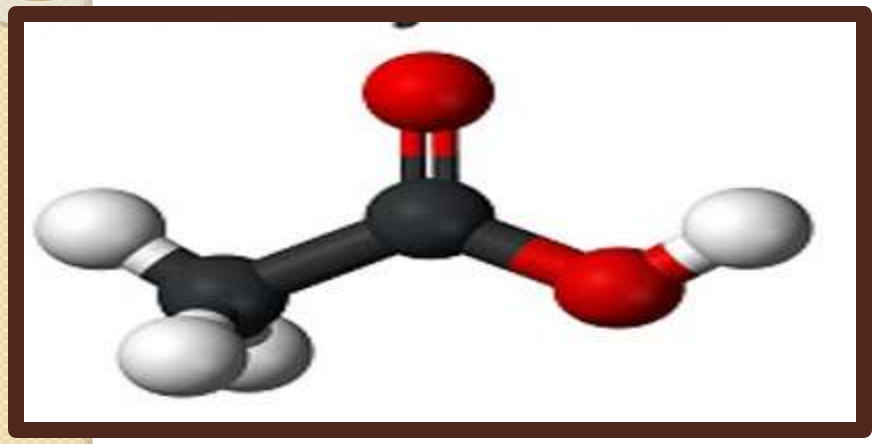
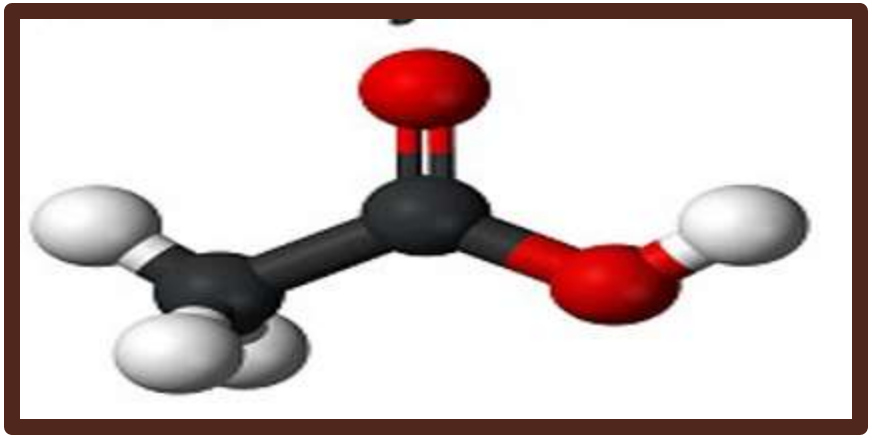
CARBOXYLIC ACIDS





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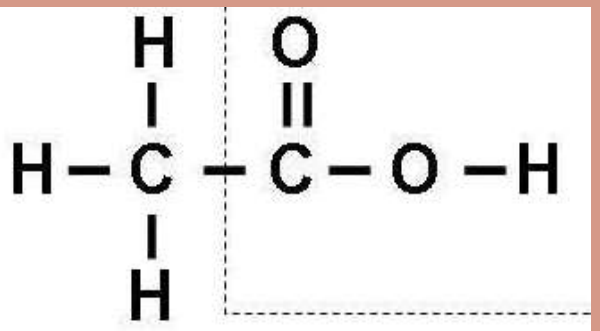
What are Carboxylic Acids?

- A carboxylic acid is an organic compound that contains a carboxyl group. The general formula of a carboxylic acid is R–COOH, with R referring to the alkyl group. Carboxylic acids occur widely. Important examples include the amino acids and acetic acid.

