Study Of Derived Lipids

Study Of Fatty Acids

FATTY ACIDS(FAs)

Class- Derived Lipids

BASIC COMPONENT OF LIPID FORMS

What are Fatty Acids?

Fatty Acids Are Derived Lipids

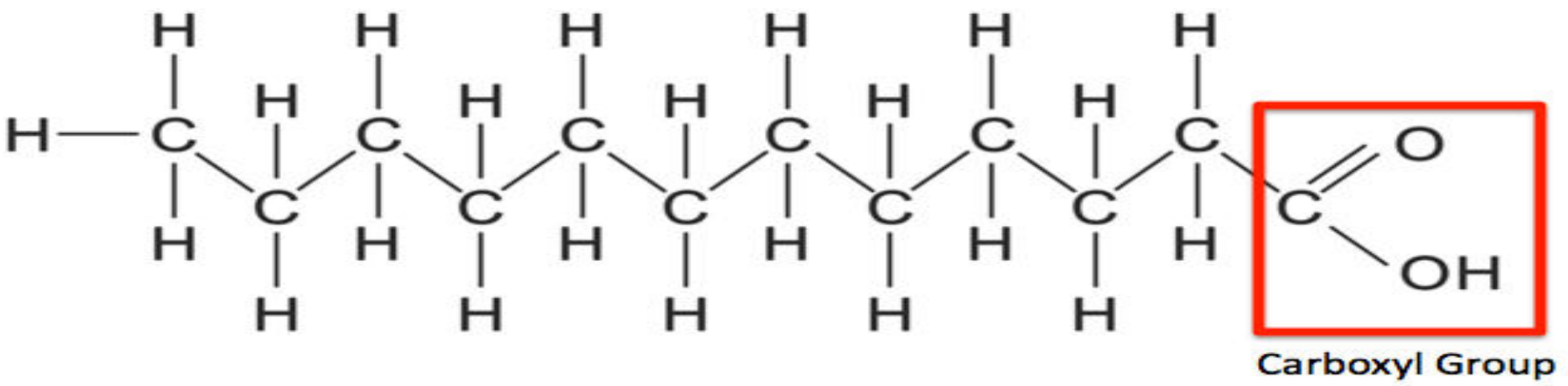
- **Fatty acids are of Class Derived Lipids:**
  - **Since Fatty acids** are **Hydrolytic products of Simple and Compound Lipids**.

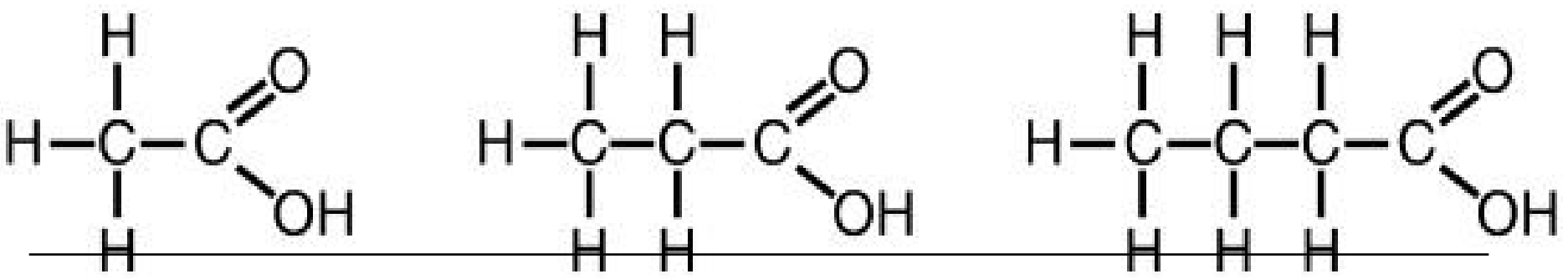
Fatty Acids (FA)

- **Fatty Acids (FA) are relatively or potentially related to various Lipid structures.**
  - **Simple Lipids**
  - **Compound Lipids**
  - **Derivatives of Lipids**

Structure And Chemical Nature Of Fatty Acids

Chemical Structure Of Fatty Acids





Fatty acid Structures Has Varied Hydrocarbon Chains

- The **Hydrocarbon chain** of each Fatty acid is of **varying chain length (C2 - C26).**

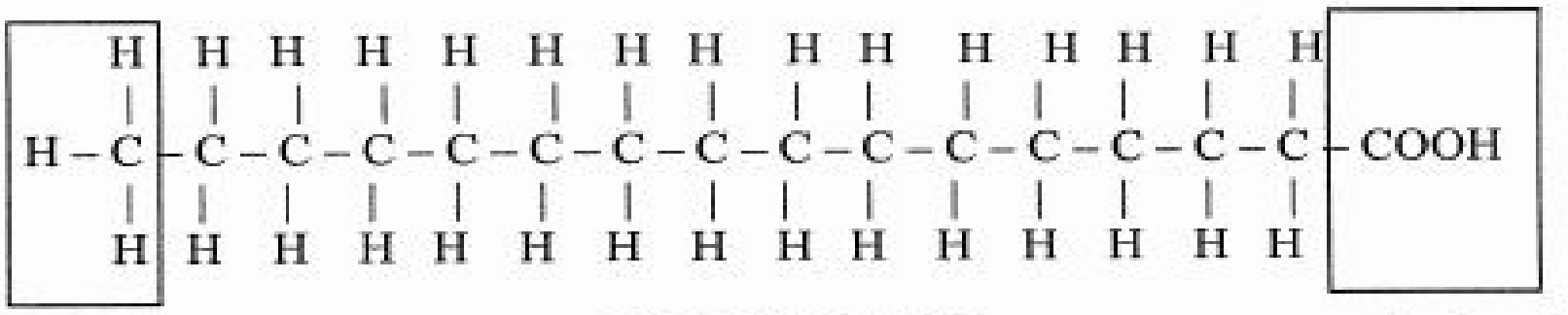
Human Body Fatty Acid From C2-C26

S.No	Fatty Acid Name	Fatty Acid Structure has Carbon atoms
1	Acetic Acid	C2
2	Propionic Acid	C3
3	Butyric Acid	C4
4	Valeric Acid	C5
5	Palmitic	C16
6	Stearic	C18
7	Oleic	C18

S.No	Fatty Acid Name	Fatty Acid Structure
8	Linoleic Acid	C18
9	Arachidic Acid	C20
10	Arachidonic Acid	C20
11	Behenic acid	C22
12	Lignoceric acid	C24
13	Cerotic acid	C26

- **Fatty acid** structure have **two ends**:
  - **Carboxylic group**(-COOH) at one end (**Delta end denoted as Δ/Alpha end α)**
  - **Methyl group** (-CH3) at another end (**Omega end denoted as ω)**

Carboxylic Acid Functional Group Of Fatty Acid



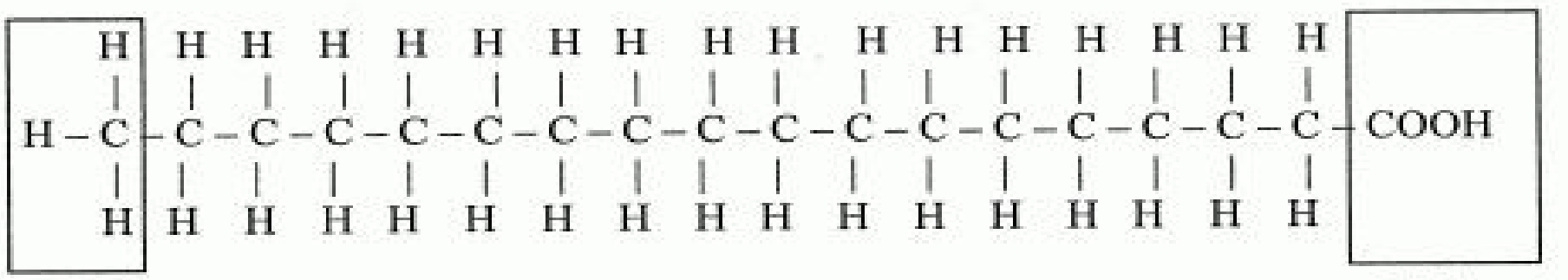
Methyl
Oil-Soluble

OMEGA (ω) END

PALMITIC ACID
16 carbons

Carboxyl
Water-Soluble

DELTA (Δ) END



Methyl
Oil-Soluble

STEARIC ACID
18 carbons

Carboxyl
Water-Soluble

OMEGA (ω) END DELTA (Δ) END

Definition of Fatty acids

Fatty Acids are Defined as:

- **Fatty acids are chemically Organic acids**
- With **Aliphatic Hydrocarbon chain (of varying length C2 to C26)** with **Mono terminal Carboxylic acid group as functional group.**

Different Forms Of Fatty acids In Body

Free Fatty acid /Unesterified Fatty acid

- Fatty acid who **has free Carboxylic group**
- Fatty acid not reacted and linked to an Alcohol by an Ester bond.

Esterified Fatty acid/Bound form of Fatty Acid

- Fatty acid **has no free Carboxylic group**
- **Fatty acid is linked to an Alcohol** with an **Ester bond.**

Classification of Fatty acids
Biomedically Important Fatty Acids

Based On Six Different Modes:

- **Classification of FAs Based on Six Modes:**

1. **Total number of Carbon atoms** in a Fatty acid structure
2. **Hydrocarbon chain length** of Fatty acid
3. **Bonds present** in Fatty acid
4. **Nutritional requirement** of Fatty acid
5. **Chemical Nature and Structure** of Fatty acids
6. **Geometric Isomerism of UFAs**

Fatty acids Based on Total Number of Carbon atoms

- **Even numbered Carbon** Atom **Fatty acids (2,4,6,8,16,18,20 etc)**
- **Odd numbered Carbon** Atom **Fatty acids (3,5,7,---)**

- Most **naturally occurring /human body** Fatty acids are **even carbon numbered FAs.**

- Since **biosynthesis of Fatty acids uses 2 Carbon units Acetyl-CoA (C2)**.

