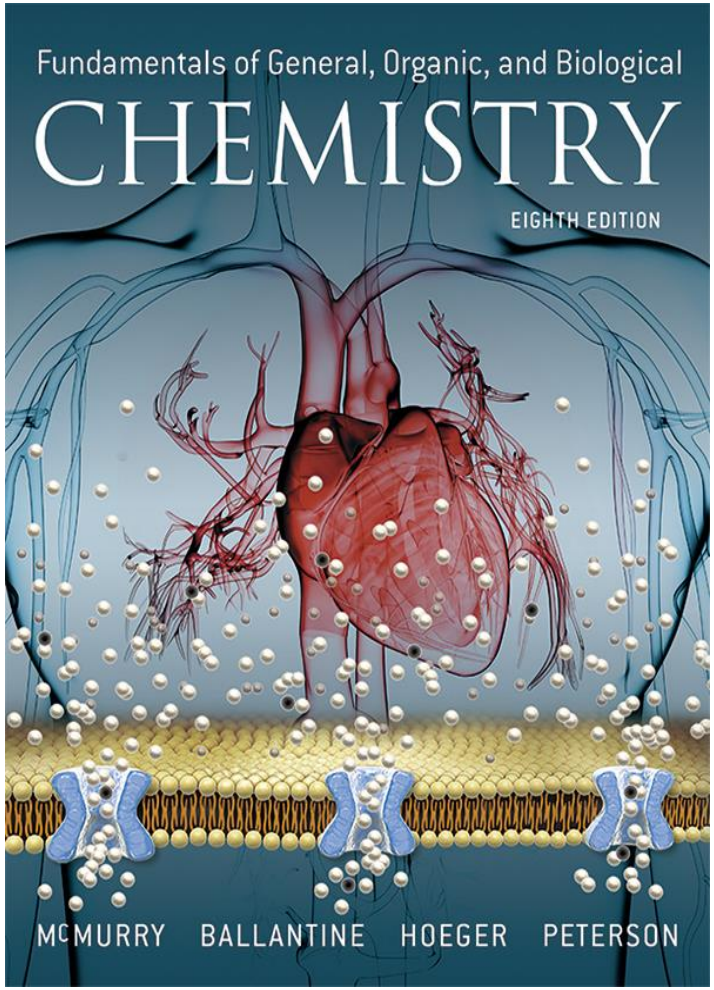
Chapter 12 Lecture



Fundamentals of General, Organic, and Biological Chemistry

8th Edition

McMurry, Ballantine, Hoeger, Peterson

Chapter Twelve

Introduction to Organic Chemistry: Alkanes

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Outline

Concepts to Review

- Covalent Bonds
  - Sections 4.1 and 4.2
- Multiple Covalent Bonds
  - Section 4.3
- Drawing Lewis Structures
  - Section 4.7
- VSEPR and Molecular Shapes
  - Section 4.8
- Polar Covalent Bonds
  - Section 4.9
- Polar Molecules
  - Section 4.10

