



HME103-Principles of Nutrition

Components in foods and their relationship with health: Lipids

Lesson Code: HME103-Principles of Nutrition

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LIPIDS

One of the basic organic compounds of living things on Earth is lipids. Lipids are among the essential nutrients of humans and animals. Fats are also lipids.

They are insoluble in water and soluble in organic solvents such as chloroform, benzene, petroleum ether and ether, including oil and similar substances.

Lipids are important sources of nutrients and energy because they are broken down in metabolism and converted into new products.

Apart from C, O and H atoms, they also contain N, P and S, although they are rare.

As a result of burning one gram of them, they give 9.1 kcal of energy. Therefore, they are the most economical energy sources.

They make salt with alkalis. This is called saponification.



CLASSIFICATION OF LIPIDS

- Simple lipids:
Oils, waxes, color waxes, sterol esters, esters of triterpenic alcohols
- Compound lipids:
 - Phospholipids: Lecithin, cephalin, sphingomyelin-
 - Glycolipids (cerebrosides)
 - Lipoproteins
- Lipid-like substances: Sterols (cholesterol analogs), lipovitamins, hydrocarbons, pro- and antioxidants, lipochromes

The Functions of Fats in Body Work

- They provide energy. They provide the body with more than twice as much energy as carbohydrates and proteins. In other words, fats provide approximately 9 kcal per gram, while carbohydrates provide 4 kcal per gram.
- They are carriers of fat-soluble vitamins A, D, E and K.
- They ensure the intake of essential fatty acids necessary for growth and normal metabolic events.
- They leave the stomach late. Therefore, they help create the feeling of satiety.
- They surround and support the organs and protect them against external factors.
- They prevent heat loss from the body. They are one of the building materials of the cell.
- Essential fatty acids that cannot be synthesized in the body are taken with the fats found in the food.



Fat sources

Vegetable oil sources: Oil obtained from plants is referred to as vegetable oil or by the name of the plant from which it is obtained such as olive oil, sunflower oil, and corn oil.

Vegetable oils are unsaturated fats. Foods such as walnuts, hazelnuts and peanuts are also rich in fat and contain unsaturated fat.

Vegetable oils consist of mono and polyunsaturated fatty acids. Olive oil and hazelnut oil contain monounsaturated fatty acids, while other vegetable oils (sunflower, corn germ, soy) contain polyunsaturated fatty acids.



Fat sources

- **Sources of animal fat:** Besides visible fats such as butter, suet, and tail fat, there are also fats in animal-derived foods such as all kinds of meat, chicken, fish, milk, and eggs.

