Alcohols

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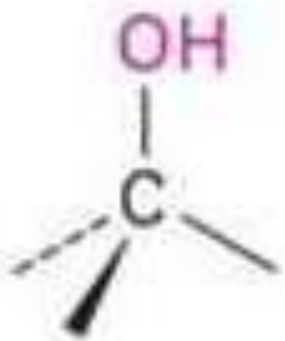
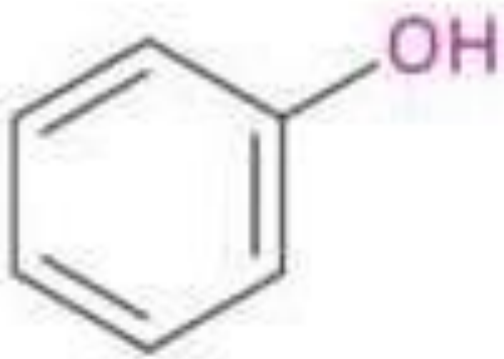
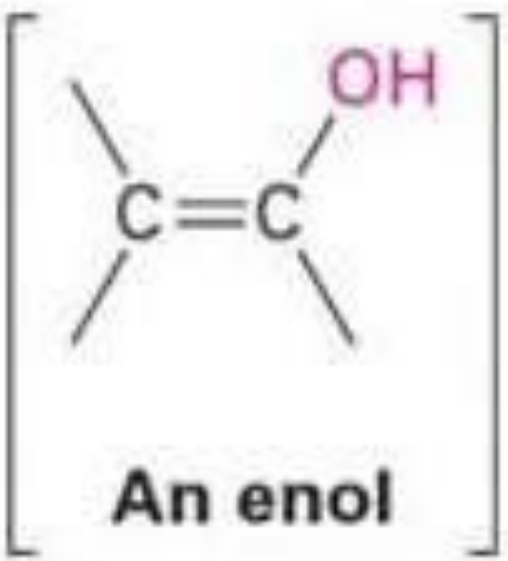
Alcohols and phenols can be thought of as organic derivatives of water in which one of the waters hydrogens is replaced by an organic group: H-O-H versus R-O-H and Ar-O-H.



An alcohol



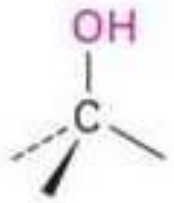
A phenol



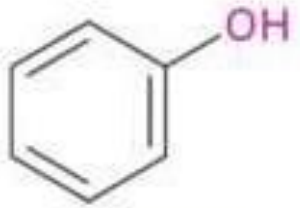
An enol

Naming

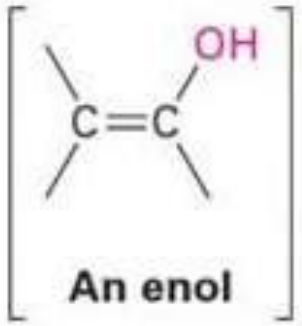
- In practice, the group name alcohol is restricted to compounds that have their -OH group bonded to a saturated sp^3 carbon atom,
- in phenol, the hydroxyl group is directly attached to the sp^2 carbon of benzene ring
- while compounds with their OH group bonded to a vinylic sp^2 hybridized carbon are called enols.



