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DEPARTMENT OF BIOCHEMISTRY

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Lipids

LIPIDS

- The lipids are a heterogeneous group of compounds, including **fats, fixed oils, steroids, waxes**, and related compounds, which are related more by their physical than by their chemical properties.
- They have the common property of being relatively **insoluble in water and soluble in nonpolar solvents such as ether and chloroform.**

- Lipids (fixed oils, fats, and waxes) are **esters of long-chain fatty acids and alcohols.**
- The chief difference between these substances is the type of **alcohol**; **in fixed oils and fats, glycerol combines with the fatty acids**; **in waxes, the alcohol has a higher molecular weight**, e.g., cetyl alcohol.

Classification of lipids

1. Simple lipids: Esters of fatty acids with various alcohols.

(a) Fats: Esters of fatty acids with glycerol. Oils are fats in the liquid state.

(b) Waxes: Esters of fatty acids with higher molecular weight monohydric alcohols.

2. Complex lipids: Esters of fatty acids containing groups in addition to an alcohol and a fatty acid.

(a) Phospholipids: Lipids containing, in addition to fatty acids and an alcohol, a phosphoric acid residue.

(b) Glycolipids (glycosphingolipids): Lipids containing a fatty acid, sphingosine, and carbohydrate.

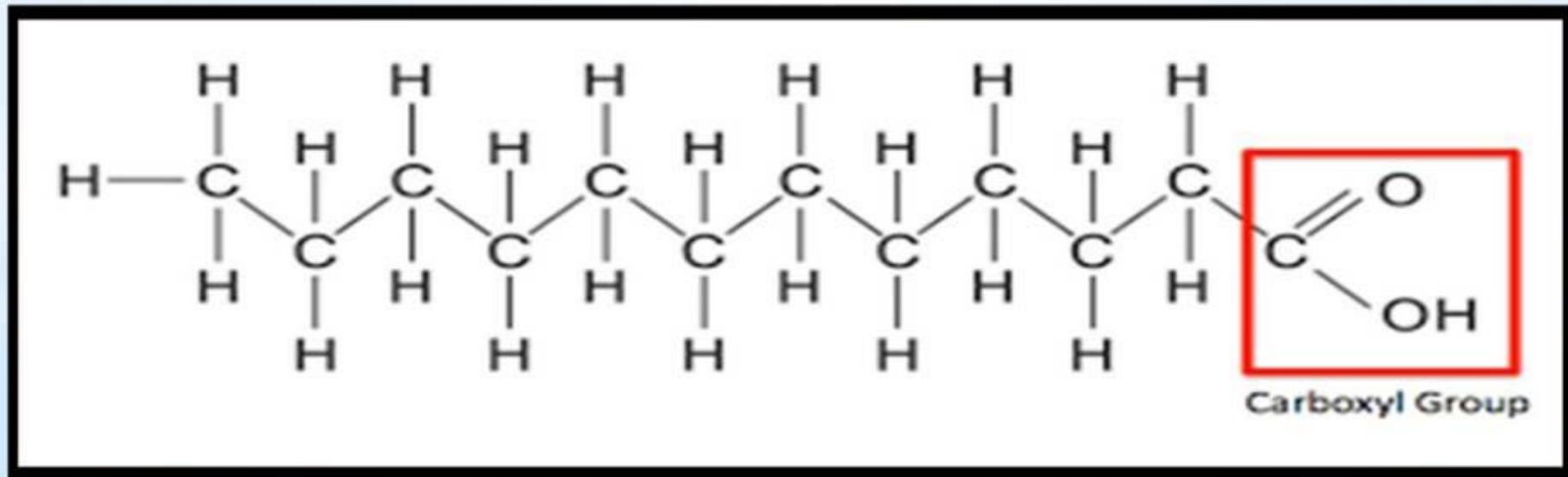
(c) Other complex lipids: Lipids such as sulfolipids and aminolipids. Lipoproteins may also be placed in this category.

3. Precursor and derived lipids: These include steroids, lipid soluble vitamins, and hormones.

Fatty Acid

- A fatty acid is a molecule characterized by the presence of a **carboxyl group attached to a long hydrocarbon chain**.
- Therefore these are molecules with a formula $R-COOH$ where R is a hydrocarbon chain.
- The “**tail**” of a fatty acid is a **long hydrocarbon chain**, making it hydrophobic.
- The “**head**” of the molecule is a **carboxyl group** which is hydrophilic.

- Fatty acids are the main component of soap, where their tails are soluble in oily dirt and their heads are soluble in water to emulsify and wash away the oily dirt.
- However, when the head end is attached to glycerol to form a fat, that whole molecule is hydrophobic.



Saturated and unsaturated fatty acids

A. Saturated fatty acids do not have any double bonds.

- A fatty acid is saturated when every carbon atom in the hydrocarbon chain is saturated with hydrogen.
- Saturated fatty acids are solids at room temperature. Animal fats are a source of saturated fatty acids.