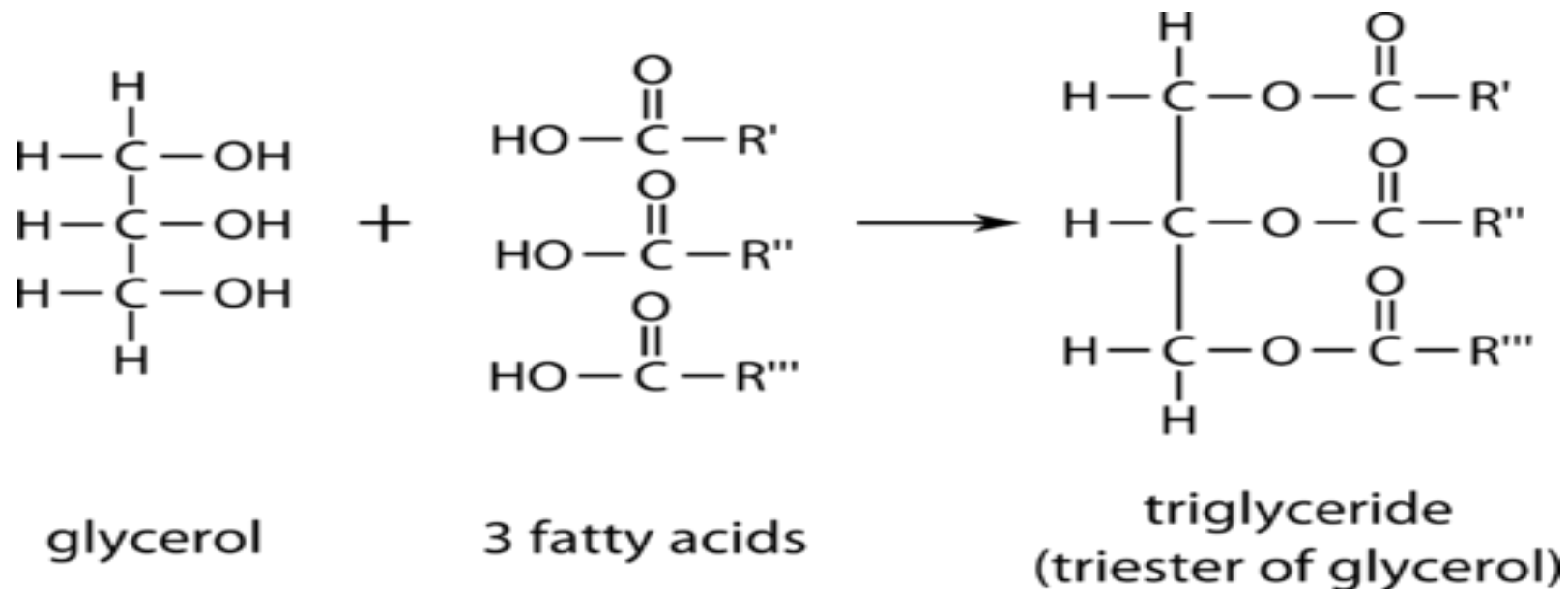


FATS AND CONSTITUENTS

Almost all fats and oils are triglycerides, which are formed by the esterification of fatty acids (R-COOH) and glycerol [$C_3H_5(OH)_3$], a trivalent alcohol.

Triglyceride (fat) formation

Fats are esters (glycerides) made of fatty acids with glycerol, a trivalent alcohol.



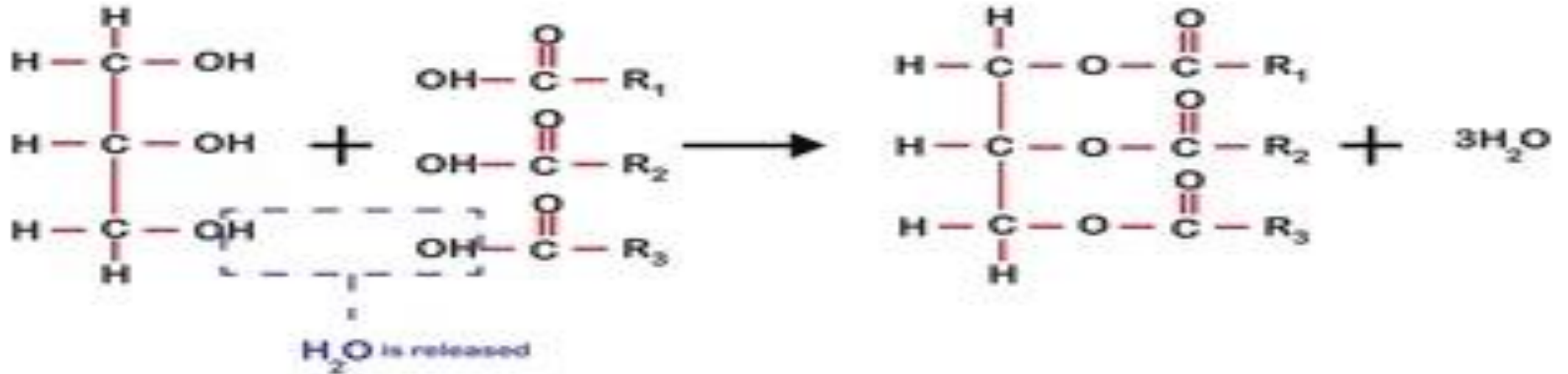
Chemical reaction

TRIGLYCERIDES

glycerol

3 fatty acids

triglycerides

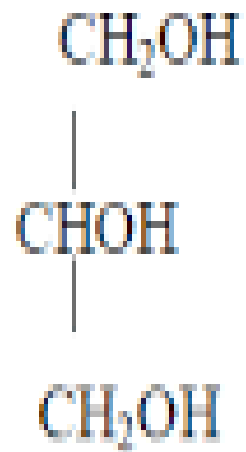


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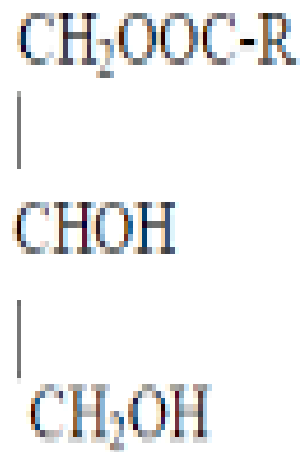
If the 3 OH groups (alcohol group) of the glycerol molecule are esterified with 3 molecules of fatty acids, it is called **triglyceride**.

