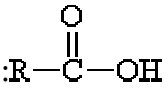
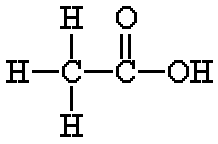
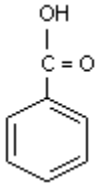
CHE 102 - Study Guide - Ch. 24-25

Chapter 24:

Carboxylic Acids

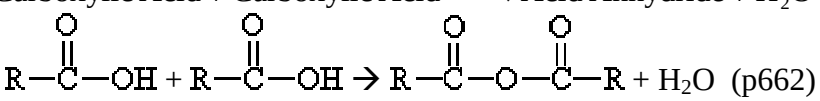
1. Functional Group (Carboxyl group):  or R-COOH or R-CO_2H

2. Naming
   a. Identify longest chain with carboxyl group
   b. Use Parent name, change "e" to "oic acid"
   c. Name the rest of the molecule like normal
   d. Use "di" to indicate two carboxyl groups (ex ethanedioc acid)

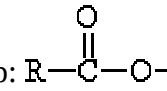
	
Ethanoic Acid	Benzoic Acid

3. Physical Properties:
   a. Carbonyl Carbon + Hydroxy group → hydrogen bonding
   b. Bp > alcohols
   c. Solubility:
      i. < 4 C = infinitely
      ii. 4-8 C = slightly
      iii. > 8 C = insoluable
   d. Dimers: Carboxylic acids tend to form dimers which explains there high Bp
   e. Acids: Carboxylic acids are acids and lose the hydroxy H when in aqueous solutions

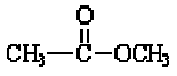
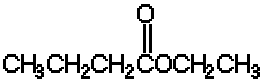
4. Classes of Carboxylic Acids (recognize and name them)
   a. Saturated
   b. Unsaturated (C=C or C≡C)
   c. Aromatics: Benzoic Acid
   d. Dicarboxylic Acids
   e. Hydroxy Acids
   f. Amino Acids

5. Chemical Reactions (* indicates especially important reactions)
   a. *Oxidation: 1^o Alcohol $\xrightarrow{[O]}$ Aldehyde $\xrightarrow{[O]}$ Carboxylic Acid (p658 + see page 555 for additional examples, and additional reaction conditions)
   b. Hydrolysis of Nitriles: $R-CN + 2H_2O \xrightarrow{[H^+]} \text{Carboxylic Acid} + NH_4^+$ (p659)
   c. Subsitituion: (-Cl, -OOCR, -OR, $-NH_2$)
      i. Acid Chlorides:
      $\text{CarboxylicAcid} + SOCl_2 \longrightarrow \text{Carboxylic Acid Chloride} + HCl + SO_2$ (p661)
      ii. Acid Anhydride: $\text{Carboxylic Acid} + \text{Carboxylic Acid} \longrightarrow \text{Acid Anhydride} + H_2O$
       (p662)
      iii. *Esterfication: $\text{Carboxylic Acid} + \text{Alcohol} \longrightarrow \text{Ester} + H_2O$ (p662)

Esters

1. Functional Group:  or R-COO-R' or RCO_2R'

2. Naming:
   a. Identify the alcohol portion and use parent name, change "ane" to "yl"
   b. Identify the carboxylic acid portion,
      i. Name the carboxylic acid, change "ic acid" to "ate" **OR**
      ii. Use parent name, change "e" to "oate"
   c. Ex

