

Chapter 24

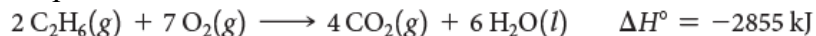
The chemistry of life: organic and biological chemistry

Review

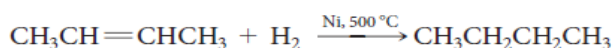
Definitions:

- **Hydrocarbons:** compounds composed of only carbon and hydrogen.
 - 1) Alkanes: contain only single C–C bonds.
 - 2) Alkenes: contain at least one C=C double bond.
 - 3) Alkynes: contain at least one C≡C triple bond.
 - 4) Aromatic hydrocarbons: the carbon atoms are connected in a planar ring structure, joined by both σ and delocalized π bonds between carbon atoms.
- **Saturated hydrocarbons:** alkanes have only single bonds, they contain the largest possible number of hydrogen atoms per carbon atom, they are saturated hydrocarbons.
- **Unsaturated hydrocarbons:** alkenes, alkynes, and aromatic hydrocarbons contain multiple carbon-carbon bonds, they contain less hydrogen than alkane with the same number of carbon atoms, they are unsaturated hydrocarbons.
- **Structural isomers:** compounds that have the same molecular formula but different bonding arrangements (and hence different structures).
- **Geometric isomers:** compounds that have the same molecular formula and the same groups bonded to one another but differ in the spatial arrangement of these groups.

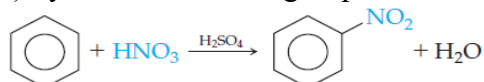
- **Combustion reaction:** combustion usually occurs when a hydrocarbon reacts with oxygen to produce carbon dioxide and water.



- **Addition reaction:** a reactant added to the two atoms that form the multiple bond.



- **Substitution reaction:** one hydrogen atom of the molecule is removed and replaced (substituted) by another atom or group of atoms.



- **Organic Functional Group:** collection of atoms at a site that have a characteristic behavior in all molecules where it occurs. It determines the chemistry of organic molecules.
- **Alcohols:** compounds in which one or more hydrogens of a parent hydrocarbon have been replaced by the functional group –OH, called either the hydroxyl group or the alcohol group.
- **Ethers:** compounds in which two hydrocarbon groups are bonded to one oxygen.
- **Aldehydes:** the carbonyl group has at least one hydrogen atom attached.
- **Ketones:** the carbonyl group occurs at the interior of a carbon chain and is therefore flanked by carbon atoms.
- **Carboxylic acids:** contain the carboxyl functional group, often written –COOH.
- **Esters:** compounds in which the H atom of a carboxylic acid is replaced by a carbon containing group.
- **Amines:** compounds in which one or more of the hydrogens of ammonia (NH₃) are replaced by an alkyl group.
- **Amide:** an amine with at least one H bonded to N can undergo a condensation reaction with a carboxylic acid to form an amide, which contains the carbonyl

group (C=O) attached to N.

Table 24.6 Common Functional Groups

Functional Group	Compound Type	Suffix or Prefix	Structural Formula	Example Ball-and-stick Model	Systematic Name (common name)
	Alkene	-ene			Ethene (Ethylene)
$\text{—C}\equiv\text{C—}$	Alkyne	-yne	$\text{H—C}\equiv\text{C—H}$		Ethyne (Acetylene)
	Alcohol	-ol			Methanol (Methyl alcohol)
	Ether	ether			Dimethyl ether
 (X = halogen)	Alkyl halide or haloalkane	-ide			Chloromethane (Methyl chloride)
	Amine	-amine			Ethylamine
	Aldehyde	-al			Ethanal (Acetaldehyde)
	Ketone	-one			Propanone (Acetone)
	Carboxylic acid	-oic acid			Ethanoic acid (Acetic acid)
	Ester	-oate			Methyl ethanoate (Methyl acetate)
	Amide	-amide			Ethanamide (Acetamide)

- **Alkyl group:** the partial structure that results from the removal of a H atom from an alkane. Name: replace **-ane** ending of alkane with **-yl** ending.

- **Nomenclature of Alkanes:**

Locant — **Prefix** — **Parent** — **Suffix**

Where are the substituents
and functional groups?

What are the
substituents?

How many
carbons?

What is the primary
functional group?

- 1) Find the longest continuous chain of carbon atoms, and use the name of this chain as the base name;
- 2) Number the carbon atoms in the longest chain, beginning with the end nearest

- a substituent;
- 3) Name each substituent;
- 4) Begin the name with the number or numbers of the carbon or carbons to which each substituent is bonded;
- 5) When two or more substituents are present, list them in alphabetical order;

No. of carbons	1	2	3	4	5	6	7	8	9	10
Parent	meth	eth	prop	but	pent	hex	hept	oct	non	dec

- **Chiral:** a molecule possessing a nonsuperimposable mirror image, the images are called optical isomers or enantiomers.
 - 1) **Compounds containing carbon atoms with four different attached groups are inherently chiral, the carbon atom is the chiral center;**
 - 2) The two members of an enantiomer pair have identical physical and chemical properties when they react with nonchiral reagents, only in a chiral environment do they behave differently from each other;
- **Racemic mixture:** when a chiral substance is synthesized in a typical reaction, the two enantiomers are formed in precisely the same quantity, the resulting mixture is racemic mixture.
- **Biopolymers: proteins, carbohydrates and nucleic acids.**
 - 1) Proteins are macromolecules present in all living cells, being composed of amino acids;
 - ✓ Primary structure: the sequence of amino acids in the polypeptide/protein chain
 - ✓ Secondary structure: interactions between the chain atoms (C=O and N—H atoms) that give structure to proteins
 - ✓ Tertiary structure: “intermolecular” forces between side-chain atoms that give structure to proteins
 - ✓ Quaternary structure: arrangement of multiple units and/or incorporation of non-amino acid portions of proteins
 - 2) Carbohydrates are biological molecules consisting of C, H, and O atoms, usually with the empirical formula $C_m(H_2O)_n$;
 - ✓ Monosaccharide: $C_6H_{12}O_6$; glucose (-OH, -CHO) and fructose (-OH, -CO-)
 - ✓ Disaccharide: $C_{12}H_{22}O_{11}$; sucrose, lactose. Dehydration between two monosaccharides forms a disaccharide.
 - ✓ Polysaccharide: $(C_6H_{10}O_5)_n$; starch, glycogen, and cellulose are the three most common polysaccharides.
 - 3) Nucleic acids are a class of biopolymers that are the chemical carriers of an organism’s genetic information;
 - 4) Lipids are a diverse class of nonpolar biological molecules used by organisms for long term energy storage and as elements of biological structures;
 - 5) Fats and oils are made from long-chain carboxylic acids and glycerol.
 - ✓ Fats have only saturated carboxylic acids. They are solids.
 - ✓ Oils have at least one unsaturated carboxylic acid. They are liquids.
 - 6) Phospholipids are similar in chemical structure to fats but have only two fatty acids attached to a glycerol. The third alcohol group of glycerol is joined to a phosphate group.