If all 3 of these 3 molecules of fatty acids are the same fatty acid, it is called **simple triglyceride**; if at least one of them is different, it is called **mixed triglyceride**.

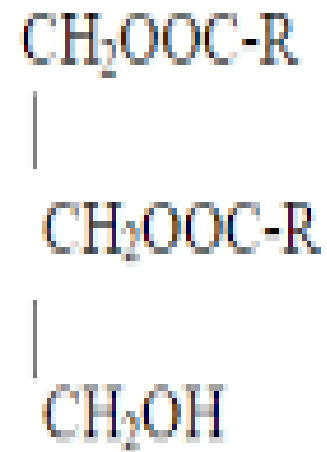
Additionally, if 2 of the OH groups of glycerol are esterified with fatty acids, it is called **diglyceride**, and if one is esterified, it is called **monoglyceride**.



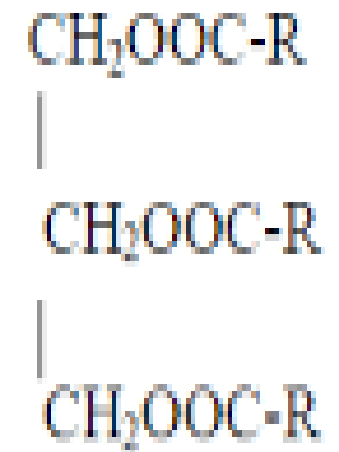
Gliserol



Monogliserit



Digliserit



Trigliserit

Naming Fatty Acids

- Standard naming:

20:4 n6

Carbon chain length

Number of double bonds

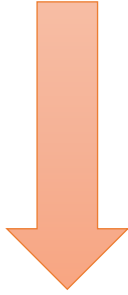
Position of double bonds

n-definition or
W-definition

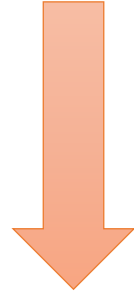
20:4 Δ 5,8,11,14

Δ -definition

Display of fatty acids



C number



Double Bond Number

10:0 (10 C, no double bonds, 0)

18:1 (18 C, there is a single double bond)

20:4 (20 C, There are 4 double bonds)

Fatty acids



They are classified according to their various characteristics

According to the number of C

1. Short chain
2. Medium chain
3. Long chain

According to the double bonds between C atoms

1. Saturated
 2. Unsaturated
 - Monounsaturated
 - Polyunsaturated
- n-6, n-3 or
w-6, w-3

According to the state of synthesis in the human body

1. Essential
2. Non-essential



Classification of fatty acids according to the number C

1. Short Chain Fatty Acids <6 C
(2,4 C)
2. Medium Chain Fatty Acids at 6-10 C
(6, 8, 10 C)
3. Long Chain Fatty Acids >10 C
(12 C and above)

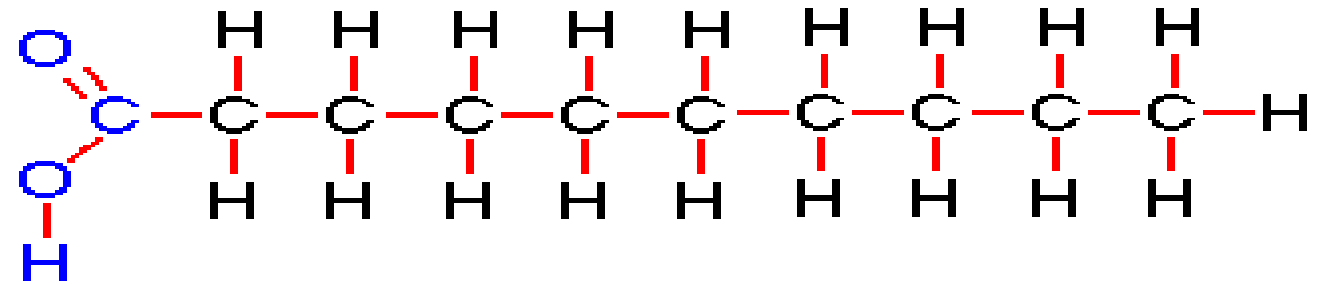
2a. Saturated Fatty Acids:

They are fatty acids that **do not contain double bonds** in their structure.