An alcohol

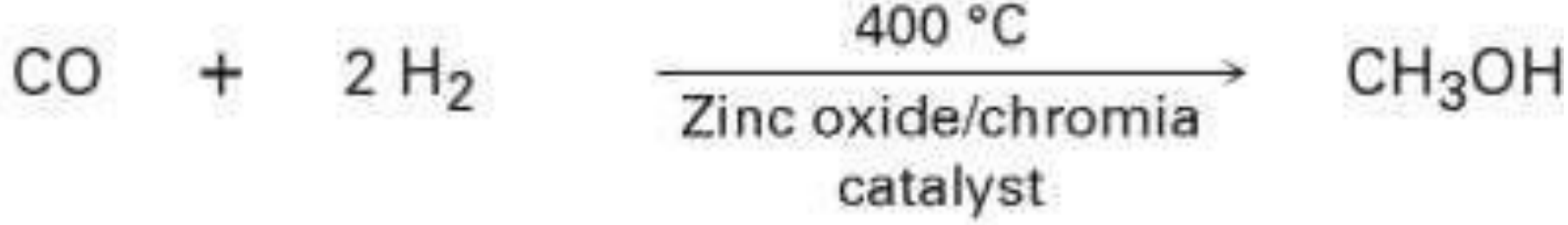


A phenol



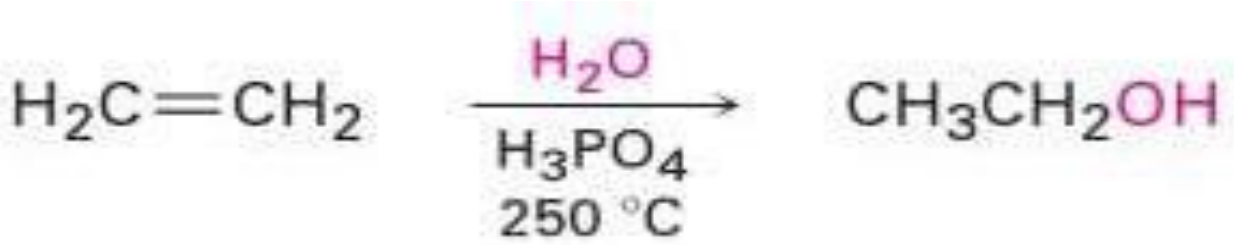
An enol

- Alcohols occur widely in nature and have many industrial and pharmaceutical applications. Methanol, for instance is one of the most important of all industrial chemicals. Historically, methanol was prepared by heating wood in the absence of air and thus came to be called wood alcohol. Methanol is prepared by catalytic reduction of carbon monoxide with hydrogen gas.



Methanol is toxic to humans, causing blindness in small doses and death in larger amounts. Industrially, it is used both as a solvent and as a starting material for production of formaldehyde (CH_2O) and acetic acid (CH_3COOH).

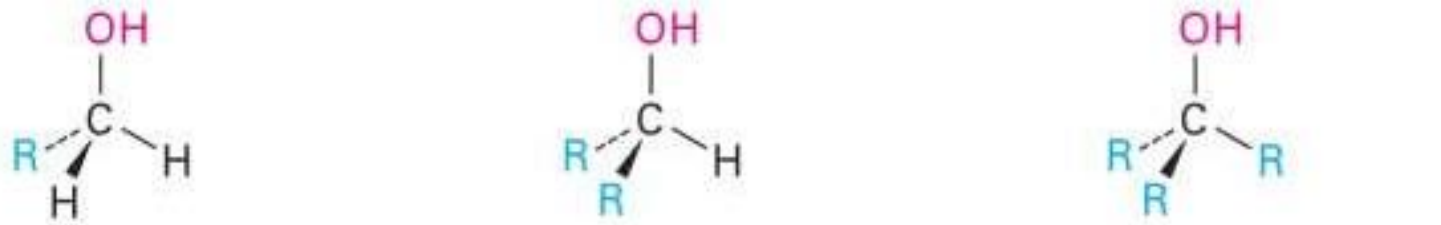
- Ethanol was one of the first organic chemicals to be prepared and purified.
- Ethanol for industrial uses as a solvent or chemical intermediate is largely obtained by acid-catalyzed hydration of ethylene at high temperature.



Phenols occur widely throughout nature and also serve as intermediates in the industrial synthesis of product as diverse as adhesives and antiseptics. Phenol itself is a general disinfectant found in coal tar (قطران الفحم)

Naming:

- Alcohols are classified as primary (1°), secondary (2°), or tertiary (3°), depending on the number of organic groups bonded to the hydroxyl-bearing carbon.



A primary (1°) alcohol A secondary (2°) alcohol A tertiary (3°) alcohol

- Simple alcohols are named by the IUPAC system as derivatives of the parent alkene using the suffix-ol

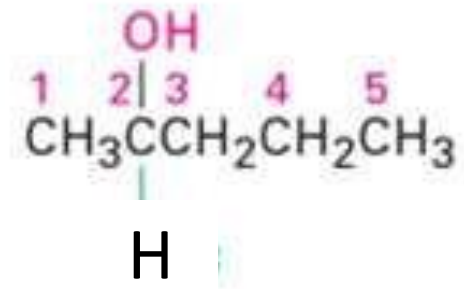
Rule 1

- Select the longest carbon chain containing the hydroxyl group, and derive the parent name by replacing the–e ending of the corresponding alkane with –ol.