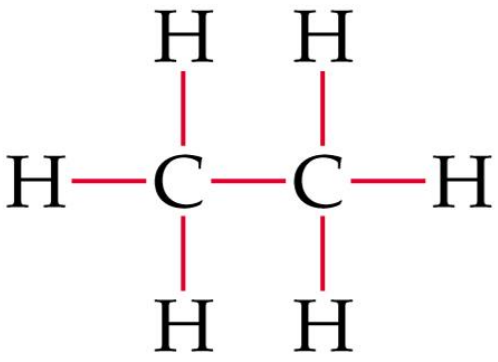
12.1 The Nature of Organic Molecules

Organic chemistry: The study of carbon compounds

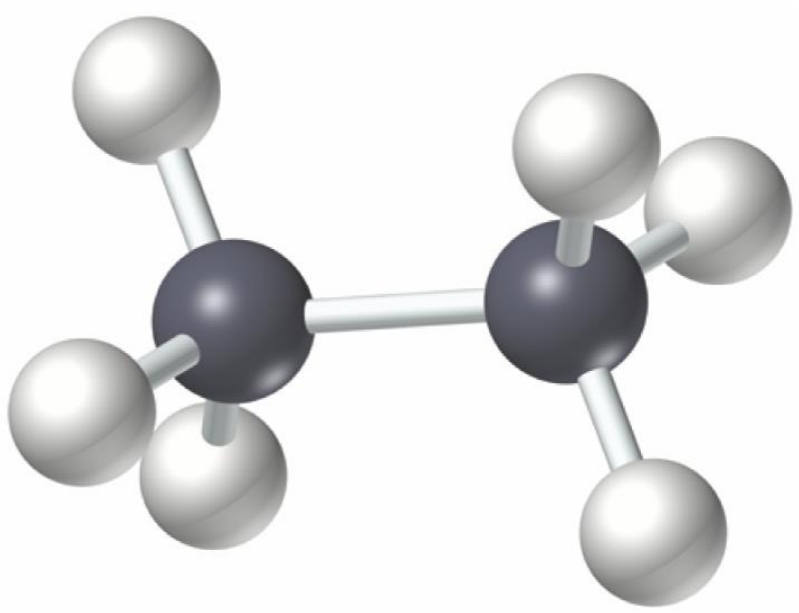
Learning Objective: Identify the general structural characteristics of organic molecules, in particular, the tetravalent nature of carbon and the different ways in which it can be expressed.

12.1 The Nature of Organic Molecules

- Carbon is tetravalent; it always forms four bonds.
- Organic molecules have covalent bonds.

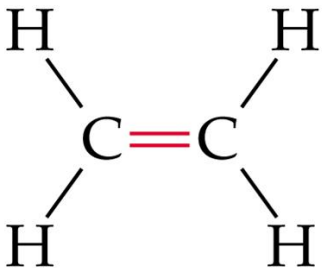


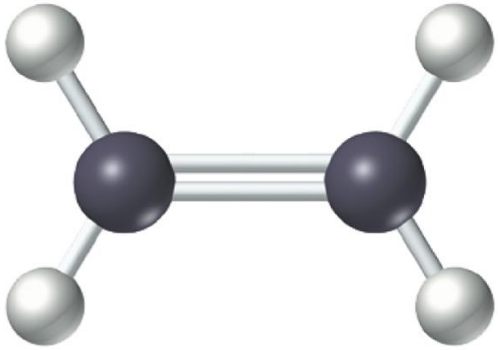
Ethane, C_2H_6



12.1 The Nature of Organic Molecules

- Carbon forms multiple covalent bonds by sharing more than two electrons with a neighboring atom.





Ethylene

Acetylene, C_2H_2

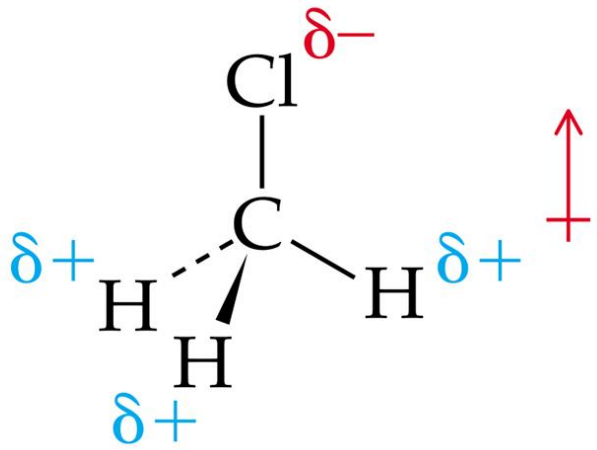
12.1 The Nature of Organic Molecules

In general:

