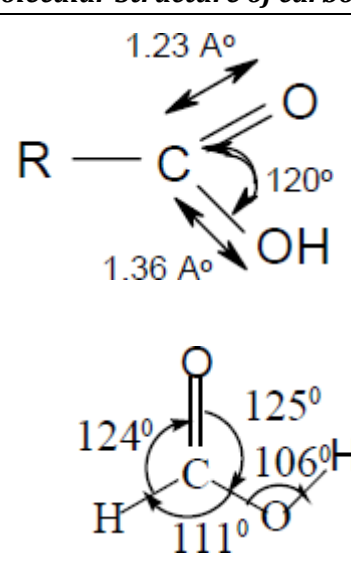
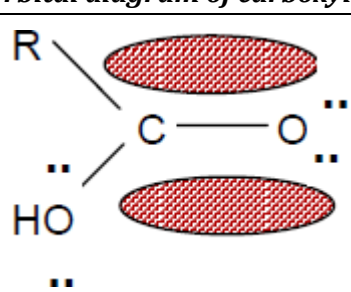


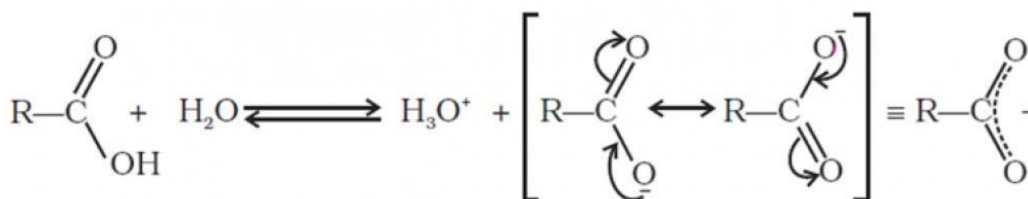
## UNIT V: CARBOXYLIC ACID

**Carboxylic acids:** Acidity of carboxylic acids, effect of substituents on acidity, inductive effect and qualitative tests for carboxylic acids, amide and ester Structure and Uses of Acetic acid, Lactic acid, Tartaric acid, Citric acid, Succinic acid. Oxalic acid, Salicylic acid, Benzoic acid, Benzyl benzoate, Dimethyl phthalate, Methyl salicylate and Acetyl salicylic acid

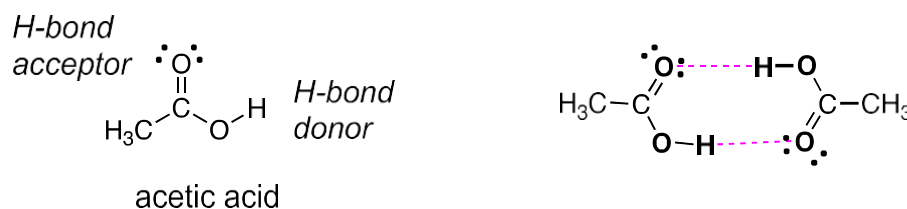
- The carboxyl functional group is represented as  $-\text{COOH}$  and is the end product of alcohol oxidation.
- The term carboxylic acid is little special in the sense that it represents two functional groups; first a carbonyl group and second hydroxyl group. One can say that in the carboxyl group a hydroxyl group is bonded to a carbonyl ( $>\text{C}=\text{O}$ ) group. It is often represented as  $\text{CO}_2\text{H}$  or  $\text{COOH}$ .
- Carboxylic acids have been found to constitute one of the most frequently encountered classes of organic compounds. A large number of natural products are either carboxylic acids derivatives or are derived from them.
- The structure of the most stable conformation of formic acid is shown below. The entire molecule is approximately planar. The  $\text{sp}^2$  hybrid carbonyl carbon atom is planar, with nearly trigonal bond angles. The O-H bond also lies in this plane, eclipsed with the  $\text{C}=\text{O}$  bond.

Molecular Structure of carboxylic acid	Orbital diagram of carboxylic acid
	

- Carboxylic acids dissociate in water to form **carboxylate ion** and **hydronium ion**. The carboxylate ion formed is stabilized through resonance by effective delocalization of the negative charge.



- Carboxylic acids exist as hydrogen bonded dimers.

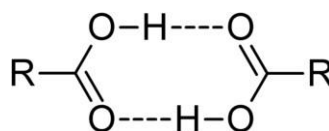




## ❖ Physical Properties of Carboxylic Acids

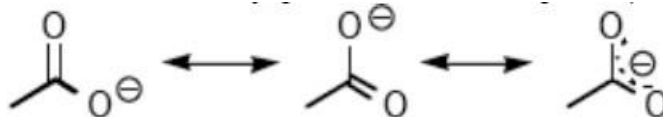
### 1. ACIDITY OF CARBOXYLIC ACIDS

- ✓ Carboxylic acids act as both hydrogen bond acceptors, due to the carbonyl group, and hydrogen bond donors, due to the hydroxyl group.
- ✓ As a result, they often participate in hydrogen bonding.
- ✓ Carboxylic acids usually exist as **dimeric pairs** in nonpolar media because of their tendency to "**selfassociate**." This tendency to hydrogen bond gives them increased stability as well as higher boiling points relative to the acid in aqueous solution.
- ✓ Carboxylic acids are polar molecules; They tend to be soluble in water, but as the alkyl chain gets longer, their solubility decreases due to the increasing hydrophobic nature of the carbon chain.
- ✓ Carboxylic acids are characterized as weak acids, meaning that they do not fully dissociate to produce **H<sup>+</sup>** cations in a neutral aqueous solution.

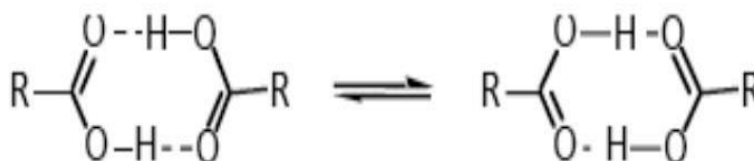


**DIMER** (*di*, "two" + *mer*, "parts") is an oligomer consisting of two structurally similar monomers joined by bonds that can be either strong or weak, covalent or intermolecular. The term *homodimer* is used when the two molecules are identical (e.g. AA) and *heterodimer* when they are not (e.g. AB). The reverse of dimerisation is often called dissociation.

- ✓ Carboxylic acids have one property that distinguishes them from most other organic compounds – they're acidic. Now not as acidic as fuming sulfuric acid, but still pretty darned acidic. The acidity of these compounds arises from the resonance stabilization of the conjugate base (bond lengths equalize):

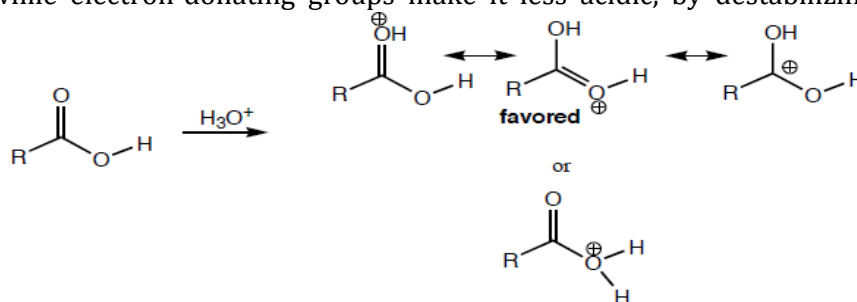


- ✓ Carboxylic acids undergo hydrogen bonding much like alcohols. However, in a carboxylic acid you have both a hydrogen bond donor and acceptor in the same molecule. These acids thus form highly stable dimers (as shown below). For small acids (e.g. acetic acid) this dimer cannot even be broken down by distillation.



- ✓ The acidity of these compounds can be modified by changing the substituents on the alkyl portion of the acid. Electron withdrawing groups make the molecule more acidic (by stabilizing the negative charge on the conjugate base), while electron-donating groups make it less acidic, by destabilizing that same charge.

- ✓ **Protonation**

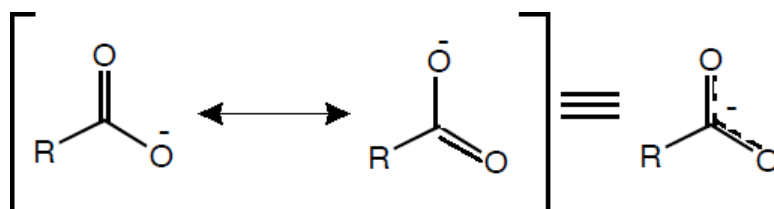


*Protonation at carbonyl is favoured by resonance stabilization while protonation at oxygen is disfavoured by partial positive charge on carbon.*

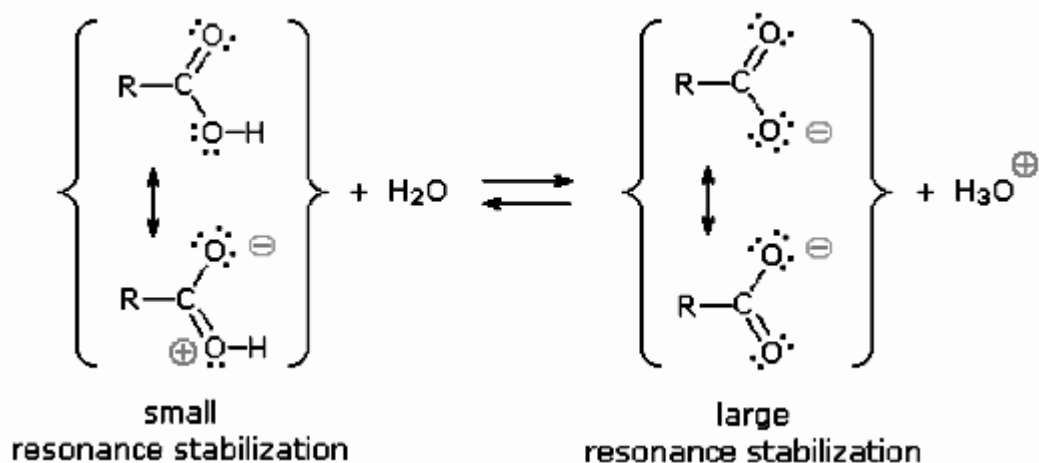


Factor that determine the strength of an acid:

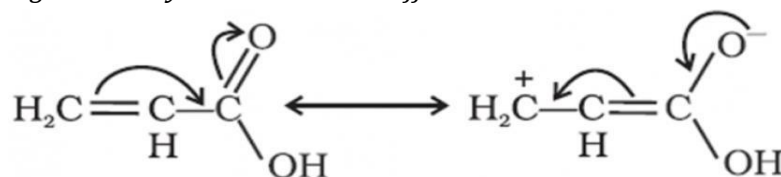
✓ **Resonance Stabilization:**



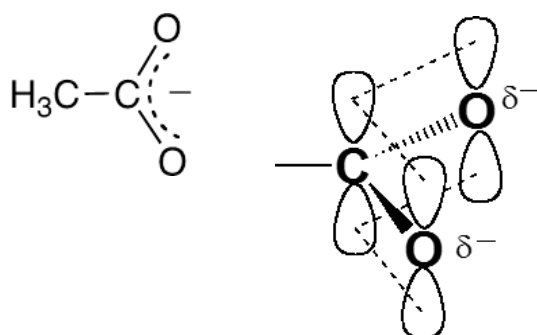
- The Ethanoate ion strongly stabilized by two equivalent resonance structures.
- Both the carboxyl group and the carboxylate anion are stabilized by resonance, but the stabilization of the anion is much greater than that of the neutral function. In the carboxylate anion the two contributing structures have equal weight in the hybrid, and the C-O bonds are of equal length (between a double and a single bond). This stabilization leads to a markedly increased acidity.



