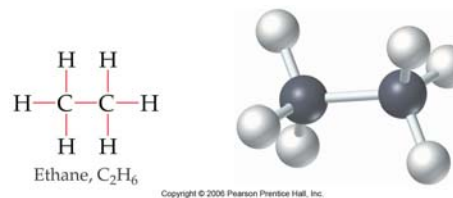
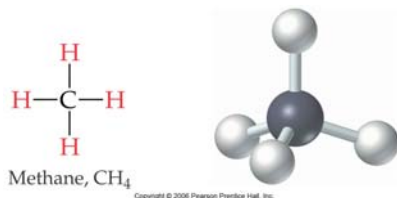


Organic Chemistry

- **Organic chemistry** is the branch of chemistry that deals with the study of carbon based compounds. Bonds between carbon atoms are covalent; each carbon is capable of forming four bonds:
 - Four single bonds = tetrahedral geometry
 - Two single, one double = trigonal planar
 - Two double = linear
 - One single, one triple = linear
- There are over 18 million known, and many more unknown possible structures ranging from one C to over a million carbons, and containing other elements such as N, O, S.
- Hydrocarbons are the simplest organic compounds and are made up of carbon and hydrogen atoms only.
 - Saturated: contain the maximum number of hydrogen atoms possible on every carbon atom. Saturated hydrocarbons are known as alkanes.



- Unsaturated: contain less than the maximum number of hydrogen atoms. Unsaturated hydrocarbons are either alkenes or alkynes.



Hydrocarbons

- Alkanes: contain only C-C single bonds; have the maximum number of H attached and are therefore referred to as saturated; alkanes have the formula C_nH_{2n+2} .
- Alkenes: contain one or more C-C double bond; do not have the maximum number of hydrogens possible about each C and are therefore referred to as unsaturated; for an alkene with one double bond the formula is C_nH_{2n} .
- Alkynes: contain one or more C-C triple bond; also unsaturated; for an alkyne with one triple bond the formula is C_nH_{2n-2} .

Nomenclature of Straight Chained Hydrocarbons

- Composed of a prefix that tells how many carbons there are.

Meth-

Eth-

Prop-

But-

Pent-

Hex-

Hept-

Oct-

Non-

Dec-

- Composed of a suffix that tells whether the molecule is an alkane, alkene or alkyne.

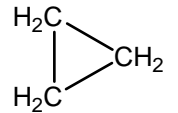
-ane

-ene

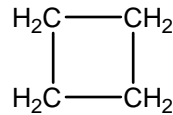
-yne

Cyclic Hydrocarbons

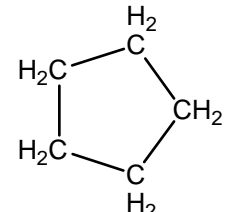
Cyclic Alkanes



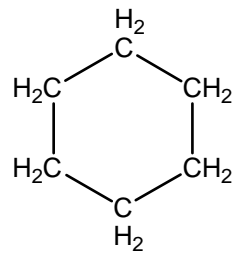
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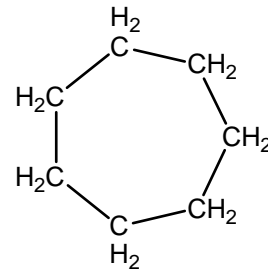
cyclobutane



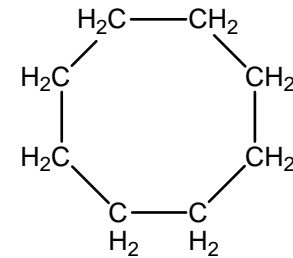
cyclopentane



cyclohexane

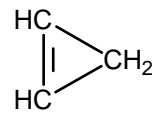


cycloheptane

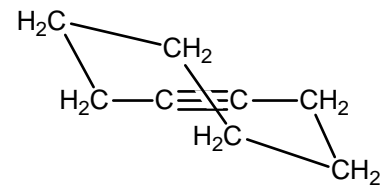


cyclooctane

Cyclic Alkenes and Alkynes



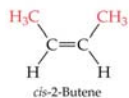
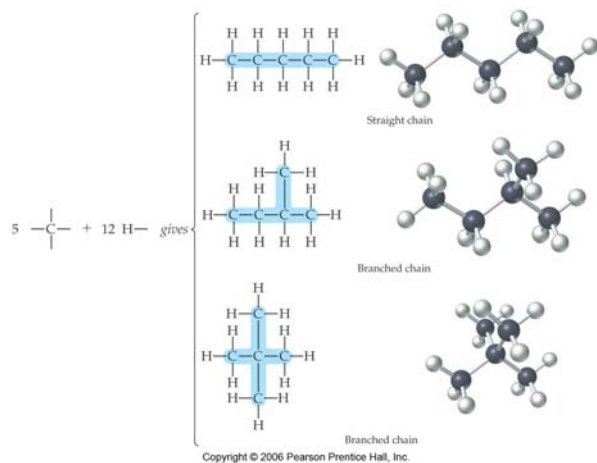
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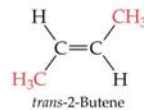
cyclooctyne