Saturated fatty acid chain $-\text{CH}_2 - \text{CH}_2 - \text{CH}_2 -$

B. Unsaturated fatty acids can have one or more double bonds along its hydrocarbon chain.

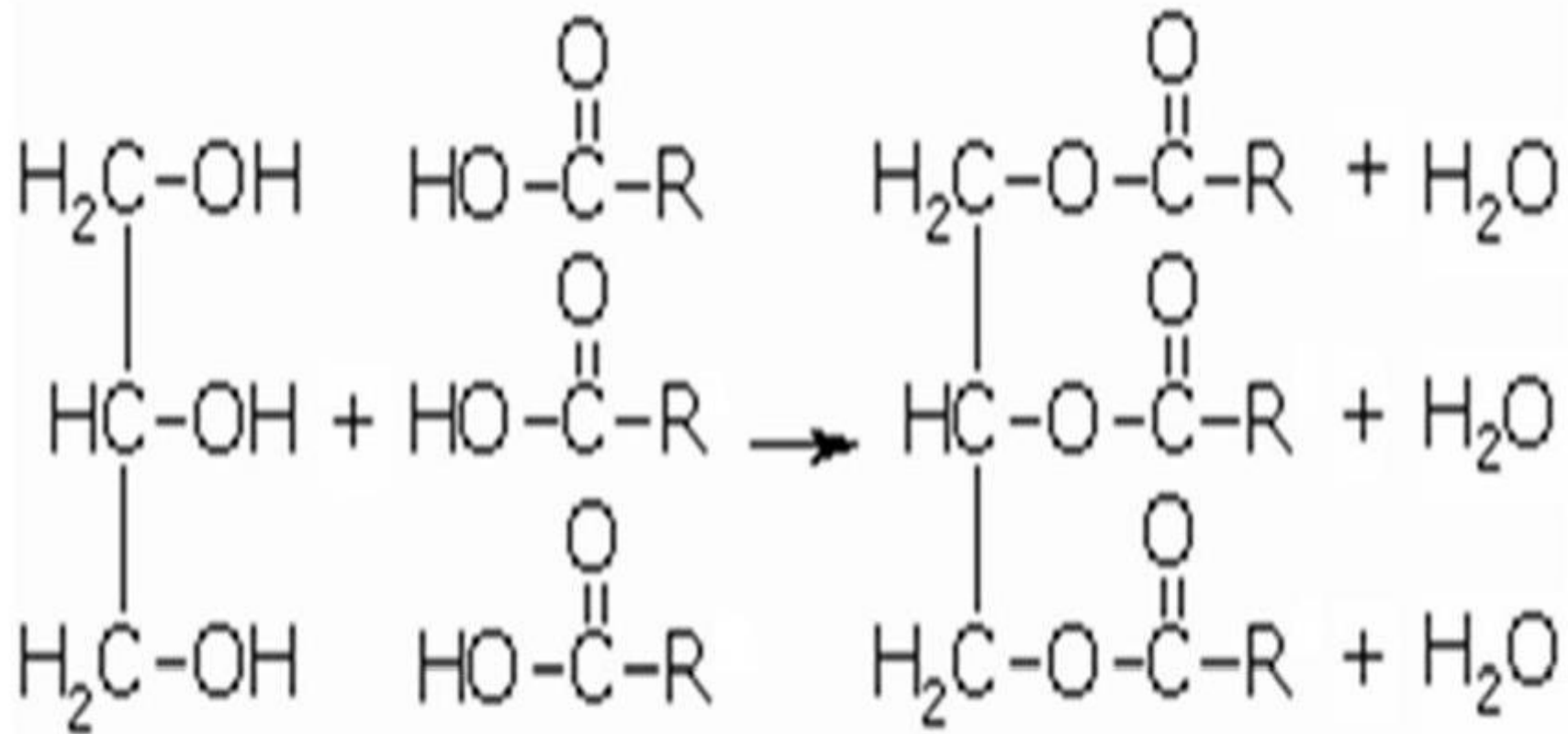
- A fatty acid with one double bond is called **monounsaturated**.
- If it contains two or more double bonds, we say that the fatty acid is **polyunsaturated**.
- When double bonds are present, they are nearly always in the **cis** rather than in the **trans** configuration.

- The melting point of a fatty acid is influenced by the **number of double bonds** that the molecule contains and by the **length of the hydrocarbon tail**.
- The **more double bonds** it contains, the **lower the melting point**.
- As the **length of the tail increases**, the **melting point increases**.
- **Plants are the source of unsaturated fatty acids.**

Unsaturated fatty acid chain $-\text{CH} = \text{CH} - \text{CH} = \text{CH} -$

Triacylglycerols

- Triacylglycerols, also called **triglycerides**, are the simplest of lipids composed of **three fatty acids each in ester linkage with a single glycerol molecule**.
- Those containing the same kind of fatty acid in all three positions are called simple triacylglycerols.



Glycerol

Fatty acids

Triacylglycerol

Fats:

- are mostly from animal sources, have **all single bonds between the carbons** in their fatty acid tails, thus all the carbons are also bonded to the maximum number of hydrogens possible.

Thank you