- Due to the resonance effect, phenyl or vinyl groups too, increase the acidity of carboxylic acids in spite of decreasing the acidity due to induction effect.



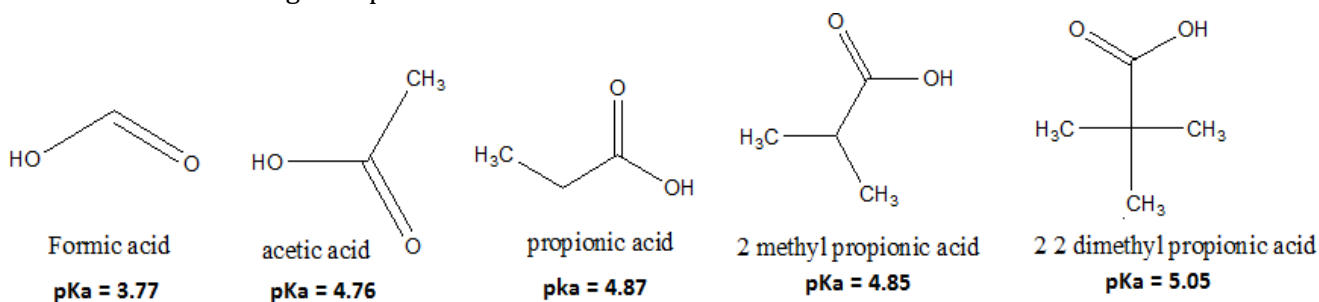
- Resonance stabilization of the carboxylate ion



4  $\pi$ -electrons delocalized over three p-orbitals,  
C-O bond lengths of a carboxylates are the same

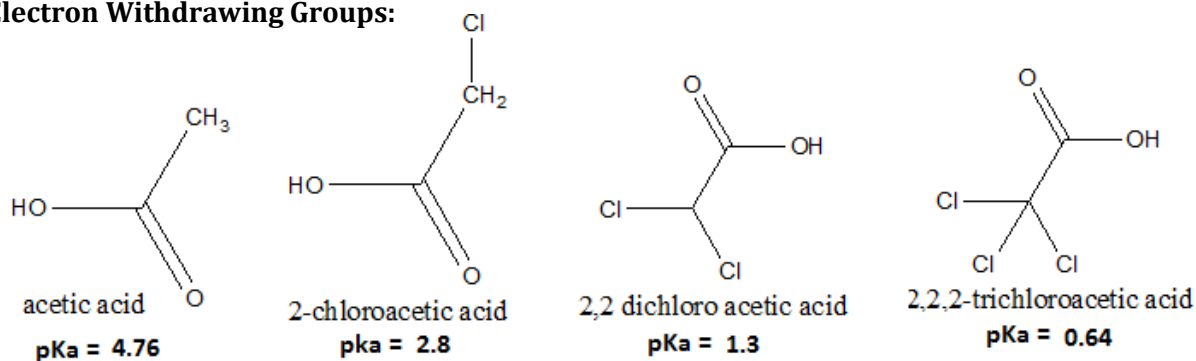


✓ Electron Donating Groups:

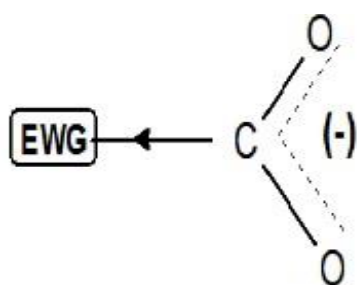


- Alkyl groups are electron donating. They tend to "push" electron away from themselves. This increase the electron density in the O-H bond. The H-atom is more strongly attached to the O-atom. It is less likely to leave. So the acid is weaker.

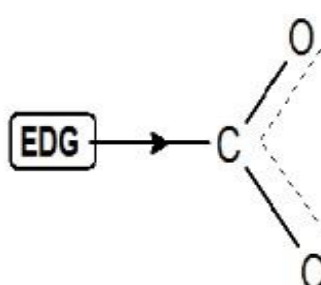
✓ Electron Withdrawing Groups:



- Electron withdrawing groups increase the acidity of an organic acid.
- An electronegative atom like Cl-atom can pull electron density towards itself. This decrease the electron density in the O-H bond. The H-atom is less strongly attracted to the O-atom. It is more likely to leave, so the acid is stronger.
- The more Cl-atom attach, the stronger the acid becomes.



Electron withdrawing group stabilises the carboxylate ion by dispersing the negative charge and hence increases the acidity of the carboxylic acid



EDG destabilises the carboxylate ion by intensifying the negative charge and hence decreases the acidity of the carboxylic acid

✓ Atomic radius affect the strength of an acid:

- Greater the atomic radius, stronger is the acid.
- If the distance between the two nucleuses is more less is the attractive forces between the nucleus and the electrons of the other atom.
- Less the attractive force, less stronger is the bond and if this bond is with the hydrogen then hydrogen is held with less strength, so it can be removed easily.



## What are pK<sub>a</sub> and pK<sub>b</sub> in acids and bases?

pK<sub>a</sub> and pK<sub>b</sub> are measures of the strengths of acids and bases, respectively

### Acids

When you dissolve an acid in water, it undergoes an equilibrium reaction with the water in an.



The value of the equilibrium constant is given by

$$K_a = \frac{[\text{H}_3\text{O}^+][\text{A}^-]}{\text{HA}}$$

The greater the value of K<sub>a</sub>, the stronger the acid.

For most weak acids, K<sub>a</sub> ranges from 10<sup>-2</sup> to 10<sup>-14</sup>.

We convert these exponential numbers into a normal range by taking their negative logarithm.

The operator p means "take the negative logarithm of".

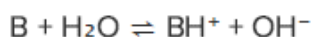
$$\text{So } \text{p}K_a = -\log K_a.$$

For most weak acids, pK<sub>a</sub> ranges from 2 to 14.

Thus, **the smaller the value of pK<sub>a</sub>, the stronger the acid.**

### Bases

When you dissolve a base in water, it reacts with the water in an equilibrium reaction.



The value of the equilibrium constant is given by

$$K_b = \frac{[\text{BH}^+][\text{OH}^-]}{\text{B}}$$

The greater the value of K<sub>b</sub>, the stronger the base.

For most weak acids, K<sub>b</sub> ranges from 10<sup>-2</sup> to 10<sup>-13</sup>.

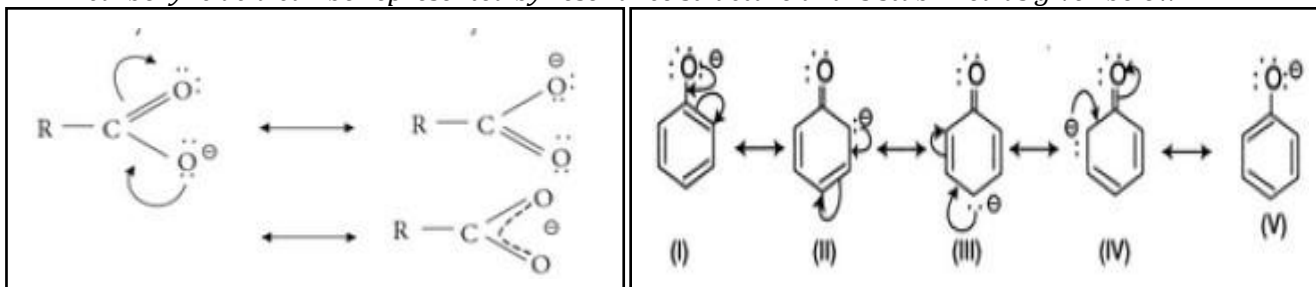
$$\text{p}K_b = -\log K_b.$$

For most weak acids, pK<sub>a</sub> ranges from 2 to 13.

**The smaller the value of pK<sub>b</sub>, the stronger the base.**

➤ Why are carboxylic acids more acidic than phenol?

- A carboxylic acid can be represented by resonance structure and is stabilized as given below



Resonance structure of carboxylate ion.

Resonance structure of phenoxide ion

- A carboxylate anion is more stabilized by resonance. Though phenoxide ion is resonance stabilized its stability is less compared to a carboxylate ion. This is because a carboxylate ion has two equivalent structures, which are equally favoured when compared to the five resonance structure of phenoxide ion (refer the resonating structures as mentioned above), all of which are not equivalent. The **pKa** of carboxylic acid for example acetic acid is **4.5** whereas phenol has **pKa** of 9.9, which shows that a carboxylic acid is stronger acid than phenol.

OR

- Carboxylate ion has equivalent resonance structures hence more stable than phenolate ion so it is more acidic.

OR

- The "equivalent resonance structures" of carboxylate ion is an important In the resonance structures of carboxylate ion, the negative charge is on oxygen but in phenoxide ion, the negative charge is present on carbon (in 3 out of 4 structures). Thus carboxylate ion is more stable than phenoxide ion. Thus carboxylic acids are more acidic than phenols.

**Two main electronic effects:**

**RESONANCE** effects are those that occur through the  $\pi$  system and can be represented by resonance structures. These can be either electron donating (e.g. -OCH<sub>3</sub>) where  $\pi$  electrons are pushed toward the arene or electron withdrawing (e.g. C=O) where  $\pi$  electrons are drawn away from the arene.

**INDUCTIVE** effects are those that occur through the  $\sigma$  system due to electronegativity type effects. These too can be either electron donating (e.g. -CH<sub>3</sub>) where  $\sigma$  electrons are pushed toward the arene or electron withdrawing (e.g. -CF<sub>3</sub>, +NR<sub>3</sub>) where  $\sigma$  electrons are drawn away from the arene.



