d $HCOOH \longrightarrow$ Methanoic acid

$HOOCH_2CH_2CH_2COOH \longrightarrow$ Pentan-1,5-dioic acid

$CH_3CH_2CH_2COOH \longrightarrow$ Butanoic acid

$HO_2C-CO_2H \longrightarrow$ Ethanedioic acid

$CH_3C(H_2)_4COOH \longrightarrow$ Hexanoic acid

$CH_3CH=CHCH_2CH_2COOH \longrightarrow$ Hex-4-eneoic acid

a Physical appearance:- All simple aliphatic carboxylic acids up to $C_{10}$ are liquids at room temperature. Most carboxylic acids are solid at room temperature although anhydrous carboxylic acid (acetic acid) also known as glacial ethanoic acid freezes to an ice-like solid below the room temperature.

b Boiling Point: This increases with increasing relative molecular mass. Aromatic carboxylic acids are crystalline solids and have higher melting points than their aliphatic counterparts of comparable relative molecular masss

c Solubility: Lower molecular mass carboxylic acids with up to four carbon atom in their molecules are soluble in water; this is largely due to their ability to form hydrogen bonds with water molecules. The water solubility of the acids decreases as the relative molecular mass increases because the structure becomes relatively more hydrocarbon in nature and hence covalent. All carboxylic acids are soluble in Organic solvents

3 From Petroleum: Liquid phase air oxidation of $C_5-C_7$ alkanes obtainable from petroleum at high temperature and pressure will give $C_5-C_7$ carboxylic acids with methanoic, propanoic and butanedioic aads as by-products.

$$C_5-C_7 \xrightarrow{O_2/\text{High temperature and pressure}} C_5-C_7 \text{ Carboxylic acid}$$

b From Ethanal: Ethanoic acid is obtained commercially by the liquid phase air-oxidation of 5% solution of ethanal to ethanoic acid using manganite (ii) ethanoate catalyst. Ethanal itself is obtained from ethylene.

$$HC\equiv CH \xrightarrow{\text{dil. } H_2SO_4/HgSO_4} CH_3CHO \xrightarrow{O_2/(CH_3COO)_2Mn} CH_3COOH$$

Hydrolysis of Nitriles (cyanides) or esters

$RCN + 2H_2O \xrightarrow{H^+} RCOOH + NH_4^+$

$RCOOR \xrightarrow{H_2O/H^+ \text{ reflux}} RCOOH + R'OH$

R = alky
aryl rad

$C_6H_5CH_2CN + 2H_2O \xrightarrow{H^+} C_6H_5CH_2COOH + NH_4^+$

$CH_3CH_2COOCH_3 \xrightarrow{H_2O/H^+ \text{ reflux}} CH_3CH_2COOH + CH_3OH$

## Reduction:

$4RCOOH + 3LiAlH_4 \xrightarrow{(C_2H_5)_2O} (RCH_2O)_4AlLi + 2LiAlO_2 + 4H$

$4H_2O$

$4RCH_2OH + Al(OH)_3 + LiOH$

$CH_3CH_2CH_2COOH \xrightarrow{LiAlH_4} CH_3CH_2CH_2CH_2OH$

Butanoic acid — Butanol

## Decarboxylation:

$CH_3CH_2CH_2COONa + NaOH \xrightarrow{\text{fuse}} CH_3CH_2CH_3 + Na_2CO_3$

Kolbe Synthesis

$2CH_3CH_2COONa + 2H_2O \xrightarrow{\text{electrolysis/aq.}CH_3OH} CH_3(CH_2)CH_3 + CO_2$

$2NaOH + H_2$

## Esterification:

$CH_3CH_2CH_2COOH + CH_3CH_2CH_2OH \xleftrightarrow{H^+} CH_3CH_2CH_2COOCH_2CH_2CH$

$+ H_2O.$