Structural Formula



Chemical Formula

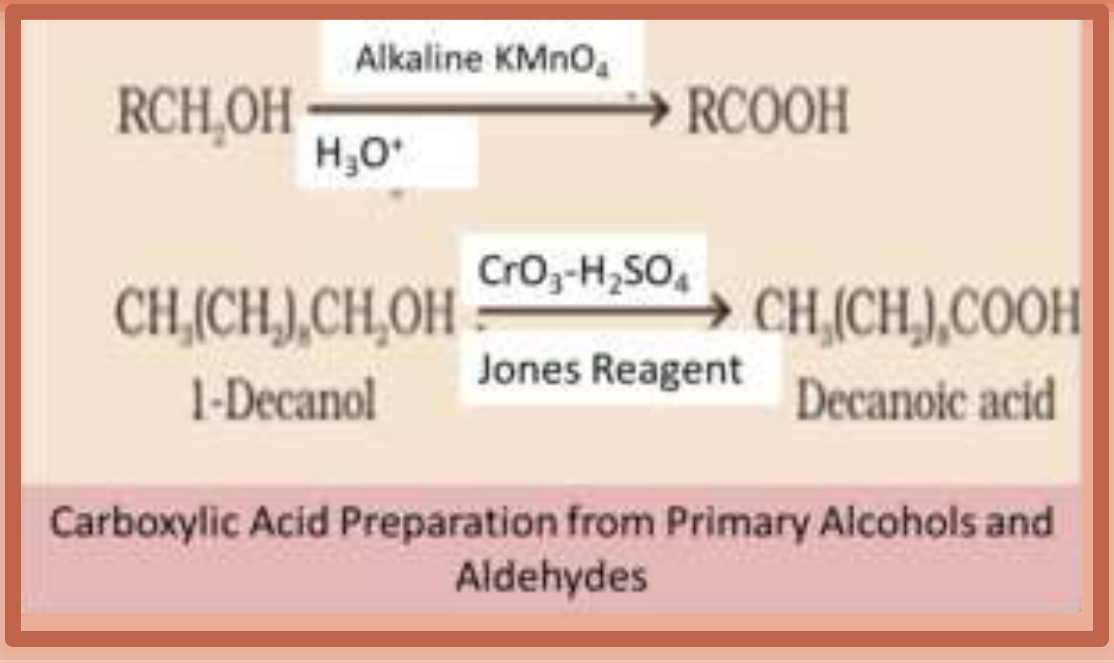
CH_3COOH or CH_3CO_2H

- Carboxylic acids occur widely in nature.
- The fatty acids are components of glycerides, which in turn are components of fat.
- Hydroxyl acids, such as lactic acid (found in sour-milk products) and citric acid (found in citrus fruits), and many keto acids are important metabolic products that exist in most living cells.
- Proteins are made up of amino acids, which also contain carboxyl groups.

Methods of Preparation of Carboxylic Acids

Preparation from Primary Alcohols

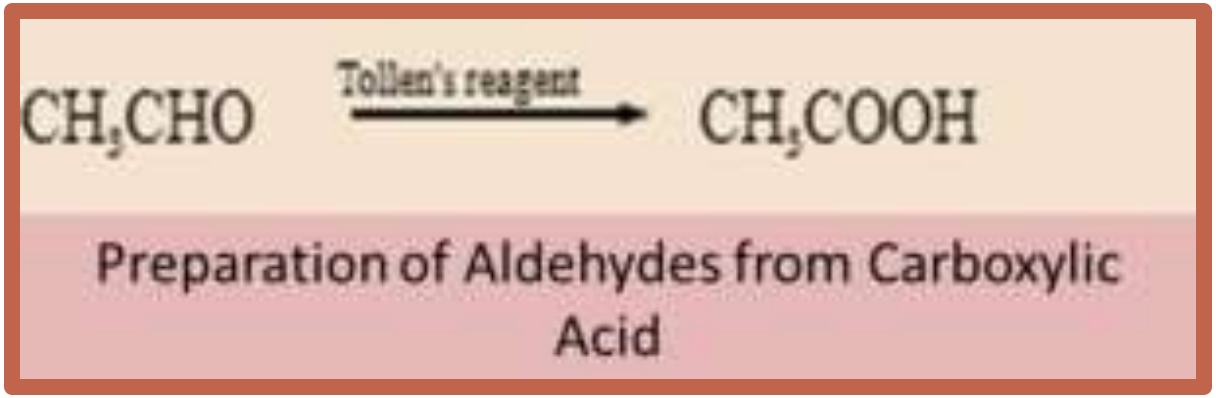
Primary alcohols, as well as aldehydes, can undergo oxidation reaction to form corresponding carboxylic acids with the help of oxidizing agents such as potassium permanganate ($KMnO_4$ for neutral or acidic or alkaline media), chromium trioxide (CrO_3^- $H_2SO_4^-$ Jones reagent), and potassium dichromate ($K_2Cr_2O_7$ acidic media).