**DIFFERENCE BETWEEN ALLOTROPES AND ISOMERS**

- Both **allotropy** and **isomerism** were concepts proposed by the Swedish scientist SIR. JÖNS JAKOB BERZELIUS. He proposed the concept of allotropy in 1841.
- **Isomerism** was first noticed in 1827, when SIR. FRIEDRICH WOehler

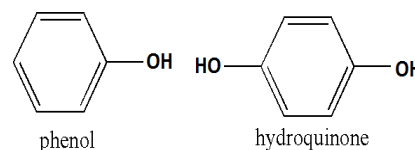
**ALLOTROPES**

- Allotropes are different structural modifications of an element.
- Which the element's atoms are bonded together in a different manner.
- For example, dioxygen (O<sub>2</sub>), ozone (O<sub>3</sub>), tetraoxygen (O<sub>4</sub>) and octaoxygen (O<sub>8</sub>) are allotropes of oxygen.
- Carbon whose allotropes include graphite and diamond.

**ISOMERS**

- Isomers are chemical compounds that share the same molecular formula but have different structural formulae.
- Isomers are compounds that share the same molecular formula but have different structural formulas.
- Isomers do not share their chemical properties unless they belong to the same functional group. For example, propanol has the formula C<sub>3</sub>H<sub>8</sub>O (or C<sub>3</sub>H<sub>7</sub>OH) and occurs as two isomers: propan-1-ol (n-propyl alcohol; I) and propan-2-ol (isopropyl alcohol; II).

**Question:** WHY IS HYDROQUINONE MORE ACIDIC THAN PHENOL?



**Answer:**

- Hydroquinone in its enol form will have a conjugated system between two Oxygen atoms at para position.
- In this form as hydroquinone loses H<sup>+</sup> to form conjugate base, the O- will resonate between two Oxygen compared to only one Oxygen in Phenolate ion (Conjugate Base of Phenol)
- Since, the stability of Conjugate Base of hydroquinone is greater than phenol, due to above stated reason, hydroquinone will lose H<sup>+</sup> more readily, and form its CB, thus greater acidic strength.

**Question:** CARBOXYLIC ACIDS DO NOT GIVE CHARACTERISTIC REACTION OF CARBONYL GROUP

**Answer:**

- The carbonyl carbon in ketones and aldehydes is more electrophilic than in carboxylic acids. This is because the lone pairs on oxygen atom attached to hydrogen atom in the -COOH group are involved in resonance thereby making the carbon atom less electrophilic.
- Hence, carboxylic acids do not give characteristic reaction of carbonyl group.

**Question:** Explain why reducing property among carboxylic acids, formic acid (Methanoic acid) is the only acid that acts as reducing agent. It reduces, acidified KMnO<sub>4</sub> to MnSO<sub>4</sub>, HgCl<sub>2</sub> to Hg, Tollen's reagent to silver mirror and Fehling's solution to red ppt. and itself gets oxidised to CO<sub>2</sub> and H<sub>2</sub>O.

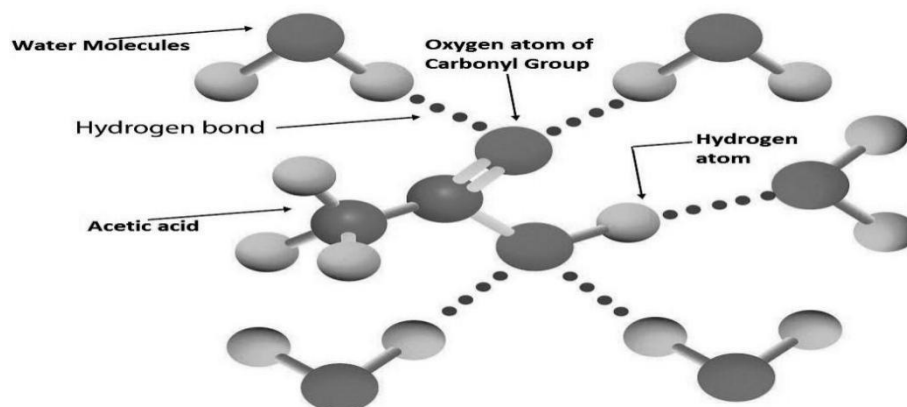
**Answer:**

- Methanoic acid is H-CO-OH. Although the -CO-OH side makes it a carboxylic acid, it has a little bit of aldehyde character from the H-CO side. As such, it can further be oxidized. As such, it can further be oxidized.



## 2. SOLUBILITY & APPEARANCE OF CARBOXYLIC ACID

- Many carboxylic acids are colorless liquids with disagreeable odours. The carboxylic acids with 5 to 10 carbon atoms all have "goaty" odours.
- These acids are also produced by the action of skin bacteria on human sebum (skin oils), which accounts for the odour of poorly ventilated locker rooms.
- The acids with more than 10 carbon atoms are wax like solids, and their odour diminishes with increasing molar mass and resultant decreasing volatility.
- Carboxylic acids exhibit strong hydrogen bonding between molecules. They therefore have high boiling points compared to other substances of comparable molar mass.
- The carboxyl group readily engages in hydrogen bonding with water molecules. The acids with one to four carbon atoms are completely miscible with water. Solubility decreases as the carbon chain length increases because dipole forces become less important and dispersion forces become more predominant.
- The solubility of the bigger acids decreases very rapidly with size. This is because the longer **hydrocarbon "tails"** of the molecules get between water molecules and break hydrogen bonds. In this case, these broken hydrogen bonds are only replaced by much weaker van der Waals dispersion forces.
- **Hexanoic acid** [CH<sub>3</sub>(CH<sub>2</sub>)<sub>4</sub>COOH] is barely (narrowly) soluble in water (about 1.0 g/100 g of water).
- **Palmitic acid** [CH<sub>3</sub>(CH<sub>2</sub>)<sub>14</sub>COOH], with its large nonpolar hydrocarbon component, is essentially insoluble in water.



- The carboxylic acids generally are soluble in such organic solvents as ethanol, toluene, and diethyl ether.

Condensed Structural Formula	Name of Acid	Melting Point (°C)	Boiling Point (°C)	Solubility (g/100 g of Water)
HCOOH	formic acid	8	100	miscible
CH <sub>3</sub> COOH	acetic acid	17	118	miscible
CH <sub>3</sub> CH <sub>2</sub> COOH	propionic acid	-22	141	miscible
CH <sub>3</sub> (CH <sub>2</sub> ) <sub>2</sub> COOH	butyric acid	-5	163	miscible
CH <sub>3</sub> (CH <sub>2</sub> ) <sub>3</sub> COOH	valeric acid	-35	187	5
CH <sub>3</sub> (CH <sub>2</sub> ) <sub>4</sub> COOH	caproic acid	-3	205	1.1
C <sub>6</sub> H <sub>5</sub> COOH	benzoic acid	122	249	0.29

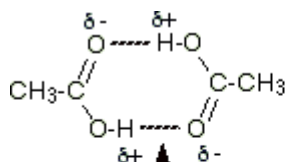
- The energetics of dissolving carboxylic acids in water is made more complicated because some of the acid molecules actually react with the water rather than just dissolving in it.





## 2. BOILING POINTS OF CARBOXYLIC ACID

- The boiling points of alcohols are higher than those of alkanes of similar size because the alcohols can form **hydrogen bonds** with each other as well as **van der Waals dispersion forces** and **dipole-dipole interactions**.
- Similarly the boiling points of the carboxylic acids are still caused by hydrogen bonding, but operating in a different way.
- In a pure carboxylic acid, hydrogen bonding can occur between two molecules of acid to produce a dimer.



Hydrogen bond between the fairly positive hydrogen atom and a lone pair on the fairly negative oxygen atom.

- This immediately doubles the size of the molecule and so increases the van der Waals dispersion forces between one of these dimers and its neighbours - resulting in a high boiling point.

**Question:** WHY DOES CARBOXYLIC ACID HAVE A HIGHER BOILING POINT THAN ALCOHOL?

**Answer:**

- Carboxylic acids exhibit stronger inter molecular hydrogen bonding as compared to alcohols of comparable masses. The **inter molecular** hydrogen bonds of carboxylic acids do not break down easily giving them a higher boiling point.

**OR**

- The Carboxylic group (-COOH) is stabilized through resonance. The double bond can lie on either of the oxygens, and that stabilizes the molecule. More stable molecules have higher boiling points (and melting points). Alcohols, ketones, and aldehydes do not have resonance to stabilize them, so their boiling points are much lower.

**OR**

- carboxylic acids with the presence of -COOH groups are capable of hydrogen bonding between molecules and more energy is necessary to overcome this additional intermolecular bonding, hence, the melting and boiling points for carboxylic acids are generally higher.

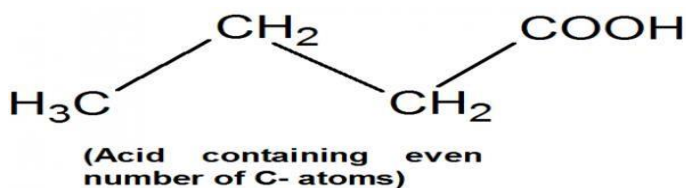
**OR**

- Carboxylic acids have stronger bonds/ van der Waals forces between them thus it takes a much higher amount of heat to break the forces thus the higher melting and boiling points

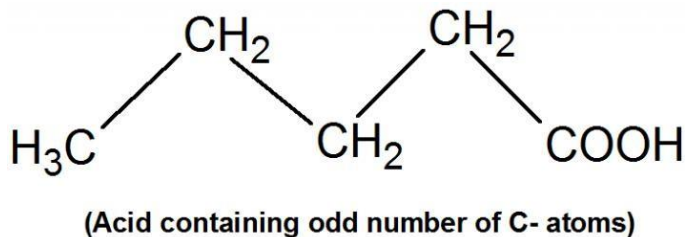


### 3. MELTING POINTS OF CARBOXYLIC ACID

- In the first ten members of the homologous series, the 'alternation effect' is observed.
- The effect implies that the melting point of an acid with even number of carbon atoms is higher than with odd number of carbon atoms above whereas no such effect is observed in homologues with more than ten carbons.
- The alternation effect is due to the fact that in the carboxylic acids with **even number of carbon atoms**, the **terminal methyl group** and **carboxylic group** are on the opposite side of the **zig-zag carbon chain**. Hence they fit better in the crystal lattice and it results in stronger intermolecular forces.



- On the other hand, in acids with **odd number of C-atoms**, the **carboxyl and terminal methyl groups** are on the same side of the carbon chain. Hence the molecules fit poorly in the crystal lattice, because of their being relatively unsymmetrical. So the intermolecular forces are weak and the melting points are relatively lower.



**Question:** WHAT IS GLACIAL ACETIC ACID

**Answer:**

- Glacial acetic acid is the pure form of vinegar. The chemical formula is  $\text{CH}_3\text{COOH}$ . The adjective glacial means that acetic acid will be frozen if put it in a refrigerator.
- Glacial acetic acid is completely pure acetic acid and represents the solid state of acetic acid. Below **16.6°C** temperature pure acetic acid is converted into ice like solid hence it is called **glacial acetic acid**.