Since each carbon atom is bonded with hydrogen, they cannot absorb any other hydrogen into their structure.

Their general formula is $C_nH_{2n}O_2$.

Oils containing high amounts of saturated fatty acids are generally solid.



Saturated fatty acid



- Saturated fatty acids can be synthesized in the human body.
- Even if no fat is eaten, these types of fatty acids can be synthesized from molecules formed by carbohydrate and protein metabolism.
- When taken in excess, they increase cholesterol levels and pose risk factors for heart diseases, cancer and obesity.



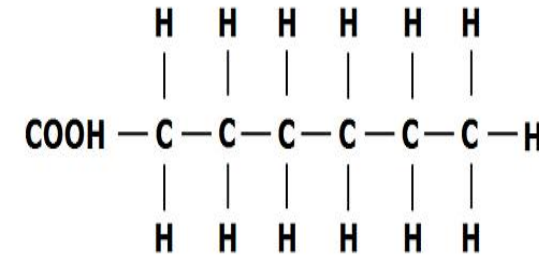


Saturated fatty acids

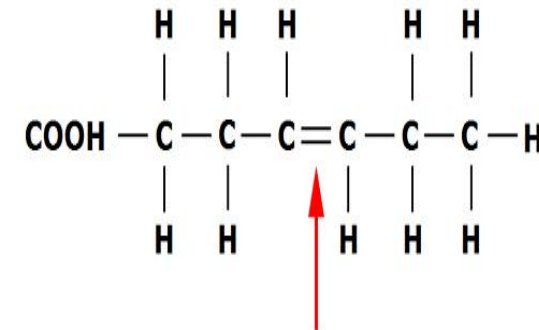
Name of fatty acid	Carbon skeleton	Formula
Acetic acid	2: 0	CH_3COOH
Propionic acid	3: 0	$\text{CH}_3\text{CH}_2\text{COOH}$
Butyric acid	4: 0	$\text{CH}_3(\text{CH}_2)_2\text{COOH}$
Caproic acid	6: 0	$\text{CH}_3(\text{CH}_2)_4\text{COOH}$
Caprylic acid	8: 0	$\text{CH}_3(\text{CH}_2)_6\text{COOH}$
Capric acid	10: 0	$\text{CH}_3(\text{CH}_2)_8\text{COOH}$
Lauric acid	12: 0	$\text{CH}_3(\text{CH}_2)_{10}\text{COOH}$
Myristic acid	14: 0	$\text{CH}_3(\text{CH}_2)_{12}\text{COOH}$
Palmitic acid	16: 0	$\text{CH}_3(\text{CH}_2)_{14}\text{COOH}$
Stearic acid	18: 0	$\text{CH}_3(\text{CH}_2)_{16}\text{COOH}$
Arachidic acid	20: 0	$\text{CH}_3(\text{CH}_2)_{18}\text{COOH}$
Bahenic acid	22: 0	$\text{CH}_3(\text{CH}_2)_{20}\text{COOH}$
Lignoceric acid	24: 0	$\text{CH}_3(\text{CH}_2)_{22}\text{COOH}$
Serotic acid	26: 0	$\text{CH}_3(\text{CH}_2)_{24}\text{COOH}$

2b. Unsaturated Fatty Acids

- They are found in natural oils
- They contain **one, two or more double bonds** between C atoms in the molecule.
- They are the best sources of essential fatty acids that the body needs.
- Oils containing large amounts of unsaturated fatty acids are generally liquid at room temperature.
- Unsaturated fatty acids are common in vegetable oils, olives and oily fish.
- Unsaturated fatty acids are easily oxidized because they contain double bonds. For this reason, it is easy for the oil to spoil.
- If they are hydrogenated, the double bonds are opened and hydrogen is added to them, turning them into saturated fatty acids.



