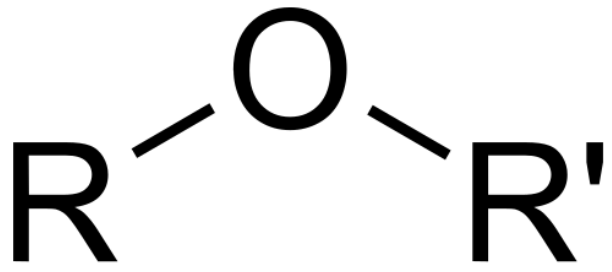
The Islamic University

Department of Pharmaceutical Chemistry

Title of the course: *Organic Chemistry* I

Level: 1st Class, 2nd Semester

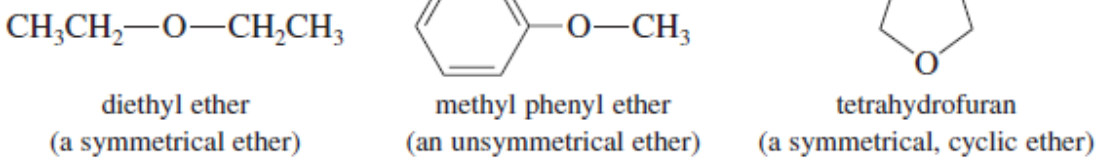
Ethers



Dr.Tabarek Alnaqib

Ethers are compounds of formula **R¬O¬R.** where **R** and **R.** may be alkyl groups or aryl (benzene ring) groups.

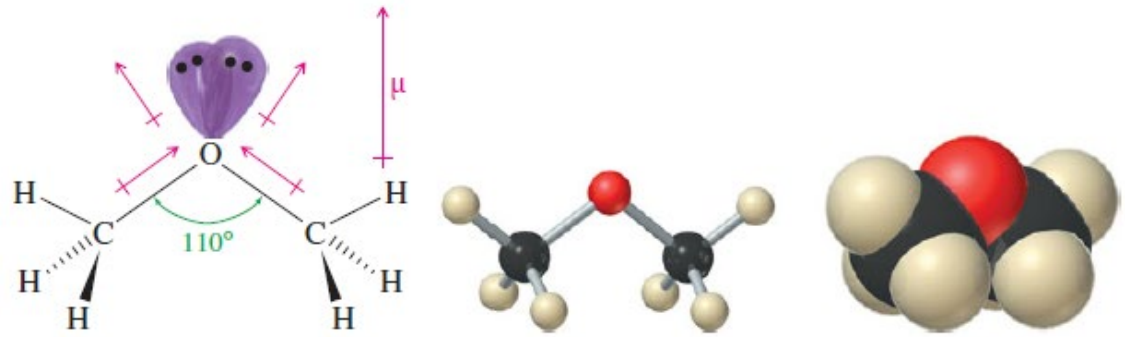
Examples of ethers



diethyl ether (a symmetrical ether) | methyl phenyl ether (an unsymmetrical ether) | tetrahydrofuran (a symmetrical, cyclic ether)

Structure and Polarity of Ethers

Like water, ethers have a bent structure, with an **sp3** hybrid oxygen atom giving a nearly tetrahedral bond angle. In water, the nonbonding electrons compress the bond angle to 104.5°, but in a typical ether, the bulk of the alkyl groups enlarges the bond angle. Figure shows the structure of dimethyl ether, with a tetrahedral bond angle of 110°.



Boiling Points of Ethers; Hydrogen Bonding

Table compares the boiling points of several ethers, alcohols, and alkanes. Notice that the boiling points of dimethyl ether and diethyl ether are nearly 100 °C lower thanthose of alcohols having similar molecular weights. This large difference results mostly from hydrogen bonding in the alcohols. Pure ethers cannot engage in hydrogen bonding because they have no groups.

TABLE 14-1 Comparison of the Boiling Points of Ethers, Alkanes, and Alcohols of Similar Molecular Weights

Compound	Formula	MW	bp (°C)	Dipole Moment (D)
water	H_2O	18	100	1.9
ethanol	$CH_3CH_2—OH$	46	78	1.7
dimethyl ether	$CH_3—O—CH_3$	46	−25	1.3
propane	$CH_3CH_2CH_3$	44	−42	0.1
n-butanol	$CH_3CH_2CH_2CH_2—OH$	74	118	1.7
tetrahydrofuran		72	66	1.6
diethyl ether	$CH_3CH_2—O—CH_2CH_3$	74	35	1.2
pentane	$CH_3CH_2CH_2CH_2CH_3$	72	36	0.1