**Question:** WHAT IS HYDROGEN BONDING?

**Answer:**

- Hydrogen bonding is a really interesting phenomenon. It can drastically change the physical properties of any substances.
- A hydrogen bond is the attractive force between the hydrogen attached to an electronegative atom of one molecule and an electronegative atom of a different molecule. Usually the electronegative atom is oxygen, nitrogen, or fluorine, which has a partial negative charge.
- Hydrogen bond is not an actual chemical bond in true sense. It's an attraction between two unlike poles. Hence, it is a dipole-dipole interaction.
- Hydrogen bonds can vary in strength from very weak (1–2 kJ mol<sup>-1</sup>) to extremely strong (161.5 kJ mol<sup>-1</sup> in the ion HF<sub>2</sub><sup>-</sup>).

Hydrogen bonding	Bond strength
F–H...:F	161.5 kJ/mol
O–H...:N	29 kJ/mol
O–H...:O	21 kJ/mol
N–H...:N	13 kJ/mol
N–H...:O	8 kJ/mol

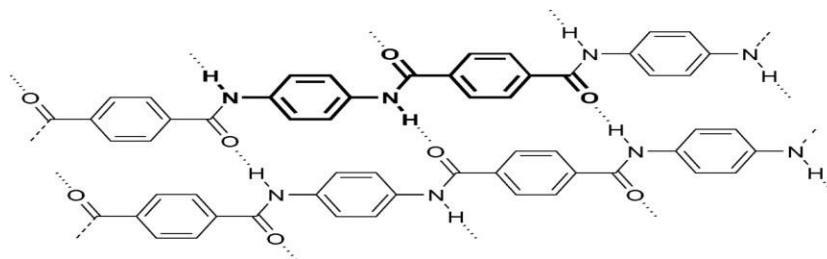
- The length of hydrogen bonds depends on bond strength, temperature, and pressure. The bond strength itself is dependent on temperature, pressure, bond angle, and environment (usually dielectric constant). **The typical length of a hydrogen bond in water is 197 pm.**

[Picometers (pm) are now preferred (1Å = 10<sup>-8</sup> cm = 100 pm.)]

- **The following hydrogen bond angles**

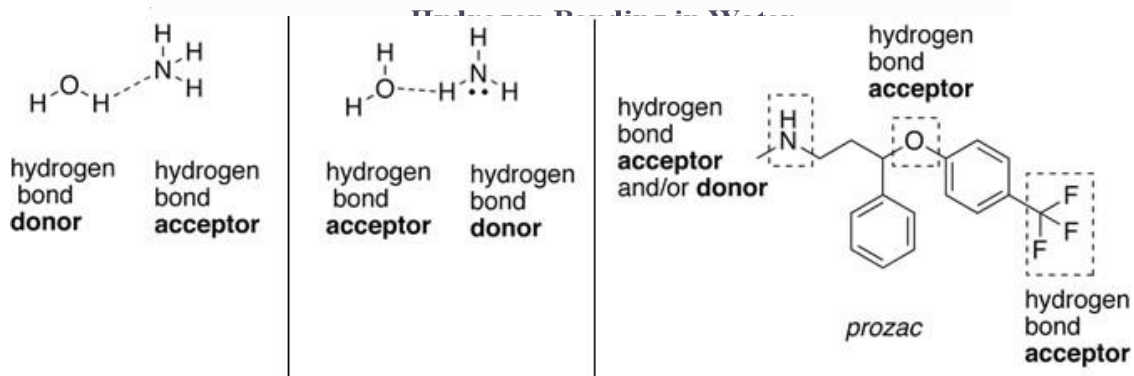
Acceptor...donor	Geometry	Angle (°)
HCN...HF	linear	180
H <sub>2</sub> CO...HF	trigonal planar	120
H <sub>2</sub> O...HF	pyramidal	46
H <sub>2</sub> S...HF	pyramidal	89
SO <sub>2</sub> ...HF	trigonal	142

- Many polymers are strengthened by hydrogen bonds in their main chains. Among the synthetic polymers, the best known example is nylon, where hydrogen bonds occur in the repeat unit and play a major role in crystallization of the material. The bonds occur between carbonyl and amine groups in the amide repeat unit. They effectively link adjacent chains to create crystals, which help reinforce the material. The effect is greatest in **aramid fiber**, where hydrogen bonds stabilize the linear chains laterally.

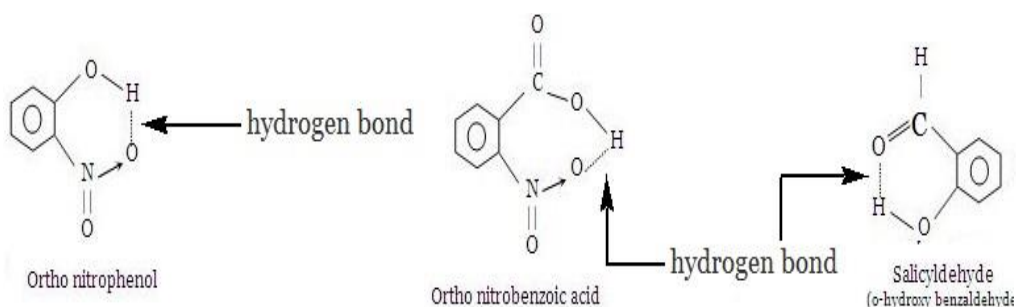


**Aramid fibers** (heat-resistant and strong synthetic fibers).

- There are two types
  1. Intermolecular hydrogen bond
  2. Intramolecular hydrogen bond.
- ✓ When the hydrogen bond is present between two atoms of two different molecules, then it is known **intermolecular hydrogen bond**.



- ✓ When the hydrogen bond is present between two atoms of the same molecule, then it is known as **intramolecular hydrogen bond**.



**Question:** SIMILARITIES AND DISSIMILARITIES BETWEEN "C=C" & "C=O" BONDS

**Answer:**

**Similarities:**

1. Both consist of a  $\sigma$  bond and a  $\pi$  bond.
2. C atom is  $sp^2$  hybridised in both.
3. Both have planar structures.
4. Both undergo addition reactions.

**Differences:**

1. C=O bond is polar while C=C bond is non-polar.
2. Their bond lengths are different. Due to the small size of oxygen as compared to carbon, C=O is shorter (123 pm) than C=C (134 pm).
3. C=O gives nucleophilic additions while C=C gives electrophilic additions generally.
4. Geometrical isomerism is possible in C=C bond but it is not possible in C=O bond

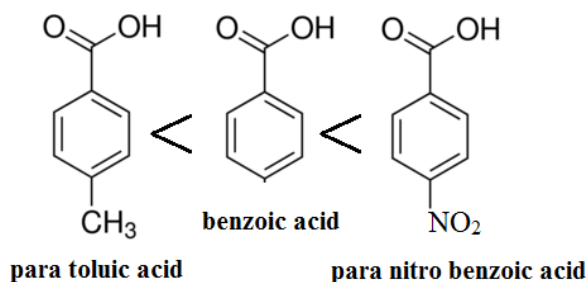
### Question: ACID STRENGTH OF SUBSTITUTED BENZOIC ACID

#### Answer:

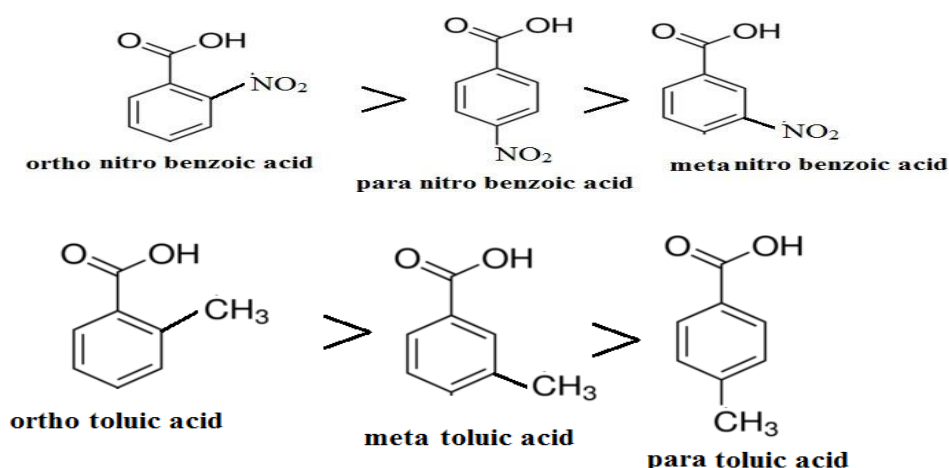
- The acid strength is also depending on Hybridization Effect.
- $sp^2$ -hybridized carbon is more electron withdrawing than  $sp^3$ , and  $sp$  is more electron-withdrawing than  $sp^2$ .

	$K_a$	$pK_a$
	$6.3 \times 10^{-5}$	4.2
$H_2C=CH-COOH$	$5.5 \times 10^{-5}$	4.3
$HC\equiv C-COOH$	$1.4 \times 10^{-2}$	1.8

- The presence of electron-withdrawing group at the para-position then acidic character increase, whereas electron releasing groups at para position then decrease the acidic strength.
- As for example *para toluic acid* is weaker acid while *para nitro benzoic acid* is stronger than *benzoic acid*.



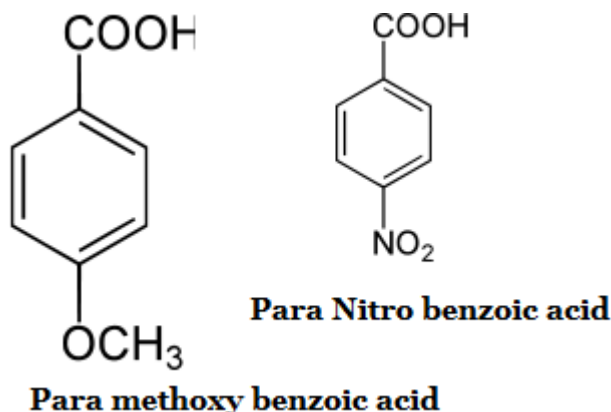
- The acid strength of *Ortho-Substitute* benzoic acid is always more than benzoic acid weather the group is *electron- withdrawing* or *electron releasing*, this is called as ORTHO EFFECT.



**ORTHO EFFECT:** While all substituents on aryl rings can influence acidity by inductive and mesomeric effects, *substituents on the ortho position are special*. They can also influence acidity significantly by sterics, forcing the carboxylic acid group to bend out of the plane of the benzene ring. Since conjugation of carboxylic acid to aryl rings is known to increase its acidity

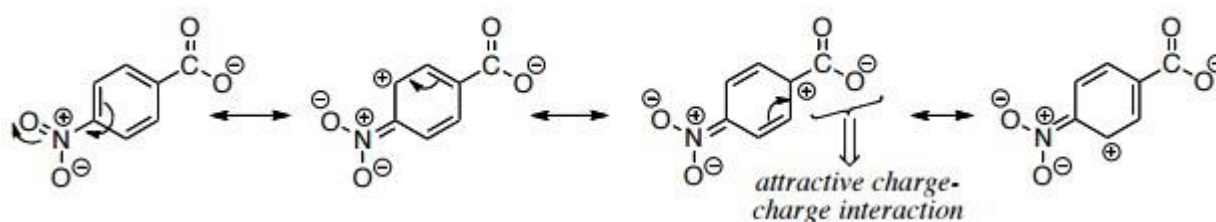
It is different for acid as well as base.