Saturated fat
(No double bonds)



Unsaturated fat
(There is double bond)

Unsaturated fatty acids

Name of fatty acid	Carbon skeleton	Formula
Myristoleic acid	14: 1 Δ^9	CH ₃ (CH ₂) ₃ CH=CH(CH ₂) ₇ COOH
Palmitoleic acid	16: 1 Δ^9	CH ₃ (CH ₂) ₅ CH=CH(CH ₂) ₇ COOH
Oleic acid	18: 1 Δ^9	CH ₃ (CH ₂) ₇ CH=CH(CH ₂) ₇ COOH
Vaccenic acid	18: 1 Δ^{11}	CH ₃ (CH ₂) ₅ CH=CH(CH ₂) ₉ COOH
Nervonic acid	24: 1 Δ^{15}	CH ₃ (CH ₂) ₇ CH=CH(CH ₂) ₁₃ COOH
Linoleic acid	18: 2 $\Delta^{9, 12}$	CH ₃ (CH ₂) ₄ CH=CHCH ₂ CH=CH(CH ₂) ₇ COOH
Linolenic acid	18: 3 $\Delta^{9, 12, 15}$	CH ₃ CH ₂ CH=CHCH ₂ CH=CHCH ₂ CH=CH(CH ₂) ₇ COOH
Arachidonic acid	20: 4 $\Delta^{5, 8, 11, 14}$	CH ₃ (CH ₂) ₄ CH=CHCH ₂ CH=CHCH ₂ CH=CHCH ₂ CH=CH(CH ₂) ₃ COOH

