Chemistry Chapter 22, 23 – Hydrocarbons & Functional Groups

22.1 Alkanes

Organic Chemistry - the study of carbon containing compounds. Found in living organisms.

Bonding & Atom Arrangement:

Single bonds to 4 atoms - tetrahedral shape.

Multiple bonding - double or triple bonds.

Carbon compounds can be in what is called normal (n) unbranched straight chains, branched chains, or in rings.

Hydrocarbons – simplest class of carbon compounds composed of hydrogen and carbon.

Saturated - hydrocarbons with single bonds only.

Unsaturated - hydrocarbons with multiple bonds present.

A. Classes of Hydrocarbons:

1. Alkanes - the simplest hydrocarbons, contain only single bonds.

General Formula of Alkanes:	$\mathbf{C_nH_{2n+2}}$
CH_4	CH_4
CH_3CH_3	C_2H_6
$CH_3CH_2CH_3$	C_3H_8
$CH_3CH_2CH_2CH_3$	C_4H_{10}
$CH_3CH_2CH_2CH_2CH_3$	C_5H_{12}
$CH_3CH_2CH_2CH_2CH_2CH_3$	C_6H_{14}

Naming Hydrocarbons:

Prefix = # carbon atoms		**Suffix = type of bonds**	
meth-	1	-ane	alkane
eth-	2	-ene	alkene
prop-	3	-yne	alkyne
but-	4		
pent-	5		
hex-	6		
hept-	7		
oct-	8		
non-	9		
dec-	10		

Unbranched Alkanes - use prefix for #carbons and suffix -ane.

Branched Alkanes

1. The longest continuous chain of carbon atoms(parent chain) gives the root name for the hydrocarbon.
2. Number the carbons in the parent chain starting at the end closest to any branching (the first substituent). When a substituent occurs the same number of carbons from each end, use the next substituent to determine from which end to start numbering.

Substituents - when a group is substituted for hydrogen on an alkane chain.

3. Name the substituent by using the name of it's parent alkane, drop the -ane and add -yl.
4. Specify the positions of substituent groups with the carbon number. A hyphen is written between the number and the name of the substituent.
5. When a given substituent occurs more than once, attach the appropriate prefix (di, tri, etc.) to the alkyl name.
6. The alkyl groups are listed in alphabetical order, disregarding any prefix.

22.3 Alkenes & Alkynes

2. Alkenes - hydrocarbons that contain double bond(s).
3. Alkynes - hydrocarbons that contain triple bond(s).

22.4 Isomers

Structural Isomerism - two or more molecules that have the same chemical formula but different arrangements of the atoms.

ex. normal butane (n-butane) vs. 2-methyl-propane (isobutene)

ex. n-pentane vs. 2-methyl-butane vs. 2,2-dimethyl propane (isopentane)

23.1-3 Functional Groups

Functional Groups - groups of atoms that are the same within a hydrocarbon which causes them to react in a similar manner. Used to classify organic compounds.

1. Halohydrocarbons – have the presence of a halogen, -Cl -Br -I .
2. Alcohols - have the presence of the –OH, hydroxyl group.

Naming: The **"e"** in the parent hydrocarbon is replaced with **"ol".**
Use a number to indicate the location of the OH group (using the shortest distance).

	Alkane	Alcohol
ex.	methane	methanol (wood alcohol)
	CH_4	CH_3OH

Produce by heating wood to a high temp in the absence of air. Causes blindness and death.

ethane	ethanol (grain alcohol)
CH_3CH_3	CH_3CH_2OH

Ferment glucose in fruit (wine) or grain (corn, barley, rice) with yeast. Produces 13%. Distill this to make higher alcohol content beverages.

ethylene glycol (antifreeze)
$HOCH_2CH_2OH$

Deadly to pets, similar structure to ethanol.

isopropanol
CH_3CHCH_3OH

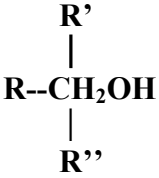
Phenol (used to make polymers for plastics & adhesives)

Classify Alcohols: according to the number of hydrocarbon fragments bonded to the carbon where the -OH is attached.

