POLY- AND HETEROFUNCTIONAL COMPOUNDS

Biochemical reactions involve the functional groups of molecules. Alcohols, amines, sulfhydryl groups, aldehydes, ketones, carboxyl groups and esters are all important components of biochemical compounds.

Polyfunctional compounds are the compounds that contain two and more same functional groups.

 $\begin{array}{ccc} CH_2 - CH - CH_2; \\ | & | \\ OH & OH & OH \end{array} \qquad HOOC - COOH \\ \end{array}$

Heterofunctional compounds are the compounds that contain different functional groups.

- amino-alcohols
- $\begin{array}{c} \tilde{C}H_2 \tilde{C}H_2 \\ NH_2 & OH \\ hydroacids \\ CH_3 CH C \swarrow_{OH}^O \\ 0H \end{array} 2-hydroxopropanoic acid (lactic acid) \end{array}$
- ketoacids

pyruvic acid

- aminoacids

0

 $CH_3 - \overset{"}{C} - COOH$

 H_2N-CH_2-COOH 2-aminoethanoic acid (glycine)

- benzene derivatives



Polyheterofunctional compounds are the compounds that contain more than two different functional groups.

СООН	СООН	COOH
СН–ОН	HO-C-CH ₂ COOH	HO-C-H
CH ₂ COOH	CH ₂ COOH	H-C-OH
malic acid	citric acid	COOH tartar acid

This acid performs an important role in biochemical process.

Hydroxyacids

Hydroxyacids are organic compounds that contain a hydroxyl group (-OH) and O a carboxyl group (-C-OH).



Chemical properties

The -OH and -COOH groups determines the chemical properties of hydroxyacids.

Properties of -OH group.

1.
$$CH_3 - CH - COOH + HBr \rightarrow CH_3 - CH - COOH + H_2O$$

OH Br
2. $CH_3 - CH - COOH + 2Na \rightarrow CH_3 - CH - COONa + H_2$
OH ONa
3. $CH_3 - CH - COOH + CH_3 - C' \rightarrow CH_3 - CH - COOH + HCl$
OH O-C-CH

4. The oxidation of hydroxyacids.

HO -
$$CH_2 - C \xrightarrow{//O}_{OH} \xrightarrow{H}_{O} C - C \xrightarrow{/O}_{OH}$$

Oxidation is carried out in living systems under the control of a dehydrogenase enzyme such as nicotinamide adenide dinucleotide (NADH).

$$\begin{array}{cccc} CH_{3}-CH-COOH \xrightarrow{+NAD^{+}} & CH_{3}-C-COOH \\ OH & & & \\ O\end{array} \\ lactic acid & pyruvic acid \\ Properties of -COOH group. \\ 1. Esterification \\ CH_{3}-CH-COOH+CH_{3}OH \xrightarrow{H^{+}} CH_{3}-CH-COOCH_{3} \\ OH & & OH \\ \end{array} \\ \begin{array}{c} cH_{3}-CH-COOH+CH_{3}OH \xrightarrow{H^{+}} OH_{3}-CH-COOCH_{3} \\ OH & & OH \\ \end{array} \\ \begin{array}{c} cH_{3}-CH-COOH+NaOH \xrightarrow{H^{+}} OH_{3}-CH-COONa+H_{2}O \\ OH & & OH \\ \end{array} \\ \begin{array}{c} cH_{3}-CH-COOH+NaOH \xrightarrow{H^{+}} OH_{3}-CH-COONa+H_{2}O \\ OH & & OH \\ \end{array} \\ \begin{array}{c} cH_{3}-CH-COOH+NaOH \xrightarrow{H^{+}} OH_{3}-CH-COONa+H_{2}O \\ OH & & OH \\ \end{array} \\ \begin{array}{c} cH_{3}-CH-COOH+NaOH \xrightarrow{H^{+}} OH_{3}-CH-COONa+H_{2}O \\ OH & & OH \\ \end{array} \\ \begin{array}{c} cH_{3}-CH-COOH+NaOH \xrightarrow{H^{+}} OH_{3}-CH-COONa+H_{2}O \\ OH & & OH \\ \end{array} \\ \end{array}$$

$$CH_{3} - CH - COOH + NH_{3} \rightarrow CH_{3} - CH - CONH_{2} + H_{2}O$$

$$OH$$

$$OH$$

4. Formation of alcohol by decarboxylation.

$$CH_{3} \xrightarrow{-CH} -COOH \xrightarrow{t^{0}} CH_{3} - CH_{2} - OH + CO_{2}$$

OH

Loss of CO₂ from a molecule is called decarboxylation.

 $\beta\text{-}$ hydroxybutyric acid produced by the body. Fatty acids are oxidized to $\beta\text{-}$ hydroxybytyric acid.

 β - hydroxybutyric acid is oxidized to acetoacetic acid.

$$CH_{3} - CH_{2} - COOH \xrightarrow{\text{NAD}^{+} - \text{NADH}_{+}} CH_{3} - C - CH_{2} - COOH \xrightarrow{\text{NADH}_{+}} CH_{3} - C - CH_{2} - COOH \xrightarrow{\text{O}} CH_{3} - C - CH_{2} - COOH \xrightarrow{\text{O}} CH_{3} - C - CH_{3} \xrightarrow{\text{O}} CH_{3} \xrightarrow{\text{O}} CH_{3} - C - CH_{3} \xrightarrow{\text{O}} CH_{3} \xrightarrow{\text{O}$$

Ketone bodies

Ketoacids

Ketoacids contains –COOH and –C=O groups.

$$CH_3$$

 $C=O$ – CO_2
 CO_2
 $CH_3 - C$
 CO_2
 $CH_3 - C$
 CO_2
 CO_2
 CO_2
 CO_2
 $CH_3 - C$
 CO_2
 CO_2
 CO_3
 $COOH$
 CO_2
 $COOH$
 $COOH$

О HOOC - C - CH₂COOH oxaloacetic acid O CH₃ - C - CH₂COOH acetoacetic (ацетоуксусная)

Amino alcohol contains –NH₂ and –OH groups.

$$HO - CH_2 - CH_2 - NH_2 - 2 - aminoethanol$$

Amino alcohols are structural components of compound lipids. Amino alcohol reach with acid to poduce salt: $HO - CH_2 - CH_2 - NH_2 + HCl \rightarrow HO - CH_2CH_2NH_2^+Cl^-$

$$O-CH_2-CH_2-NH_2+HCI \rightarrow HO-CH_2CH_2NH_3^+Cl^-$$

2-aminoethanol hydrochloride

2- aminoethanol derivative is medicine.

$$C_6H_5$$
 CH - O - CH₂ - CH₂NH2 CH₃
C₆H₅ CH₃

This is sleeping draught, antiallergy

Choline $OH - CH_2 - CH_2 - N^+(CH_3)_3$ is structural components of phosphoglyceride. Preparation of choline: $HO - CH_2 - CH - COOH \xrightarrow{Decarboxylation} HO - CH_2 - CH_2 - NH_2 \xrightarrow{methylation} HO - CH_2CH_2N^+(CH_3)_3$ NH_2 2-amsnoethanol Serine Chorine reach with CH₃COOH to produse acetylcholine $HO - CH_2 - CH_2 - N^+(CH_3)_3 \xrightarrow{CH_3COOH} CH_3COOCH_2 - CH_2N^+(CH_3)_3$

Chemical properties of o-hydroxybenzoic acid.