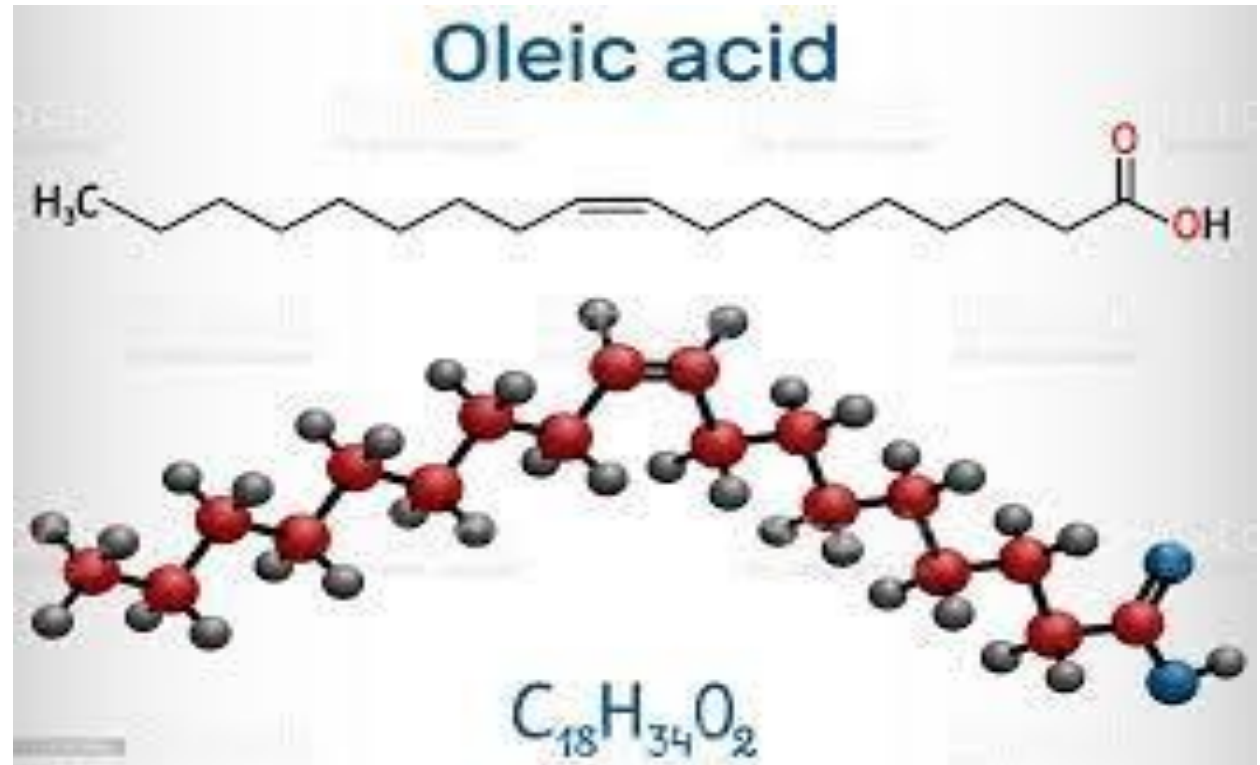


Unsaturated Fatty Acids

- Unsaturated fatty acids (Unsaturated Fatty Acids).
 - a. Mono Unsaturated Fatty Acids
 - MUFA. Contains a single double bond.
 - b. Polyunsaturated (Poly Unsaturated Fatty Acids)
 - PUFA. Contains more than one double bond.

Monounsaturated Fatty Acids (MUFA) $C_nH_{(2n-2)}O_2$

- Myristoleic Acid (14:1)
- Palmitoleic Acid (16:1)
- Oleic acid (18:1)



Polyunsaturated

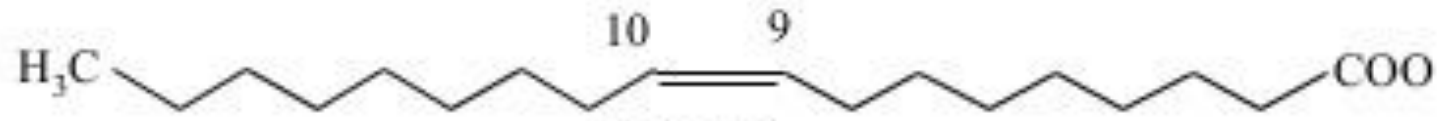
Fatty (PUFA)

Acids

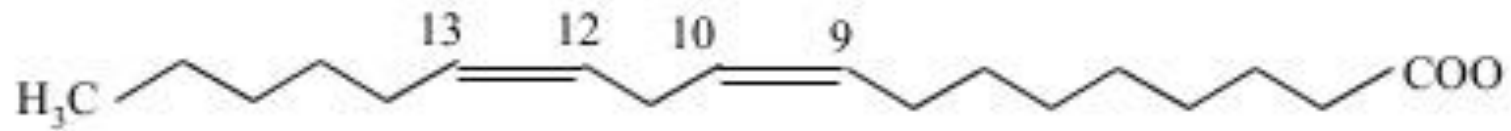
There is more than 1 double bond in the C chain.

- Linoleic acid [C18:2 (w-6); 2 double bonds with 18 C atoms],
- Linolenic acid [C18:3 (w-3); 18 C atoms and 3 double bonds],
- Arachidonic acid (C20:4 (w-6) with 20 C atoms and 4 double bonds),
- Eicosapentaenoic acid (EPA; C20:5 (w-3); 20 C atoms and 5 double bonds),
- Docosahexaenoic acid (DHA; C22:6 (w-3); 22 C atoms and 6 double bonds).

