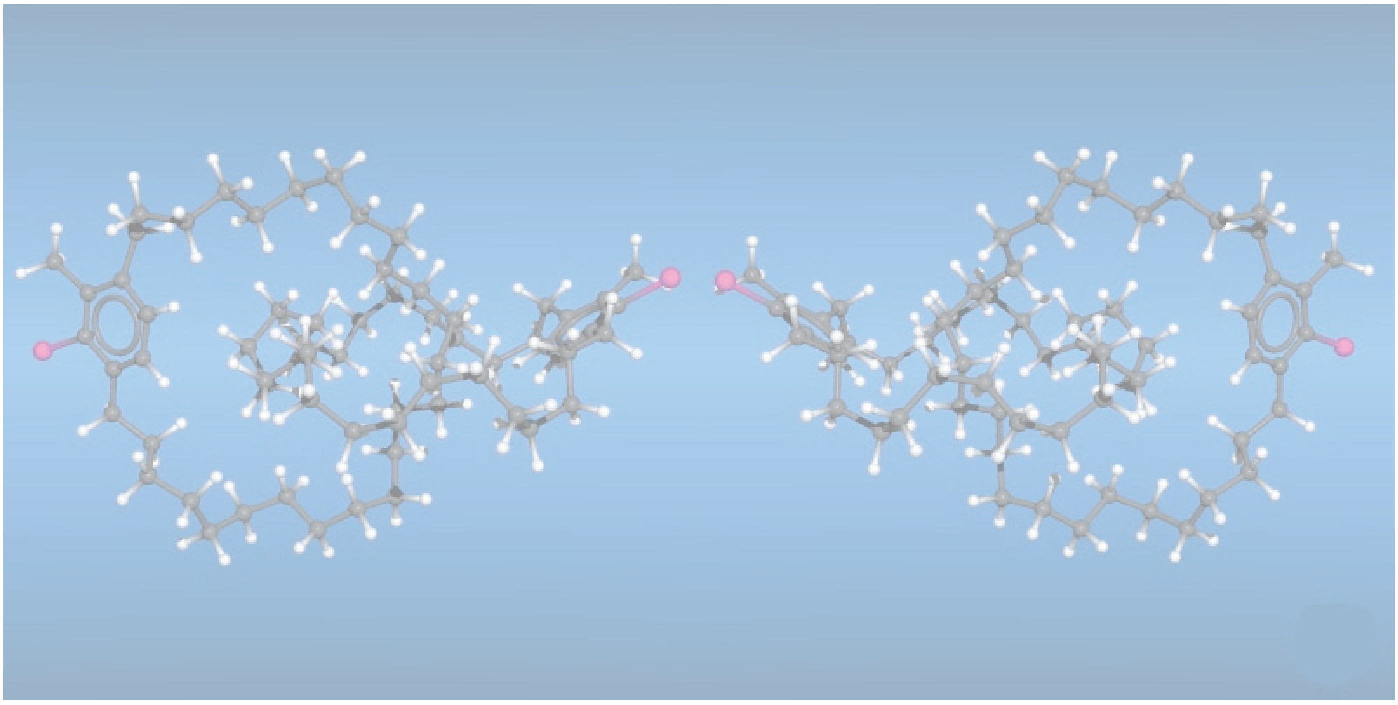
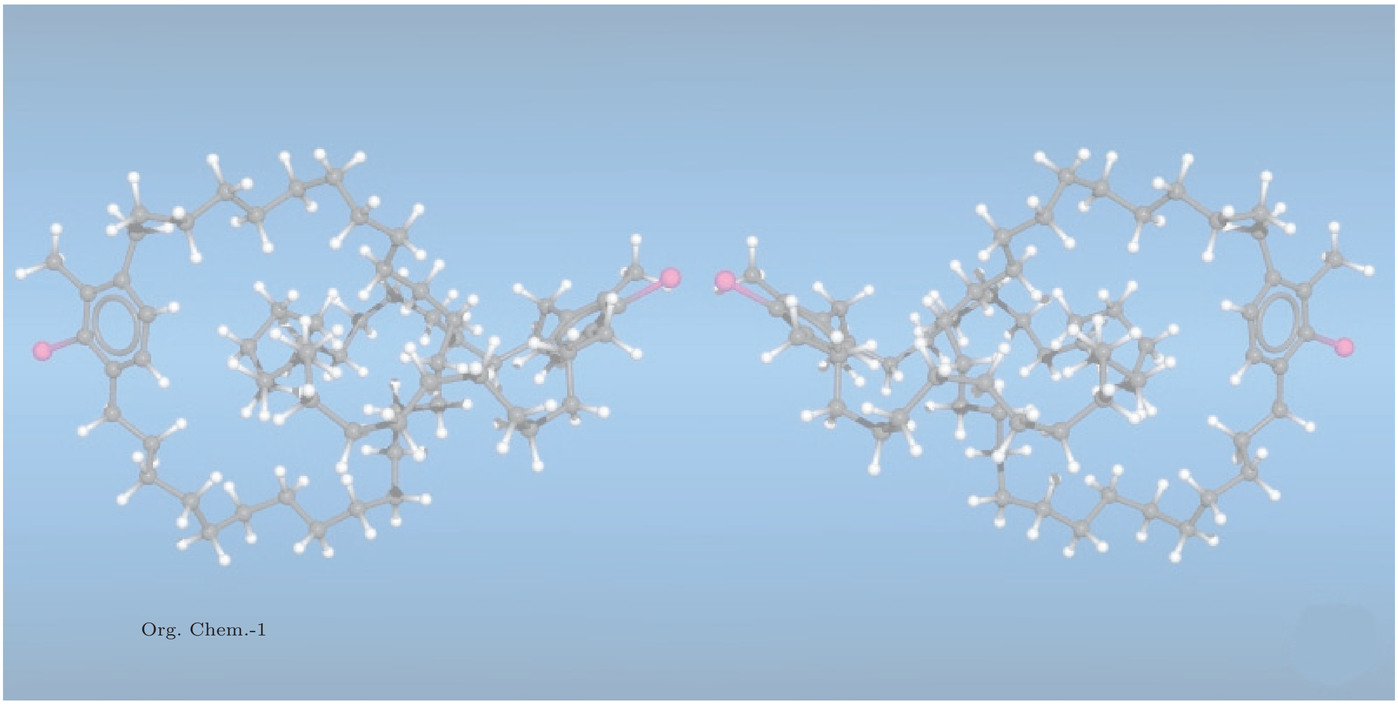