Isomers

- Iso- means same and –mers means parts; Isomers are compounds with the same molecular formulas, but different chemical structures.



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Naming Branched Alkanes, Alkenes and Alkynes

TABLE 12.4 Some Common Alkyl Groups*

$\text{CH}_3\text{—}$ Methyl	$\text{CH}_3\text{CH}_2\text{—}$ Ethyl	$\text{CH}_3\text{CH}_2\text{CH}_2\text{—}$ <i>n</i> -propyl	$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3\text{CH—} \end{array}$ Isopropyl
$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{—}$ <i>n</i> -Butyl	$\begin{array}{c} \\ \text{CH}_3\text{CHCH}_2\text{CH}_3 \end{array}$ <i>sec</i> -Butyl	$\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_3\text{CHCH}_2\text{—} \end{array}$ Isobutyl	$\begin{array}{c} \\ \text{CH}_3\text{CCH}_3 \\ \\ \text{CH}_3 \end{array}$ <i>tert</i> -Butyl

*The red bond shows the connection to the rest of the molecule.

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Branched Alkanes

1. Name the longest chain.
2. Number that chain so as to give the lowest number priority to any branched groups.
3. Name the branched groups.
4. Write the full name as one word:
 - a. Use hyphens to separate numbers from prefixes
 - b. Use commas to separate numbers from other numbers
 - c. Use alphabetical order to list branched groups

Branched Alkenes and Alkynes

1. Name the longest continuous chain containing the double or triple bond.
2. Number the chain giving the lowest priority to the double or triple bond.
3. Write the full name as one word:
 - a. Use hyphens to separate numbers from prefixes
 - b. Use commas to separate numbers from other numbers
 - c. Use alphabetical order to list branched groups
 - d. If it is an alkene, do cis-trans isomers apply?

Sample Problems

- Draw:

butane

propene

2-butene

2-methyldecane

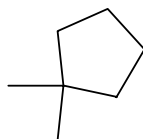
cyclopentane

methylcyclohexane

3-methylcycloheptene

- Name:

CH_4



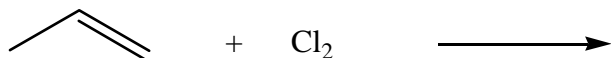
- Why do we not specify the location of the double bond in propene?
- Why is there no such compound known as methyne?

Basic Reactions of Hydrocarbons

- Alkanes: Not very reactive. Takes energy from a spark or heat to get over the activation energy barrier!
 - Combustion:
 - Halogenation:
- Alkenes and Alkynes: more reactive than alkanes.
 - Combustion:
 - Halogenation:
 - Hydrogenation:
 - Hydrohalogenation:
 - Hydration (alkenes only, alkynes do something different when hydrated):
- Mechanisms: A mechanism shows the theoretical details of a reaction including bond breakage and formation, and the direction of electron movement.

Sample Problems




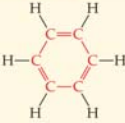
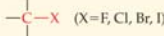

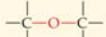

- Write out the following reactions using structural formulas. Show only the MAJOR product formed.
 - Methyl propene reacts with HBr
 - methyl cyclopentene reacts with HCl
 - 2-methyl-2-butene reacts with water in the presence of an acid catalyst
- Draw the MAJOR product formed when the following reactions occur.



Functional Groups

When a small portion of a molecule is responsible for the reactivity of that molecule, we call that small portion a functional group.


