Nakshalbari College
Department of Bio-Science

Topic- Lipid

Subject- Botany

Semester-II (Major)

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Lipids

- The lipids are a heterogeneous group of compounds, including fats, oils, steroids, waxes, and related compounds, that are related more by their physical than by their chemical properties.

- They have the common property of being
- (1) relatively **insoluble in water** and (2) **soluble in nonpolar solvents** such as ether and chloroform.

Functions of lipids

- **Storage** form of energy
- Important dietary components because of their **high energy value** and also because of the fat-soluble vitamins and the essential fatty acids contained in the fat of natural foods.
- Structural components of biomembranes
- Serve as **thermal insulators** in the subcutaneous tissues and around certain organs
- Nonpolar lipids act as electrical insulators, allowing rapid propagation of depolarization waves along **myelinated nerves**

Functions of lipids(Contd.)

- Provide **shape and contour** to the body
- Act as **metabolic regulators**
- Combinations of lipid and protein (lipoproteins) are important cellular constituents, occurring both in the cell **membrane** and in the mitochondria, and serving also as the means of **transporting lipids** in the blood.

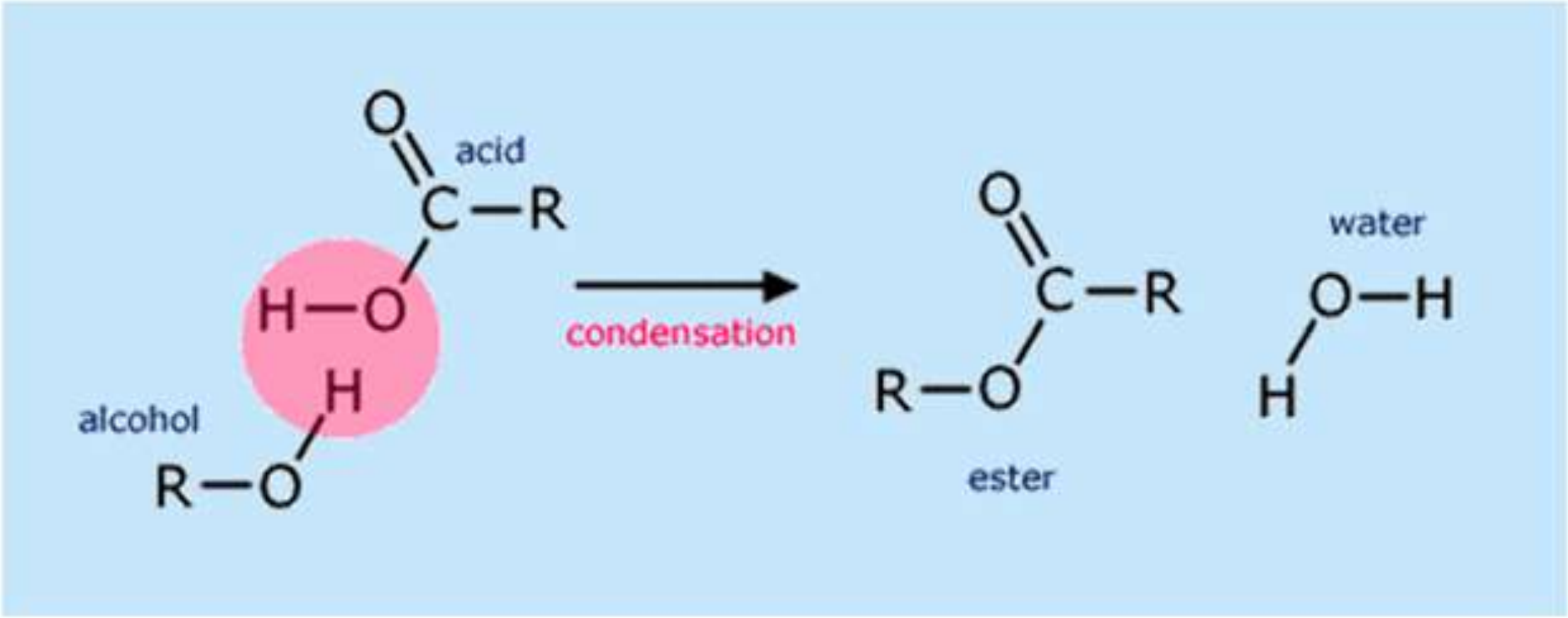
Classification of Lipids

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.

Ester formation



Classification of Lipids(Contd.)

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. They frequently have nitrogen-containing bases and other substituents, eg, in **glycerophospholipids** the alcohol is glycerol and in **sphingophospholipids** the alcohol is sphingosine.

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.

Classification of Lipids(Contd.)