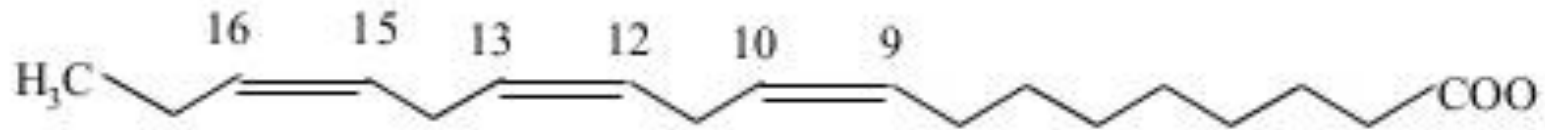




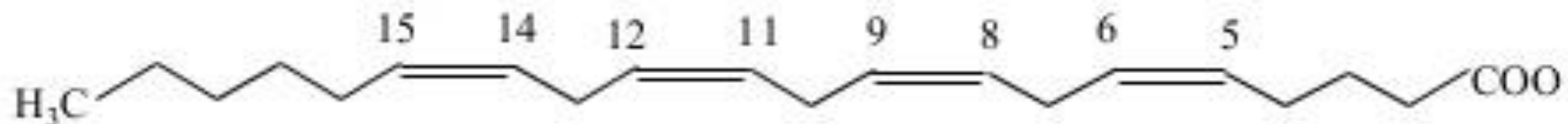
OLEIC ACID



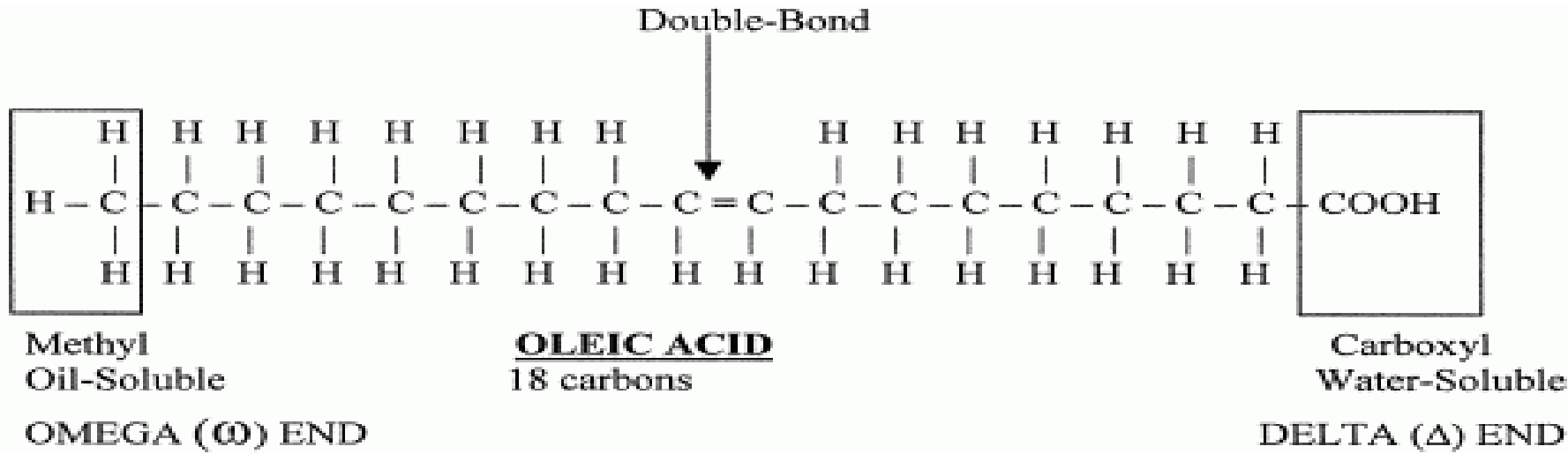
LINOLEIC ACID



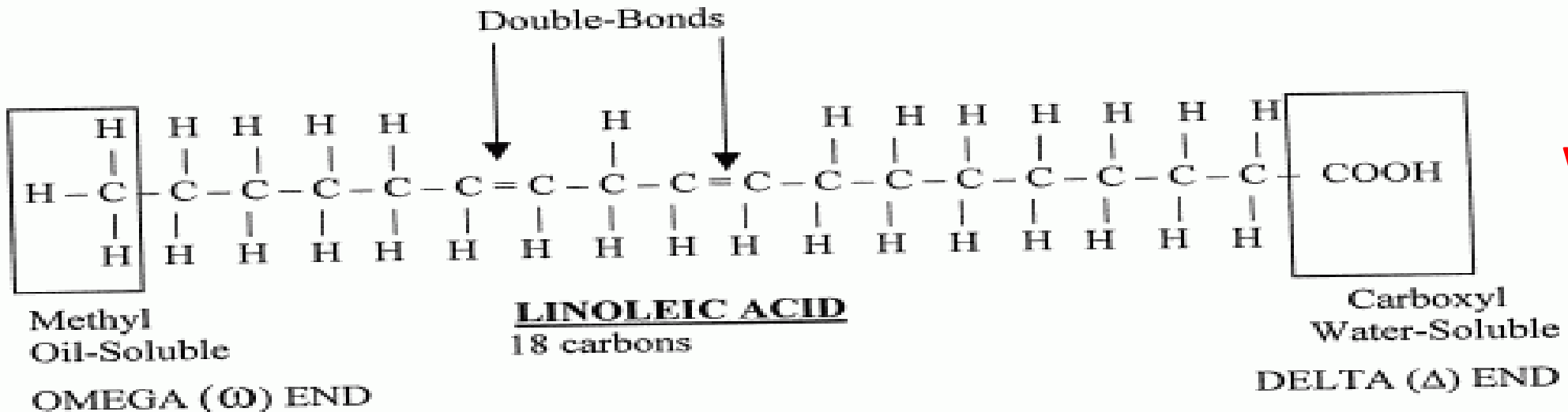