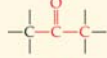
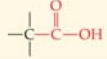
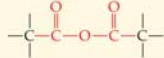
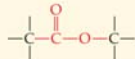
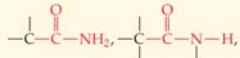
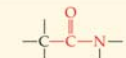
TABLE 12.1 Some Important Families of Organic Molecules

FAMILY NAME	FUNCTIONAL GROUP STRUCTURE*	SIMPLE EXAMPLE	NAME ENDING
Alkane	Contains only C—H and C—C single bonds	CH ₃ CH ₃ Ethane	-ane
Alkene		H ₂ C=CH ₂ Ethylene	-ene
Alkyne		H—C≡C—H Acetylene (Ethyne)	-yne
Aromatic		 Benzene	None
Alkyl halide	 (X=F, Cl, Br, I)	CH ₃ —Cl Methyl chloride	None
Alcohol		CH ₃ —OH Methyl alcohol (Methanol)	-ol
Ether		CH ₃ —O—CH ₃ Dimethyl ether	None
Amine		CH ₃ —NH ₂ Methylamine	-amine

*The bonds whose connections are not specified are assumed to be attached to carbon or hydrogen atoms in the rest of the molecule.

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TABLE 12.1 Some Important Families of Organic Molecules

FAMILY NAME	FUNCTIONAL GROUP STRUCTURE*	SIMPLE EXAMPLE	NAME ENDING
Aldehyde		CH ₃ —C(=O)—H Acetaldehyde (Ethanal)	-al
Ketone		CH ₃ —C(=O)—CH ₃ Acetone	-one
Carboxylic acid		CH ₃ —C(=O)—OH Acetic acid	-ic acid
Anhydride		CH ₃ —C(=O)—O—C(=O)—CH ₃ Acetic anhydride	None
Ester		CH ₃ —C(=O)—O—CH ₃ Methyl acetate	-ate
Amide		CH ₃ —C(=O)—NH ₂ Acetamide	-amide
			

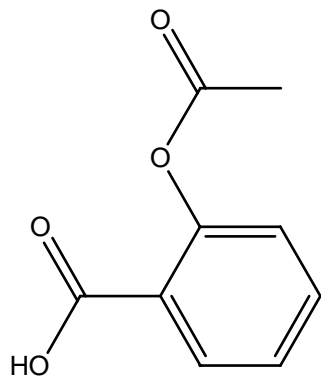
*The bonds whose connections are not specified are assumed to be attached to carbon or hydrogen atoms in the rest of the molecule.

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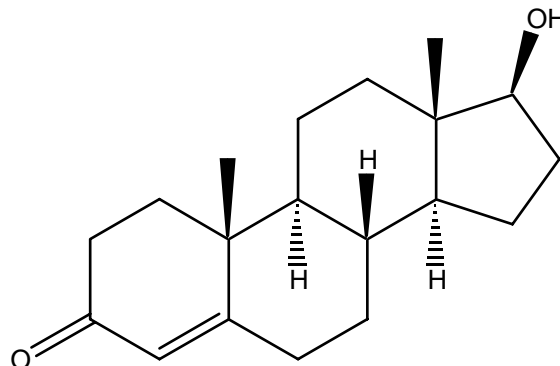
IUPAC Nomenclature

- *Alcohol: Name as usual, -e ending, +ol ending*
 - *Example: ethanol*
- *Halide: Name the halide as a side group using:*
 - *Chloro-*
 - *Bromo-*
 - *Fluoro-*
 - *Iodo-*
 - *Example: dichloromethane*
- *Ether: List alkyl groups alphabetically with the -yl ending and add the word ether*
 - *Example: diethyl ether*
- *Amine: Name the alkyl groups alphabetically with the -yl ending and the suffix -amine*
 - *Example: propyl amine*
- *Aldehyde: Name as usual, -e ending, +al ending*
 - *Example: ethanal*
- *Ketone: Name as usual, -e ending, +one ending*
 - *Example: 4-octanone*
- *Carboxylic Acid: Name as usual, -e ending, +oic acid ending*
 - *Example: propanoic acid*
- *Amide: Name as usual, -e ending, +amide suffix*
 - *Example: ethanamide*
- *Ester: Name the alkyl group off of the oxygen, name the alkyl group that includes the carbonyl carbon -e ending, +oate ending*
 - *Example: ethyl butanoate*

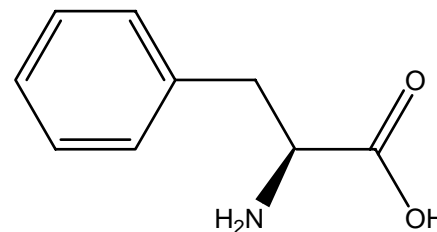
Circle and name each functional group:



acetylsalicylic acid; aspirin



testosterone; a steroid/sex hormone



phenylalanine; an essential amino acid

Problems:

- 1) Draw and name the saturated, unbranched alkane with 5 carbons.
- 2) Draw all 5 isomers of hexane.
- 3) Draw 2-methyl-2-butene. Why is there no cis-trans isomers?