**For Acid** - Ortho substituted carboxylic acid is strong acid than the benzoic acid, due to steric hindrance effect by Ortho substituent. **For Base**- Ortho substituted aniline is always weak base than Aniline.



- Comparing the acidic strength, the nitro-substituted group is definitely more acidic. This can be reasoned by fact that a higher delta positive charge which develops on the H due to the strong **-M** nature of the nitro group. Another way to check the acidity is to check the stability of the conjugate base.
- The conjugate base would be the carboxylate ion which being a **-M** group creates a lesser electron density at the ortho and para positions. This positive charge is however stabilised by the methoxy group, which is a **+M** group, and destabilised by the nitro group. So from this viewpoint, the methoxy derivative should have been more acidic.
- Electron-withdrawing groups like **p-NO<sub>2</sub>** (nitro group in the para position) increase acidity by making the carboxylate ion stable relative to the protonated form. However, electron-donating groups like **p-methoxy** decrease acidity relative to standard benzoic acid by destabilizing the (already negatively charged) carboxylate anion!
- An electron-withdrawing group like **p-NO<sub>2</sub>** will better stabilize the negatively charged **-COO** group than an electron-donating group like **p-OCH<sub>3</sub>**.

**Resonance structures of the conjugate base of 4-nitrobenzoic acid:**

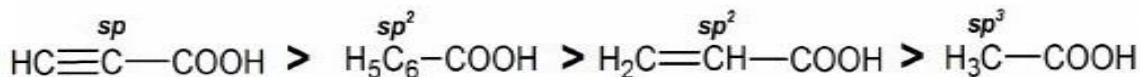




**Question:** WHAT IS THE EFFECT OF THE TYPE OF HYBRIDISATION OF CARBON ATOM CARRYING -COOH GROUP?

**Answer:**

- The acidity increases as the electronegativity of the carbon chain directly attached to -COOH group or the hybridisation of the carbon atom directly attached to -COOH changes the acidic character.

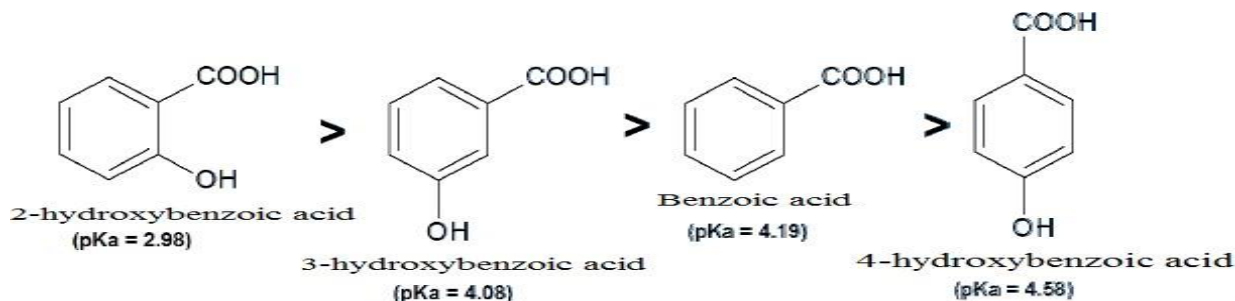


- Benzoic acid (pK = 4.19) is stronger than acetic acid (pK = 4.25). It is because the double bond of a benzene ring is less electron donating since this delocalisation destroys the aromatic character of the benzene ring.
- In benzoic acid, the -COOH group is attached to a sp hybridised carbon. In acetic acid, the -COOH group is linked to a sp hybridised carbon. Hence benzoic acid is stronger than acetic acid. As HCOOH does not contain any alkyl group, it is a stronger (pK = 2.75) than benzoic acid. Thus, **HCOOH > C<sub>6</sub>H<sub>5</sub>COOH > CH<sub>3</sub>COOH** gives the order of the relative strengths of the three acids.

**Question:** EXPLAIN THE RELATIVE ACID STRENGTHS OF HYDROXYBENZOIC ACIDS.

**Answer:**

- The -OH group has both electron donating resonance effect (i.e. **+R effect**) as well as electron withdrawing inductive effect (i.e. **-I effect**). A *meta* OH group cannot exert its **+R effect** but can exert only -I effect from this position. Hence, *meta*-hydroxybenzoic acid is stronger than benzoic acid. But *para*-hydroxybenzoic acid is weaker than benzoic acid due to **+R effect** of the -OH group.



**Question:** ARE ACIDS OXIDISING AGENTS OR REDUCING AGENTS?

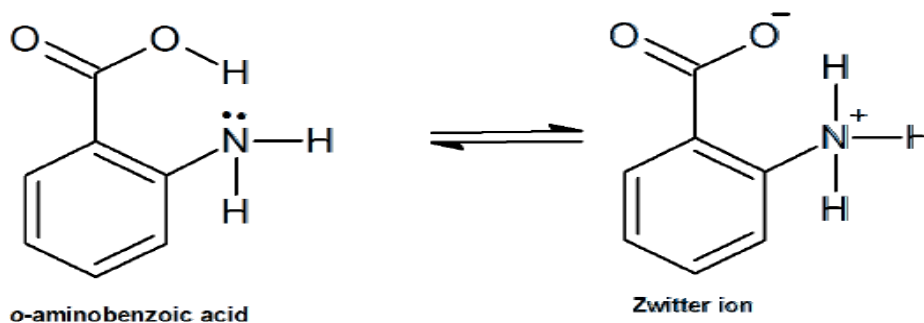
**Answer:**

- It depends on the oxidation state of the concerned nonmetal that forms the particular acid.
- Hydrides like **HBr, HI, H<sub>2</sub>S** are powerful reducing agents. **HCl** is only a mild reducing agent. In these acids, the concerned **nonmetals (Cl, Br, I and S)** are in the lowest possible (negative) oxidation states.
- When an oxyacid has its central nonmetal in a higher oxidation state, it acts as an oxidising agent. Common examples are **nitric acid (HNO<sub>3</sub>), sulphuric acid (conc.H<sub>2</sub>SO<sub>4</sub>) and perchloric acid (HClO<sub>4</sub>)**.
- **Nitric acid** is a powerful oxidising agent both in its dilute and concentrated versions, but dilute sulphuric acid is mostly non-oxidising.
- **Nitrous acid (HNO<sub>2</sub>)** can act both as an oxidising agent and as a reducing agent, depending on the nature of the substance it encounters. In this oxyacid, nitrogen is in the intermediate state of **+3**, and so it can be reduced or oxidised.
- But, some oxyacids like **sulphurous acid (H<sub>2</sub>SO<sub>3</sub>) and hypophosphorous acid (H<sub>3</sub>PO<sub>2</sub>)** are fairly strong reducing agents. In these acids, the oxidation numbers of the central nonmetals, sulphur and phosphorus, are **+4** and **+1** respectively. Sulphurous acid can also act as an oxidising agent when pitted against powerful reducing agents like **hydrogen sulphide**.

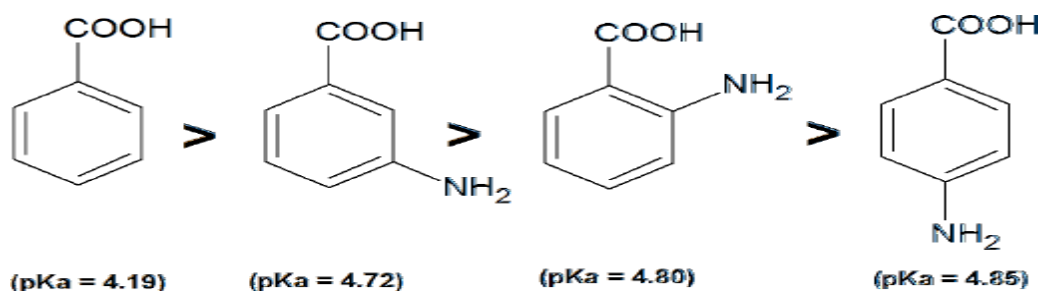
**Question:** EXPLAIN THE RELATIVE ACID STRENGTHS OF AMINO BENZOIC ACIDS.

**Answer:**

- Amino group has a strong **+R effect** and a weak **-I effect**. Since **-NH<sub>2</sub>** group is basic while **-COOH** group is acidic, *ortho*-aminobenzoic acid undergoes **Zwitter ion** formation via **H-bonding**.



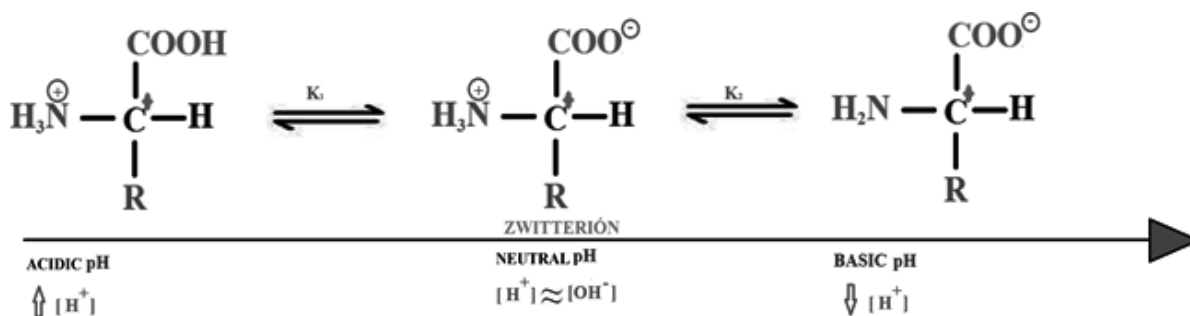
- As a result of this, *ortho* effect is reduced to such an extent that it becomes a weaker acid than benzoic acid and even weaker than *meta*-aminobenzoic acid.
- All amino acids are weaker than benzoic acid because of strong **+R effect**. As **-NH<sub>2</sub> group** cannot exert its **+R effect** from *meta*-position, but can exert only **-I effect**, *meta*-aminobenzoic acid is stronger than the *ortho*- and *para*- isomers.
- The relative strengths of the three aminobenzoic acids relative to benzoic acid are in the order.



**Question:** WHAT IS ZWITTERION?

**Answer:**

- **Zwitterion** (from German *Zwitter*-meaning "*hermaphrodite*"), formerly called a dipolar ion, is a neutral molecule with both positive and negative electrical charges. (In some cases multiple positive and negative charges may be present.)
- **Zwitterions** are distinct from molecules that have dipoles at different locations within the molecule. Zwitterions are sometimes called inner salts.