Carboxylic Acid Preparation from Primary Alcohols and Aldehydes

Preparation from Aldehydes

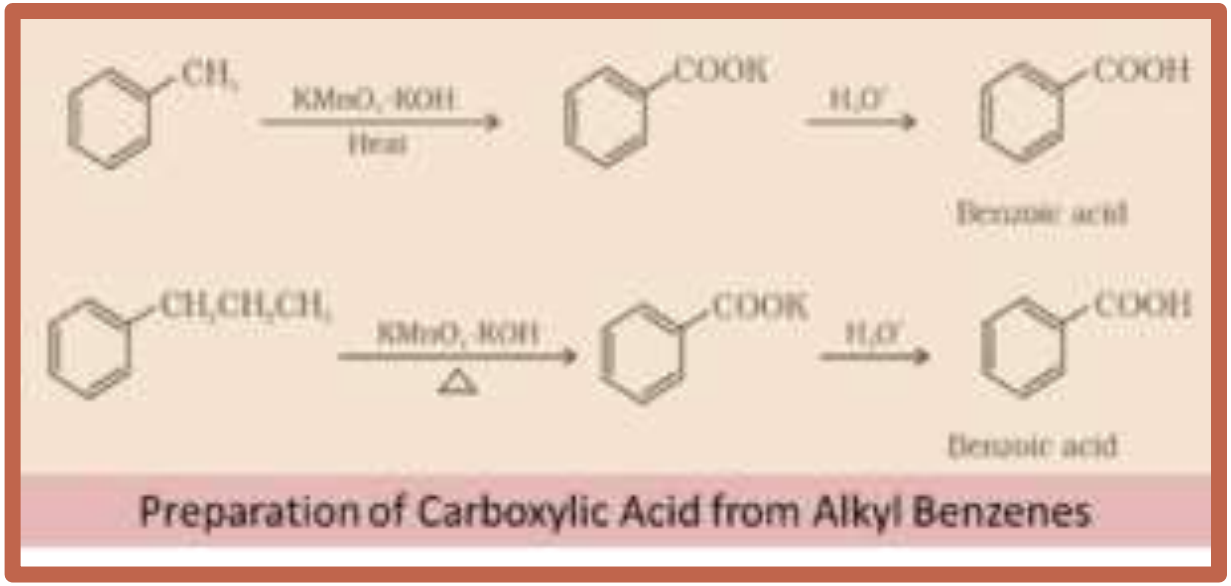
Preparation of carboxylic acid is possible from the usual strong oxidizing agents. Carboxylic acids formation is possible with mild oxidizing agents such as Tollen's reagents [$Ag(NH_3)_2^+OH^-$] and manganese dioxide (MnO_2).



Preparation of Aldehydes from Carboxylic Acid

Preparation from Alkylbenzenes

Aromatic carboxylic acid preparation is possible through the oxidation of alkyl-benzenes. Vigorous oxidation of alkyl benzene compound with acidic or alkaline $KMnO_4$ or acidic $K_2Cr_2O_7$ can lead to the formation of aromatic carboxylic acid compounds. The oxidation of complete side chain of the carboxyl group takes place regardless of the side chain length.