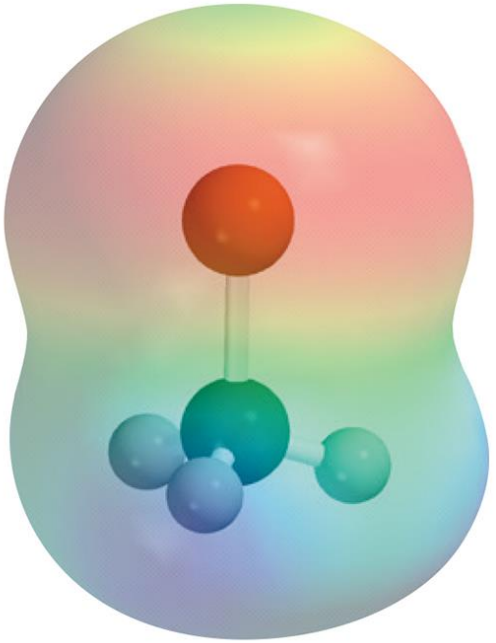
1. A carbon that has 4 groups attached will be tetrahedral.
2. A carbon that has 3 groups attached will be trigonal planar.
3. A carbon that has 2 groups attached will be linear.

12.1 The Nature of Organic Molecules

- When carbon bonds to a more electronegative element, polar covalent bonds result.