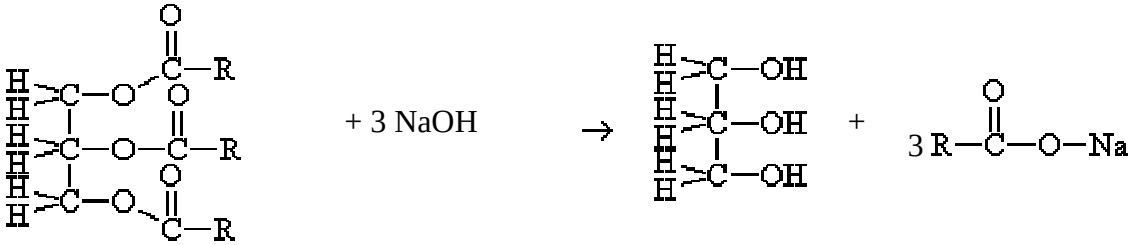
	
Methylethanoate	Ethylbutanoate

3. Physical Properties:
   a. Carbonyl carbon + Ether Oxygen
   b. Bp < Carboxylic Acids/Alcohols (no hydrogen bonding)
   c. Solubility < Carboxylic Acids/Alcohols
   d. Odors: 1-10 carbon atoms = fruity flavors p664, Table 24.3)
   e. Make good solvents for polar and nonpolar compounds because the molecule has a polar and nonpolar portions. Used as solvent for paints, varnish and laquer and for organic dyes.
   f. High molar mass esters → Waxes (cars, furniture)
   g. Polyesters (polymers) used in fabrics (Dacron)

4. Chemical Reactions (* indicates especially important reactions)
   a. *Hydrolysis: $\text{Ester} + H_2O \xrightarrow{H^+ \text{ or Enzyme}} \text{Carboxylic Acid} + \text{Alcohol}$ (opposite of Esterfication) (p 667)
   b. *Saponification: $\text{Ester} + \text{Base} \xrightarrow{H_2O + \Delta} \text{Carboxylic Acid Salt} + \text{Alcohol}$ (Reversible by adding Acid) (p667)

5. Gycerol Esters: (Picture on p668)
   a. Fats = solids at room temperature (saturated fats from animals)
   b. Oils = liquids at room temperature (unsaturated or polysaturated from plants)
   c. Principally form of energy storage in the body
   d. Normally cis isomers but can make trans isomers which are bad for your health

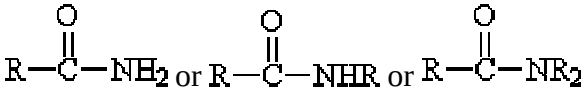
6. Soaps: Fat + NaOH → Soaps (Salts of long chain fatty/carboxylic acids + Glycerol (p670)



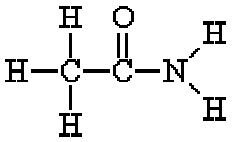
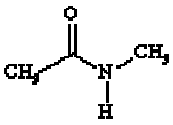
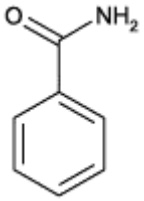
fat + sodium hydroxide → glycerol + 3 soap

Chapter 25

Amides

1. Functional Group:  or or

2. Naming
   a. Find longest chain with amide group.
   b. Use parent name, change "e" to "amide"
   c. Identify R groups attached to Nitrogen with an "N" instead of numbering like normal groups.
   d. Ex:

		
Ethanamide	N-Methylethanamide	Benzamide

3. Physical Properties:
   a. Solids
   b. NH_2 group is capable of hydrogen bonding and is responsible for the high Bp and high solubility of amides

4. Chemical Reactions: (* indicates especially important reactions)
   a. *Formation: $\text{Carboxylic Acid} + \text{Ammonia} \longrightarrow \text{Ammonia Salt} \xrightarrow{\Delta} \text{Amide} + H_2O$ (p683)

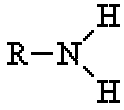
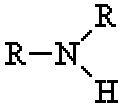
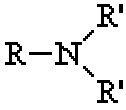
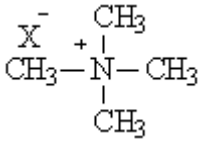
      $\text{Carboxylic Acid} + 1^o/2^o/3^o\ \text{Amine} \longrightarrow \text{Amine Salt} \xrightarrow{\Delta} \text{Amide} + H_2O$

   b. *Acid Hydrolysis: $\text{Amide} + H_2O + \text{Acid} \longrightarrow \text{Carboxylic Acid} + \text{Ammonia Salt}$ (p687)

