METHODS OF PREPARATION OF CARBOXYLIC ACIDS

General Introduction and Method of Preparation of Carboxylic Acid

General Introduction

The typical molecular formula representing carboxylic acids is CnH2n+1COOH. Carboxylic acids represent a class of organic compounds where carbon atoms form a double bond with an oxygen atom. Additionally, the carbon atom may form a single bond with a hydroxyl group (−OH). A fourth bond links the carbon atom either to a hydrogen atom or to another univalent combining group. Generally, carboxylic acids contain one carboxyl group, but those with multiple carboxyl groups attached are termed dicarboxylic acids, tricarboxylic acids, and so forth.

These organic compounds occur naturally in various sources, such as fruits, vegetables, and animal fats. In biological systems, they play pivotal roles, acting as intermediates in metabolic pathways and constituting essential components of cellular membranes.

General Method of Preparation

By oxidation of primary alcohol with acidic $KMnO_4$ or acidic $K_2Cr_2O_7$

$$R\text{–}CH_2OH + [O] \xrightarrow[K_2Cr_2O_7/\,H^-]{KMnO_4/H^-} RCHO + H_2O \xrightarrow{[O]} RCOOH$$

By oxidation of aldehydes

When aldehydes are subjected to oxidation using common oxidizing agents, they form carboxylic acids with an equivalent number of carbon atoms as the original aldehyde.

$$R\text{–}CHO + [O] \xrightarrow{\text{Tollen's Reagent}} R\text{–}COO^- \xrightarrow{H^\oplus} R\text{–}COOH$$

$$C_6H_5CHO + [O] \xrightarrow{\text{Tollen's Reagent}} C_6H_5COO^1 \xrightarrow{H^\oplus} C_6H_5COOH$$

By oxidation of alkenes

(a) $RCH = CHR' \xrightarrow[(ii)H_3O^\oplus]{(i)\ \text{conc.}KMnO_4/OH^\ominus\ \text{heat}} RCOOH + R'COOH$

(b) $RCH = CHR' \xrightarrow[(ii)H_2\text{Distill}]{(i)\ O_3} RCOOH + R'COOH$

By Carboxylation of Grignard Reagent

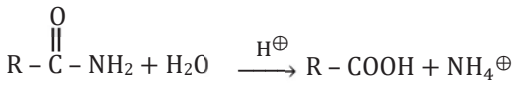
$$R - Br \xrightarrow[\text{dry ether}]{Mg} RMgBr \xrightarrow{CO_2} R - \underset{\displaystyle O}{\overset{\displaystyle \|}{C}} - OMgBr \xrightarrow[-MgBr(OH)]{H_2O/H^+} R - \underset{\displaystyle O}{\overset{\displaystyle \|}{C}} - OH$$

By hydrolysis of acyl derivatives of carboxylic acid

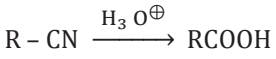
$$R - \underset{\displaystyle O}{\overset{\displaystyle \|}{C}} - Cl + H_2O \xrightarrow{H^\oplus} R - COOH + HCl$$

$$(R - CO)_2O + H_2O \xrightarrow{H^\oplus} R\text{–}COOH + R - \underset{\displaystyle O}{\overset{\displaystyle \|}{C}} - OH$$

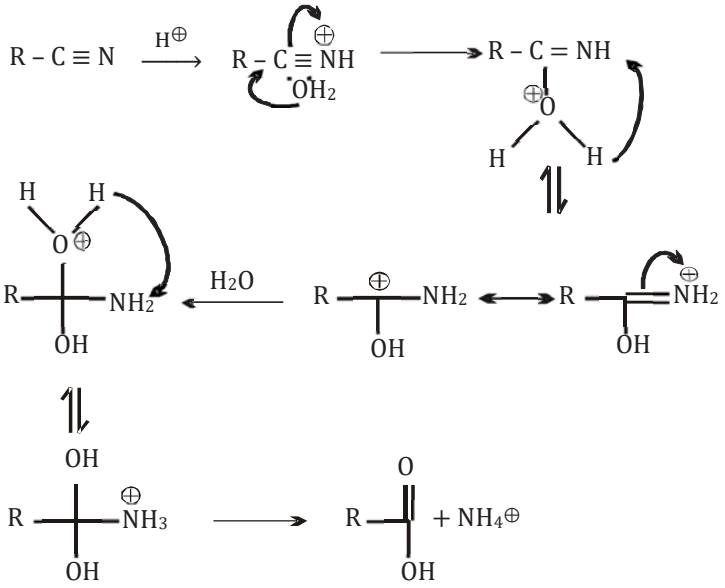
$$R - COOR' + H_2O \xrightarrow{H^\oplus} R\text{–}COOH + ROH$$



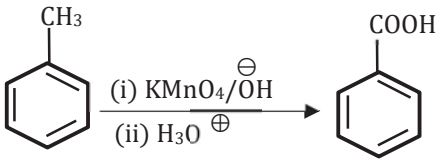
Cyanide hydrolysis with dilute acids



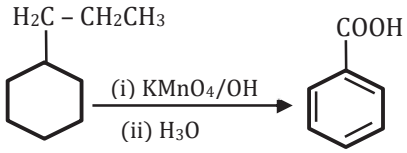
The mechanism of hydrolysis of R–CN is as follows.

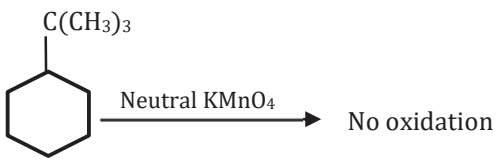


By oxidation of alkyl benzene



Alkyl groups lacking α-hydrogen atoms will not undergo oxidation to form carboxylic acids (-COOH), whereas any alkyl group that contains at least one α-hydrogen atom will undergo oxidation to yield benzoic acid as the final product.





The sequence in which benzoic acid is produced through the oxidation of alkylbenzenes.

Methyl benzene >1° alkyl benzene >2° alkyl benzene