*Hermaphrodite* is an organism that has reproductive organs normally associated with both male and female sexes





## Qualitative tests for Carboxylic Acids and Amide

### • Test for Carboxylic Acids

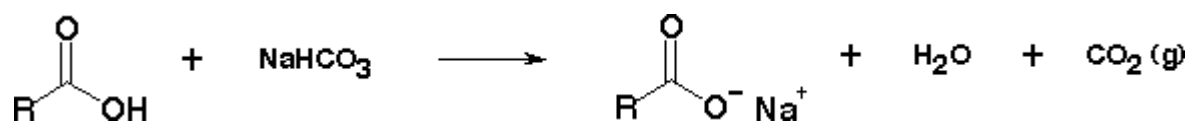
#### - Procedure

- A few drops or a few crystals of the unknown sample are dissolved in 1mL of methanol and slowly added to 1 mL of a saturated solution of sodium bicarbonate.

#### - Positive Test

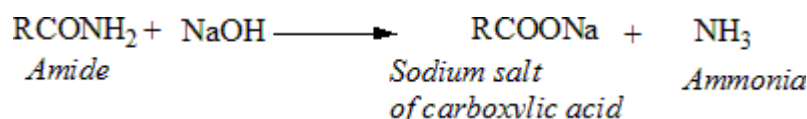
- Evolution of a carbon dioxide gas is a positive test for the presence of the carboxylic acid and certain phenols listed in the Complications section.

#### - Reaction

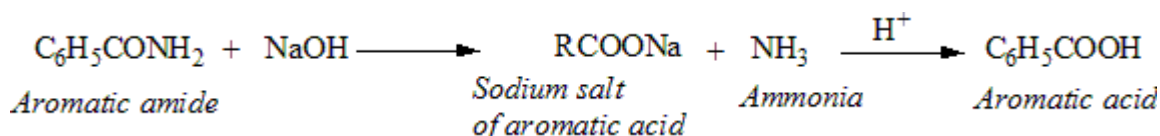


### • Test for Amides

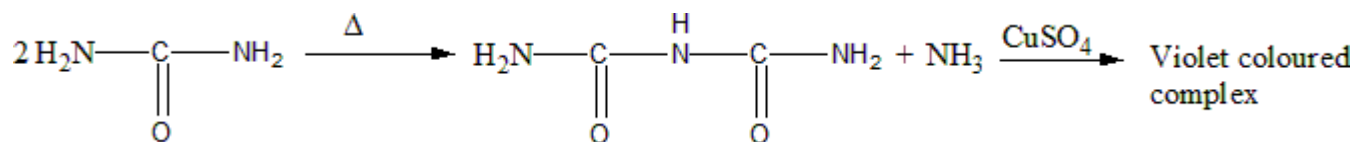
- ✓ **Reaction of NaOH:** Amides are decomposed by NaOH to evolve ammonia. The gas can be tested by a moist red litmus paper which is then turned blue.



- ✓ **Alkaline hydrolysis of aromatic amides to aromatic acid:** The soluble sodium salt of aromatic acid formed from aromatic amides upon hydrolysis is regenerated as white precipitate in acidic medium.

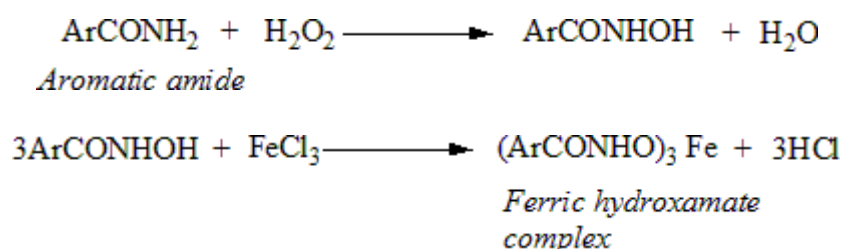


- ✓ **Biuret Reaction for aliphatic diamide:** When aliphatic diamide is heated at a temperature above its melting point, ammonia is evolved and crystalline biuret is formed. This biuret in alkaline medium gives a violet colour with a drop of copper sulphate solution.

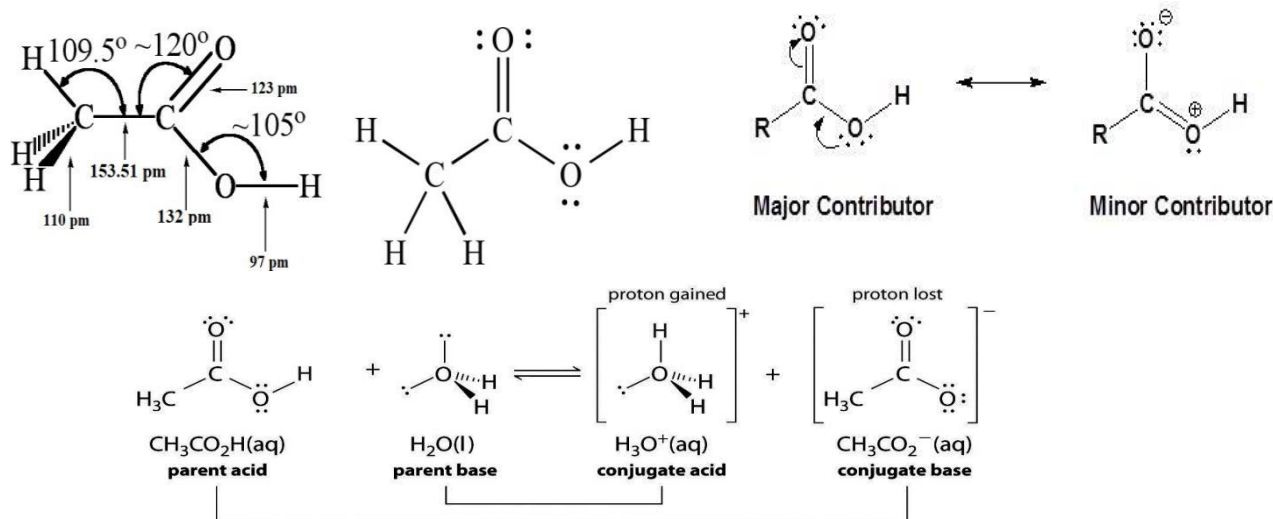


Biuret reaction

- ✓ **Hydroxamic acid test for aromatic primary amides:** Hydrogen peroxide reacts with aromatic primary amides to form the hydroxamic acid, which then reacts with ferric chloride to form ferric hydroxamate complex having a violet colour.



## ❖ Structure and uses of Acetic Acid



- Acetic acid is a colourless liquid organic compound with the chemical formula  $\text{CH}_3\text{COOH}$  or  $\text{CH}_3\text{CO}_2\text{H}$  or  $\text{C}_2\text{H}_4\text{O}_2$ .
- When undiluted, it is sometimes called glacial acetic acid.
- Vinegar is roughly 3–9% acetic acid by volume, making acetic acid the main component of vinegar apart from water. Acetic acid has a distinctive sour taste and pungent smell. In addition to household vinegar.

<i>IUPAC name</i>	Acetic acid
<i>Other names</i>	Ethanoic acid; Vinegar (when dilute); Hydrogen acetate; Methane carboxylic acid
<i>Chemical formula</i>	$\text{C}_2\text{H}_4\text{O}_2$
<i>Molar mass</i>	$60.05 \text{ g}\cdot\text{mol}^{-1}$
<i>Appearance</i>	Colourless liquid
<i>Odor</i>	Pungent/Vinegar-like
<i>Density</i>	$1.049 \text{ g cm}^{-3}$
<i>Boiling point</i>	118 to 119 °C
<i>Solubility in water</i>	Miscible
<i>Acidity (pKa)</i>	4.76

### • Uses

- Industrial chemical, used primarily in the production of cellulose acetate for photographic film, polyvinyl acetate for wood glue, and synthetic fibres and fabrics.
- The major esters of acetic acid are commonly used as solvents for inks, paints and coatings.
- In households, diluted acetic acid is often used in descaling agents.
- In the food industry, acetic acid is used as food additive.
- *Medicinal Uses:*
  - Acetic acid injection into the tumor has been used to treat cancer since the 1800s.
  - While diluted acetic acid is used in Iontophoresis.
  - As a treatment for otitis externa.
  - It is an effective antiseptic when used as a 1% solution, with broad spectrum of activity against streptococci, staphylococci, pseudomonas, enterococci etc.

#### Note By:

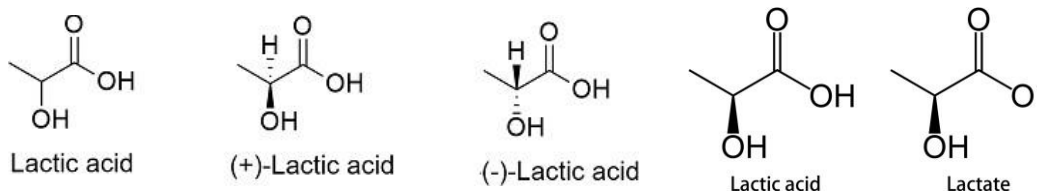
**Iontophoresis** is a process of transdermal drug delivery by use of a voltage gradient on the skin.

**Otitis externa**, also called swimmer's ear, is inflammation of the ear canal.



## ❖ Structure and uses of Lactic Acid

- Lactic acid is an organic compound with the formula  $\text{CH}_3\text{CH}(\text{OH})\text{COOH}$ .
- In its solid state, it is white and water-soluble. In its liquid state, it is colorless. It is produced both naturally and synthetically. With a hydroxyl group adjacent to the carboxyl group, lactic acid is classified as an alpha-hydroxy acid (AHA). In the form of its conjugate base called lactate, it plays a role in several biochemical processes.



<i>IUPAC name</i>	2-Hydroxypropanoic acid
<i>Other names</i>	Milk acid
<i>Chemical formula</i>	$\text{C}_3\text{H}_6\text{O}_3$
<i>Molar mass</i>	$90.08 \text{ g}\cdot\text{mol}^{-1}$
<i>Appearance</i>	Colourless crystalline in nature
<i>Melting point</i>	$53^\circ\text{C}$
<i>Solubility in water</i>	Soluble
<i>Acidity (pKa)</i>	3.86

### • Uses

#### - **In Pharmaceutical and cosmetic:**

- Lactic acid is also employed in pharmaceutical technology to produce water-soluble lactates from otherwise-insoluble active ingredients.
- It is used in topical preparations and cosmetics to adjust acidity and for its disinfectant and keratolytic properties.
- It is also used as a buffer.

