Review of Organic Functional Groups

Introduction to Medicinal Organic Chemistry

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Alcohols

-Common (Alkyl alcohol)

CH_3OH	Methyl alcohol (Wood alcohol)
CH_3CH_2OH	Ethyl alcohol (Alcohol U.S.P.)
CH_3CHOH $\quad\quad CH_3$	Isopropyl alcohol (Rubbing alcohol)
$\quad\quad CH_3$ $CH_3C\text{-}OH$ $\quad\quad CH_3$	tert-Butyl alcohol

-IUPAC (Alkanol)

CH_3OH	Methanol
CH_3CH_2OH	Ethanol
CH_3CHOH $\quad\quad CH_3$	2-Propanol
$\quad\quad CH_3$ $CH_3C\text{-}OH$ $\quad\quad CH_3$	2-Methyl-2-propanol

A. Nomenclature. The alcohols are named as "alcohol" preceded by the names of the hydrocarbon radical. Methyl and ethyl alcohol are examples of primary alcohols, isopropyl alcohol of a

secondary alcohol, and tertiary butyl alcohol of a tertiary alcohol. The primary, secondary, and tertiary designation given to an alcohol depends upon the number of carbons that are attached to the carbon that contains the OH group. The primary designation indicates that one carbon is attached to the carbon bearing the OH group; the secondary designation that two carbons are attached, and the tertiary designation that three carbons are attached.

Once again, the nomenclature becomes clumsy as the hydrocarbon portion branches, and the official nomenclature must be used. The longest continuous chain that contains the hydroxyl group is chosen. The chain is then numbered to give the lowest number to the hydroxyl group. Other substituents preceded by their numbered location come first, followed by the location of the hydroxyl group, followed by the name of the alkane. To show that this is an alcohol, the "e" is dropped from the alkane name and replaced by "ol," the official sign of an alcohol.

B. Physical-Chemical Properties. The properties of the alcohol offer a departure from the compounds that have been discussed previously. The OH group can participate in intermolecular hydrogen bonding. Because of the electronegativity of the oxygen and the electropositive proton, a permanent dipole exists. The hydrogen attached to the oxygen is slightly positive in nature and the oxygen slightly negative. Remember, this is not a formal charge, but simply an unequal sharing of the pair of electrons that make up the covalent bond. The intermolecular hydrogen bonding that is now possible between the alcohol molecules results in relatively high boiling points as compared with their hydrocarbon counterparts (Table 6–1). Also important is the fact that the alcohol group can hydrogen bond to water. This means that it can break into the water lattice, with the result that the alcohol functional group promotes water solubility. The extent of water solubility for each alcohol will depend on the size of the hydrocarbon portion (Table 6–1). C_1 through C_3 alcohols are miscible with water in all proportions. As the length of the hydrocarbon chain increases, the hydrophilic nature of the molecule decreases. The location of the hydroxyl radical also influences water solubility, although not as dramatically as chain length. A hydroxyl group centered in the molecule will have a greater potential for producing water solubility than a hydroxyl at the end of the straight chain. If a second hydroxyl is added, solubility is increased. An example of this is 1,5-pentanediol. It can be thought of as ethanol and propanol put together. Since both alcohols are quite water soluble, it would be predicted that 1,5-pentanediol would also be quite water soluble, and it is. It also follows that, as the solubility of the alcohol in water decreases, the solubility of the alcohol in nonaqueous media increases. In summary, it can be said that an

Table 6–1.
Boiling Points and Water Solubility of Common Alcohols

	Boiling Points °C	Solubility (g /100g H_2O)
Methanol	65.5	∞
Ethanol	78.3	∞
1-Propanol	97.0	∞
2-Propanol	82.4	∞
1-Butanol	117.2	7.9
2-Butanol	99.5	12.5
1-Pentanol	137.3	2.3

alcohol functional group has the ability to solubilize to the extent of 1% or greater an alkane chain of five to six carbon atoms.

Looking at the chemical reactivity of the alcohol, it is found that, from a pharmaceutical standpoint, the alcohol functional group is a relatively stable unit. Remember, though, that in the presence of oxidizing agents, a primary alcohol will be oxidized to a carboxylic acid after passing through an intermediate aldehyde (Fig. 6–1).

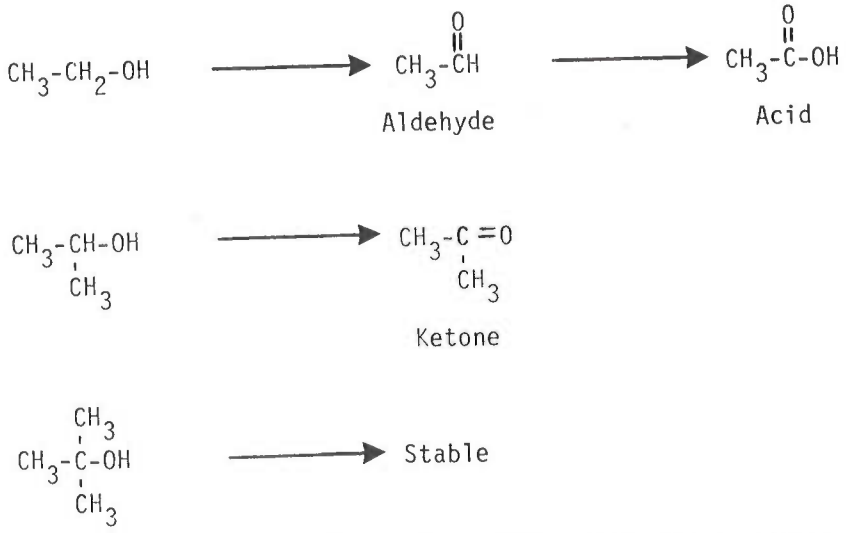

Fig. 6–1. Oxidation of a primary and secondary alcohol by oxidizing agents

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