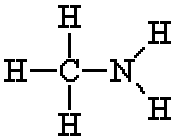
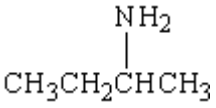
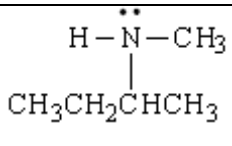
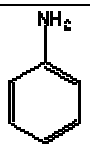
   c. *Base Hydrolysis: $\text{Amide} + \text{Base} \longrightarrow \text{Carboxylic Acid Salt} + \text{Ammonia(g)}$ (p687)

Amines

1. Functional Group:

			
Primary / 1°	Secondary / 2°	Tertiary / 3°	Quaternary Ammonium Salt

2. Naming
   a. Find longest chain with amine group
   b. Use parent name, change "e" to "amine"
   c. Identify R groups attached to Nitrogen with an "N" instead of numbering like normal groups.
   d. Diamines: Add "di" before "amine"
   e. Ex:

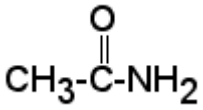
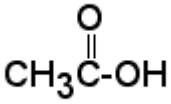
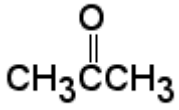
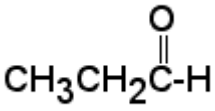
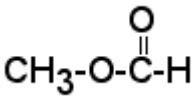
			
Methanamine	2-butanamine	N-methyl-2-butanamine	Aniline

3. Physical Properties
   a. N-H capable of hydrogen bonding. The more H attached to N the more hydrogen bonding that occurs
   b. Polar compounds therefore very soluable in water when R < 6 Carbons
   c. Responsible for many "bad" odors (p693 bottom of page for examples)
   d. Weak bases: $\text{Amine} + H_2O \longrightarrow \text{Ammonium Ion} + OH^-$

4. Chemical Reactions: (* indicates especially important reactions)
   a. *Alkylation: $\text{Ammonia} + \text{Alkyl Halide} \longrightarrow 1^o\ \text{Amine}$ (p694)
      $1^o\ \text{Amine} + \text{Alkyl Halide} \longrightarrow 2^o\ \text{Amine}$
      $2^o\ \text{Amine} + \text{Alkyl Halide} \longrightarrow 3^o\ \text{Amine}$
      $3^o\ \text{Amine} + \text{Alkyl Halide} \longrightarrow \text{Quaternary ammonium salt}$
   b. *Reduction: $\text{Amide} \xrightarrow{LiAlH_4} \text{Amine}$ (p694)
      $\text{Nitrile} \xrightarrow{H_2/Ni} \text{Amine}$
   c. *Salt Formation: $\text{Amine}\ \text{Strong Acid} \longrightarrow \text{Ammonium Salt}$ (p696)
   d. *Formation: $\text{Acid Chloride} + 2\ (1^o/2^o\ \text{Amine}) \longrightarrow \text{Amide}$ (p697)

5. Amines in everyday life (Section 25.8)
   a. Sulfa drugs + Ampicillin to combat disease
   b. Vitamins: Thiamine (Vitamin B_1)
   c. Novacaine
   d. Alkaloids: Nicotine, Methadone, Cocaine
   e. Amphetamines: Medications for depression, obesity, narcolepsy, alertness drugs
   f. Barbiturates: Depressants/sedatives
   g. Tranquilizers: Valium and Prozac

Boiling Point Comparison of Similar Compounds

Functional Group Name	Boiling Point	Polar Rank (most to least)	Structure Name
Amide	222°	1	
Acid	118°	2	
Alcohol	117°	3	$CH_3CH_2CH_2OH$
Ketone	56°	4, 5	
Aldehyde	49°	4, 5	
Amine	49°	6	$CH_3CH_2CH_2NH_2$
Ester	32°	7	
Ether	11°	8	$CH_3\text{-}O\text{-}CH_2CH_3$
Alkane	-42°	9	$CH_3CH_2CH_3$