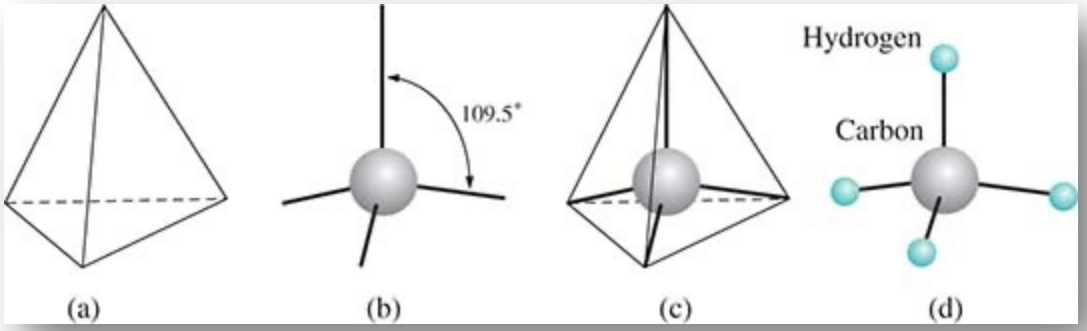
Chapter 19 Organic Chemistry Introduction



Hein * Pattison * Arena * Best *

Chapter Outline

Chapter Outline

19.8 Isomerism

19.9 Naming Organic Compounds

19.10 Introduction to the Reactions of Carbon

19.11 Reactions of Alkanes

19.12 Sources of Alkanes

19.13 Gasoline: A Major Petroleum Product

19.14 Cycloalkanes

19.1 Organic Chemistry: History and Scope

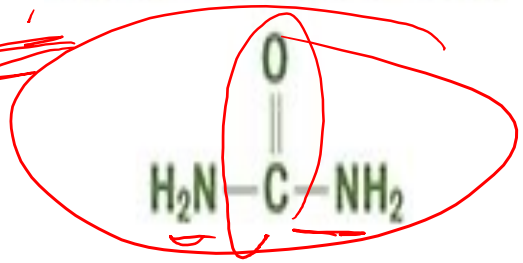
What is organic chemistry?

Organic chemistry is the study of compounds containing carbon.

These compounds occur naturally but can be prepared in a laboratory.

The early history of organic chemistry included vital force theory *(i.e. that organic compounds exist only in living organisms).* The German chemist Wöhler disproved this theory in 1828 with the lab synthesis of urea.

The formula for urea is



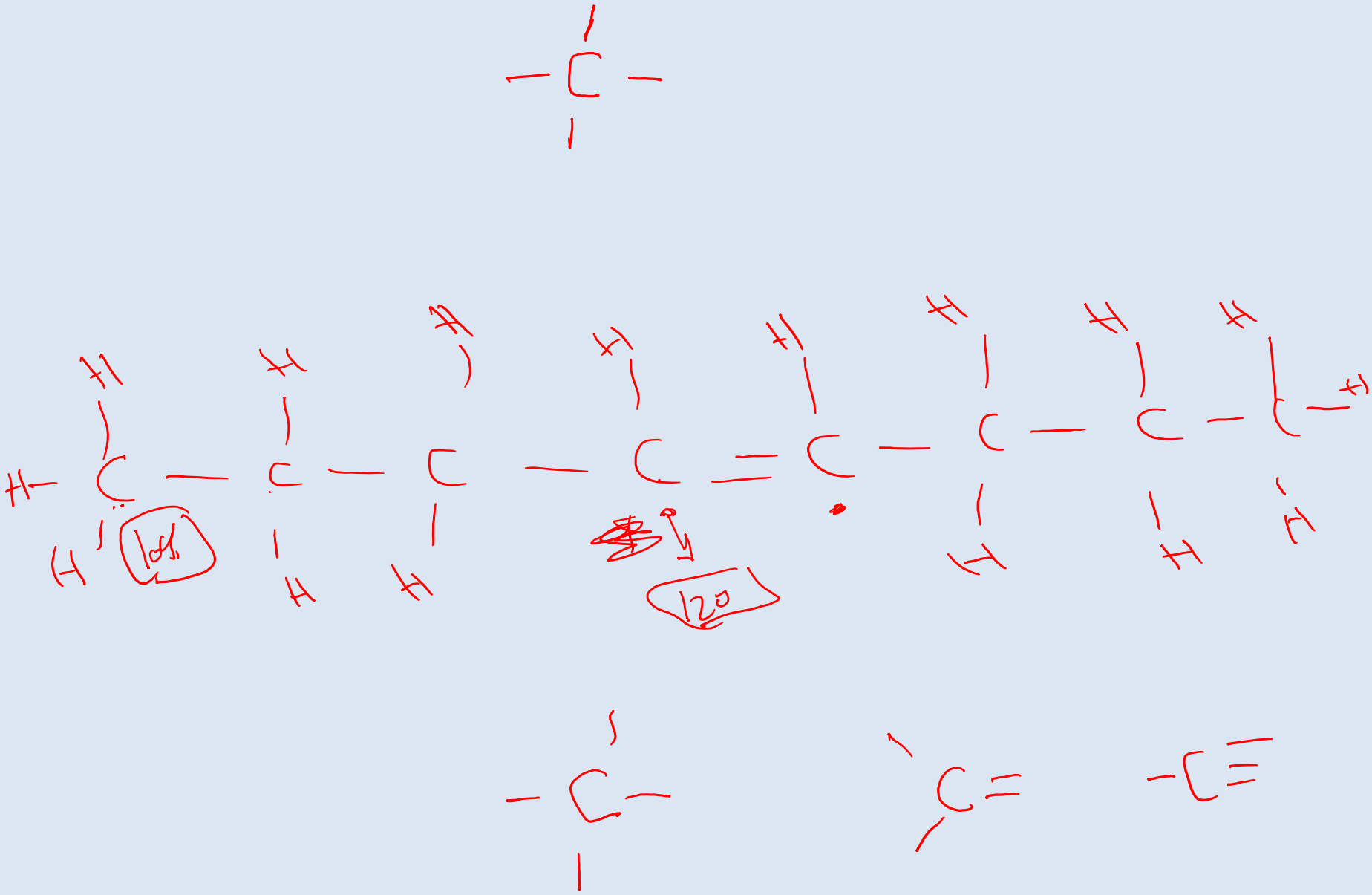
What is organic chemistry?

