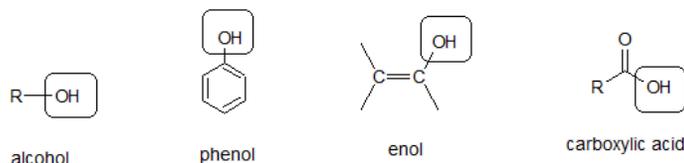


13.1: INTRODUCTION TO STRUCTURE AND SYNTHESIS OF ALCOHOLS

INTRODUCTION

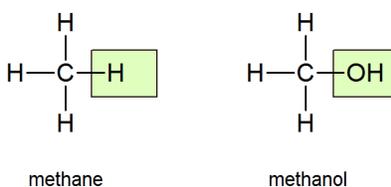
Alcohols, phenols, enols, and carboxylic acids all contain a hydroxyl group. However, the chemistry of these four different functional groups are different.



ALCOHOLS

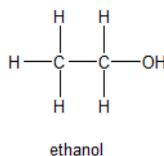
Molecules of alcohols contain one or more hydroxyl groups (OH groups) substituted for hydrogen atoms along the carbon chain.

The structure of the simplest alcohol, methanol (methyl alcohol), can be derived from that of methane by putting an OH in place of one of the H's:



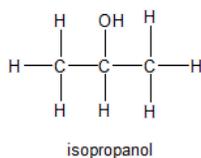
Methanol is also called wood alcohol because it can be obtained by heating wood in the absence of air, a process called **destructive distillation**. Methanol vapor given off when the wood is heated can be condensed to a liquid by cooling below its boiling point of 65°C. Methanol is highly toxic. In 1986, there were six deaths of residents of Peerless Lake, Alberta, brought about by drinking photocopier fluid which contained methanol (or methyl hydrate as it is often called in press reports). In 2000, more than 100 people died in El Salvador after black marketeers sold discarded liquor bottles that had been refilled with a methanol mixture. Indeed the problem has repeated itself globally and so often that in 2014 the [World Health Organization released an information note](#) warning of methanol poisoning outbreaks which “occur when methanol is added to illicitly- or informally-produced alcoholic drinks.”

The second member of the alcohol family is ethanol (ethyl alcohol)—the substance we commonly call *alcohol*. Ethanol is also known as grain alcohol because it is obtained when grain or sugar ferments.



Fermentation refers to a chemical reaction which is speeded up by enzymes and occurs in the absence of air. (Enzymes, catalysts which occur naturally in yeasts and other living organisms, are discussed in more detail elsewhere.) Almost everyone is aware that the alcohol present in alcoholic beverages is ethanol (also called ethyl alcohol or grain alcohol). However, many people do not realize that in its pure state, or in solutions of high concentration, this substance is poisonous. In the laboratory one may find containers labeled “absolute ethanol,” “95% ethanol” and “denatured ethanol.” The acquisition of ethanol by laboratories, and its subsequent disposal, is carefully monitored by provincial authorities. On no account should one consider drinking laboratory ethanol, even after it has been diluted to a concentration equivalent to that found in beer. Denatured alcohol is ethanol to which appropriate quantities of poisonous or nauseating substances (such as methanol) have been added. Ethanol is used as a solvent, in some special fuels, in antifreeze, and to manufacture a number of other chemicals. You are probably most familiar with it as a component of alcoholic beverages. Ethanol makes up 3 to 6 percent of beer, 12 to 15 percent of most wines, and 49 to 59 percent of distilled liquor. (The “proof” of an alcoholic beverage is just twice the percentage of ethanol.) Alcohol’s intoxicating effects are well known, and it is a mild depressant. Prolonged overuse can lead to liver damage.

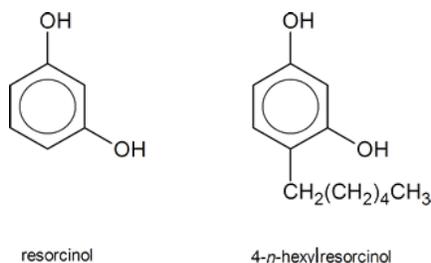
A third commonly encountered alcohol, isopropyl alcohol (“rubbing alcohol” or 2-propanol), is also toxic. It has the ability to kill germs and has a temporary lubricating effect during the rubbing process. Unlike methanol, 2-propanol is not absorbed through the skin; therefore it poses less of a health hazard.



PHENOLS

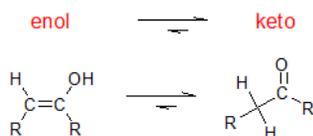
A phenol is an organic compound in which a hydroxyl group is directly bonded to one of the carbon atoms of an aromatic ring. The chemical behavior of phenols is different in some respects from that of the alcohols, so it is sensible to treat them as a similar but characteristically distinct group.

Until the late nineteenth century, a person undergoing surgery had to face the fact that he or she might suffer the consequences of what we now know to be bacterial infection, contracted during the course of the operation. The physicians of the time did not know that bacteria existed, and had no way to counter the problems that bacteria caused. In 1867, Joseph Lister, who had learned of the existence of bacteria as a result of research done by Louis Pasteur, began using solutions of phenol to clean wounds and surgical instruments. The phenol solution was an effective antiseptic, killing bacteria, and as a result, a patient's chances of surviving surgery improved greatly. Phenol itself was rather strong for these purposes—it burns healthy tissue—and substitutes were eventually found. One such substitute, used today in throat lozenges and mouthwashes, is 4-*n*-hexylresorcinol.



ENOLS

When a hydroxyl group is bonded to a vinyl carbon, the functional group is called an enol. As discussed in Chapter 10, alkyne hydration can result in enol formation. Enols undergo tautomerization to form ketones. In most cases, the keto-form is more stable and predominates the equilibrium. Phenol is an important exception to this trend.



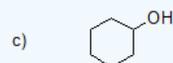
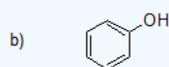
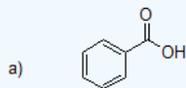
CARBOXYLIC ACIDS

In carboxylic acids, the hydroxyl group is bonded to a carbonyl carbon. As the name implies, this functional group is acidic and can readily donate the proton on the hydroxyl group.



Exercise

1. Classify the following compounds as alcohols, phenols, enols, or carboxylic acids. One compound can be classified by two of the options.



Answer

1.
 - a) carboxylic acid
 - b) phenol and enol
 - c) alcohol

CONTRIBUTORS AND ATTRIBUTIONS

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