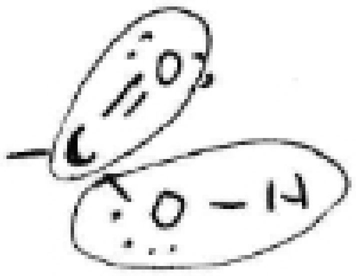


Chapter 17: Carboxylic Acids

Lecture Outline

– COOH

I. Structure

A. The functional group of a carboxylic acid is the carboxyl group (it contains both a carbonyl group and a hydroxyl group.)

II. Nomenclature

A. IUPAC System

1. We name a carboxylic acid by naming the longest carbon chain that contains the carboxyl group, drop the final -e and add the ending –oic acid.

Carboxylic Acid has priority over all other groups

a. Carbon-1 is supposed to be the carboxyl carbon (there is no need to give that number).

2. If the carboxylic acid contains a C=C or C≡C, change the infix from *–an-* to *–en-* or *–yn-* to indicate the presence of a double/triple bond and report the location.

3. Remember Table 16.1 on pg. 563 – carboxylic acids take precedence over most functional groups so if you have a compound that contains 2 or more functional groups, you will have to keep this in mind.

4. Dicarboxylic acids are named by adding the suffix *–dioic acid* to the name of the carbon chain that contains both carboxyl groups. Because they're at the ends of chains, you don't have to worry about reporting the locations of the groups.

5. A carboxylic acid containing a carboxylic group bonded to a cycloalkane ring is named by naming the ring and adding the ending –carboxylic acid. The carbon that has the carboxylic group is C-1.

6. Concerning aromatics: we use numbers to show the location of substituents on the benzene ring relative to the carboxyl group.

B. Common Names

1. Table 17.1 (pg. 623) lists several common names for carboxylic acids. They're mostly derived from Latin names (ooo fun!)

2. To name substituents we use greek letters to locate these groups relative to the carboxyl group

Table 17.1 Several Aliphatic Carboxylic Acids, Their Common Names, and Derivations

Structure	IUPAC Name	Common Name	Derivation
$HCOOH$	Methanoic acid	Formic acid	Latin: *formica*, ant
CH_3COOH	Ethanoic acid	Acetic acid	Latin: *acetum*, vinegar
CH_3CH_2COOH	Propanoic acid	Propionic acid	Greek: *propion*, first fat
$CH_3(CH_2)_2COOH$	Butanoic acid	Butyric acid	Latin: *butyrum*, butter
$CH_3(CH_2)_3COOH$	Pentanoic acid	Valeric acid	Latin: *valeriana*, a flowering plant
$CH_3(CH_2)_4COOH$	Hexanoic acid	Caproic acid	Latin: *caper*, goat
$CH_3(CH_2)_6COOH$	Octanoic acid	Caprylic acid	Latin: *caper*, goat
$CH_3(CH_2)_8COOH$	Decanoic acid	Capric acid	Latin: *caper*, goat
$CH_3(CH_2)_{10}COOH$	Dodecanoic acid	Lauric acid	Latin: *laurus*, laurel
$CH_3(CH_2)_{12}COOH$	Tetradecanoic acid	Myristic acid	Greek: *myristikos*, fragrant
$CH_3(CH_2)_{14}COOH$	Hexadecanoic acid	Palmitic acid	Latin: *palma*, palm tree
$CH_3(CH_2)_{16}COOH$	Octadecanoic acid	Stearic acid	Greek: *stear*, solid fat
$CH_3(CH_2)_{18}COOH$	Eicosanoic acid	Arachidic acid	Greek: *arachis*, peanut

<u>Problem 1</u>. Draw the corresponding structure for each of these names.

a. (Z)-9-Octadecenoic acid (oleic acid)

b. 2-hydroxybenzoic acid

c. pentanedioic acid

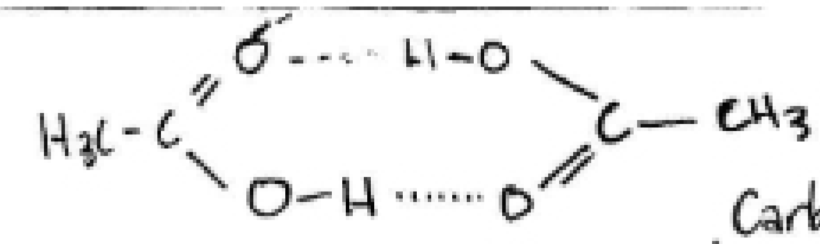
d. adipic acid

e. γ-aminobutyric acid

III. Physical Properties

two places to form H-bond

A. Highest boiling and melting points of anything we have yet seen.
- They can form dimers through H-bonding



Carboxylic Acids are the strongest group we will deal with.