#### - **In Food uses**

- Lactic acid can be used in meat, poultry and fish in the form of sodium or potassium lactate to extend shelf life, control pathogenic bacteria.
- Because of its mild taste, lactic acid is used as an acidity regulator in beverages such as soft drinks and fruit juices.
- Lactic acid is effective in preventing the spoilage of olives, gherkins, pearl onions and other vegetables preserved in brine.
- Lactic acid may be also used as a preservative in salads and dressings, resulting in products with a milder flavour while maintaining microbial stability and safety.

#### - **In Detergents**

- It is a good descaler, soap-scum remover, and a registered anti-bacterial agent.

#### - **In Mosquito lure**

- Lactic acid, along with ammonium bicarbonate, is used in the Lurex brand mosquito attractant.

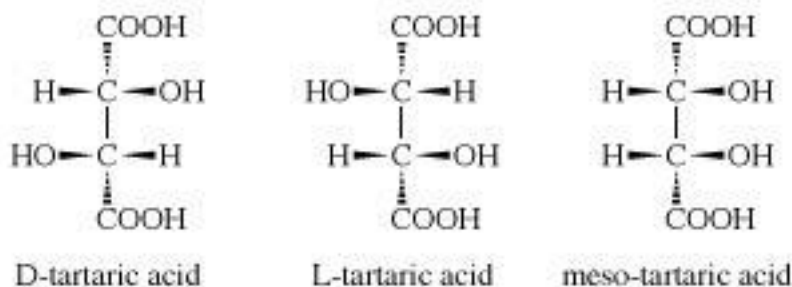
#### Application of various Lactate preparation

<i>Buffered Lactic acid</i>	Hard/soft candy
<i>Calcium Lactate</i>	Tooth paste and mouth washes; Chewing gum
<i>Ethyl Lactate</i>	Flavours (straw berry and butter); Pesticide; Hair Care(Shampoo)
<i>Lactic Acid</i>	Wound Dressing; Beer; Ice cream; Gum & jellies; Biscuit/cookies
<i>Zinc Lactate</i>	Oral care(tooth paste and mouth washes)
<i>Sodium/Potassium Lactate</i>	Cakes, breads, rolls; Fresh meat; Pancake bread



## ❖ Structure and uses of Tartaric Acid

- Tartaric acid is a white crystalline organic acid that occurs naturally in many fruits, most notably in grapes, but also in bananas, tamarinds and citrus.
- Its salt, potassium bitartrate, commonly known as cream of tartar.
- It is commonly mixed with sodium bicarbonate and is sold as baking powder used as a leavening agent in food preparation.
- The acid itself is added to foods as an antioxidant and to impart its distinctive sour taste.



<i>IUPAC name</i>	2,3-Dihydroxybutanedioic acid
<i>Other names</i>	Tartaric acid; Threarcic acid; Racemic acid; Uvic acid; Paratartaric acid
<i>Chemical formula</i>	$\text{C}_4\text{H}_6\text{O}_6$ [ $\text{HO}_2\text{CCH}(\text{OH})\text{CH}(\text{OH})\text{CO}_2\text{H}$ ]
<i>Molar mass</i>	$150.087 \text{ g}\cdot\text{mol}^{-1}$
<i>Appearance</i>	white powder
<i>Melting point</i>	171 to 174°C
<i>Solubility in water</i>	Soluble
<i>Acidity (pKa)</i>	2.89

### • Uses

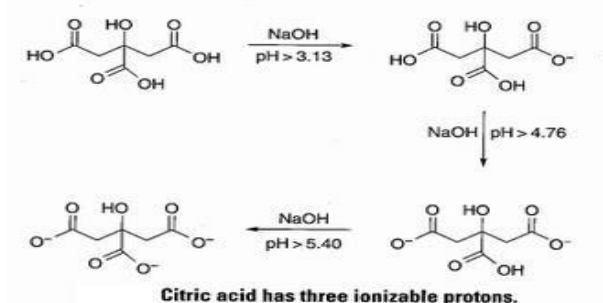
- Tartaric Acid is used for **Antiscorbutic** and **Antiseptic**.
- It has been used in the production of effervescent salts, in combination with citric acid, to improve the taste of oral medications.
- Tartaric acid is a great source of **antioxidants**.
- Another health benefit of tartaric acid is that it aids digestion and fights **flatulence**. It improves intestinal absorption as well which will increase the rate at which healthy nutrients flow into your bloodstream.
- One of the most surprising benefits of tartaric acid is that it significantly improves **glucose intolerance**.
- Salt of Tartaric acid like Potassium sodium tartrate, also known as **Rochelle salt** which is used as **Saline (Osmotic) Cathartics**.

### Note By:

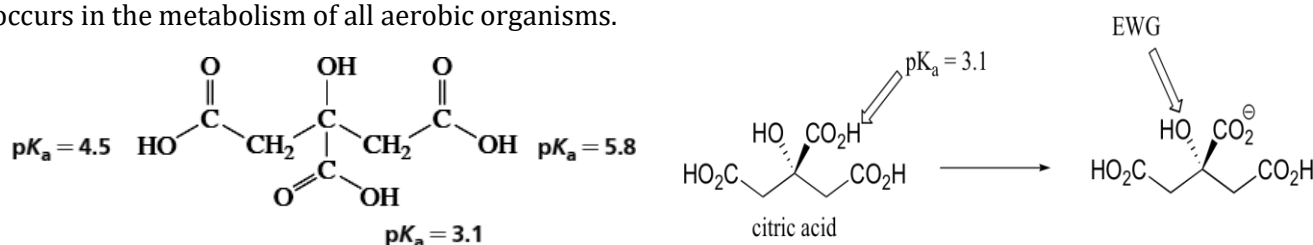
- **Antioxidants:** Substance that inhibits oxidation, especially one used to counteract the deterioration of stored food products.
- **Flatulence:** The accumulation of gas in the alimentary canal.
- **Glucose Intolerance:** It is an umbrella term for metabolic conditions which result in higher than normal blood glucose levels - hyperglycemia.
- **Saline (Osmotic) Cathartics:** The agents that quicken and increase evacuation of bowel.
- **Antiscorbutic:** Drug having the effect of preventing or curing scurvy.
- **An antiseptic:** It is a substance which inhibits the growth and development of microorganisms. It was applied over animate object.

## ❖ Structure and uses of Citric Acid

- Citric acid is a weak organic acid that has the chemical formula  $C_6H_8O_7$ .
- Citric acid is **Polyprotic acids** are capable of donating more than **one proton**.



- It occurs naturally in citrus fruits. In biochemistry, it is an intermediate in the **Citric Acid Cycle**, which occurs in the metabolism of all aerobic organisms.



- In Citric acid the middle acid group that has the lowest pKa. This is because the hydroxyl group also bonded to the middle carbon is electron-withdrawing by induction, and a negative charge associated with a conjugate base will be stabilized to the greatest extent on the middle carboxylate.

<i>IUPAC name</i>	2-Hydroxypropane-1,2,3-tricarboxylic acid
<i>Other names</i>	Citric acid
<i>Chemical formula</i>	$C_6H_8O_7$
<i>Molar mass</i>	192.12 g/mol
<i>Appearance</i>	crystalline white solid
<i>Melting point</i>	156 °C
<i>Solubility</i>	Soluble in Water, alcohol, ether, ethyl acetate, DMSO

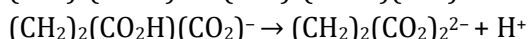
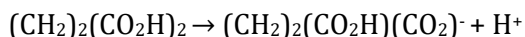
### • Uses

- Citric acid powder is used as a food preservative, added to beverages and pharmaceutical products and To Prevent Sugar Crystallizing
- It has a tangy taste which makes it as a flavouring ingredient for candy and beverages.
- It is also an antioxidant, which makes it a favourable product to be used in skin care products.
- Citric acid is a type of alpha-hydroxy acid (AHA), making it a good agent to remove dead skin cells and exfoliate the skin.
- It is important for producing energy that keeps you active and healthy and is safe for human consumption. Also, its alkaline nature helps to balance the acid levels in the body.
- It is used in the canning process as it helps to maintain a healthy pH balance inside the foods and helps to prevent botulism (a harmful form of food poisoning).
- Citric acid can also be used as a mouth rinse.
- Citric acid combined with other ingredients can make up a very good anti-aging face mask.
- Citric acid has alkalizing properties which help to bind calcium and therefore preventing the formation of kidney stones. It also helps to keep the kidneys in a proper functioning state.

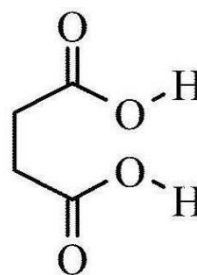


## ❖ Structure and uses of Succinic Acid

- Succinic acid is a dicarboxylic acid with the chemical formula  $(\text{CH}_2)_2(\text{CO}_2\text{H})_2$ .
- The name derives from Latin *succinum*, meaning **amber**.
- Succinate can exit the mitochondrial matrix and function in the cytoplasm as well as the extracellular space, changing gene expression patterns.
- As a diprotic acid, succinic acid undergoes two successive deprotonation reactions and The pKa of these processes are 4.3 and 5.6.



<i>IUPAC name</i>	Butandioic acid
<i>Other names</i>	1,4-Butandioic Acid
<i>Chemical formula</i>	$\text{C}_4\text{H}_6\text{O}_4$
<i>Molar mass</i>	118.09 g/mol
<i>Appearance</i>	crystalline white solid
<i>Melting point</i>	184 °C
<i>Solubility</i>	Soluble in Water, alcohol, glycerol



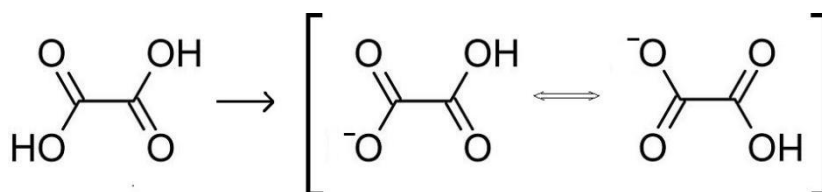
### ● Uses

- Succinic acid regulates *cardiomyocyte*. It means that it's helps the heart pump blood properly. This is good for people suffering from a cardiovascular disorder. Succinic acid has even been known to help prevent heart attacks.
- Succinic acid is used as an acidity regulator and pH regulator in food.
- Succinic Acid can be used as an excipient.
- Succinic Acid can be used as **Masking Buffering** in Cosmetics and personal care products.
- The analgesic properties make succinic acid a great remedy for many ailments. Reducing irritability and preventing menopause, succinic acid has played a key role in healing and providing pain relief.



## ❖ Structure and uses of Oxalic Acid

- Oxalic acid is an organic compound with the formula  $C_2H_2O_4$ . It is a colorless crystalline solid that forms a colorless solution in water. Its condensed formula is  $HOCCOOH$ , reflecting its classification as the simplest dicarboxylic acid.
- Its acid strength is much greater than that of acetic acid.
- Oxalic acid is a reducing agent and its conjugate base, known as oxalate ( $C_2O_4^{2-}$ ), is a chelating agent for metal cations. Typically, oxalic acid occurs as the dihydrate with the formula  $C_2H_2O_4 \cdot 2H_2O$ .