Carbon can form a vast array of long chain and ring containing compounds because carbon has the unique ability to bond to itself.

Organic compounds include drugs, fuels, toiletries, plastics, and fabrics. You can see why organic chemistry is such an important field of study.

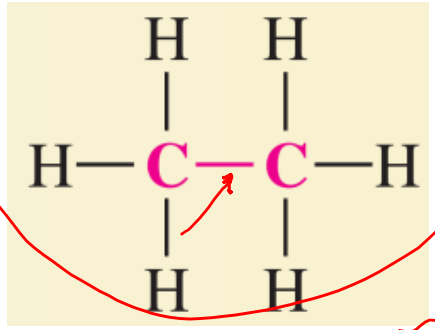
Lipstick is made of organic molecules. Cosmetics and perfumes contain organic compounds.

19.2 The Carbon Atom: Bonding and Shape

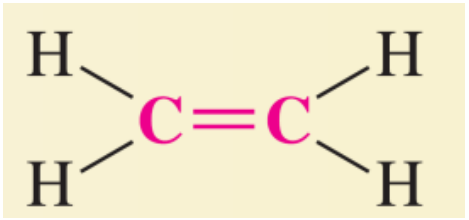

109
120

Bonding in Carbon Compounds

Carbon can form saturated compounds *(i.e. all carbon atoms have four single bonds)* or unsaturated compounds *(i.e. at least one carbon has a double bond (C=C) or a triple bond (C≡C)).*

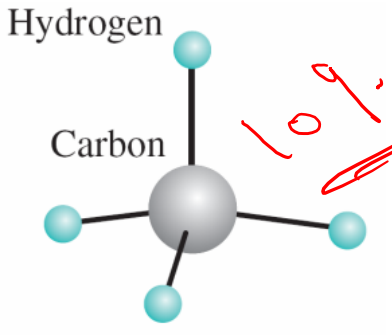


Ethane is a saturated hydrocarbon because it has all single bonds.

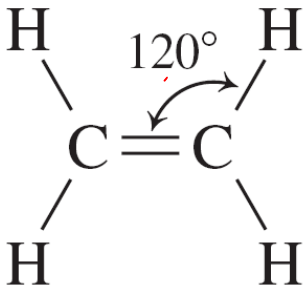


Ethene is an unsaturated hydrocarbon because it has a double bond.

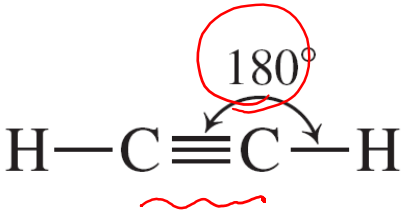
Molecular Shapes of Carbon Compounds
Predicted by the VSEPR Bonding Theory



Carbons with four single bonds have a tetrahedral shape.



