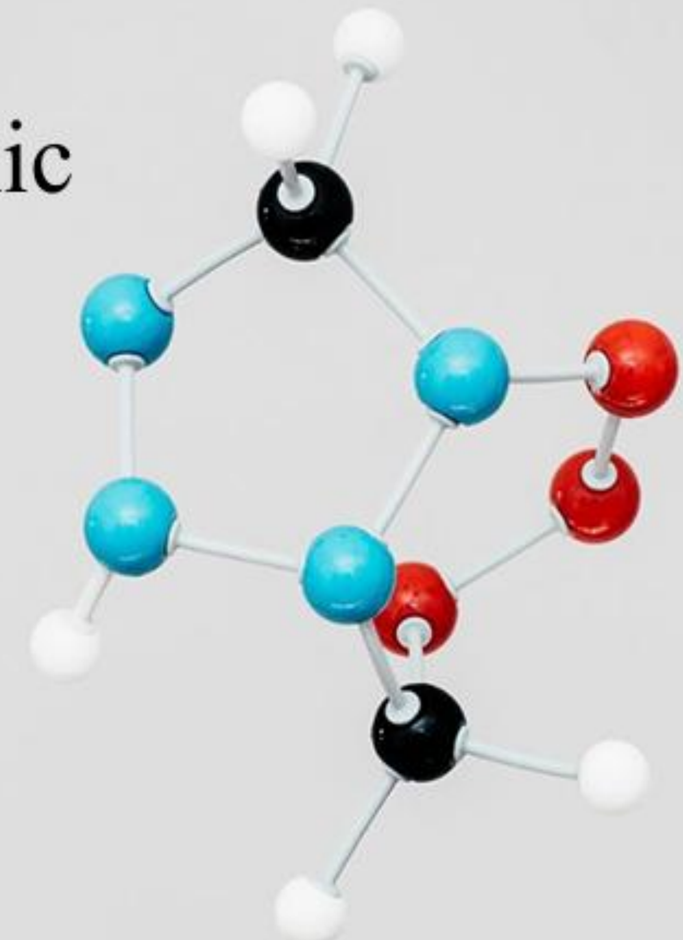
Lab (2)

Solubility of Organic Compounds

1st stage- college of Dentistry



By

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Introduction:

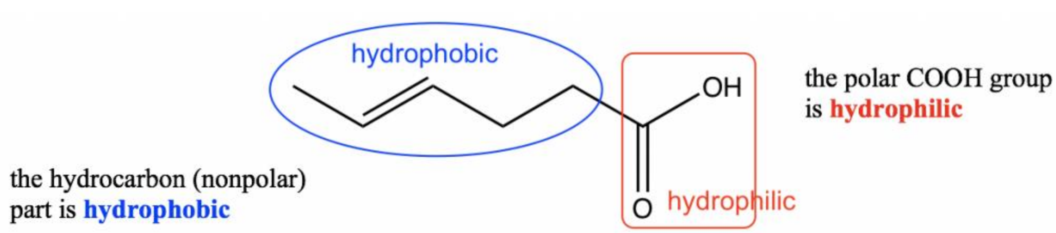
A general rule for solubility is summarized by the expression “like dissolves like”. This means that one substance can dissolve in another with similar polarity, and as a result, with similar intermolecular forces. More specifically:

- Nonpolar substances are usually soluble in nonpolar solvents.
- Polar and ionic substances are usually soluble in polar solvents.
- Polar and nonpolar substances are insoluble to each other.

Water, methanol and ethanol are examples of very polar solvents that can form Hydrogen bonds. Ether, ketone, halide and esters are polar solvents as well, but not as polar as water or methanol. Non-polar solvents include hydrocarbons like hexane, benzene, toluene etc.

For some organic compounds, however, it may not be that easy to simply call it polar or non-polar, because part of the compound may be polar, and the another part may be nonpolar. This is often described as hydrophilic or hydrophobic.

- **Hydrophobic** (***hydro***, water; ***phobic***: fearing or avoiding) meaning it does not like water or is insoluble in water.
- **Hydrophilic** (***hydro***, water; ***philic***: loving or seeking) meaning it likes water or is soluble in water.