<i>IUPAC name</i>	Ethanedioic acid
<i>Other names</i>	Oxalic acid; Wood bleach
<i>Chemical formula</i>	$C_2H_2O_4$
<i>Molar mass</i>	90.03 g/mol
<i>Appearance</i>	White crystals
<i>Melting point</i>	189 to 191°C
<i>Solubility</i>	Soluble in Water, alcohol, glycerol, Diethyl ether

### • Uses

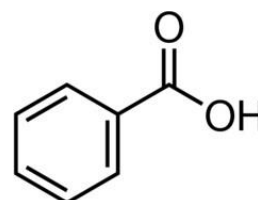
- **As a Cleaning Agent:** The oxalic acid is an ideal chemical for cleaning purposes. Its bleach-like qualities make it perfect for sterilizing household items.
- **For Industrial Uses:** This acid is sometimes used in mineral processing mechanisms. Its bleaching properties can be used to sterilize equipment in a number of corporate environments. Textile mills and factories use it for bleaching in order to color cloths.
- **Other Uses**
  - Aside from bleaching, rust removing, and stain removing, oxalic acid is also used as a reducing agent in developing photographic film.
  - It is also used in wastewater treatment as well since oxalic acid can effectively remove calcium from wastewater.
  - And lastly, oxalic acid is also used as a grinding agent when polishing marble.
- **Medicinal properties:** Organic oxalic acid does not present any problem. In its raw form, it is one of the most important minerals needed in the body to maintain tone and peristalsis of the bowel.
- **Negative effect:** The negative effect of oxalic acid is that it may contribute to kidney stones. Normally, calcium and small amounts of oxalate are present in the urinary tract at the same time, but they remain dissolved and does not cause problems. Apparently, there are times when they bind to form crystals. These crystals can lead to the formation of stones, especially when oxalate is high and urine volume is low.



## ❖ Structure and uses of Benzoic Acid

- Benzoic acid ( $C_6H_5COOH$ ), is a colorless crystalline solid and a simple aromatic carboxylic acid.
- The name is derived from gum benzoin.

<i>IUPAC name</i>	Benzenecarboxylic acid
<i>Other names</i>	Carboxybenzene; Dracrylic acid; Phenylmethanoic acid
<i>Chemical formula</i>	$C_7H_6O_2$
<i>Molar mass</i>	122.12 g/mol
<i>Appearance</i>	Colorless crystalline solid
<i>Melting point</i>	122°C
<i>Solubility</i>	Soluble in Water, alcohol, glycerol, Diethyl ether



### • Uses

#### - Medicinal uses:

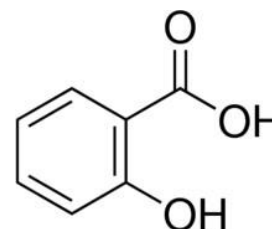
- Benzoic acid is used for the treatment of fungal skin diseases such as tinea, ringworm, and athlete's foot.
- Benzoic acid was used as an expectorant, analgesic, and antiseptic in the early 20th century.

- **Preservatives:** Benzoic acid and its salts are used as food preservatives.

## ❖ Structure and uses of Salicylic Acid

- Salicylic acid is a lipophilic Monohydroxybenzoic acid, a type of phenolic acid, and a beta hydroxy acid (BHA).
- Salicylic acid is a compound obtained from the bark of the **white willow** (*Salix alba* L.; Family: Salicaceae).

<i>IUPAC name</i>	2-Hydroxybenzoic acid
<i>Other names</i>	Salicylic acid
<i>Chemical formula</i>	$C_7H_6O_3$
<i>Molar mass</i>	138.12 g/mol
<i>Appearance</i>	Colorless to white crystals
<i>Melting point</i>	158.6 °C
<i>Solubility</i>	Slightly Soluble in Water; Soluble ether, benzene, ethanol



### • Uses

#### - Medical uses of salicylic acid

- It is also used to treatment of,
  - ✓ **Acne:** It is a skin condition characterized by red pimples on the skin, especially on the face, due to inflamed or infected sebaceous glands
  - ✓ **Psoriasis:** It is a skin disease marked by red, itchy, scaly patches.
  - ✓ **Seborrheic dermatitis:** It is a common skin condition that mainly affects your scalp. It causes scaly patches, red skin and stubborn dandruff. It can also affect oily areas of the body, such as the face, sides of the nose, eyebrows, ears, eyelids and chest.
  - ✓ **Eczema:** It is an inflammatory condition of the skin characterized by redness, itching, and oozing vesicular lesions which become scaly, crusted, or hardened.
  - ✓ **Viral warts:** It is typically small, rough and hard growths that are similar in color to the rest of the skin.
  - ✓ **Dandruff:** scaly white or grayish flakes of dead skin cells especially of the scalp
  - ✓ **Ringworm:** a contagious itching skin disease occurring in small circular patches, caused by any of a number of fungi and affecting chiefly the scalp or the feet. The commonest form is athlete's foot.



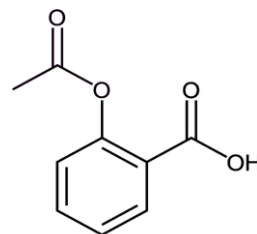
- **Chemistry:** Salicylic acid used for synthesis of Aspirin (acetylsalicylic acid).
- **Other Uses:** Salicylic acid is used as a food preservative, a bactericidal and an antiseptic.



## ❖ Structure and uses of Acetyl Salicylic Acid

- Aspirin, also known as acetylsalicylic acid (ASA), is a medication used to treat pain, fever, or inflammation.
- Aspirin is also known as Nonsteroidal Anti-Inflammatory Drug (NSAID).

<i>IUPAC name</i>	2-Acetoxybenzoic acid
<i>Other names</i>	Aspirin
<i>Chemical formula</i>	$C_9H_8O_4$
<i>Molar mass</i>	180.15 g/mol
<i>Appearance</i>	Colorless to white crystals
<i>Melting point</i>	136°C
<i>Solubility</i>	Soluble in Water



acetylsalicylic acid  
(aspirin)

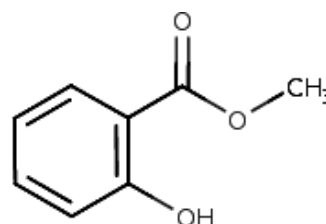
### • Uses

- Aspirin is used in the treatment of a number of conditions, including fever, pain, rheumatic fever, and inflammatory diseases, such as rheumatoid arthritis, pericarditis, and Kawasaki disease.
- It is sometimes used to treat or prevent heart attacks, strokes, and chest pain (angina).
- Aspirin is thought to reduce the overall risk of both getting cancer and dying from cancer. This effect is particularly beneficial for **colorectal cancer** (CRC).

## ❖ Structure and uses of Methyl Salicylate

- Methyl salicylate (oil of wintergreen or wintergreen oil) is an organic compound with the formula  $C_6H_4(OH)(CO_2CH_3)$ .
- It is the methyl ester of salicylic acid.
- It is a colorless, viscous liquid with a sweet odor.
- It is produced by many species of plants, particularly wintergreens.
- It is also synthetically produced, used as a fragrance, in foods and beverages, and in liniments.

<i>IUPAC name</i>	Methyl 2-hydroxybenzoate
<i>Other names</i>	Salicylic acid methyl ester; Oil of wintergreen; Betula oil
<i>Chemical formula</i>	$C_8H_8O_3$
<i>Molar mass</i>	152.15 g/mol
<i>Appearance</i>	colorless, viscous liquid with a sweet odor
<i>Boiling point</i>	222°C
<i>Solubility</i>	Miscible in organic solvents



### • Uses

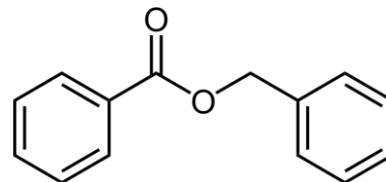
- It is used in high concentrations as a rubefacient and analgesic in deep heating liniments
- It is used in low concentrations (0.04% and under) as a flavouring agent in chewing gum and mints.
- Methyl salicylate (oil of wintergreen) is a non-selective COX inhibitor (traditional NSAID), used to treat minor aches and pains of the muscles/joints (e.g., arthritis, backache, sprains).
- Used as Anti-inflammatory agent.
- Used as Analgesic agent.



## ❖ Structure and uses of Benzyl Benzoate

- Benzyl benzoate is a medication and insect repellent.
- Benzyl benzoate was first studied medically in 1918. It is on the World Health Organization's List of Essential Medicines.

<i>IUPAC name</i>	Benzyl benzoate
<i>Other names</i>	Benzoic acid phenylmethyl ester; Phenyl benzoate
<i>Chemical formula</i>	$C_{14}H_{12}O_2$
<i>Molar mass</i>	212.25 g/mol
<i>Appearance</i>	Clear colorless liquid
<i>Boiling point</i>	323°C
<i>Solubility</i>	Insoluble in Water; Miscible with ethanol, alcohol, chloroform, ether



### • Uses

#### - **Medical uses of Benzyl benzoate:**

- 25%W/V Benzyl benzoate used for treating Scabies & Pediculosis (lice infestation of any part of the body).
- It has vasodilating and spasmolytic effects and is present in many asthma and whooping cough drugs.
- It is also used as an excipient in some testosterone-replacement medications for treating hypogonadism.

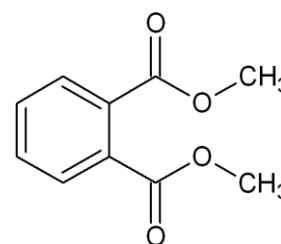
#### - **Non-medical uses of Benzyl benzoate:**

- It is used as a repellent for chiggers, ticks, and mosquitoes.
- It is also used as a dye carrier, solvent for cellulose derivatives, plasticizer, and fixative in the perfume industry.

## ❖ Structure and uses of Dimethyl Phthalate

- Dimethyl phthalate is a methyl ester of phthalic acid.

<i>IUPAC name</i>	Dimethyl benzene-1,2-dicarboxylate
<i>Other names</i>	Dimethyl phthalate
<i>Chemical formula</i>	$C_{10}H_{10}O_4$
<i>Molar mass</i>	194.18 g/mol
<i>Appearance</i>	Colorless oily liquid with slight aromatic odor
<i>Boiling point</i>	283°C
<i>Solubility</i>	Insoluble in Water; Miscible with ethanol, alcohol, chloroform, ether



### • Uses

- Dimethyl phthalate is used as an insect repellent for mosquitoes and flies.
- It is also an ectoparasiticide and has many other uses, including in solid rocket propellants, and plastics.