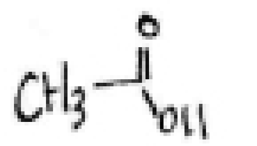
B. Carboxylic acids have higher BPs than other types of organic compounds of comparable MW (remember – the higher the BP, the stronger the interactions).

C. CA's are more soluble in water than alcohols, aldehydes, and ketones.

D. As the MW increases, carboxylic acids lose their solubility.
-occurs after we add 4-5 carbons

IV. Acidity

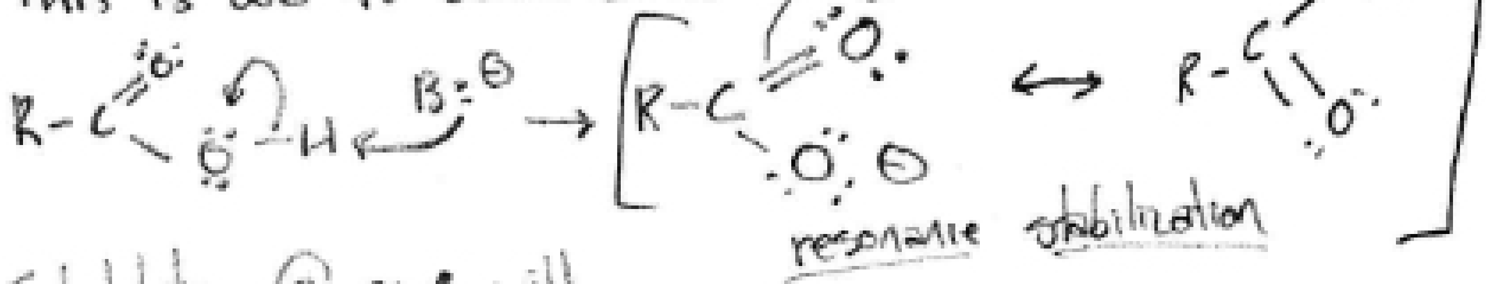
A. Acid Ionization Constants



Acetic Acid

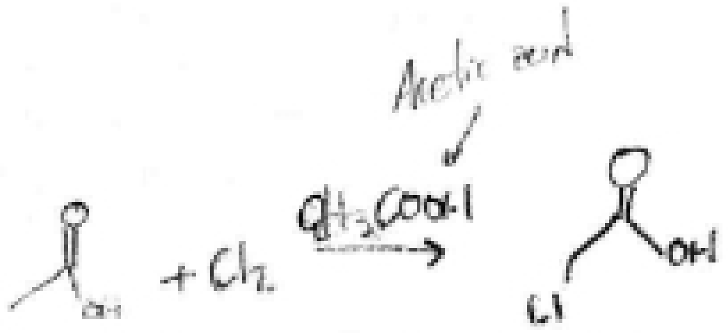
1. Carboxylic acids are weak acids (K_a values are between 10^{-4} and 10^{-5}; pK_a values are between 4-5) Some of the strongest organic acids we will see.

a. This is due to delocalization



b. Substituting @ α-C will increase acidity.

c. Example: acetic acid



Adding chlorines to α-C increases acidity of the molecule.

Formula:	CH_3COOH	$ClCH_2COOH$	$Cl_2CHCOOH$	Cl_3CCOOH
Name:	Acetic acid	Chloroacetic acid	Dichloroacetic acid	Trichloroacetic acid
pK_a:	4.76	2.86	1.48	0.70

Increasing acid strength →

2. What if you dissolve a carboxylic acid in an aqueous solution?

* a. When the pH is equal to the pK_a (pH = 4 – 5), you will have equal amounts of the carboxylic acid and its conjugate base in solution.

b. When the pH is equal or less than 2.0, then the predominant species will be the carboxylic acid.

c. When the pH is greater than or equal to 7.0, the conjugate base (the anion) will be predominant).