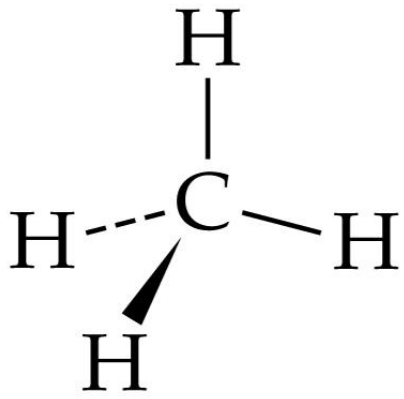


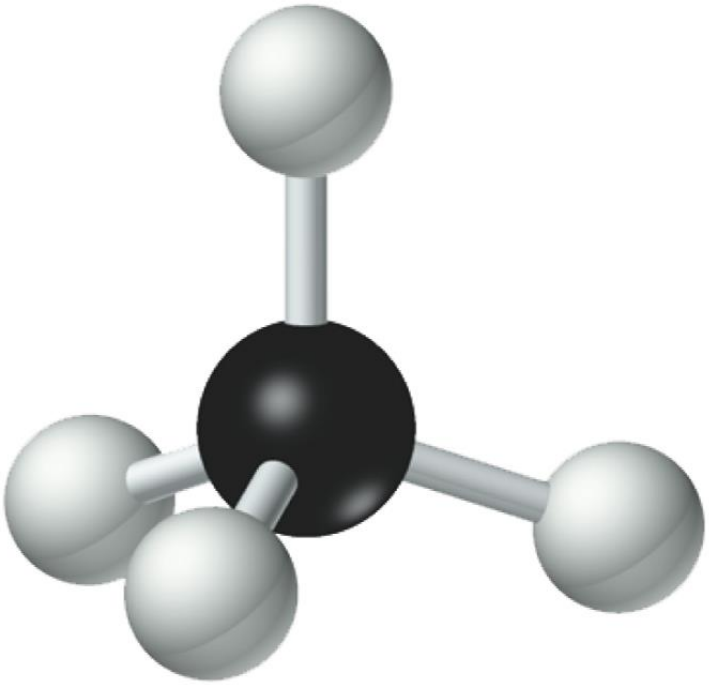
Chloromethane, CH_3Cl



12.1 The Nature of Organic Molecules

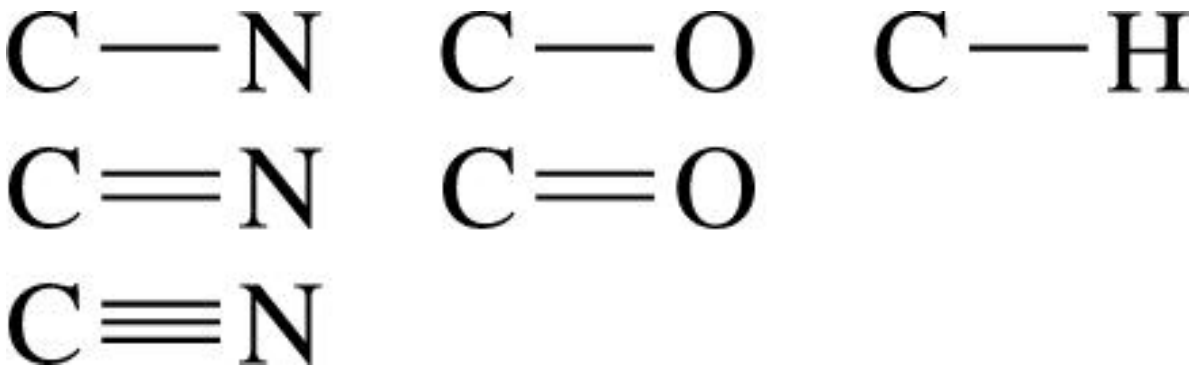
- Organic molecules have specific three-dimensional shapes.





12.1 The Nature of Organic Molecules

- Organic molecules often contain nitrogen and oxygen in addition to carbon and hydrogen.



12.1 The Nature of Organic Molecules

- Most organic compounds are insoluble in water.
- Almost all of those that are soluble do not conduct electricity.
- Only small polar organic molecules or large molecules with many polar groups interact with water molecules and, thus, dissolve in water.
- Lack of water solubility for organic compounds has important consequences.

12.2 Families of Organic Molecules: Functional Groups

Functional group: An atom or group of atoms within a molecule that has a characteristic physical and chemical behavior

Learning Objectives:

- Define functional group.
- Identify the functional groups in organic molecules.

12.2 Families of Organic Molecules: Functional Groups

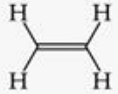
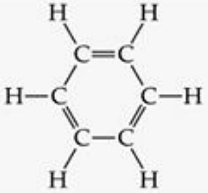
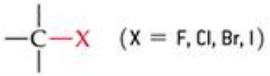
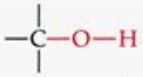
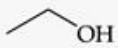
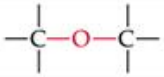
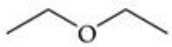
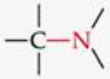
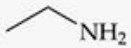
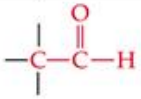
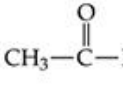
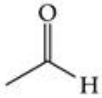
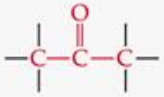
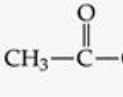
- Organic compounds can be classified into families according to functional groups (structural features).
- The chemical behavior of family members is often predictable based on these specific groupings of atoms.
- Millions of compounds can be sorted into just a few general families of organic compounds with simple chemical patterns.

12.2 Families of Organic Molecules: Functional Groups

- A functional group is usually part of a larger molecule, and a molecule may have more than one class of functional group present.
- A given functional group tends to undergo the same types of reactions in every molecule that contains it.
- The chemistry of an organic molecule is primarily determined by the functional groups it contains, not by its size or complexity.

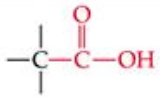
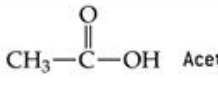
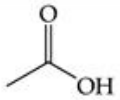
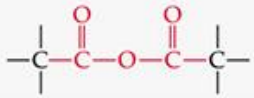
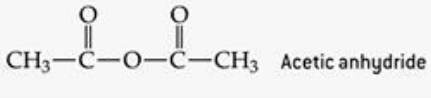
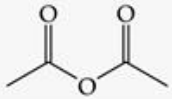
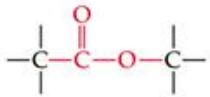
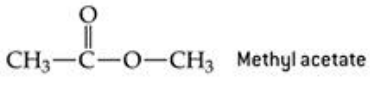
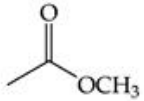
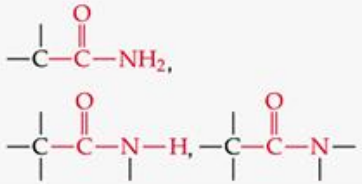
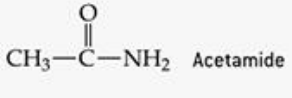
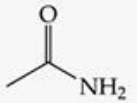
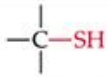
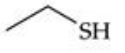
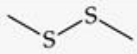
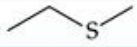
12.2 Families of Organic Molecules: Functional Groups