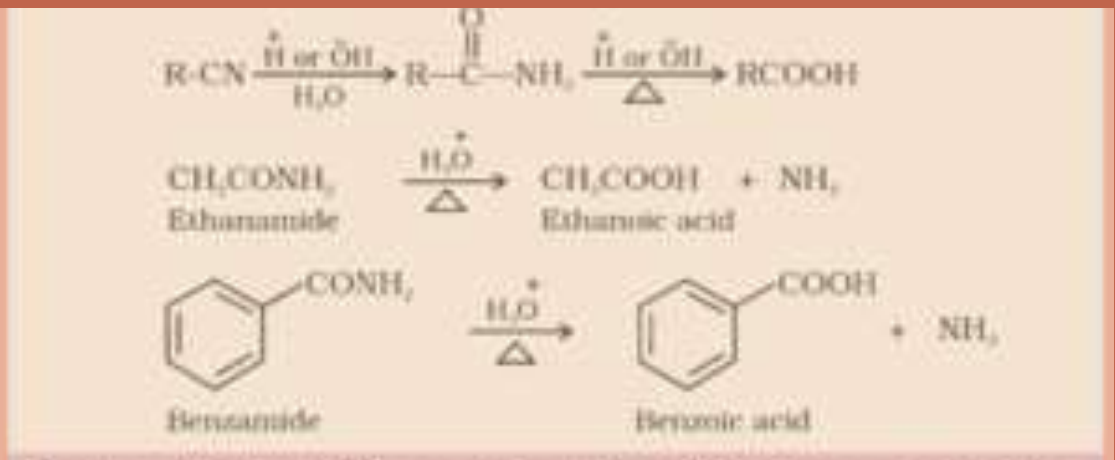
Preparation of Carboxylic Acid from Alkyl Benzenes

Preparation from Nitriles

Nitriles undergo hydrolysis to form amides, which then form carboxylic acids in the presence of a catalyst .The catalyst for this reaction is H^+ or OH^-. Furthermore, application of mild reaction condition helps in ceasing the reaction in the amide stage

Preparation from Amides

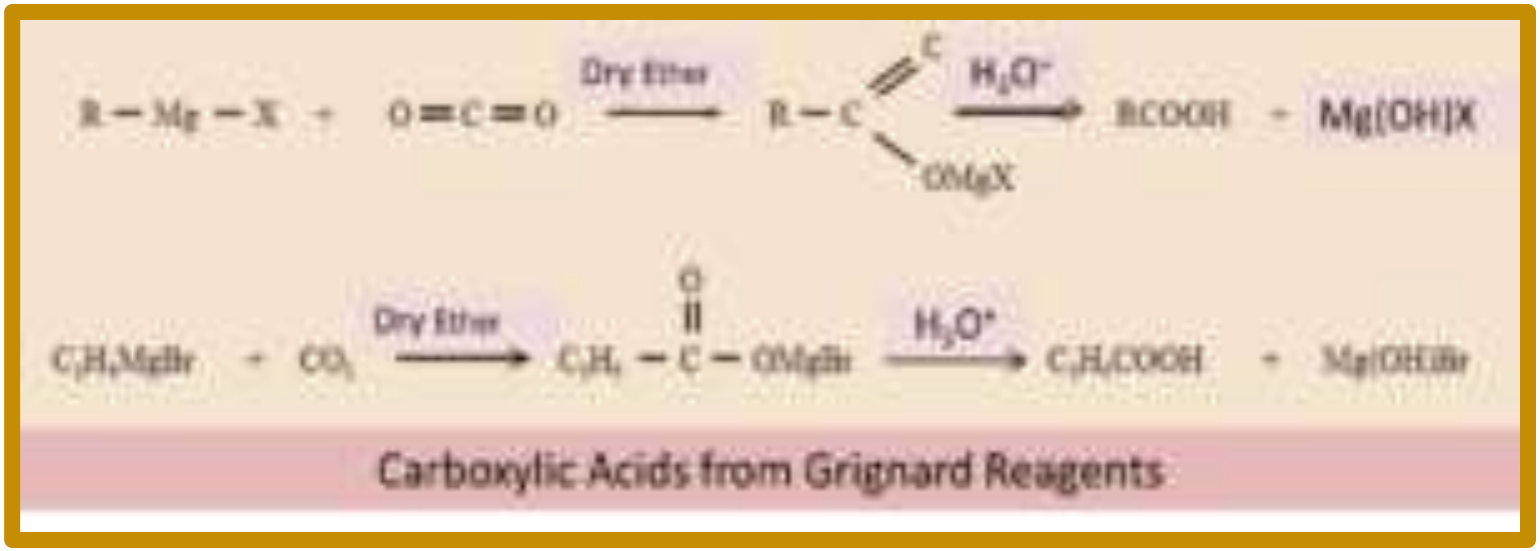
Amide undergoes hydrolysis in the presence of catalyst H^+ or OH^- to form carboxylic acids.