3) Precursor and derived lipids: These include-

- fatty acids
- glycerol
- steroids
- other alcohols
- fatty aldehyde
- ketone bodies
- hydrocarbons, lipid-soluble vitamins, and hormones.

Fatty Acids

- Fatty acids are aliphatic carboxylic acids
- Have the general formula R-(CH2)n-COOH
- They occur mainly as esters in natural fats and oils but do occur in the unesterified form as **free fatty acids,** a transport form found in the plasma.
- Fatty acids that occur in natural fats are usually straight-chain derivatives containing an even number of carbon atoms.
- The chain may be **saturated** (containing no double bonds) or **unsaturated** (containing one or more double bonds).

Classification of Fatty Acids

Fatty acids can be classified in many ways-

1) According to nature of the hydrophobic chain-

a) Saturated
b) Unsaturated
c) Branched chain fatty acids
d) Substituted Fatty acids

Saturated fatty acids do not contain double bonds, while unsaturated fatty acids contain double bonds

Saturated Fatty Acids

- Saturated fatty acids may be envisaged as based on acetic acid (CH_3 —COOH) as the first member of the series in which —CH_2 — is progressively added between the terminal CH_3 — and —COOH groups.
- Fatty acids in biological systems usually contain an even number of carbon atoms, typically between 14 and 24. The 16- and 18-carbon fatty acids are most common.
- The hydrocarbon chain is almost invariably unbranched in animal fatty acids. A few branched-chain fatty acids have also been isolated from both plant and animal sources.

Saturated Fatty Acids

Number of C atoms	Common Name	Systemic Name	Formula
2	Acetic acid	Ethanoic acid	CH3COOH
4	Butyric acid	Butanoic acid	$CH_3(CH_2)_2COOH$
6	Caproic acid	Hexanoic acid	$CH_3(CH_2)_4COOH$
8	Caprylic acid	Octanoic acid	$CH_3(CH_2)_6COOH$
10	Capric acid	Decanoic acid	$CH_3(CH_2)_8COOH$
12	Lauric acid	Dodecanoic acid	$CH_3(CH_2)_{10}COOH$
14	Myristic acid	Tetradecanoic acid	$CH_3(CH_2)_{12}COOH$
16	Palmitic acid	Hexadecanoic acid	$CH_3(CH_2)_{14}COOH$
18	Stearic acid	Octadecanoic acid	$CH_3(CH_2)_{16}COOH$
20	Arachidic acid	Eicosanoic acid	$CH_3(CH_2)_{18}COOH$
22	Behenic acid	Docosanoic acid	$CH_3(CH_2)_{20}COOH$

Unsaturated fatty Acids

Unsaturated fatty acids may further be divided as follows–

(1) Monounsaturated (monoethenoid, monoenoic) acids, containing one double bond.

(2) Polyunsaturated (polyethenoid, polyenoic) acids, containing two or more double bonds.

The configuration of the double bonds in most unsaturated fatty acids is cis.

The double bonds in polyunsaturated fatty acids are separated by at least one methylene group.

TYPES OF FATTY ACIDS
(according to the number of double bonds)

Saturated (No bond)

Monounsaturated (1 bond)

Polyunsaturated (>1 bond)

Nomenclature of Fatty acids

- The systematic name for a fatty acid is derived from the name of its parent hydrocarbon by the substitution of *oic*

for the final *e.*

- For example, the C18 saturated fatty acid is called *octadecanoic acid* because the parent hydrocarbon is octadecane.
- A C18 fatty acid with one double bond is called octadec*enoic* acid; with two double bonds, octadeca*dienoic* acid; and with three double bonds, octadeca*trienoic* acid.
- The notation 18:0 denotes a C18 fatty acid with no double bonds, whereas 18:2 signifies that there are two double bonds.

Nomenclature of Fatty acids(Contd.)

Carbon atoms are numbered from the carboxyl carbon (carbon No. 1). The carbon atoms adjacent to the carboxyl carbon (Nos. 2, 3, and 4) are also known as the α ,β , and γ carbons, respectively, and the terminal methyl carbon is known as theω or n-carbon. The position of a double bond is represented by the symbol Δfollowed by a superscript number.

