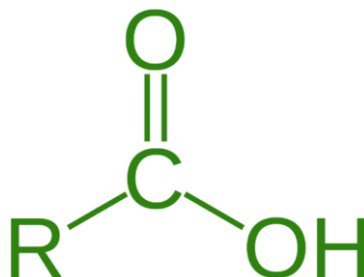


Carboxylic acid

Carboxylic acid

- Carboxylic acids are a fundamental class of organic compounds characterized by the presence of a carboxyl group (-COOH), which consists of a carbonyl group (C=O) and a hydroxyl group (-OH) attached to the same carbon atom.
- These compounds exhibit weak acidic properties and versatile reactivity, making them crucial in many biological and industrial processes.



Classification of Carboxylic Acids

Carboxylic acids can be categorized based on the nature of the carbon chain or ring attached to the carboxyl group:

1. Aliphatic Carboxylic Acids

- **Saturated:** No double or triple bonds between carbon atoms.
- Examples include formic acid, acetic acid, and propionic acid.
- **Unsaturated:** One or more double or triple bonds between carbon atoms.
- Examples include acrylic acid and sorbic acid.

2. Aromatic Carboxylic Acids

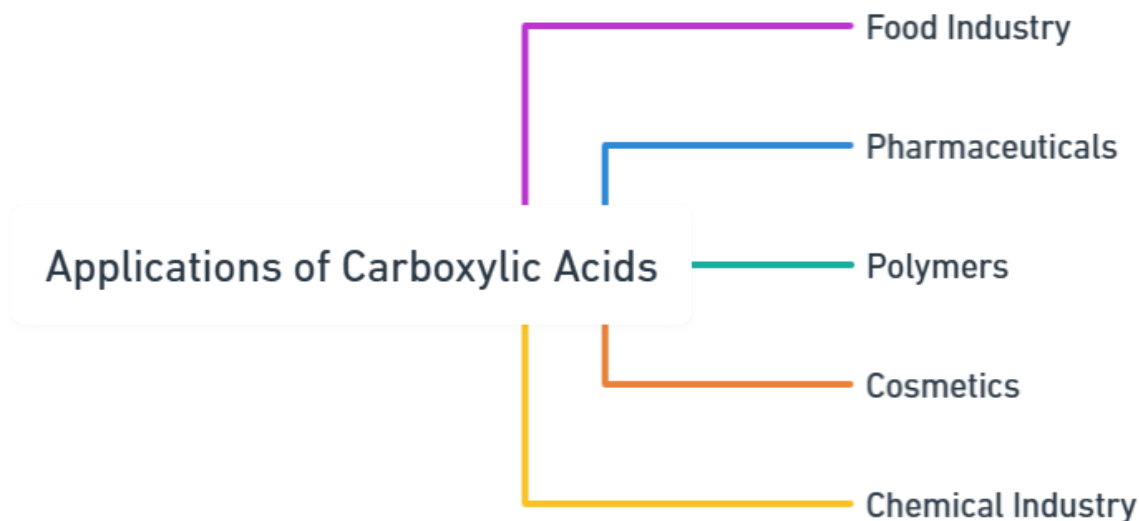
- Contain an aromatic ring attached to the carboxyl group.
- Examples are benzoic acid and salicylic acid.

Physical and Chemical Properties

- Polarity:** Carboxylic acids are polar due to the electronegative oxygen atoms, which enhances their solubility in water and other polar solvents, especially for lower-molecular-weight acids.
- Boiling and Melting Points:** They have higher boiling and melting points compared to hydrocarbons or alcohols of similar size due to strong hydrogen bonding.
- Acidity:** As weak acids, they can donate a hydrogen ion (H⁺).
- Their acidity is influenced by electron-withdrawing substituents and the resonance stabilization of the carboxylate ion upon deprotonation.
- Reactivity:** Carboxylic acids participate in several key reactions:
 - **Esterification:** React with alcohols to form esters and water.

- **Reduction:** Convert into primary alcohols or aldehydes.
- **Decarboxylation:** Removal of the carboxyl group, releasing carbon dioxide.

Applications



1. Food Industry

- **Preservatives:** Benzoic acid inhibits microbial growth.
- **Flavorings:** Contribute to the flavor of food products.
- **Acidity Regulators:** Compounds like citric and acetic acids adjust acidity in beverages and vinegar.

2. Pharmaceuticals

- **Aspirin (Acetylsalicylic Acid):** A common anti-inflammatory and pain reliever.
- **Ibuprofen:** Another significant anti-inflammatory drug.

3. Polymers

- **Polyesters and Polyamides:** Adipic acid is used for nylon production, and terephthalic acid is used for PET polymers.

4. Cosmetics

- **Emulsifiers:** Help blend water with oils and fats.
- **Preservatives:** Extend shelf life of products.
- **pH Adjusters:** Maintain desired acidity in skincare products.

5. Chemical Industry

- Serve as intermediates in the synthesis of esters, amides, and anhydrides, showcasing their versatility in chemical manufacturing processes.

Preparation of carboxylic acid

- Carboxylic acids can be prepared through various methods, each involving specific reactants and conditions.

Overview of the primary preparation methods:

1. Oxidation of Primary Alcohols and Aldehydes

A. Oxidation of Primary Alcohols:

- Primary alcohols are oxidized to carboxylic acids using strong oxidizing agents like potassium permanganate (KMnO_4) or potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$) under acidic conditions.

- Reaction:**



- Example:** Ethanol to Acetic Acid



Ethanol $\rightarrow$ Acetic acid

B. Oxidation of Aldehydes:

- Aldehydes are converted to carboxylic acids using oxidizing agents like silver(I) oxide (Ag_2O) or Tollens' reagent.

- Reaction:**



- Example:** Acetaldehyde to Acetic Acid



Acetaldehyde $\rightarrow$ Acetic acid

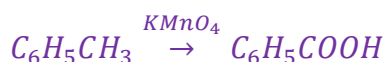
2. Oxidation of Alkyl Side Chains of Aromatic Compounds

- Alkylbenzenes with a benzylic hydrogen can be oxidized to aromatic carboxylic acids using oxidizing agents such as KMnO_4 or chromium trioxide (CrO_3) in an acidic medium.

- Reaction:**



- Example:** Toluene to Benzoic Acid



Toluene $\rightarrow$ Benzoic acid

3. Hydrolysis of Nitriles

- Nitriles can be hydrolyzed into carboxylic acids under acidic or basic conditions, producing ammonia as a byproduct.



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