- **Examples of Even Carbon Numbered Fatty acids:**
  - **Butyric Acid (C4)**
  - **Palmitic Acid (C16)**
  - **Stearic Acid (C18)**
  - **Oleic Acid (C18)** **(Most Common)**
  - **Linoleic acid (C18)**
  - **Linolenic Acid (C18)**
  - **Arachidic acid (C20)**
  - **Arachidonic acid (C20)**

- **Odd Carbon numbered Fatty acids** are **less related to human body**

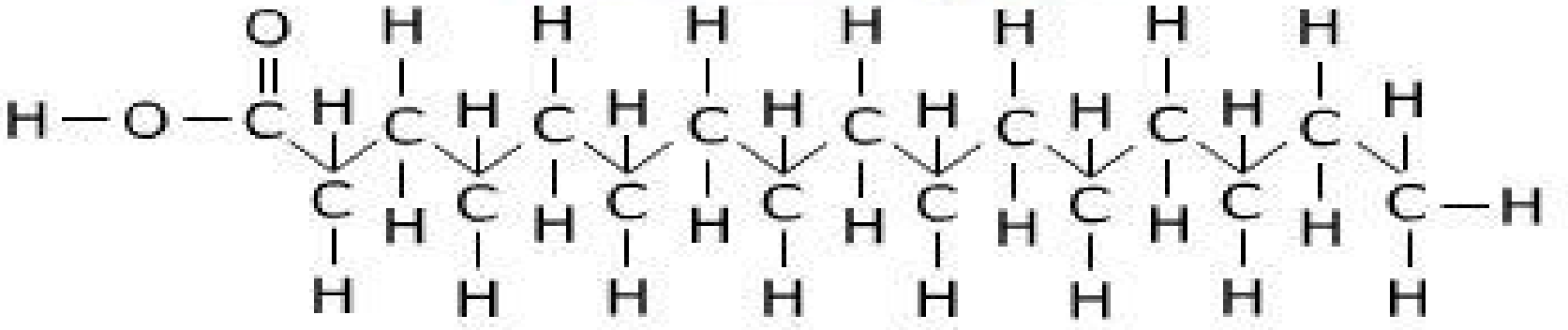
- **Example of Odd carbon Fatty acid associated to human body**

  –**Propionic Acid (3C)**

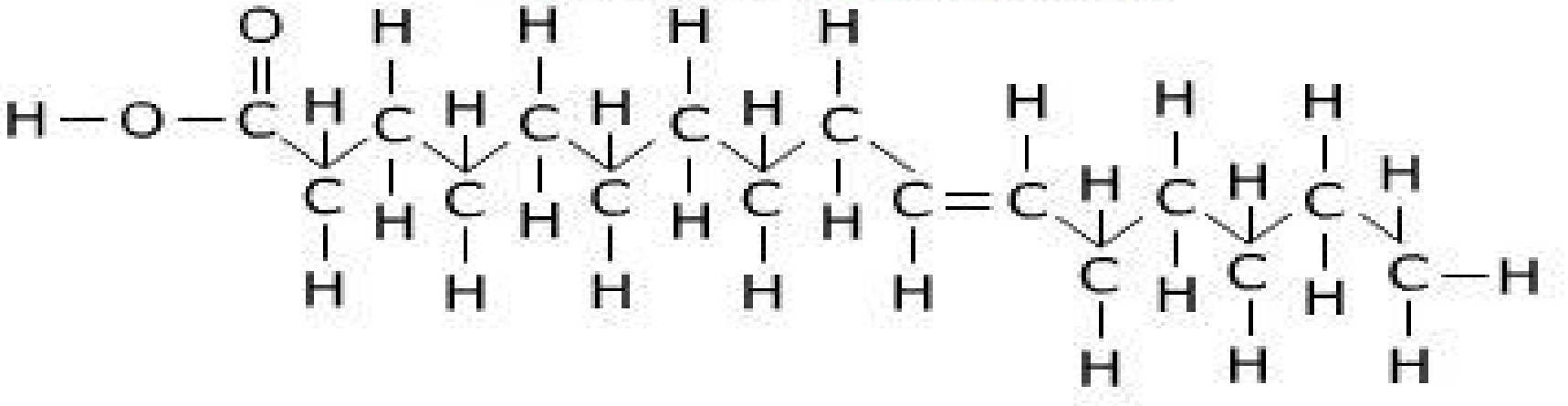
Fatty acids Based on Nature and Number of Bonds present

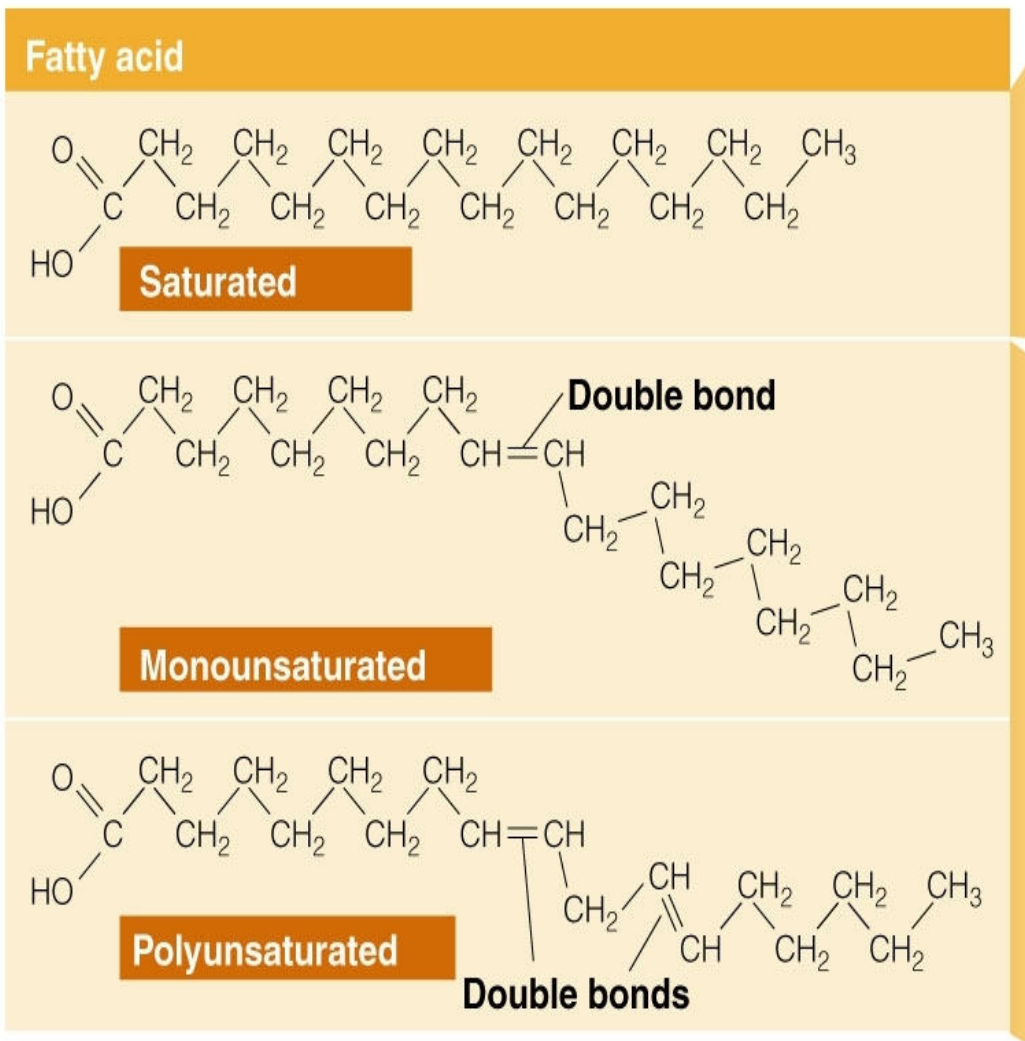
Fatty Acids

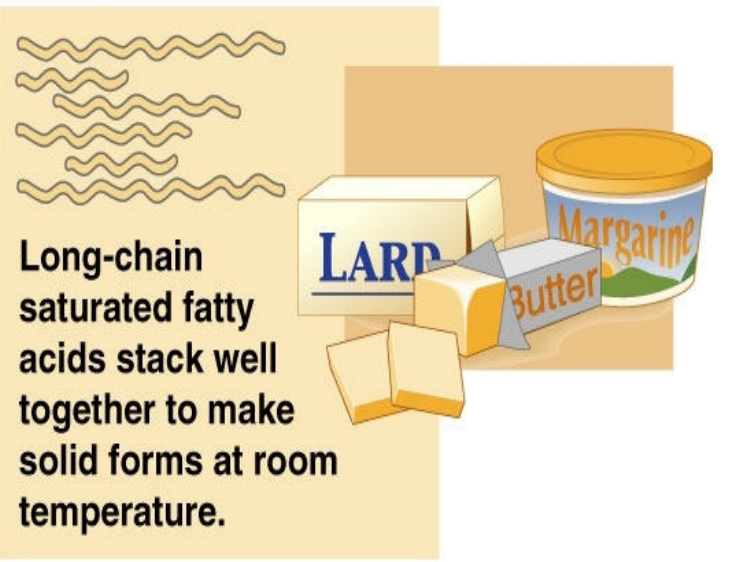
Saturated Fatty Acids

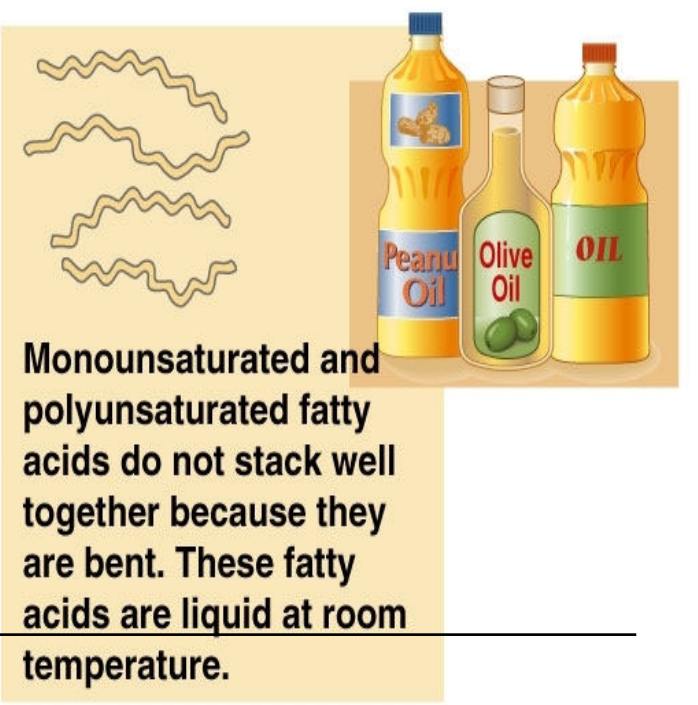


Unsaturated Fatty Acids









- **Saturated Fatty acids(SFAs)**

- Fatty acids having **single bonds** in hydrocarbon chain structure.
- **Examples**:
  - **Acetic acid (C2)**
  - **Butyric acid (C4)**
  - **Palmitic acid (C16)**
  - **Stearic acid (C18)**
  - **Arachidic acid(C20)**

- **Unsaturated Fatty acids (UFAs)**

- Fatty acids having **double bonds** in its structure.