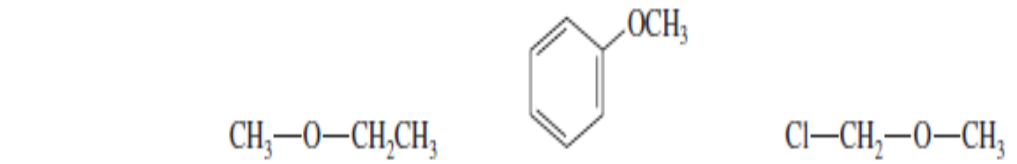
Ethers as Polar Solvents

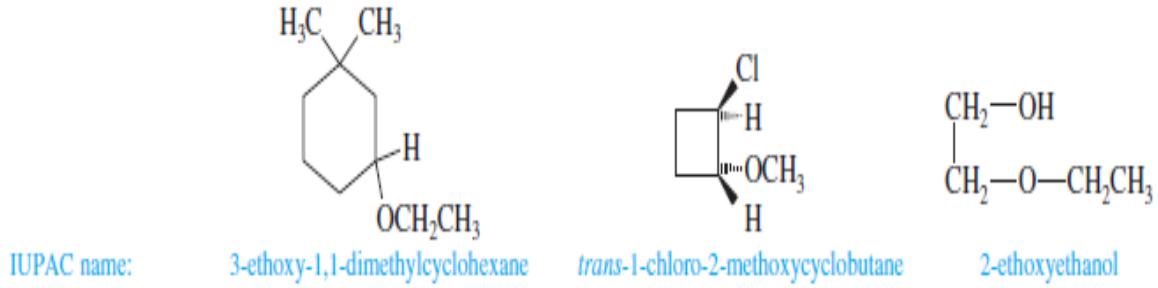
Ethers are ideally suited as solvents for many organic reactions. They dissolve a wide range of polar and nonpolar substances, and their relatively low boiling points simplify their evaporation from the reaction products. Nonpolar substances tend to be more soluble in ethers than in alcohols because ethers have no hydrogen-bonding network to be broken up by the nonpolar

solute. Polar substances tend to be nearly as soluble in ethers as in alcohols .

IUPAC Names

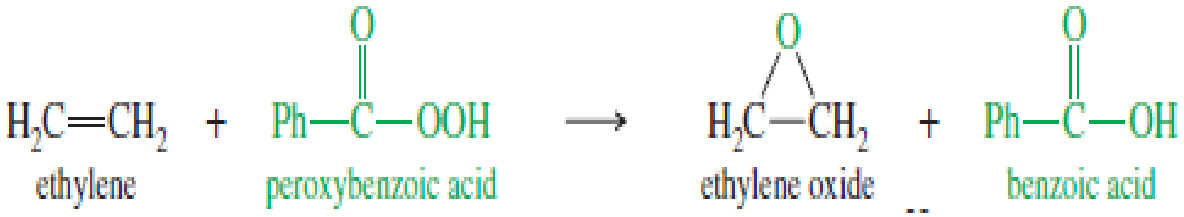
IUPAC names use the more complex alkyl group as the root name, and the rest of the ether as an **alkoxy group.** For example, cyclohexyl methyl ether is named methoxycyclohexane.This systematic nomenclature is often the only clear way to name complex ethers.



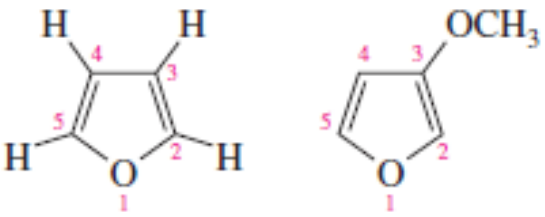


Nomenclature of Cyclic Ethers

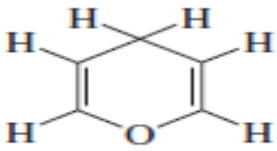
1. **Epoxides** : We have already encountered some of the chemistry of epoxides in Section 8-12. **Epoxides** are three-membered cyclic ethers, usually formed by peroxyacid oxidation of the corresponding alkenes. The common name of an epoxide is formed by adding "oxide" to the name of the alkene that is oxidized.



2. **Furans** : The five-membered cyclic ethers are commonly named after an aromatic member of this group, **furan.**

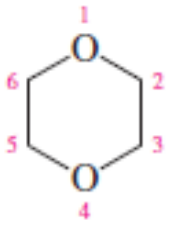


3. **Pyrans** : The six-membered cyclic ethers are commonly named as derivatives of **pyran,** an unsaturated ether.



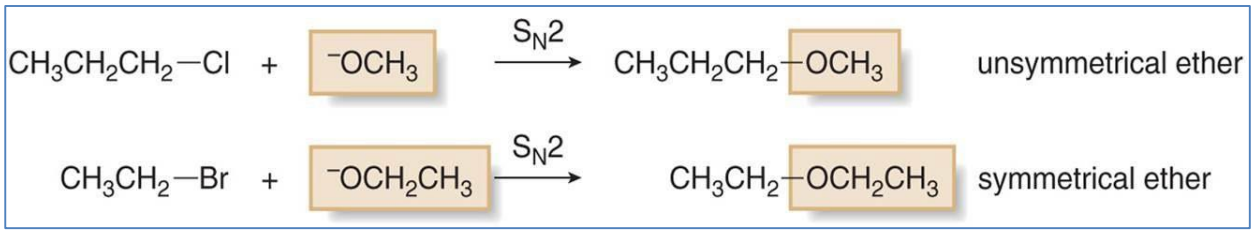
pyran

4. **Dioxanes**: Heterocyclic ethers with two oxygen atoms in a six-membered ring are called **dioxanes.** The most common form of dioxane is the one with the two oxygen atoms in a 1,4-relationship. 1,4-Dioxane is miscible with water, and it is widely used as a polar solvent for organic reactions.



1,4-dioxane

Preparation of Ethers



The preparation of ethers by the method shown in the last two equations is called the **Williamson ether synthesis**.

Reaction of Ethers with Strong Acid