Carbons with double bonds have a triangular or trigonal planar shape.



Carbons with triple bonds are linear.

Bond Angle and Shape of Methane

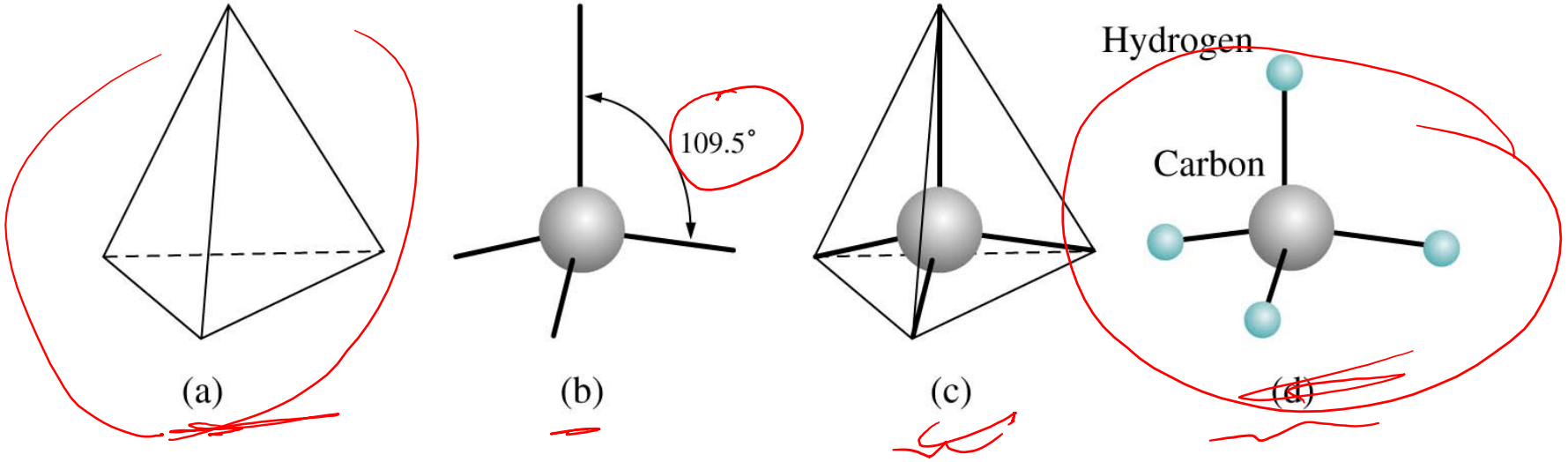
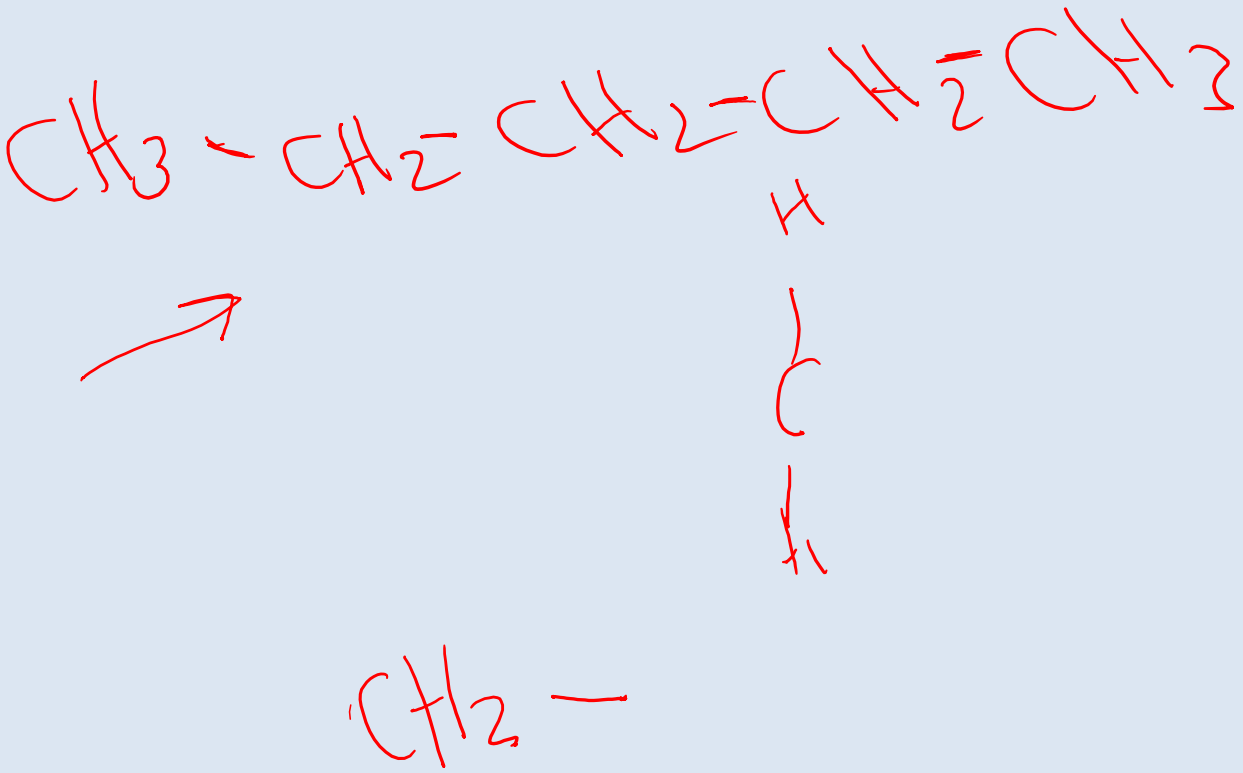