- **Types of UFAs:**

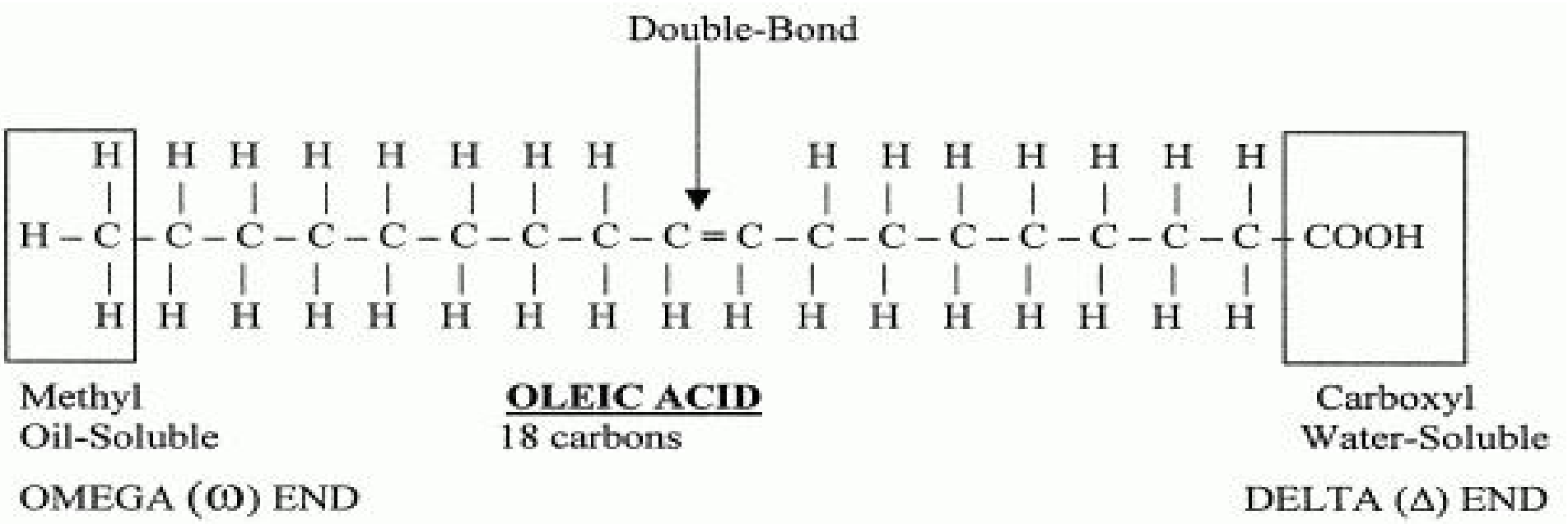
- **Monounsaturated Fatty acids (MUFAs)**

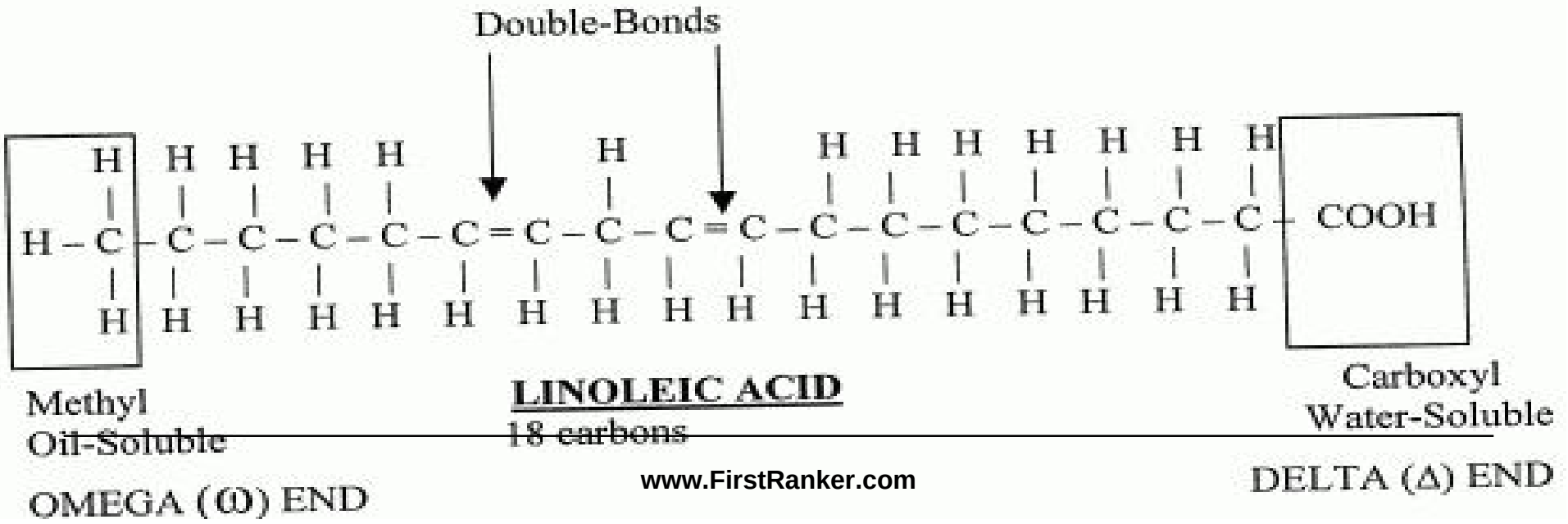
- **Polyunsaturated Fatty acids (PUFAs)**

- Human body have **no Enzyme system to introduce double bond beyond Carbon atom 10** in the hydrocarbon chain.

- Hence **PUFAs are not biosynthesized**

in human beings.





- **Monounsaturated Fatty Acids(MUFAs):**

- **MUFAs h**ave **one double bond** in a fatty acid structure

- **Examples of MUFAs :**
  - **Palmitoleic acid (C16:1;9) (ω7)**
  - **Oleic acid (C18:1;9)(ω9)**
  - **Erucic acid (C22:1;9)(ω9)**

- **Poly Unsaturated Fatty Acids (PUFAs):**

- UFAs with **two or more double bonds in** the structure are termed as **PUFAs.**

- **Examples Of PUFAS:**

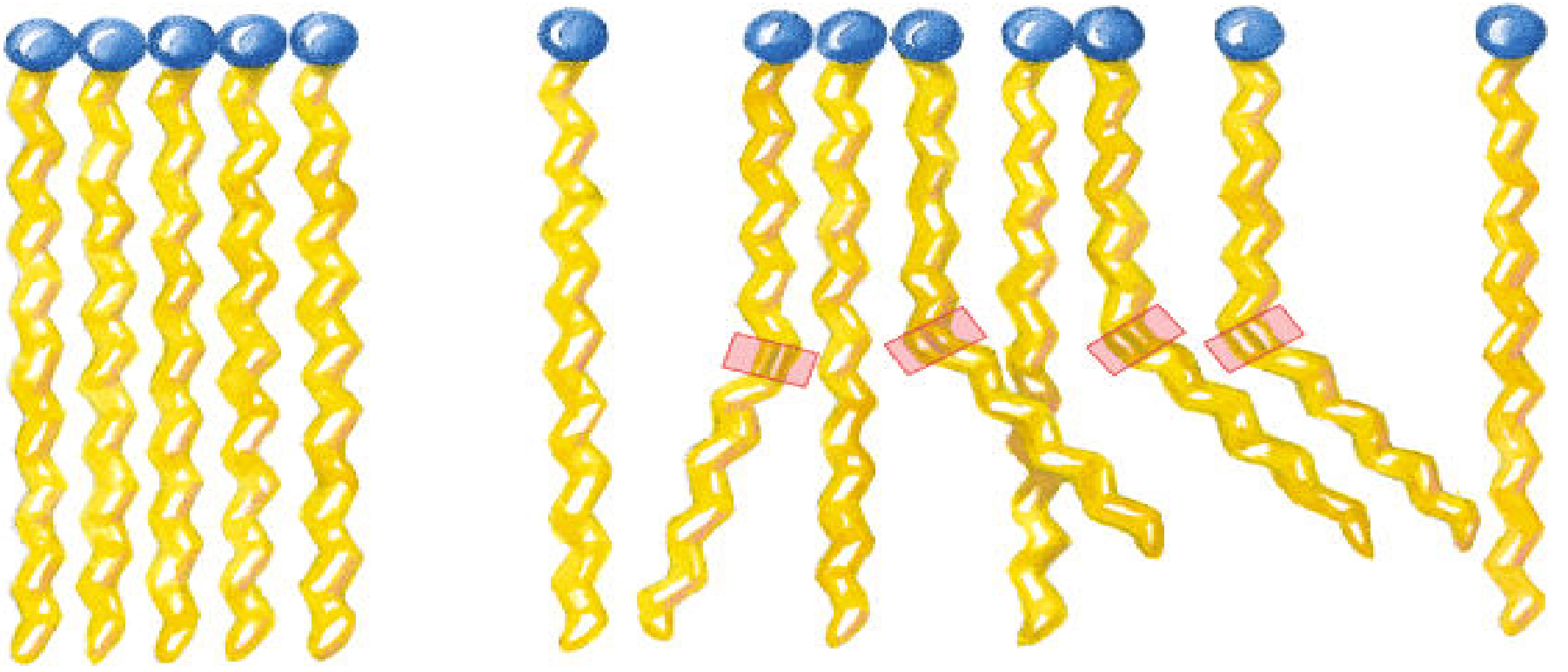
- **Linoleic(18:2;9,12) (ω6)**
- **Linolenic(18:3;9,12,15) (ω3)**
- **Arachidonic(20:4;5,8,11,14) (ω6)**
- **Timnodonic (20:5;5,8,11,14,17) (ω3)**
- **Cervonic/Docosa Hexaenoic acid(DHA)(22:6;4,7,10,13,16,19) (ω3)**

- **Remember Unsaturated Fatty acids**

- **Double bonds are:**
  - **Weaker /unstable bonds.**
  - **Get easily cleavable/metabolized**
  - **More the degree of Unsaturation** in Fatty acids.
  - **More is the unstability** of Fatty acids.

- **Saturated Fatty acids** structures are **Straight.**

- **Unsaturated Fatty acids** structures are **bent** (Kink).