Part I

Structure, Isomerism and Mechanism



Chapter 1

Introduction

Objectives

- To understand the property of catenation [1.2] p. 5
- To understand the role of organic compounds [1.4] p. 6
- To understand the points of difference between organic and inorganic compounds [1.5] p. 6
- To understand the importance of structure [1.7] p. 7
- To follow the stepwise approach to study the science of organic chemistry [1.8] p. 7

1.1 Organic Compounds

The aim of organic chemistry is to study the science of organic compounds. Most of the covalent compounds of carbon may be called organic compounds. Of course, some of the authors define organic compounds simply as carbon compounds. According to many others, hydrocarbons (binary compounds of C and H) and their derivatives are organic compounds. Each of the definitions has some exception. However, more than three millions of organic compounds are known and almost ninety thousand new compounds are discovered every year. These include a fantastic variety of substances ranging from simple hydrocarbons used as fuels to complex nucleic acids of the genetic material. Their properties markedly differ from those of ionic inorganic compounds. They are a part and parcel of the life processes (nutrition, growth, respiration, reproduction, etc.). Organic compounds make up living bodies, food-stuff, clothes, drugs, paper, films, dyes, and almost everything of daily use.

1.2 A Unique Property of Carbon

$$^{12}_{6}\mathrm{C}\,1s^2 2s^2 2p^2$$

The electron configuration, atomic volume, atomic mass of C atoms and oxygen of the earth's atmosphere have developed in carbon almost a unique property of catenation. By catenation we mean the formation of chains of identical atoms. C atoms are able to combine among themselves indefinitely to produce wide and varied types of carbon chains, short and long, straight and branched, open and closed (Fig. 1.1). Sulphur and silicon also have a tendency to catenation.