Primary Alcohol - one R group **R--CH_2OH**

Secondary Alcohol - two R groups

Tertiary Alcohol - three R groups



2. Ethers **R – O - R** Ethers have an oxygen bonded between two hydrocarbon ends.

3. Amines **R – NH_2** Amines have a nitrogen bonded to a hydrccarbon.

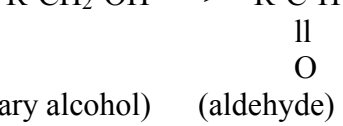
4. Aldehydes:

Aldehydes have the carbonyl group at the end of the hydrocarbon.

citral (lemons fragrance)
vanillin (vanilla fragrance)
Cinnamaldehyde (cinnamon fragrance)
formaldehyde (preservative)
butyraldehyde (rancid butter odor)

Naming: The **"e"** in the parent hydrocarbon is replaced with **"-al".**
Examples: methanal = formaldehyde

ethanal = acetaldehyde
Properties: Typically have strong odors.
Produced: From oxidation of a primary alcohol.



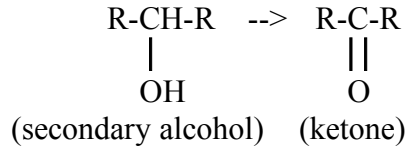
(primary alcohol) (aldehyde)

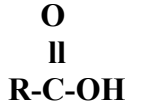
5. Ketones

Ketones have the carbonyl group C=O in the middle of the hydrocarbon.

Naming: The **"e"** in the parent hydrocarbon is replaced with **"-one".**
Examples: propanone = acetone
2-butanone
Properties: Solvents

Produced: From oxidation of a secondary alcohol.

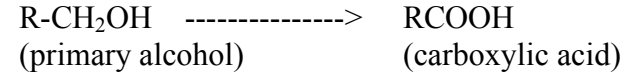


6. <u>Carboxylic Acids</u>:  **Have the carboxyl group -COOH.**

(RCOOH)

Naming: The **"e"** in the parent hydrocarbon is replaced with **"-oic acid".**
Examples: ethanoic acid (acetic acid)

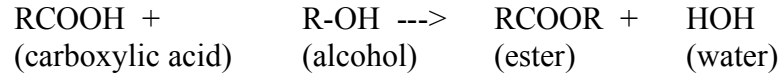
propanoic acid (cheese odor), butanoic acid (rancid fat)
Properties: Weak acids
Produced: From oxidation of primary alcohols with a strong oxidizing agent.



7. <u>Esters</u>:  **Have the group –COOR.**

Naming: The **"-ol"** in the <u>alcohol</u> is replaced with **"-yl"** for the <u>first part of the name</u> and the <u>last part of the name</u> uses the <u>carboxylic acid</u> where the **"-ic"** is replaced with **"-ate".**

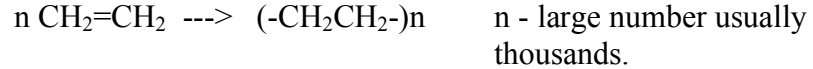
Examples: isopropanol + ethanoic acid --> isopropylethanoate
Properties: Often have sweet, fruity, or minty fragrances.
isobutylmethanoate or isobutyl formate (raspberry)
octylethanoate or octyl acetate (orange)
ethylbutanoate or ethyl butyrate (pineapple)
Produced:



23.5 Polymers

<u>Polymers</u> - large, usually chain-like molecules that are built from small molecules called <u>monomers</u>.

Examples: ethylene monomers form polyethylene



n - large number usually thousands.

Properties: Tough, flexible plastic used for piping, bottles, electrical insulation, film for packaging, garbage bags, etc.

tetrafluoroethylene monomers for teflon
nylon
dacron (polyester from carboxylic acid + alcohol)

Reactions: 1. Addition Polymerization - monomers simply add together to form the polymer with no other products.
ex. polyethylene

2. Condensation Polymerization - a small molecule such as water is formed for each extension of the polymer chain.
ex. polyester