Saturated fatty acids

(c)

Mixture of saturated and unsaturated fatty acids

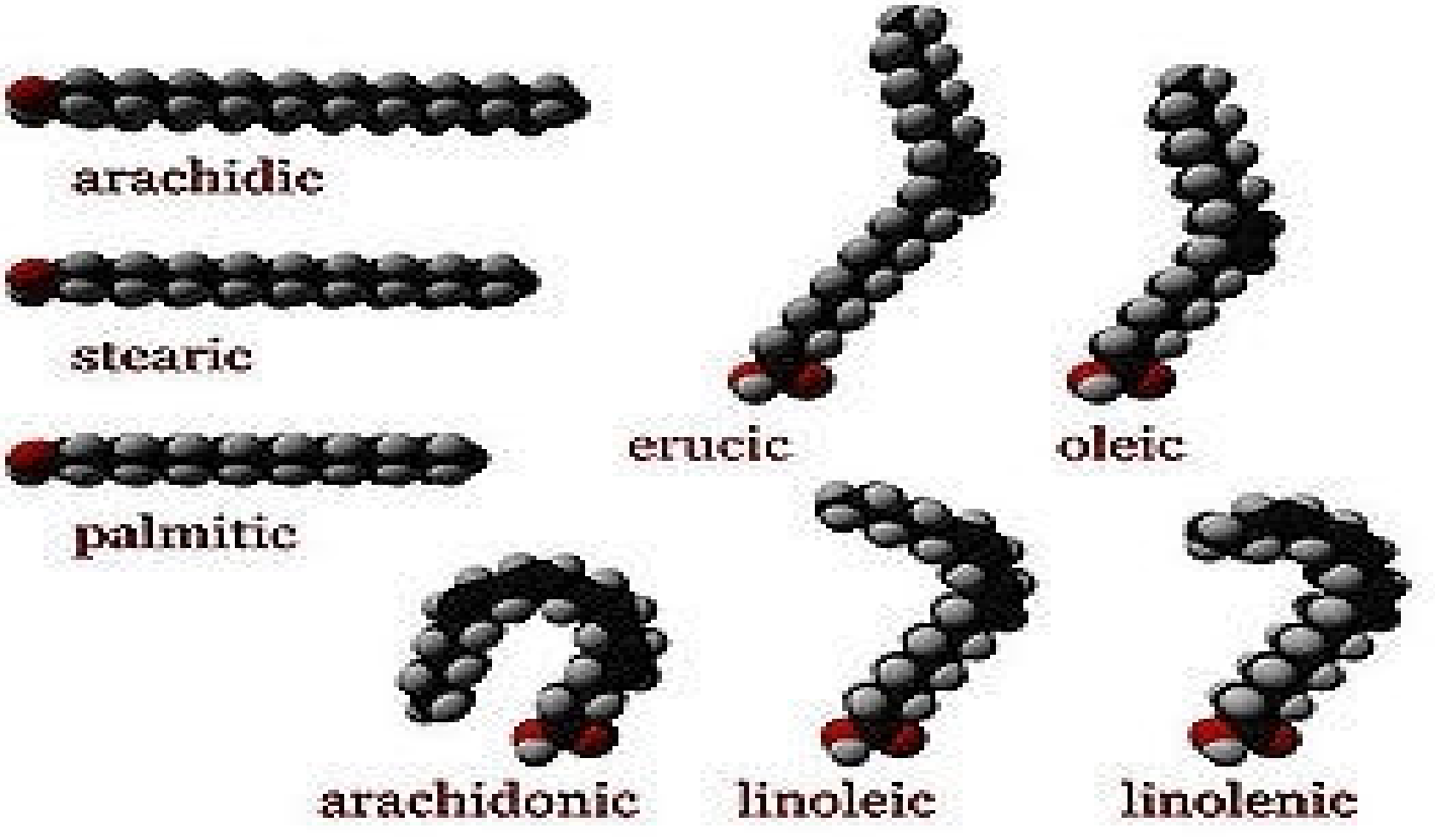
(d)

- **Saturated** FAs: with **straight structures** are **tightly packed together**.

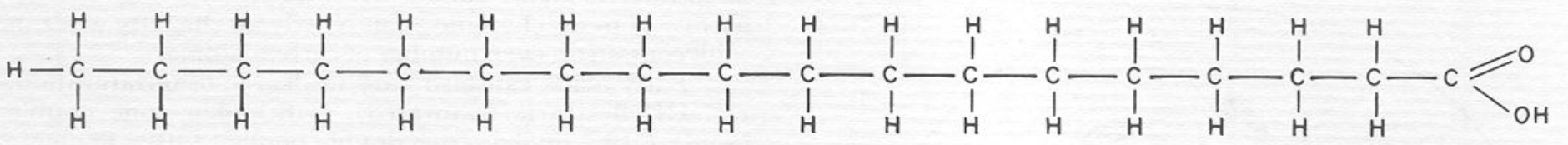
- **Unsaturated FAs:** with **bent structures** are **not compact** and has **no tight packing.**

- **More the degree of unsaturation in FA/More double bonds in FA structure**

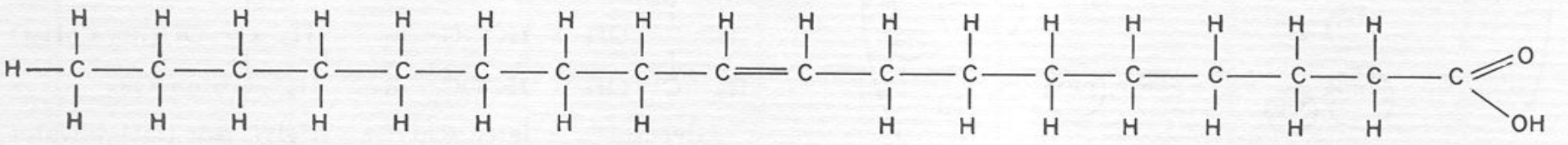
- **More is the bent** of Fatty acid structure.



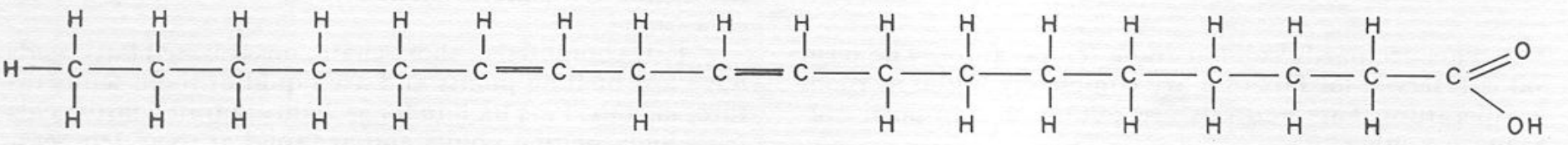
Stearic acid CI8:0



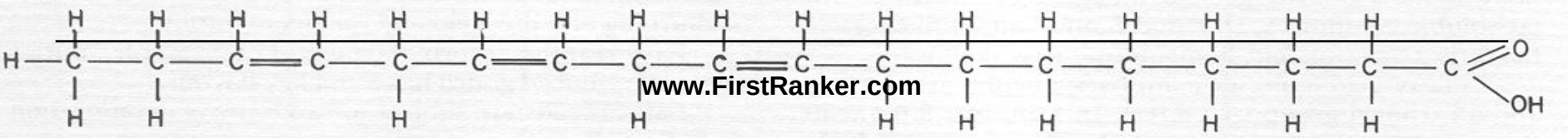
Oleic acid CI8:1



Linoleic acid CI8:2



Linolenic acid CI8:3



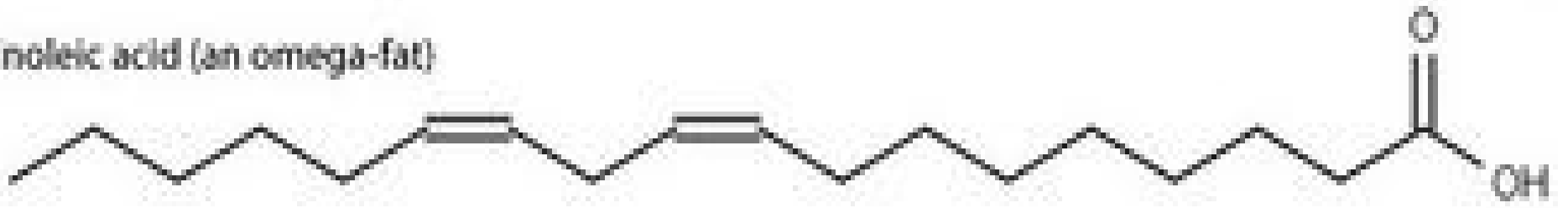
A

The mono-unsaturated fat oleic acid

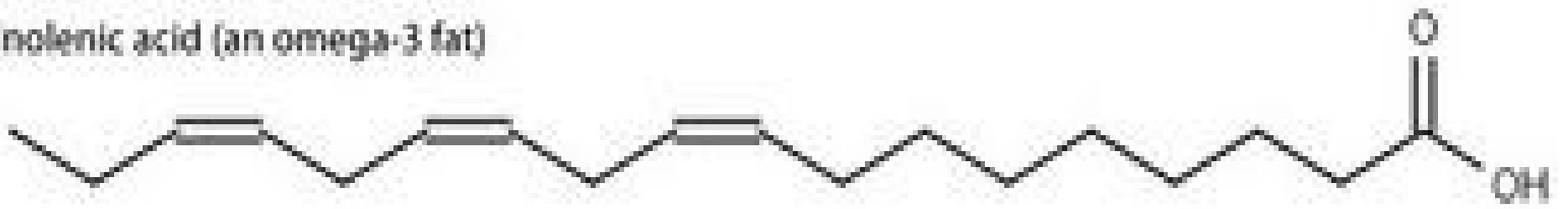
An 18 carbon saturated fatty acid-stearic acid

B

Linoleic acid (an omega-fat)



Linolenic acid (an omega-3 fat)



Fatty acids Based on the Nutritional Requirement

Nutritionally Essential Fatty acids

–Nutritionally Essential Fatty acids:

–Fatty acids **not biosynthesized in human body and indispensable through** nutrition/diet are termed as Essential Fatty acids.

–**PUFAS are nutritionally essential Fatty acids**.

Examples of Essential Fatty Acids/PUFAs:

- Linoleic
- Linolenic
- Arachidonic acids
- Timnodonic and
- Cervonic

Nutritionally Non Essential Fatty acids

- **Nutritionally Non essential Fatty acids:**

- Fatty acids which are **biosynthesized in the body** and are nutritionally non essential Fatty acids.