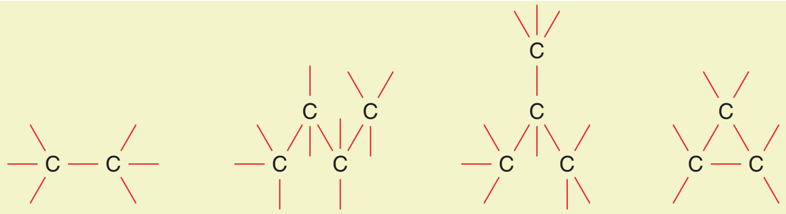


Fig. 1.1. Catenation property of carbon

But the catenated carbon compounds are unusually stable in comparison to their sulphur and silicon analogues. This is because of the high intrinsic energy of C—C bond and its relative stability towards oxidation compared to those of Si—Si and S—S bonds. C—C and C—O bonds have comparable stability but Si—O and S—O bonds are considerably stronger than Si—Si and S—S bonds respectively. So, compounds with Si—Si linkage get converted into compounds with Si—O linkage easily and exothermically. Same is the case with catenated compounds of sulphur. These can be understood from the bond energy values as given in Table 1.1.

Table 1.1 Bond energy

Bond	Energy, kJ/mole	Bond	Energy, kJ/mole	Bond	Energy, kJ/mole
C—C	348.6	Si—Si	228.4	S—S	224.2
C—O	344.4	Si—O	369.6	S—O	336.0

Therefore, it may be possible for Si and S to form catenated compounds in the absence of oxygen atmosphere outside the earth.

1.3 Huge Number of Organic Compounds

Besides catenation, carbon atoms form stable bonds with many other chemical elements, the most important being hydrogen, oxygen, nitrogen, sulphur and the halogens. This ability and catenation of C atoms explain the existence of about 3 millions of organic compounds, simple and complex. Being devoid of these properties, the rest of the elements form only 55,000 compounds.

1.4 Role of Organic Compounds

Plant and animal bodies are composed of organic compounds. Intensive knowledge about them, therefore, is very helpful to understand the life processes. Living cells, their constituents, amino acids, fats, hormones, carbohydrates, proteins, enzymes, vitamins, etc., are synthesised within the body from organic compounds. Hence study of organic compounds helps the study of biochemistry, the chemistry of living matter. Green plants synthesise carbohydrate from carbon dioxide and water with the help of sunlight and chlorophyll. They convert carbohydrates into fats and proteins and animals take in them. We eat meat, egg, fish and pulse for protein; rice, fruits, wheat, sugar for carbohydrate. Cotton, woollen and synthetic fibre like polyester, nylon, vinylon, etc., are made up of organic compounds. Sulphur drugs, antimalarials, antibiotics, antiseptics are nothing but organic compounds. Petrol, diesel, natural gas, i.e., fuels are organic substances. To make our life comfortable and easy-going soaps, cosmetics, dyes, polythene, photographic film, paper, etc., are playing their valuable roles. Explosives like nitroglycerine, T.N.T. are used in war and for the welfare of mankind. In a nutshell, we can say life and modern civilization would not be possible if organic compounds were not there.

1.5 General Nature of Organic Compounds

Organic compounds, being mostly covalent, consist of individual molecules and differ largely in their properties from the inorganic compounds which are mostly ionic and possess ionic crystals. Some of the differences are noted in Table 1.2.

Table 1.2 Organic vs Inorganic compound

Organic compounds (covalent)		Inorganic compounds (ionic)	
1.	Volatile and distil steadily	1.	Non-volatile
2.	Low melting	2.	High melting
3.	Soluble in non-aqueous liquids	3.	Insoluble in non-aqueous liquids
4.	Insoluble in water	4.	Soluble in water
5.	Non-electrolytes	5.	Electrolytes
6.	Less stable to heat and decompose above 700°C	6.	More stable to heat
7.	More susceptible to oxidation	7.	Less susceptible to oxidation
8.	Most reactions take place slowly and need temperature, catalyst, pressure, etc.	8.	Reactions are rapid and spontaneous
9.	Reaction products are often mixtures of several compounds	9.	Reaction products contain less number of compounds
10.	Isomeric compounds are often found	10.	Isomeric compounds are rare