LINOLENIC ACID



ARACHIDONIC ACID

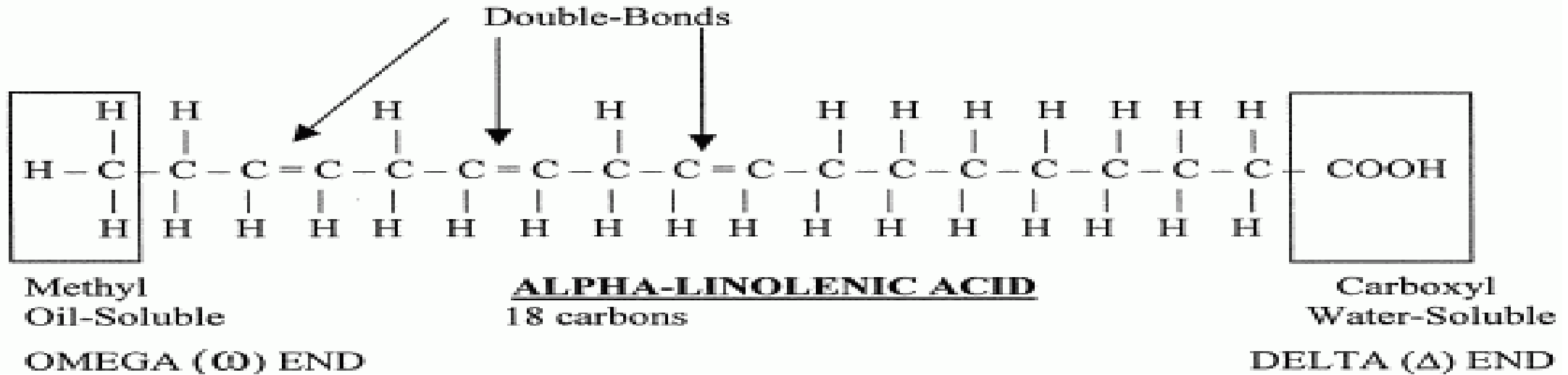


W-9

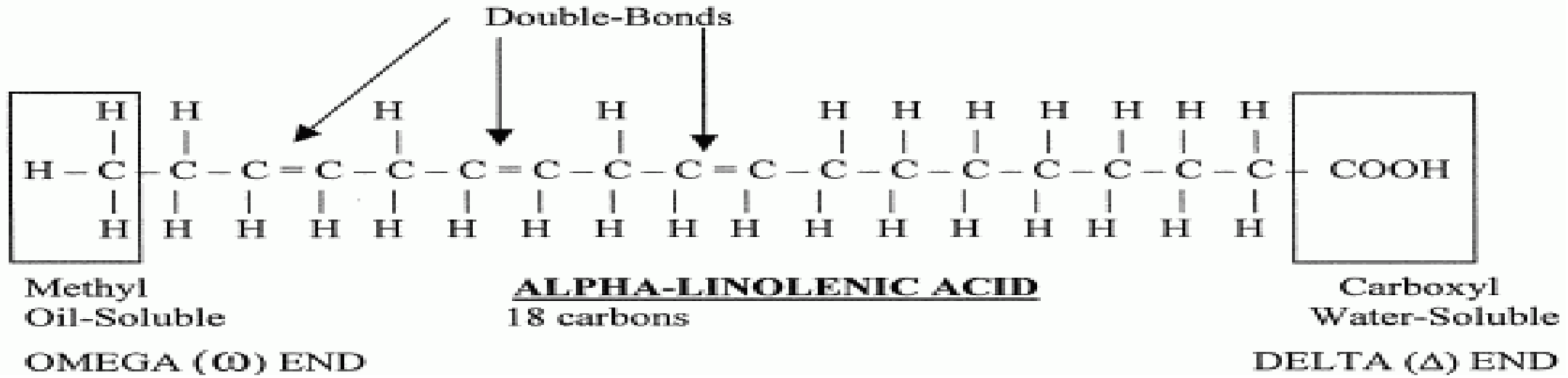


W-6

Question: W ???



Answer



W-3