  – **Saturated Fatty acids and MUFAs are non essential Fatty acids.**

Examples Of Non Essential Fatty Acids

- **Palmitic**
- **Stearic**
- **Oleic acid**

Based on Geometric Isomerism of Unsaturated Fatty acids

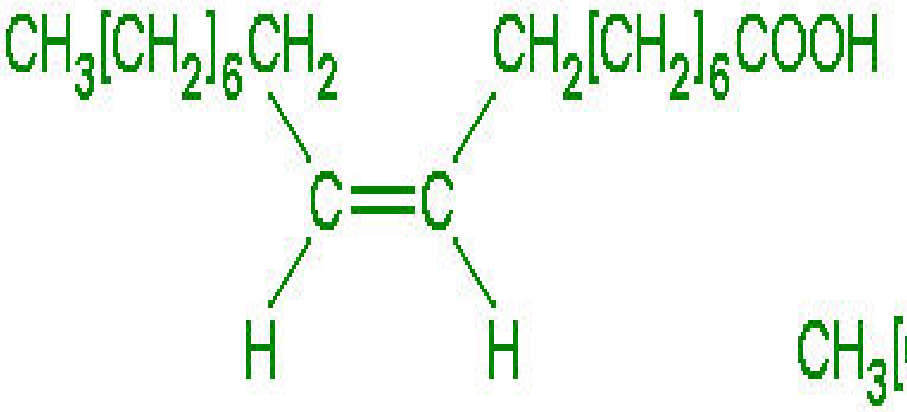
- **Cis Fatty Acids:**

The **Groups around double bond** of Unsaturated FAs are on **same side.**

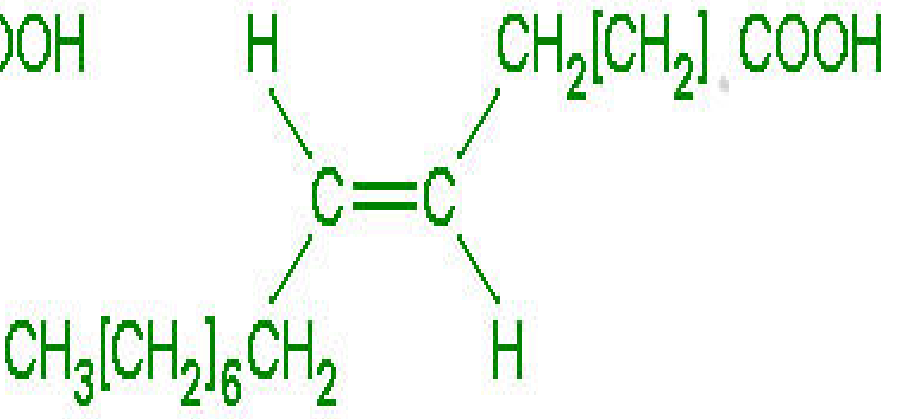
- **Examples:**
  - **Cis Oleic acid (rich in Olive oil)**
  - **Palmitoleic acid**

• Trans Fatty Acids :

- The groups around double bond of UFAs are on **opposite side**
- **Example :**
  - **Elaidic acid /Trans Oleic acid (Hydrogenated Fats)**



Oleic acid



Elaidic acid

Types Of Fatty acids Based on Hydrocarbon chain length

- **Short Chain Fatty acids (2-6 Hydrocarbon Chain length)**

- **Examples:**
  - **Acetic acid (C2)**
  - **Propionic acid (C3)**
  - **Butyric acid (C4)**
  - **Valeric acid (C5)**
  - **Caproic acid (C6)**

- **Medium Chain Fatty acids (8-14 Carbon length)**
- **Examples:**
  - **Caprylic acid (C8)**
  - **Capric acid (C10)**
  - **Lauric acid (C12)**
  - **Myristic acid (C14)**

- **Long Chain Fatty acids (16-20 Carbon length)**
- **Examples:**
  - **Palmitic acid (C16)**
  - **Palmitoleic acid (C16)**
  - **Stearic acid (C18)**
  - **Oleic acid (C18)**
  - **Linoleic acid (C18)**
  - **Linolenic acid (C18)**
  - **Arichidic acid (C20)**
  - **Arachidonic acid /ETA(C20)**
  - **Timnodonic acid/EPA (C20)**

- **Very Long Chain Fatty Acids (C22 onwards)**
  - **Examples:**

  - **Behenic acid/Docosanoic (C22)**
  - **Erucic acid/Docosa 13 Enoic (C22)**
  - **Clupanodonic/Docosapentaenoic acid (DPA) (C22)**
  - **Cervonic acid/DocosaHexaenoic (DHA) (C22)**
  - **Lignoceric acid /Tetracosanoic (C24)**
  - **Nervonic /Tetracosaenoic (C24)**
  - **Cerotic acid/Hexacosanoic (C26)**

Fatty acids Based on Chemical Nature and Structure

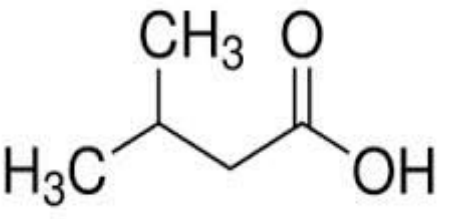
– **Aliphatic Fatty acids:**

Straight Hydrocarbon chain

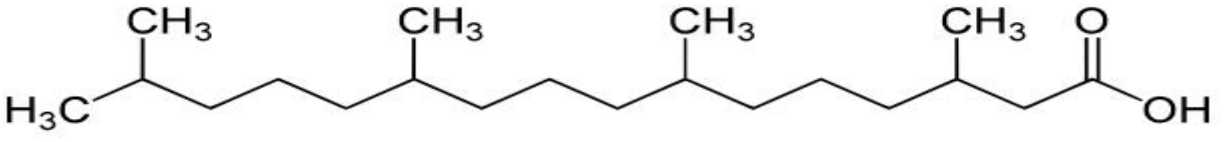
- Examples:
  - **Palmitic acid (C16)**
  - **Stearic acid (C18)**

- **Branched Chain Fatty acids:**
  - Possess Branched chains

- **Examples:**
  - **Isovaleric (C5)**



  - **Phytanic acid (Butter , dairy products)**



- **Cyclic Fatty acids :**
- Contains Ring structure

- **Examples:**
  - **Chaulmoogric acid**

(Used for Leprosy treatment in olden days)

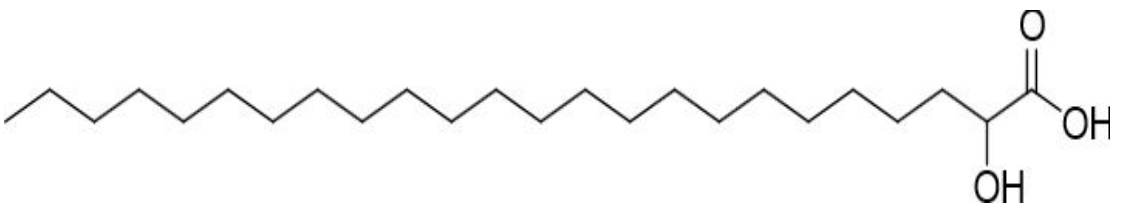
  - **Hydnocarpic acid**

Hydnocarpic acid (n=10)
Chaulmoogric acid (n=12)

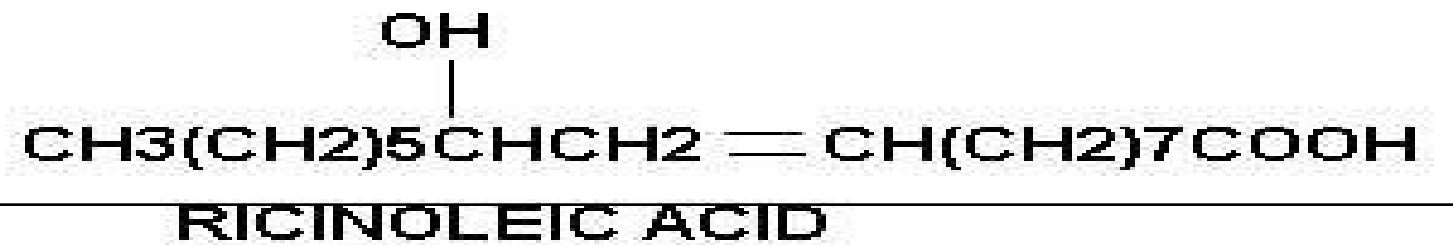
- **Hydroxy Fatty acids:**
- **Contain Hydroxyl Groups**

- **Examples:**
  - **Cerebronic acid (C24)/**

2-HydroxyTetracosanoic acid



  - **Ricinoleic acid(C18) (Castor oil)**



RICINOLEIC ACID

Naming And Numbering Of Fatty Acids

- Every Fatty acids has a:
  - **Common Name**
  - **Systematic Name**

- Most of the Fatty acids are known by their **common names**.(Since easy to use)

- **Systematic names** of Fatty acids are **limited in use**. (Since not easy to use)

Remember

- **Long chain Fatty acids** are also termed as **Acyl chains**.

❖The systematic names of **Saturated Fatty acids** are named by adding **suffix ‘anoic’.**

❖ Example : Palmitic acid- C16/ **Hexadecanoic acid**

- The systematic names of **Unsaturated Fatty acids** are named by **suffix ‘enoic’.**

- **Example:** Oleic acid- C18/ Octadeca**enoic** acid

S.N	Common Name	Systematic Name
1	Palmitic Acid	Hexadec**anoic** Acid
2	Stearic Acid	Octadec**anoic** Acid
3	Oleic acid	Octadeca**enoic** acid
4	Linoleic Acid	Octadeca**dienoic** acid
5	Linolenic Acid	Octadeca**trienoic** acid
6	Arachidonic acid	Eicosa**tetraenoic** acid

Numbering Of Fatty Acids

- **Numbering of Carbon atoms of Fatty acids is done from :**

–Both ends of Fatty acids-

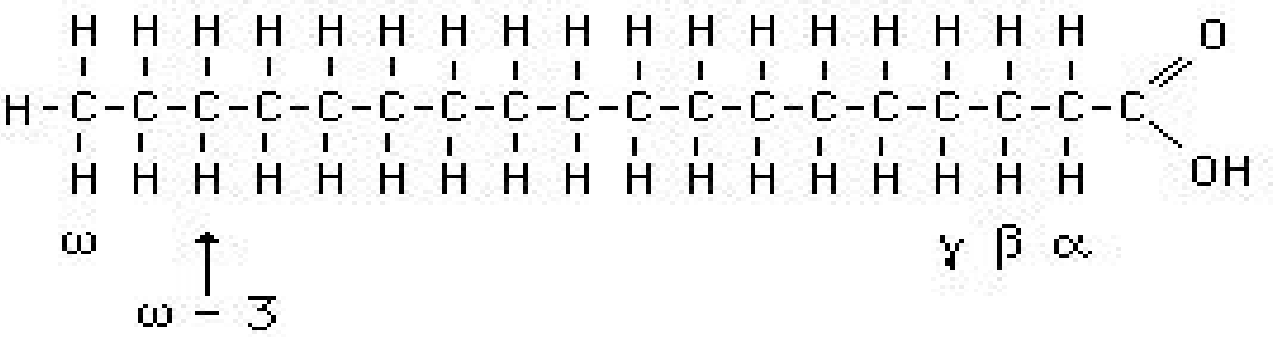
- **Δ end/α end**
- **ω end**

Numbering Of Fatty acid From Carboxyl/ Δ end (α end)

- From **Carboxyl Group end(Δ end)** :
- Carboxylic acid group of Fatty acid is numbered as C1
- C2 is next adjacent Carbon atom ,
- C3 and so onn…….

- **α Carbon atom** is next to the functional group –COOH of a Fatty acid.