Table 12.1 Some Important Families of Organic Molecules

Family Name	Functional Group Structure*	Simple Example	Line Structure	Name Suffix
Alkane (Chapter 12)	No readily reactive bonds. Contains only C—H and C—C single bonds	$CH_3CH_2CH_3$ Propane		*-ane*
Alkene (Chapter 13)		$H_2C{=}CH_2$ Ethylene		*-ene*
Alkyne (Chapter 13)		H—C≡C—H Acetylene (Ethyne)		*-yne*
Aromatic (Chapter 13)		 Benzene		None
Alkyl halide (Chapters 12, 14)	 (X = F, Cl, Br, I)	CH_3CH_2Cl Ethyl chloride		None
Alcohol (Chapter 14)		CH_3CH_2OH Ethyl alcohol (Ethanol)		*-ol*
Ether (Chapter 14)		$CH_3CH_2{-}O{-}CH_2CH_3$ Diethyl ether		None
Amine (Chapter 16)		$CH_2CH_3NH_2$ Ethylamine		*-amine*
Aldehyde (Chapter 15)		 Acetaldehyde (Ethanal)		*-al*
Ketone (Chapter 15)		 Acetone		*-one*

12.2 Families of Organic Molecules: Functional Groups

Table 12.1 Some Important Families of Organic Molecules

Family Name	Functional Group Structure*	Simple Example	Line Structure	Name Suffix
Carboxylic acid (Chapter 17)		 Acetic acid		*-ic acid*
Anhydride (Chapter 17)		 Acetic anhydride		None
Ester (Chapter 17)		 Methyl acetate		*-ate*
Amide (Chapter 17)		 Acetamide		*-amide*
Thiol (Chapter 14)		CH_3CH_2SH Ethyl thiol		None
Disulfide (Chapter 14)	C—S—S—C	CH_3SSCH_3 Dimethyl disulfide		None
Sulfide (Chapter 14)	C—S—C	$CH_3CH_2SCH_3$ Ethyl methyl sulfide		None

The bonds shown in RED refer to the functional group of interest and the atoms required.
*The bonds whose connections are not specified are assumed to be attached to carbon or hydrogen atoms in the rest of the molecule.

12.2 Families of Organic Molecules: Functional Groups

- The first four families are **hydrocarbons**, organic compounds that contain only carbon and hydrogen.
  - *Alkanes* have only single bonds and contain no functional groups.
  - *Alkenes* contain a carbon–carbon double-bond functional group.

12.2 Families of Organic Molecules: Functional Groups

- The first four families are **hydrocarbons**, organic compounds that contain only carbon and hydrogen.
  - *Alkynes* contain a carbon–carbon triple-bond functional group.
  - Simple *aromatic* compounds contain a six-membered ring of carbon atoms with three alternating double bonds.

12.2 Families of Organic Molecules: Functional Groups

- The next four families have functional groups that contain only single bonds and a carbon atom bonded to an electronegative atom.
  - *Alkyl halides* have a carbon–halogen bond.
  - *Alcohols* have a carbon–oxygen bond.
  - *Ethers* have two carbons bonded to the same oxygen.
  - *Amines* have a carbon–nitrogen bond.

12.2 Families of Organic Molecules: Functional Groups

- The next six families contain a carbon–oxygen double bond: *aldehydes, ketones, carboxylic acids, anhydrides, esters*, and *amides*.
- The remaining three families have functional groups that contain sulfur: *thioalcohols* (known simply as *thiols*), *sulfides*, and *disulfides*. These play an important role in protein function.