Figure 19.1 Tetrahedral structure of carbon: (a) a regular tetrahedron; (b) a carbon atom with tetrahedral bonds; (c) a carbon atom within a regular tetrahedron; (d) a methane molecule, CH_4

19.3 Organic Formulas and Molecular Models


CH3 - CH2 - CH2 - CH = CH2
H
C
H
CH2 -

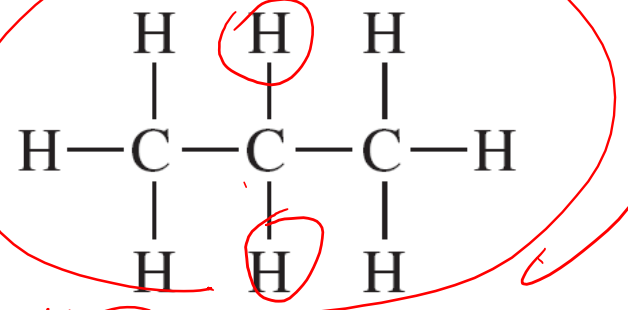
Formulas and Molecular Models

Structural formulas or models are often used in organic chemistry to illustrate molecules.

For example,

$CH_3-CH_2-CH_3$

C_3H_8 is shown as



or in the case of a model.

C_3H_8 is shown as

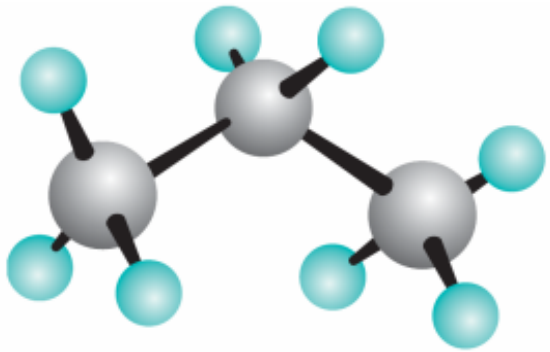
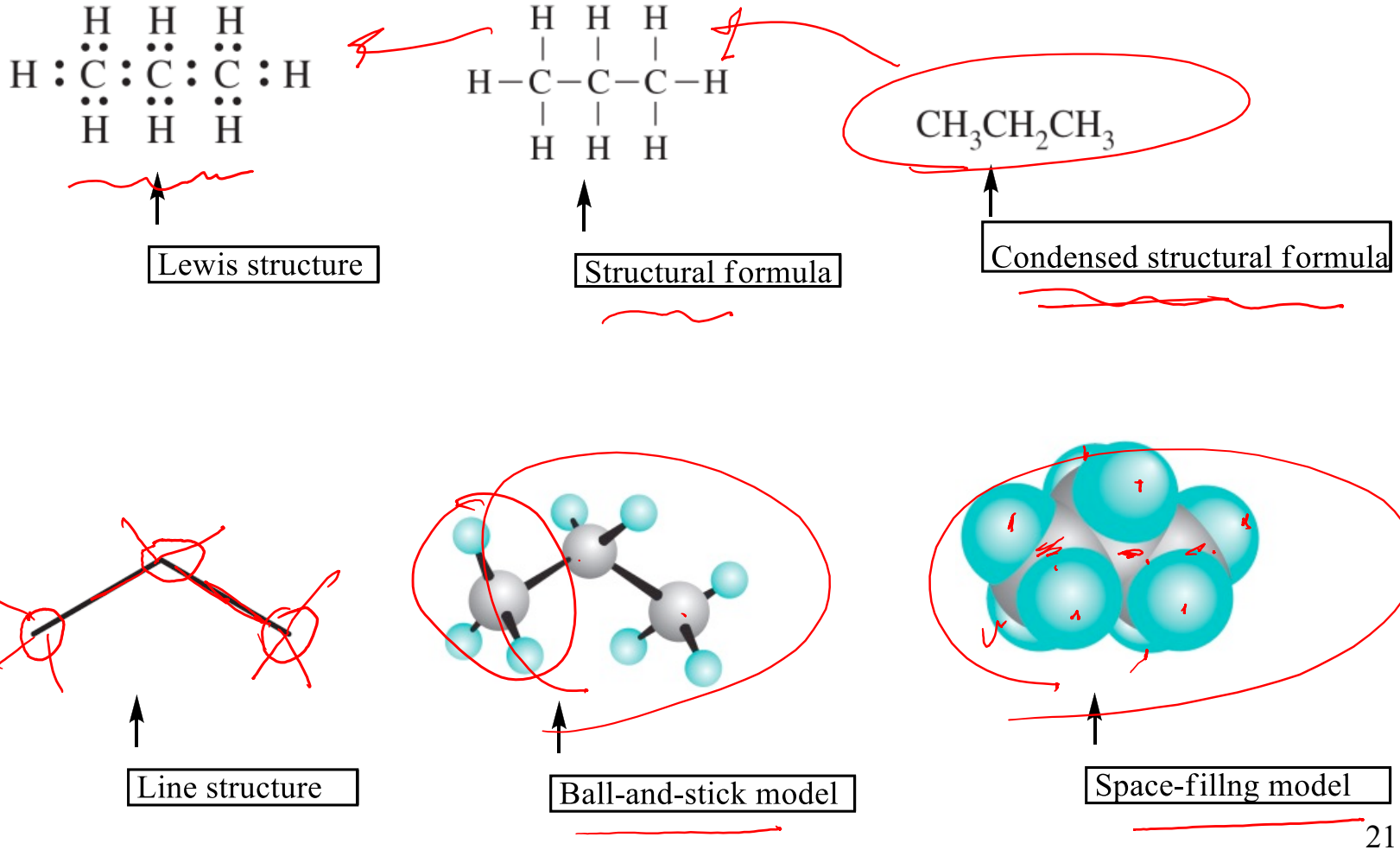
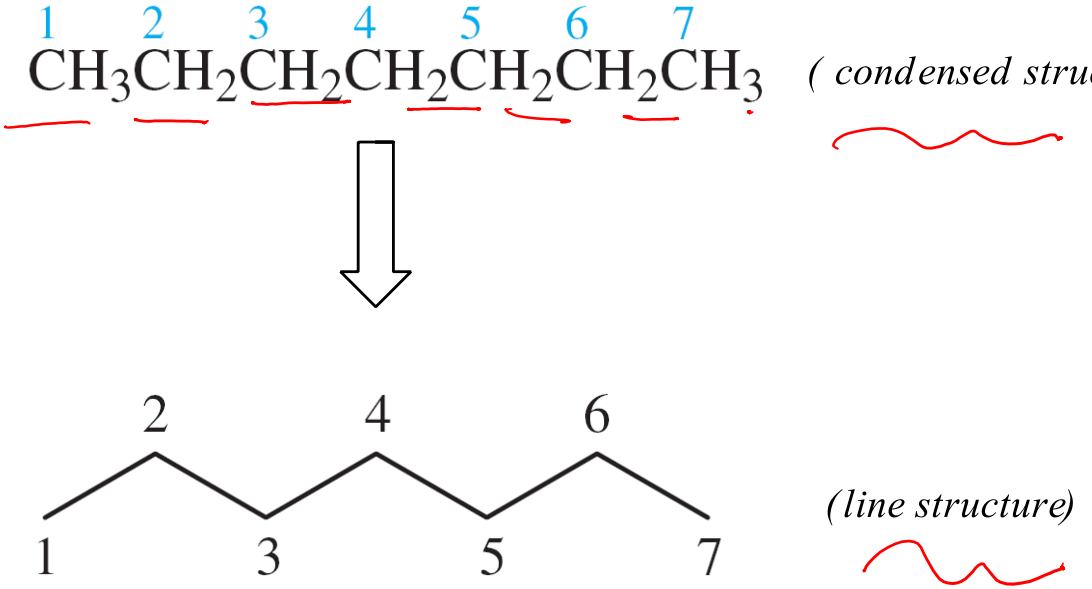


Figure 19.3 Types of formulas and models used to represent organic molecules. Each diagram is a representation of a propane molecule.