Carboxylic Acid Preparation from Nitriles and Amides

Preparation from Grignard Reagents

The carboxylic acid can be prepared from Grignard reagents. The reaction of Grignard reagents with crushed dry ice or solid carbon dioxide leads to the formation of salts of carboxylic acids. Further, the acidification of the salts of a carboxylic acid with mineral acids leads to the formation of corresponding carboxylic acids.

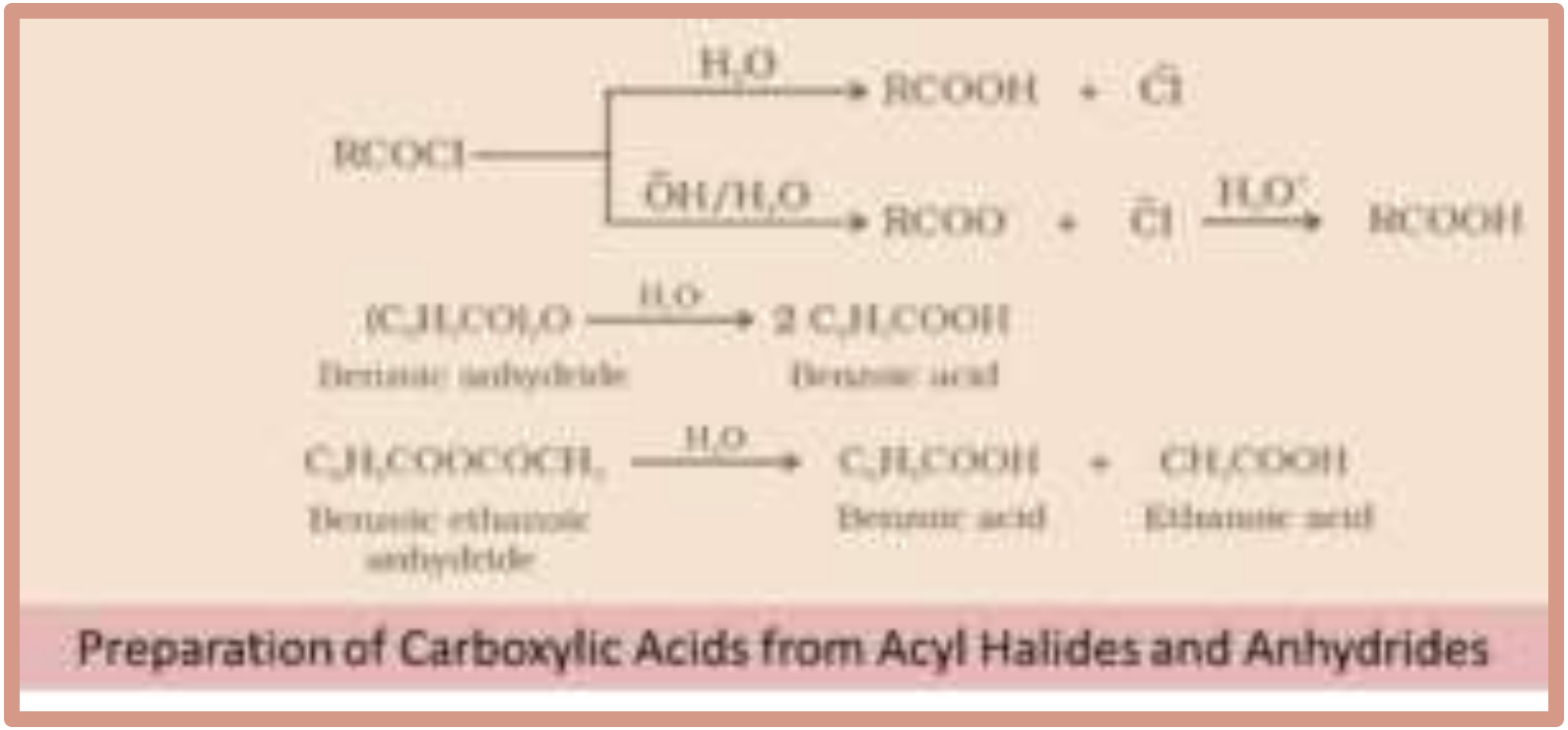


Carboxylic Acids from Grignard Reagents

Preparation from Acyl Halides and Anhydrides

Hydrolysis of acid chlorides with water produces carboxylic acids.