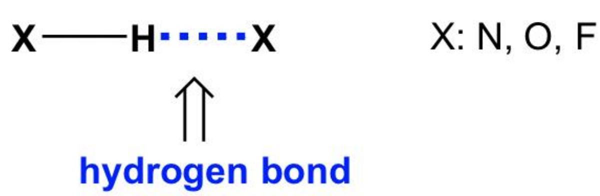


The hydrocarbon part of the organic compound is *hydrophobic*, because it is nonpolar and therefore does not dissolve in polar water. The functional group of OH, COOH, NH_2 etc is polar and is therefore *hydrophilic*. With both hydrophobic and hydrophilic parts present in an organic compound, the overall polarity depends on whichever part is the major one. If the carbon chain is short (1~3 carbons), the hydrophilic effect of the polar group is the major one, so the whole compound is soluble in water; with carbon chains of 4~5 carbons, the hydrophobic effect begins to overcome the hydrophilic effect, and water solubility is lost.

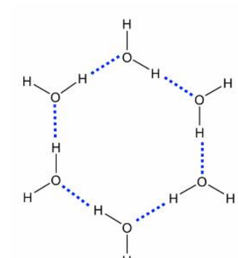
- ***The solubility of organic compounds depends on two important factors:***

1- Hydrogen bonding

A hydrogen bond is not a covalent bond, it is a type of intermolecular force. The hydrogen bond is the force between a H atom that is bonded to O, N or F (atoms with high electronegativity) and the neighbouring electronegative atom,. It can be shown in a general way as:



The most common example of hydrogen bonding is for water molecules. Water has two O-H bonds, and both are available as hydrogen bond donors for neighbouring molecules. This explains the extraordinarily high b.p. of water (100 °C), considering the rather small molar mass of 18.0 g/mol.



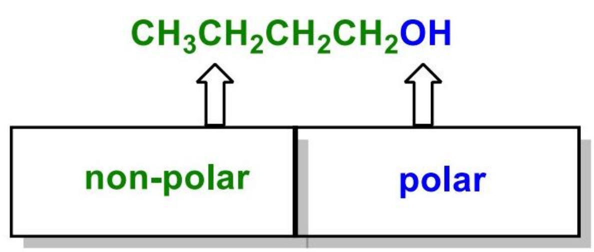
- For organic compounds, hydrogen bonds play important roles in determining the properties of compounds with OH or NH bonds, for example alcohol (R-OH), carboxylic acid (R-COOH), amine ($R-NH_2$) and amide $RCONH_2$.

2- polarity

- For organic compounds, the hydrocarbons (C_xH_y) are always non-polar. This is mainly because of the small electronegativity difference between carbon atoms and hydrogen atoms, making C-H bonds technically non-polar bonds.

- For other organic compounds that contain functional groups with heteroatoms, like R-O-R, C=O, OH, NH, they are all polar molecules.

- The rule is "like dissolves like" which is based on the polarity of the systems i.e. polar molecules tend to dissolve in polar solvents (e.g. water, alcohols) and non-polar molecules in non-polar solvents (e.g. the hydrocarbon hexane). This is why ionic compounds, like table salt (sodium chloride), or compounds like sugar, dissolve in water but do not dissolve to any great extent in most organic solvents. It also applies to the separation of oil and water.



The objective of this experiment is to investigate the solubility of some simple "unknown" organic molecules containing a variety of common organic functional groups. Using the important relationship between the solubility properties of an organic molecule and its' structure, you will then be able to use the solubility results to assign each of the unknown organic compounds to a solubility class.

Materials	***Tools***
Distilled water	Beaker
Ethanol	Dropper
Benzene	Micropipette
Alkane	Glass rod
Naphthalene	

Procedure

-dissolve 10 ml of ethanol in 10 ml of distilled water.

- dissolve 5 g of naphthalene in 10 ml of distilled water.

- dissolve 10 ml of benzene in 10 ml of distilled water.

- dissolve 10 ml of alkane in 10 ml of distilled water.

-dissolve 10 ml of naphthalene in 10 ml of benzene.

- dissolve 10 ml of alkane in 10 ml of benzene.

Calculation:

-Dissolve in water:

Substance	result	cause
Ethanol		
naphthalene		
Benzene		
Alkane		

-Dissolve in organic solvents:

naphthalene		
alkane		