CH3-CH2-CH2-CH3	**Butane**
CH3-CH2-CH2-CH2-OH	**Butanol**

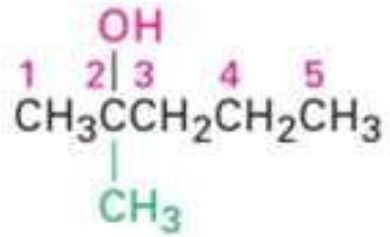
Rule 2

- Number the alkane chain beginning at the end nearer the hydroxyl group.

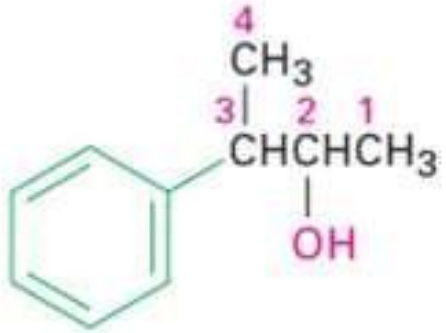


Rule 3

•Number the substituents according to their position in the chain, and write the name, listing the substituents in alphabetical order and identifying the position to which the –OH is bonded.

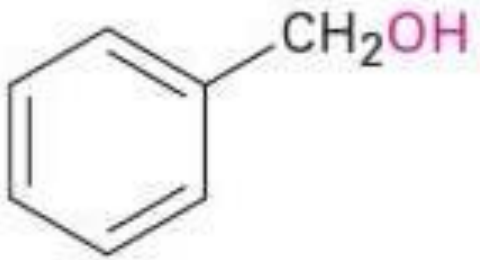


2-Methyl-2-pentanol

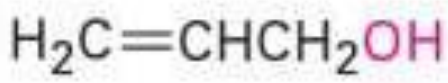


3-Phenyl-2-butanol

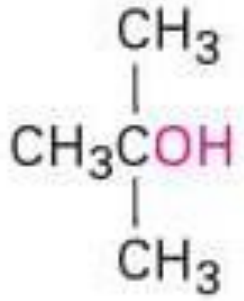
Some simple and widely occurring alcohols have common names that are accepted by IUPAC. For example.



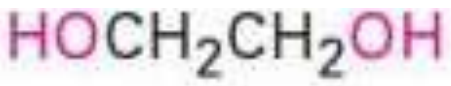
Benzyl alcohol
(phenylmethanol)



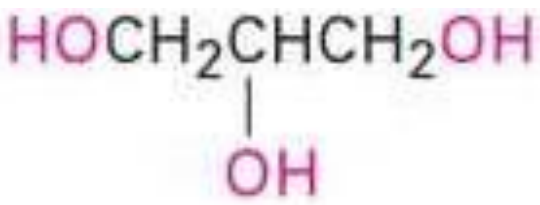
Allyl alcohol
(2-propen-1-ol)



***tert*-Butyl alcohol**
(2-methyl-2-propanol)



Ethylene glycol
(1,2-ethanediol)



Glycerol
(1,2,3-propanetriol)

- **Preparation of Alcohols**

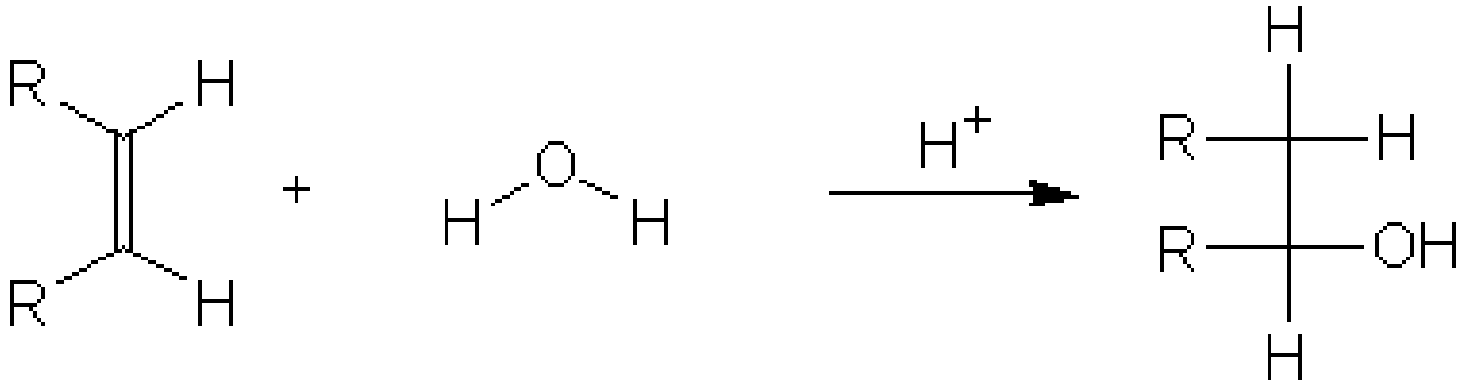
1- Hydration of an Alkene.