$CH_3CH_2CH_2CH_2CH_2CH_2CH_3$

This is an example of how to change a condensed formula into a line structure.



The tables in the next two slides summarize formulas and models used in organic chemistry.

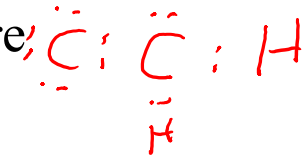
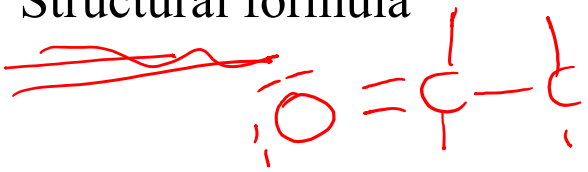
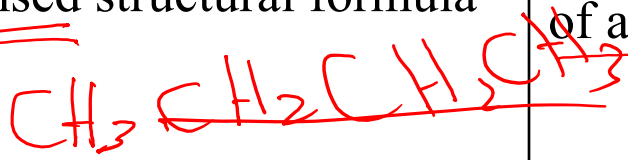
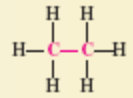
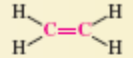
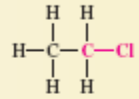
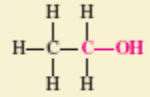
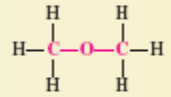
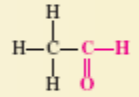
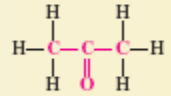
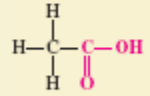
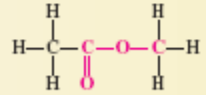
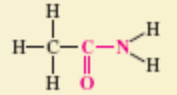
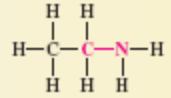
Formula or model	Definition
Lewis structure 	Shows all bonds, all atoms, and all nonbonding e-
Structural formula 	Same as Lewis structure except nonbonding e- are not shown 
Condensed structural formula 	Bonds are collapsed so relative positions of atoms are group together
Line structure 	Only bonds and functional groups are shown and each endpoint and bend represent carbon atoms
Ball-and-stick model 	Atoms are shown as balls and bonds as sticks and the shape is shown at the central atom.
Space-filling model 	Bonds are omitted and the size of atoms are emphasized.

Table 19.1 Classes of Organic Compounds

Class of compound	General formula*	IUPAC name**, ***	Molecular formula	Condensed structural formula	Structural formula
Alkane	RH	Ethane (Ethane)	C_2H_6	CH_3CH_3	
Alkene	$R-CH=CH_2$	Ethene (Ethylene)	C_2H_4	$H_2C=CH_2$	
Alkyne	$R-C\equiv C-H$	Ethyne (Acetylene)	C_2H_2	$HC\equiv CH$	
Alkyl halide	RX	Chloroethane (Ethyl chloride)	C_2H_5Cl	CH_3CH_2Cl	
Alcohol	ROH	Ethanol (Ethyl alcohol)	C_2H_6O	CH_3CH_2OH	
Ether	R—O—R	Methoxymethane (Dimethyl ether)	C_2H_6O	CH_3OCH_3	
Aldehyde	$R-C(=O)-H$	Ethanal (Acetaldehyde)	C_2H_4O	CH_3CHO	
Ketone	$R-C(=O)-R$	Propanone (Dimethyl ketone)	C_3H_6O	CH_3COCH_3	
Carboxylic acid	$R-C(=O)-OH$	Ethanoic acid (Acetic acid)	$C_2H_4O_2$	CH_3COOH	
Ester	$R-C(=O)-OR$	Methyl ethanoate (Methyl acetate)	$C_3H_6O_2$	CH_3COOCH_3	
Amide	$R-C(=O)-NH_2$	Ethanamide (Acetamide)	C_2H_5ON	CH_3CONH_2	
Amine	$R-CH_2-NH_2$	Aminoethane (Ethylamine)	C_2H_7N	$CH_3CH_2NH_2$	

* The letter R is used to indicate any of the many possible alkyl groups. ** Class name ending in italic. *** Common name in parentheses.