- **Next to α Carbon is β, γ,δ ,ε and so onn.**



Use of Greek letters to designate carbons

- Carbon atoms from Methyl(–CH3) group /non polar end(ω) of a fatty acid are numbered as **ω1,ω2,ω3 and so onn**.

Structure and nomenclature of fatty acids.

ω-terminus carboxy terminus

CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-COOH

10 9 8 7 6 5 4 3 2 1

ω ω1 ω2 ω3 δ γ β α

An ω-3 fatty acid

Nomenclature Of Fatty acids

- **FA Nomenclature is Based On**

- **Chain length/Total Number of Carbon atoms in a FA.**
  - Count Number of Carbon atoms in FA

- **Number and Position of Double bonds**

  - Position of double bond **from Carboxyl/Delta end**

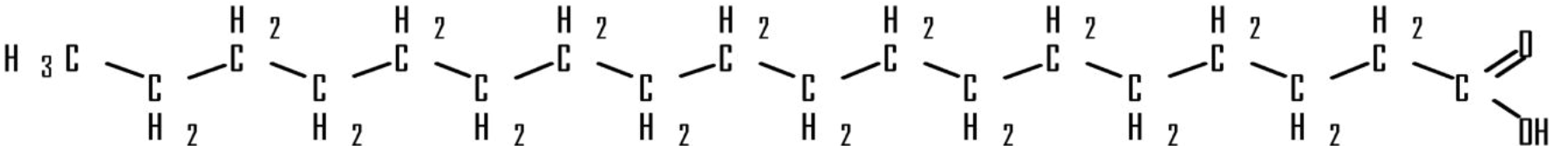
  - Position of double bond **from Methyl/Omega**

Short Hand Representations of Fatty acids

- **Short Hand Representations of Fatty acids:**
  - **Palmitic Acid (16:0)**
  - **Palmitoleic acid (16:1;9)**
  - ****
- **First digit stands** for total number of carbon atoms in the fatty acid.
- **Second digit designates** number of double bonds.
- **Third digit onwards** indicates the position of double bonds.

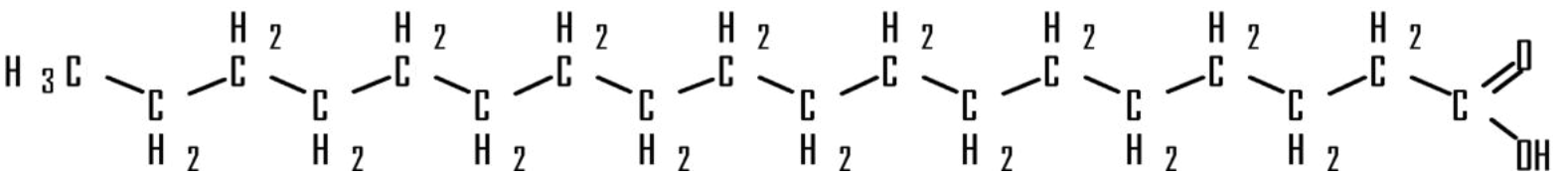
Fatty-acid Nomenclature

- **Named according to chain length**
  - **C18**



Fatty-acid Nomenclature

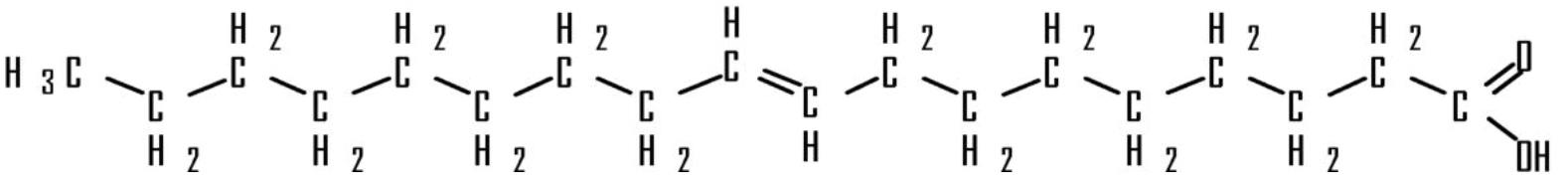
- **Named according to the number of double bonds**
  - **C18:0**



Common name:
Stearic acid

Fatty-acid Nomenclature

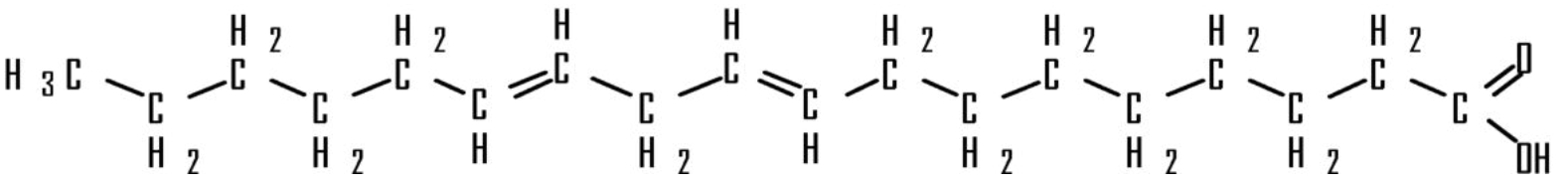
- **Named according to the number of double bonds**
  - **C18:1**



Common name:
Oleic acid

Fatty-acid Nomenclature

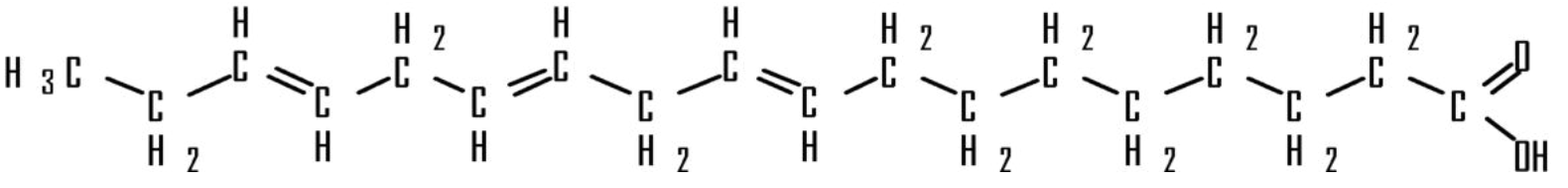
- **Named according to the number of double bonds**
  - **C18:2**



Common name:
Linoleic acid

Fatty-acid Nomenclature

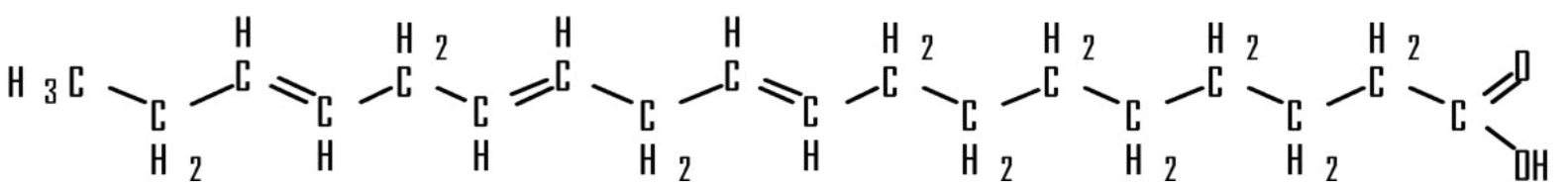
- Named according to the number of double bonds
  - **C18:3**



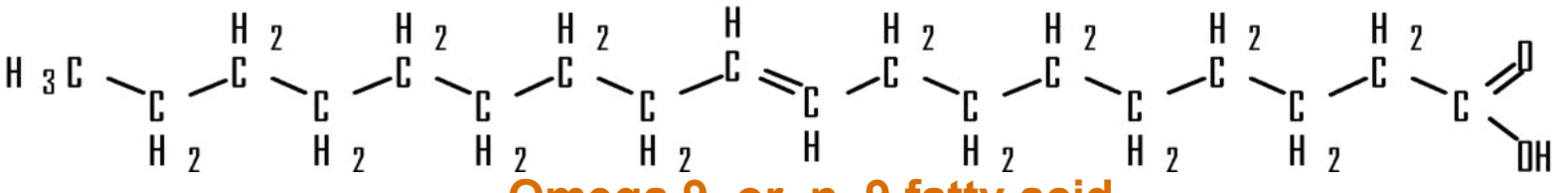
Common name:
Linolenic acid

Omega System Nomenclature

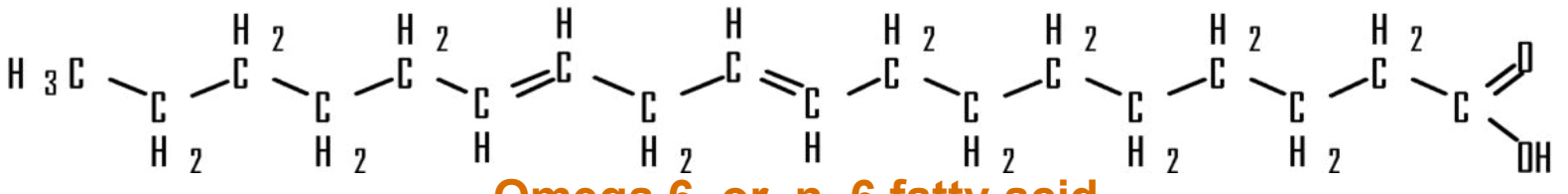
- Named according to the location of the ***first* double** bond from the non-carboxyl **Methyl end** (count from the Methyl end /**Omega end ω**)



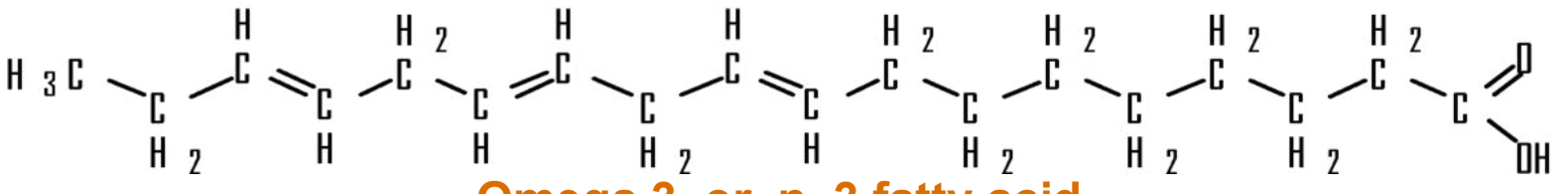
Omega Fatty-acid Nomenclature



Omega 9 or n–9 fatty acid



Omega 6 or n–6 fatty acid



Omega 3 or n–3 fatty acid

- Stearic acid (18:0)
- Oleic acid (18:1;9)
- Linoleic acid (18:2;9,12)
- Linolenic acid (18:3;9,12,15)
- Arachidonic acid (20:4;5,8,11,14)

- **A Fatty acid may also be designated as :**
- Linoleic acid (18C;$\Delta^{9,12}$)
- Linolenic acid (18C;$\Delta^{9,12,15}$)
- Δ indicates from COOH end.
- 9,12,15 are double bond positions from delta end.