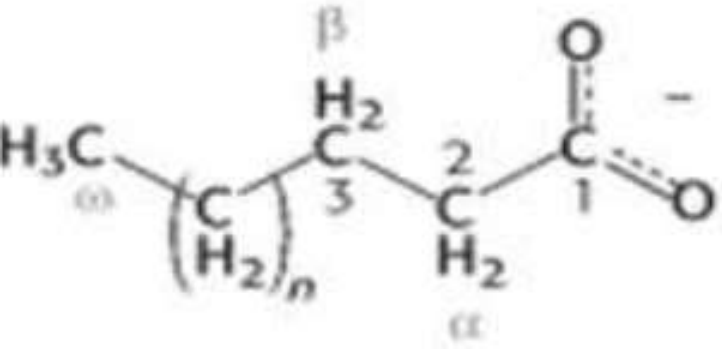
eg, Δ 9 indicates a double bond between carbons 9 and 10 of the fatty acid;

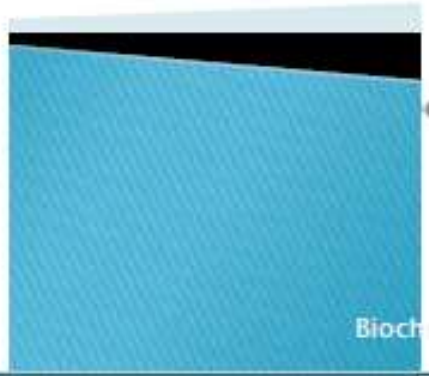
Nomenclature of Fatty acids(Contd.)

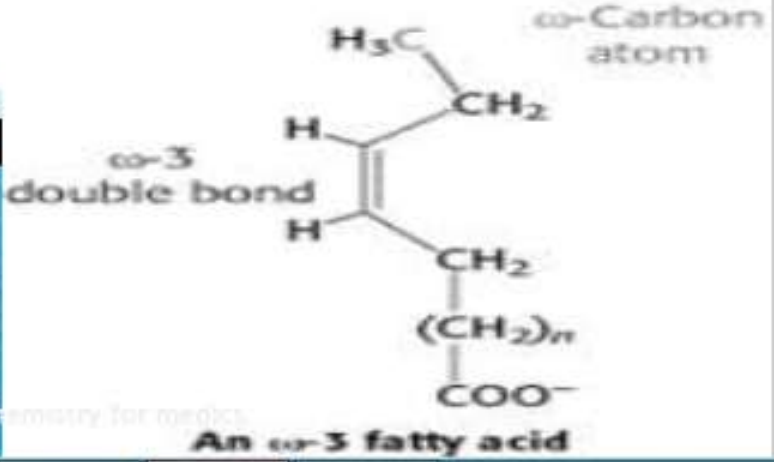
Alternatively, the position of a double bond can be denoted by counting from the distal end, with the ω-carbon atom (the methyl carbon) as number 1.

ω9 indicates a double bond on the ninth carbon counting from the ω-carbon.

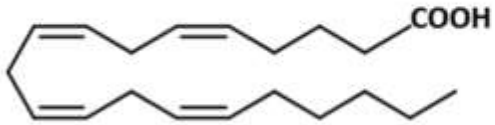
In animals, additional double bonds are introduced only between the existing double bond (eg, 9, 6, or 3) and the carboxyl carbon, leading to three series of fatty acids known as the ω9, ω6, and ω3 families, respectively.



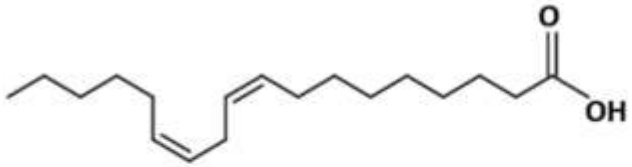




Omega 6

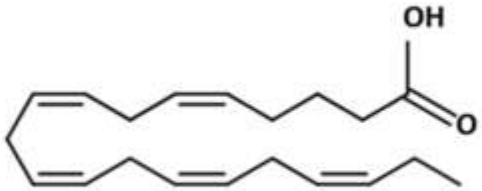


Arachidonic Acid

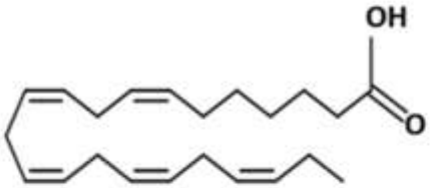


Linoleic Acid

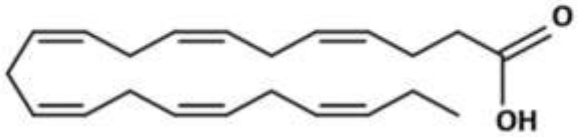
Omega 3



EPA

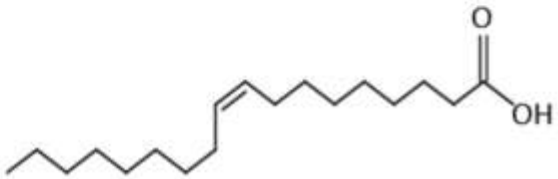


DPA



DHA

Omega 9



Oleic Acid