R-OH

Alcohol

or

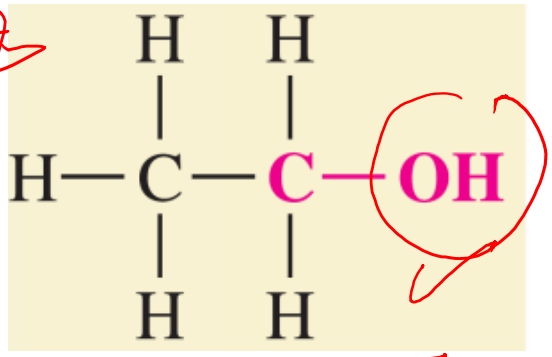
$CH_3CH_2CH_2-OH$

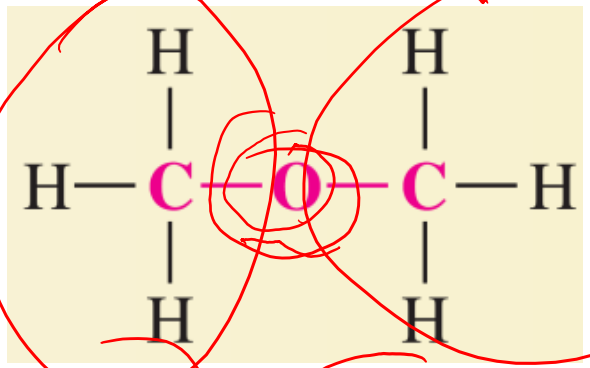
Propanol

19.4 Classifying Organic Compounds

What are functional groups?

Functional groups are group of atoms *(or atom)* that have specific behavorial characteristics in organic compounds.





For example ethanol *(i.e. the alcohol functional group)* and dimethyl ether *(i.e. the ether functional group)* have the same molecular formula but the boiling point *(b.p.)* of ethanol is 78 °C while the b.p. of dimethyl ether is -23 °C because of the structural differences between the molecules.

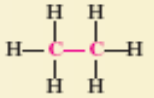
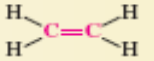
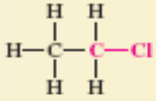
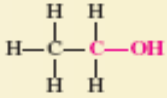
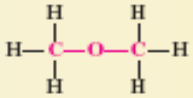
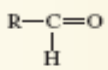
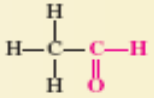
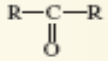
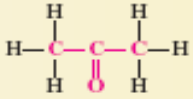
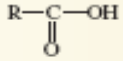
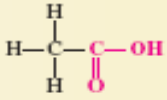
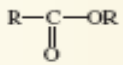
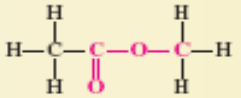
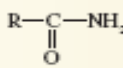
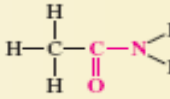
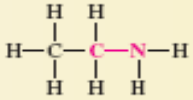
@chem3phys

م/ عبد [illegible]