Short Hand Presentation of FA

14:0 **Myristic acid**

16:0 **Palmitic acid**

18:0 **Stearic acid**

18:1 cis Δ^{9} **Oleic acid** **(ω9)**

18:2 cis$\Delta^{9,12}$ **Linoleic acid (ω6)**

18:3 cis$\Delta^{9,12,15}$ **α-Linolenic acid (ω3)**

20:4 cis$\Delta^{5,8,11,14}$ **Arachidonic acid (ω6)**

20:5 cis$\Delta^{5,8,11,14,17}$ **Eicosapentaenoic acid (ω3)**

22:5 Cis$\Delta^{7,10,13,16,19}$ **Docosapentaenoic acid (ω3)**

Important Properties Of Fatty Acids

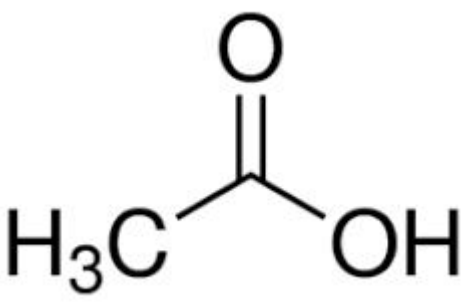
Properties Of Fatty Acids

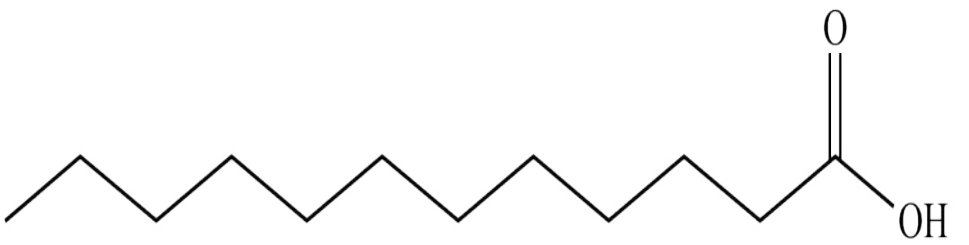
- Physical Properties
- Chemical Reactions

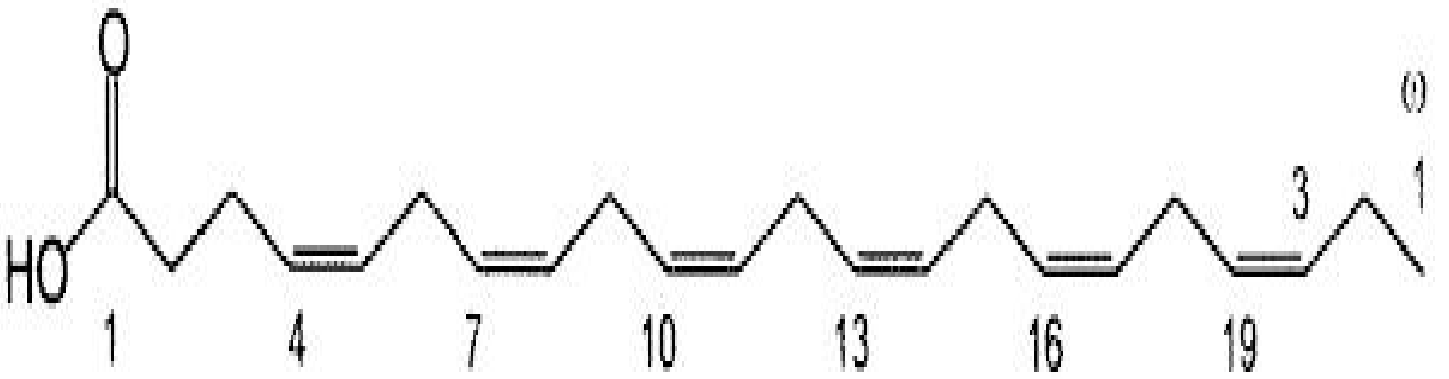
Physical Properties Of Fatty Acids

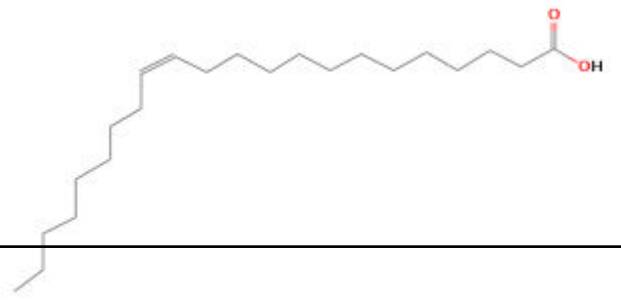
1. Solubility
2. Melting Point

Solubility Of Fatty Acids Depends Upon









Factors Responsible For Solubility Of Fatty Acids

1. **Hydrocarbon chain length**
2. **Degree of Unsaturation- Number of Double Bonds**
3. **Hydrophobicity/Polarity of Fatty acids**
4. **Polarity of Solvents**

- **Small hydrocarbon chain length** are **less hydrophobic and more soluble**
- Long Chain FA and VLCFA more hydrophobic are very less soluble
- Solubility of Fatty acids decreases with increase in Fatty acid hydrocarbon chain length.
- Double bonds increases solubility

Melting Point of Fatty Acids

Factors Responsible For Melting Points Of Fatty Acids

1. Hydrocarbon chain length
2. Nature of Bonds
3. Degree of Unsaturation/Number of double bonds

Fatty Acids With Decreased Melting Points

- **Short and Unsaturated** Fatty acids has **low melting point**

- **More degree of unsaturation low is melting point of FAS**

Melting Points

- **Affected by chain length**

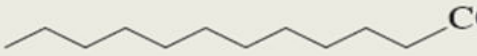
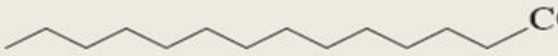
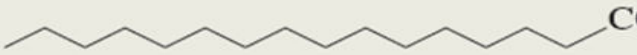
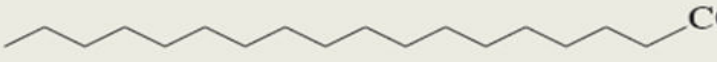
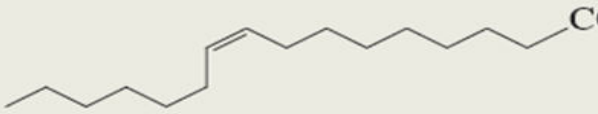
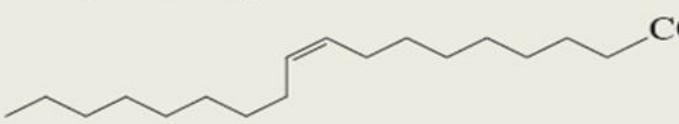
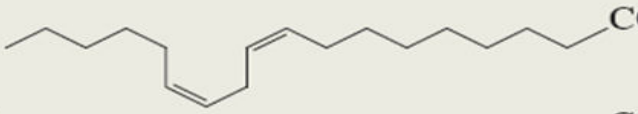
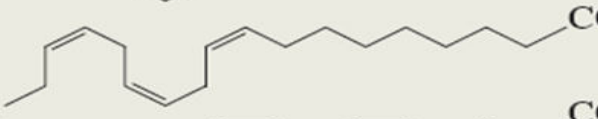
–Longer chain = higher melting temp

Fatty acid:	***C12:0***	***C14:0***	***C16:0***	***C18:0***	***C20:0***
Melting point:	***44°C***	***58°C***	***63°C***	***72°C***	***77°C***

Melting Points

- Affected by **number of double bonds**
  - More saturated = higher melting temp

Fatty acid:	***C18:0***	***C18:1***	***C18:2***	***C18:3***
Melting point:	***72°C***	***16°C***	***–5°C***	***–11°C***

Number of carbons	Common name	Systematic name	Structure	Melting point °C
Saturated				
12	lauric acid	dodecanoic acid		44
14	myristic acid	tetradecanoic acid		58
16	palmitic acid	hexadecanoic acid		63
18	stearic acid	octadecanoic acid		69
20	arachidic acid	eicosanoic acid		77
Unsaturated				
16	palmitoleic acid	(9Z)-hexadecenoic acid		0
18	oleic acid	(9Z)-octadecenoic acid		13
18	linoleic acid	(9Z,12Z)-octadecadienoic acid		–5
18	linolenic acid	(9Z,12Z,15Z)-octadecatrienoic acid		–11
20	arachidonic acid	(5Z,8Z,11Z,14Z)-eicosatetraenoic acid		–50
20	EPA	(5Z,8Z,11Z,14Z,17Z)-eicosapentaenoic acid		–50