2- Reduction of Aldehydes.

3- From Amines.

Hydration of an alkene:

- The addition of water to an alkene occurs in living systems. Rather than use a strong acid catalyst, which would destroy the system, reactions in cells use enzymes, biological catalysts that work efficiently at the temperature and pH of the cell.



- An example of a reactions the hydration of fumarate to malate that is catalyzed by the enzyme fumarase. This is an important reaction in the citric acid cycle.

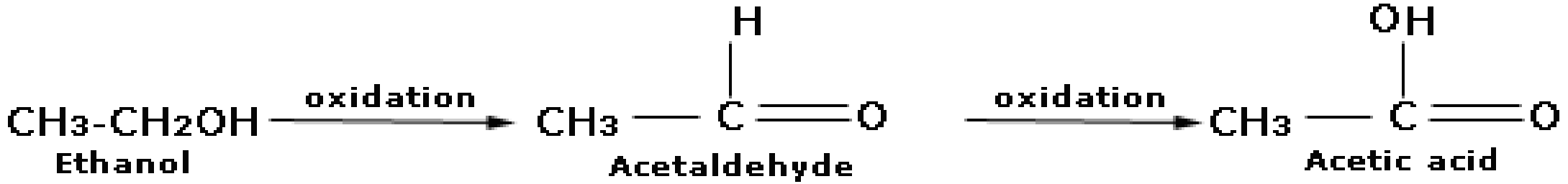
Fumarate

S-malate

Oxidation of alcohol

- Primary alcohols can be oxidized to form aldehydes and carboxylic acids; secondary alcohols can be oxidized to give ketones. Tertiary alcohols, in contrast, cannot be oxidized.

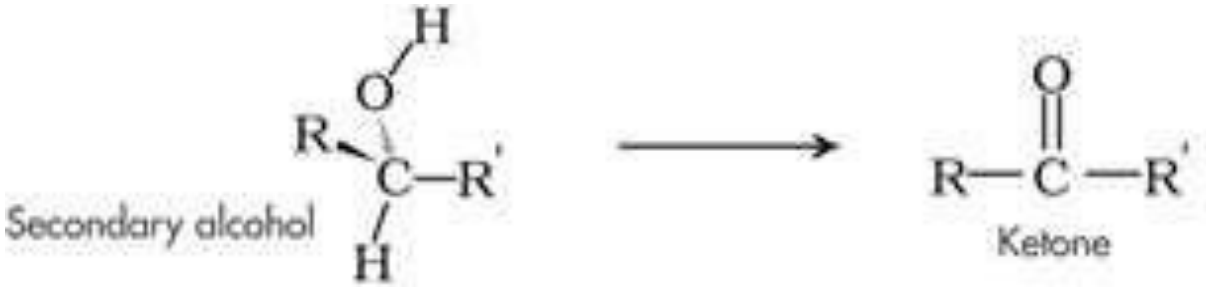
- <u>Primary alcohol</u>



Ethanol Acetaldehyde Acetic acid

- Secondary alcohol

Alcohols can be oxidized to form ketones

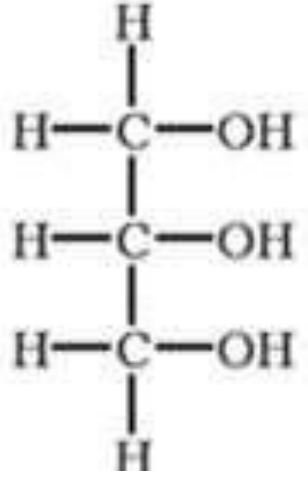


Tertiary alcohol cannot be oxidized

Oxidation of alcohols in living systems:

- The oxidation of alcohols is an important reaction in living systems. Enzymes called dehydrogenase catalyze these reactions. The major enzyme system(s) responsible for the oxidation of ethanol, alcohol dehydrogenase.
- **Glycerol (propane-1,2,3-triol).**

Figure 1. Structure of Glycerol



Glycerol

- It is widely distributed in all living tissue. It is obtained by the hydrolysis of animal fats or plant oils, which are naturally occurring esters of glycerol and long chain carboxylic acids.
- It is a colorless, viscous liquid of sweet taste, b.p.290°, miscible in water.