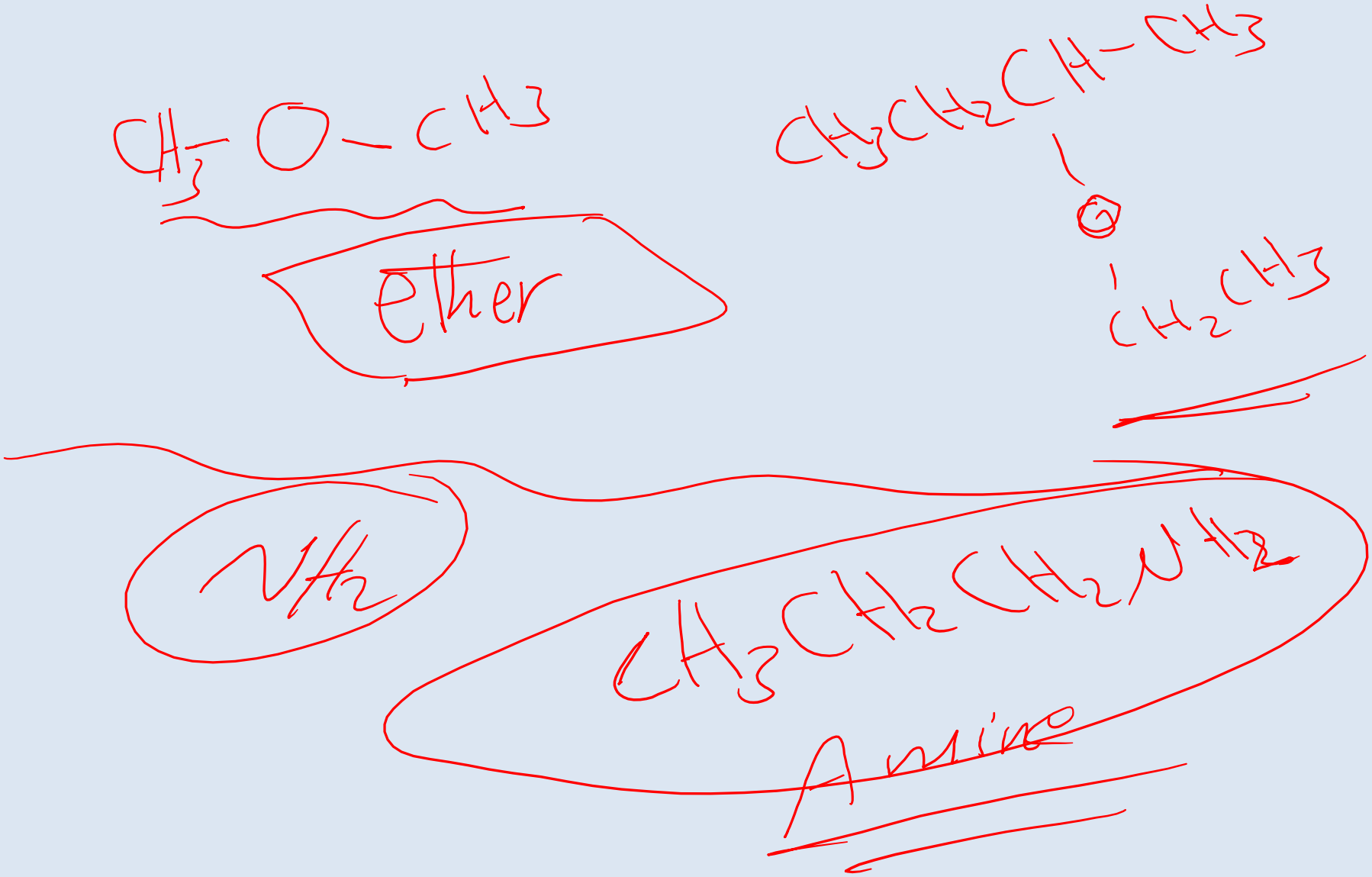
دعواتكم بالتوفيق للجميع

Organic compounds are organized by functional groups into classes as shown in Table 19.1.

Table 19.1 Classes of Organic Compounds

Class of compound	General formula*	IUPAC name**, ***	Molecular formula	Condensed structural formula	Structural formula
Alkane	RH	Ethane (Ethane)	C_2H_6	CH_3CH_3	
Alkene	R—CH=CH$_2$	Ethene (Ethylene)	C_2H_4	$H_2C{=}CH_2$	
Alkyne	R—C≡C—H	Ethyne (Acetylene)	C_2H_2	$HC{\equiv}CH$	
Alkyl halide	RX	Chloroethane (Ethyl chloride)	C_2H_5Cl	CH_3CH_2Cl	
Alcohol	ROH	Ethanol (Ethyl alcohol)	C_2H_6O	CH_3CH_2OH	
Ether	R—O—R	Methoxymethane (Dimethyl ether)	C_2H_6O	CH_3OCH_3	
Aldehyde		Ethanal (Acetaldehyde)	C_2H_4O	CH_3CHO	
Ketone		Propanone (Dimethyl ketone)	C_3H_6O	CH_3COCH_3	
Carboxylic acid		Ethanoic acid (Acetic acid)	$C_2H_4O_2$	CH_3COOH	
Ester		Methyl ethanoate (Methyl acetate)	$C_3H_6O_2$	CH_3COOCH_3	
Amide		Ethanamide (Acetamide)	C_2H_5ON	CH_3CONH_2	
Amine	R—CH$_2$—NH$_2$	Aminoethane (Ethylamine)	C_2H_7N	$CH_3CH_2NH_2$	

* The letter R is used to indicate any of the many possible alkyl groups. ** Class name ending in italic. *** Common name in parentheses.


CH_3-O-CH_3
ether
$CH_3CH_2CH-CH_3$
CH_2CH_3
NH_2
$CH_3CH_2CH_2NH_2$
Amine