

Chemistry 1506: Allied Health Chemistry 2

Section 3: Alcohols, Phenols, Ethers, and Halides

Functional Groups with Single Bonds to Oxygen

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Section 3.1 Introduction and Nomenclature of Alcohols

➤ Methanol

➤ "Wood alcohol", causes blindness

➤ $\text{CH}_3\text{-OH}$

➤ Ethanol

➤ Oldest man made chemical (history of agriculture)

➤ "Grain alcohol"

➤ $\text{CH}_3\text{-CH}_2\text{-OH}$

➤ Made by sugar fermentation with yeast (wine, beer, gasoline)

➤ Made industrially by Ethene Hydration ($\text{H}_2\text{O}/\text{H}_2\text{SO}_4$)

- Isopropanol
 - "rubbing alcohol"
 - $(\text{CH}_3)_2\text{CH-OH}$

- IUPAC Nomenclature
 - Use anol suffix
 - Number longest chain to include as many OH groups as possible
 - Polyols (diol, triol, tetraol, etc.)
 - Examples

- Alcohol Classification
 - Primary Alcohols, 1°
 - Secondary Alcohols, 2°
 - Tertiary Alcohols, 3°

- Properties
 - Related to Water
 - Intermolecular Hydrogen Bonding
 - Mp and Bp
 - Polar
 - Solubility
 - Biologically Active

Section 3.2 Alcohol Reactions

- Sources of Alcohol **Reactivity**
 - **Bond polarity** of R-OH
 - **Weak acidity** of R-OH

- **Dehydration**
 - **Elimination of water** (i.e., H₂O loss)
 - **Acid Catalyzed** (H₂SO₄ and heat)
 - **Generic Reaction**

- **Zaitsev's Rule**
 - Elimination proceeds to give the **most substituted alkene**
 - **Dehydration** of 2-butanol

➤ Oxidation

➤ Effects due to class of alcohol

➤ 3° vs. 2° vs. 1°

➤ Effects due to Oxidizing agent Strength

➤ "Generic" Oxidizing Agent, [O]

➤ CrO₃ / pyridine (pyr)

➤ Chromium trioxide

➤ “poisoned” oxidation

➤ K₂Cr₂O₇/H₂SO₄

➤ Potassium Dichromate

➤ “full strength” oxidation

➤ "Weak Oxidation" of 1° Alcohols

➤ Oxidation of Aldehydes

➤ "Strong Oxidation" of 1° Alcohols

➤ Oxidation of 2° Alcohols

➤ Failed Oxidation of 3° Alcohols

Section 3.3 Biological Alcohols

➤ Glycerol

➤ Component of Triglycerides

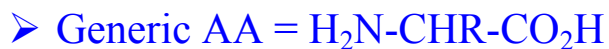
➤ Most common animal and vegetable fats

➤ Triol

➤ $\text{CH}_2(\text{OH})\text{-CH}(\text{OH})\text{-CH}_2(\text{OH})$

Section 3.4 Amino Acids having Alcohol Containing Side Chains

➤ Amino Acids (Building Blocks of Proteins)



➤ Serine



➤ Threonine



Section 3.5 Phenols

➤ Aromatic Alcohols

- Originally derived industrially from coal tar
- Generic Structure (Aromatic-OH)

➤ Properties

- Often unpleasant odors
- Intermolecular Hydrogen Bonding
- Mp and Bp
- Solubility
- Toxicity
- Acidity (cf. Alcohols)

➤ Phenol (C_6H_5-OH)

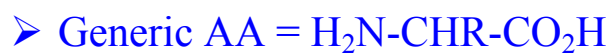
➤ Cresol (ortho, meta, and para-methyl phenol)

- Many Natural Products
 - Lignins in wood
 - Pulp mill effluent
 - Aerobic oxidation
 - "Trout test"

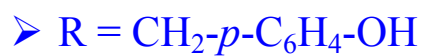
 - Vanillin (1-OH, 2-OCH₃, 4-CHO)

Section 3.6 Amino Acids having Phenol Side Chains

➤ Amino Acid



➤ Tyrosine



Section 3.7 Ethers

- R-O-R Structure
 - Bond angles $\approx 109.5^\circ$

- Physical Properties
 - Mp and Bp vs. Alcohols
 - Polarity
 - Hydrogen Bonding (cf. Alcohols and Water)
 - Solubility

- Nomenclature
 - Dialkyl Ether (two words)
 - Alkyl Alkyl' Ether (three words)

- Chemical Reactivity
 - Generally very low
 - Used as Solvents

- Diethyl Ether
 - $\text{CH}_3\text{-CH}_2\text{-O-CH}_2\text{-CH}_3$
 - "ether", "ethyl ether"
 - Anaesthetic
 - Made from grain alcohol and acid

- THF (tetrahydrofuran)
 - Made from Oat husks, Quaker Oat Company
 - Used to make specialty plastics (car dashboards)

- Ethylene Oxide
 - Exceptionally reactive due to ring strain
 - Medical sterilization

- MTBE (methyl tertiarybutyl ether)

Section 3.8 Thiols, Thioethers, and Disulfides

- Cf. **Hydrogen Sulfide (H₂S)**
- **Stink and Toxic**

- **Thiols (Mercaptans)**
 - R-S-H
 - **Pentanethiol (CH₃CH₂CH₂CH₂CH₂-SH), skunk oil**

- **Thioethers**
 - R-S-R

- **Disulfides**
 - R-S-S-R

Section 3.9 Amino Acids having Sulfur Containing Side Chains

➤ Amino Acids (Generic AA = $\text{H}_2\text{N}-\text{CHR}-\text{CO}_2\text{H}$)

➤ Cysteine (neutral polar)

➤ $\text{R} = \text{CH}_2-\text{SH}$

➤ Cystine

➤ $\text{CH}_2-\text{S}-\text{S}-\text{CH}_2$ bridge

➤ Methionine (non-polar)

➤ $\text{R} = \text{CH}_2\text{CH}_2-\text{S}-\text{CH}_3$

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