Hydrolysis of acid anhydrides leads to carboxylic acids.



Preparation of Carboxylic Acids from Acyl Halides and Anhydrides

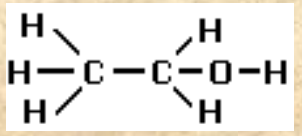
Properties and uses of carboxylic acids

- Carboxylic acids are colourles liquids with very strong odors' (pungent smell) and tastes.
- The obnoxious smell of rancid butter and sweaty socks are due to the formation of carboxylic acids.
- It should be mentioned here that carboxylic acids with long carbon chains are called fatty acids, because they are combined with an alcohol called glycerol to form large ester molecules (glycerides/triesters) that make up most natural oils from plants and fat in animals.
- The fatty acids may be saturated (no C=C double bonds) or unsaturated (with at least one C=C double bond) in the carbon chain.

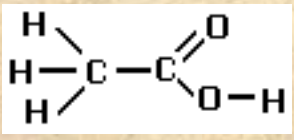
- Vinegar contains ethanoic acid (acetic acid)
- In the chemical industry **ethanoic acid** can be manufactured on a large scale by oxidising the ethanol.
- It is used as a food preservative and in food flavourings.
- It is the oxidation of ethanol to ethanoic acid that results in alcoholic drinks turning sour (e.g. cider, wine) when exposed to air.
- The fruit material already contains the enzymes that catalyse the oxidation of ethanol ('alcohol') in the presence of air.

ethanol + oxygen ====> ethanoic acid + water

$CH_3CH_2OH + O_2 ====> CH_3COOH + H_2O$

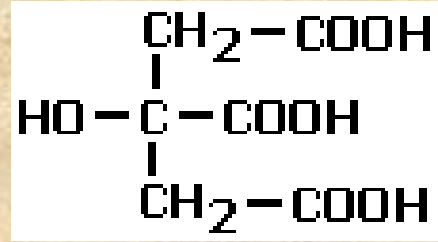


$+ O_2 ====>$



$+ H_2O$

❖ Citrus fruits like oranges and lemons and many soft drinks contain the tri–carboxylic acid citric acid. and contribute to the 'tarter' or 'sour' taste of fruit. The molecule contains three acidic carboxylic acid groups –COOH.



❖ **Citric acid** is a natural preservative (E330 on food labels) and is found in oranges, lemons, limes and grapefruit. It is an anti–oxidant. Metal salts, i.e. citrates, are used in dietary supplements to deliver trace metal minerals in a biologically absorbable chemical form.

❖ **Citric acid** can be used in baking powder to react with sodium bicarbonate giving the raising action from carbon dioxide gas formation. The same combination can be used to give the fizzy drink effect in medicines like ant–acid stomach powders.

- **Ethanoic acid** is used in the manufacture of the fibre, acetate rayon, cellulose plastics and esters. Aspirin, the ester of salicylic acid, is prepared from acetic acid.
- **Formic acid** In addition to its use as a disinfectant, is employed in textile treatment and as an acid reducing agent.
- **Palmitic acid** and **Stearic acid** are important in the manufacture of soaps, cosmetics, textiles, pharmaceuticals, candles, and protective coatings.

•Acrylic acid is employed as an ester in the production of polymers (long-chain molecules) known as acrylates.
•Methacrylic acid serves as an ester and is polymerized to form Lucite.

REACTIONS OF CARBOXYLIC ACIDS

Reactions due to H-atom of the carboxylic group
Reaction due to Carbonyl group >C=O
Reactions due to Carboxyl group