Fatty Acids With Increased Melting Points

- **Long and Saturated** Fatty acids are has **high melting point.**

- **Less degree of Unsaturation more is melting point of Fatty acids**

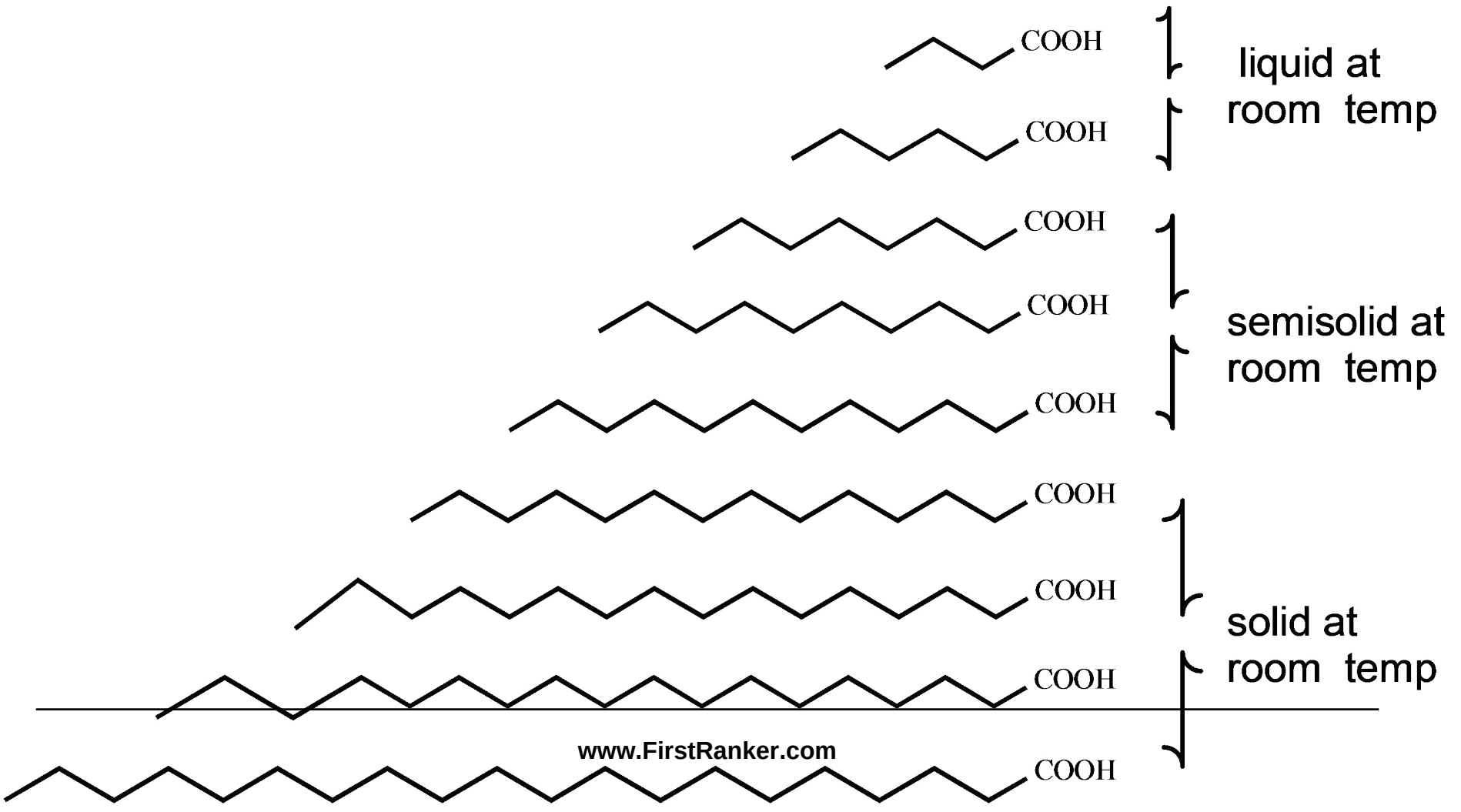
- **Thus melting point of Fatty acids(FAs):**
  - **Increases with increase in chain length of FAs.**
  - **Decreases with decrease in chain length of FAs.**
  - **Increases with low unsaturation of FAs**
  - **Decreases with more unsaturation of Fatty acids**

Structures and Melting Points of Saturated Fatty Acids

Table 18.1 Structures and Melting Points of Common Fatty Acids

Name	Carbon Atoms	Structure	Melting Point (°C)	Source
Saturated Fatty Acids				
Capric acid	10		32	Saw palmetto
Lauric acid	12		43	Coconut
Myristic acid	14		54	Nutmeg
Palmitic acid	16		62	Palm
Stearic acid	18		69	Animal fat
Arachidic acid	20		76	Peanut oil, vegetable and fish oils

Fatty Acids



Chemical Reactions Of Fatty Acids

Types Of Chemical Reactions Of Fatty acids

Reactions due to Carboxyl group of Fatty acids:

- **Esterification/Esterified forms of Lipids**
- **Saponification/Soap Formation**

Reactions Associated to Double bonds of Fatty acids:

- Halogenation/Addition of Halogens around double bond

- Hydrogenation/Transform to UFAs to SFAs

Significance Of Halogenation

- Halogenation of fatty acids is an **index of assessing the degree of unsaturation**

- **Iodine Number** is a process of **Halogenation** which checks the **content of SFA and PUFAs** of Fats and Oils.

- **SFA** has **zero Iodine number.**
- PUFAs has **high Iodine number.**

Hydrogenation Of Fatty acids

Alters Geometric Isomerism Of Unsaturated Fatty acids

Transforms Natural Cis Form to Trans Form

Increases Shelf life of PUFAs

All-Cis Fatty acids

Good for Health

- Human body **contain Enzyme system** to **metabolize Cis form** of Fatty acids.
- Cis forms when ingested through food are easily metabolized and **does not retain in the body.**
- Hence All –Cis forms are good for health and **no risk of Atherosclerosis and CVD.**
- **All Cis form of fatty acids are unstable and easily metabolizable.**

- More content of **Trans Fatty acids** are found in **processed/Refined foods** viz:
  - **Hydrogenated Oils (Vanaspati Dalda)**
  - **Ghee**
  - **Margarine**
  - **Bakery products /Fast foods**
  - **Deeply Fried recipes in Oils which are prepared in repeatedly heated oils.**

- **Trans fatty acids increases risk of :**
  - –Atherosclerosis
  - –Cardio Vascular disorders:
    - Ischemia
    - Myocardial Infarction
  - –Stroke(Brain attack)

Message
Learnt, Understood And To Be Implemented

For Good Fatty acid metabolism and Significant Health

- Eat natural Cis forms of Fatty acids
- Avoid Hydrogenated Trans Fatty acids
- Eat home made food
- Avoid Processed/Junk Foods

PUFAs And Omega Fatty Acids

Types Of Omega Fatty acids

- **In Nutrition and Clinical practice**
  - »ω3 Fatty acids
  - »ω6 Fatty acids
  - »ω7 Fatty acids
  - »ω9 Fatty acids

Omega Fatty Acids

Omega 3 Fas PUFAs	Omega 6 Fas PUFAs	Omega 7 Fas MUFAs	Omega 9 Fas MUFAs
Linolenic C18-(ODTA) **Timnodonic C20-**(EPA) **Cervonic** C22-(DHA) **Clupanodonic** C22-(DPA)	**Linoleic** C18- (ODDA) **Arachidonic** C20-(ETA)	**Palmitoleic** C16-(HDA)	**Oleic** – C18(ODA) **Erucic –** C22(DA) **Nervonic** C24-(TA)

Examples of ω3 Fatty acids

- **Linolenic (18:3;9,12,15) (ω3)**
- **Timnodonic/Ecosapentaenoic Acid /EPA (20:5;5,8,11,14,17)(ω3)**
- **Clupanodonic acid/(Docosa Pentaenoic Acid): (DPA) (C22:5;7,10,13,16,19)(ω3)**
- **Cervonic/Docosa Hexaenoic Acid (DHA)(22:6;4,7,10,13,16,19)(ω3)**

Rich sources of dietary Omega and nutritional essential PUFAS are:

- Vegetable Oils
- Green Leaves, Algae
- Fish and Fish oils
- Flax Seeds

Sources,Distribution,Composition Of Fatty Acids In Human Body

Sources Of Fatty Acids To Human Body

- **Exogenous Sources-** Dietary Food Items
- **Endogenous Biosynthesis-** From Free Excess Glucose in Liver

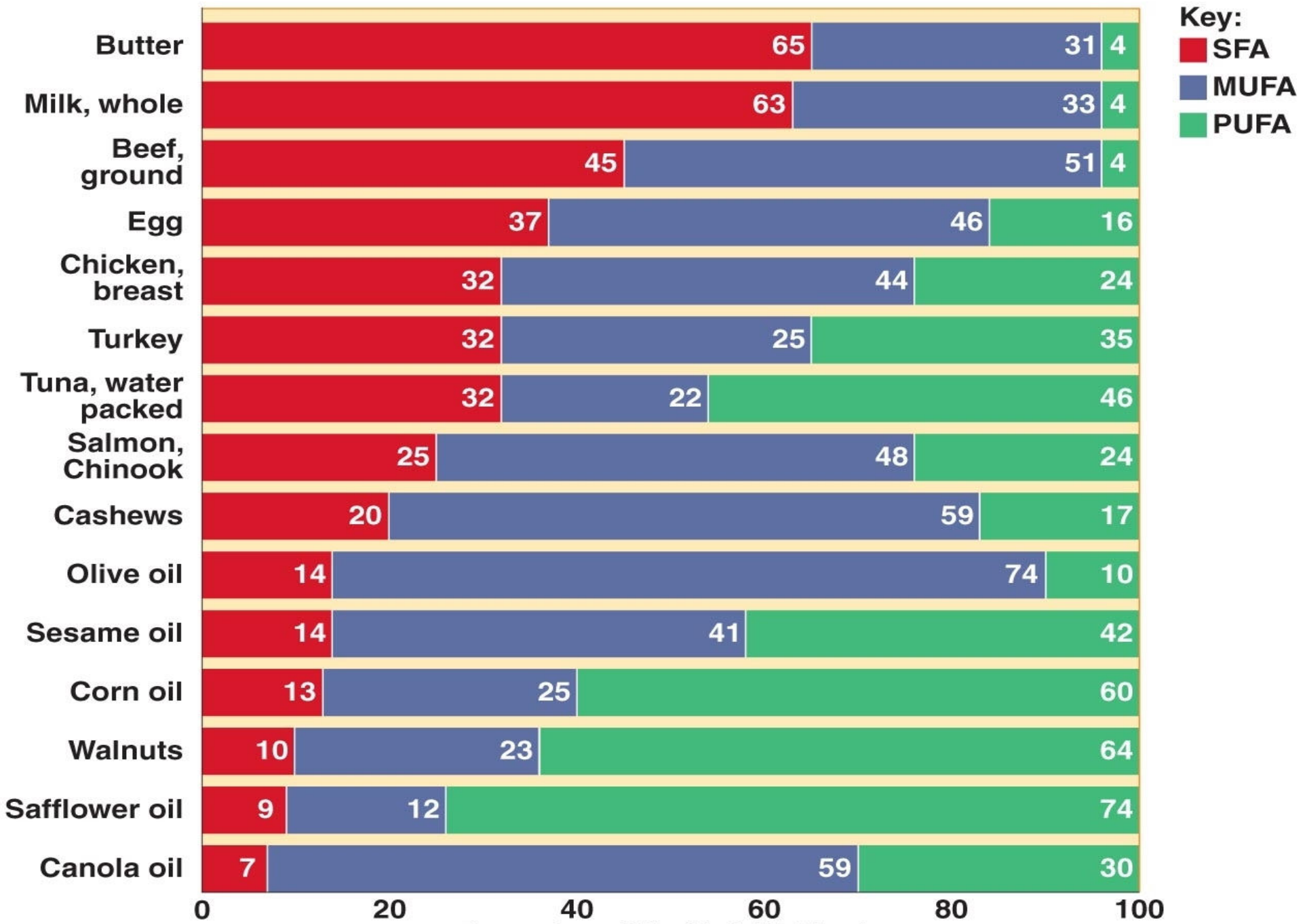
Forms of Dietary Fatty Acids To Be Ingested

Natural Forms Of Fatty Acids

- Fatty acids in nature mostly presently in
  - **Esterified form of FAs– (TAG,PL,CE)**
  - **Even Numbered Carbon**
  - **Unsaturated- PUFAs/Omega 3 and 6**
  - **Cis forms**

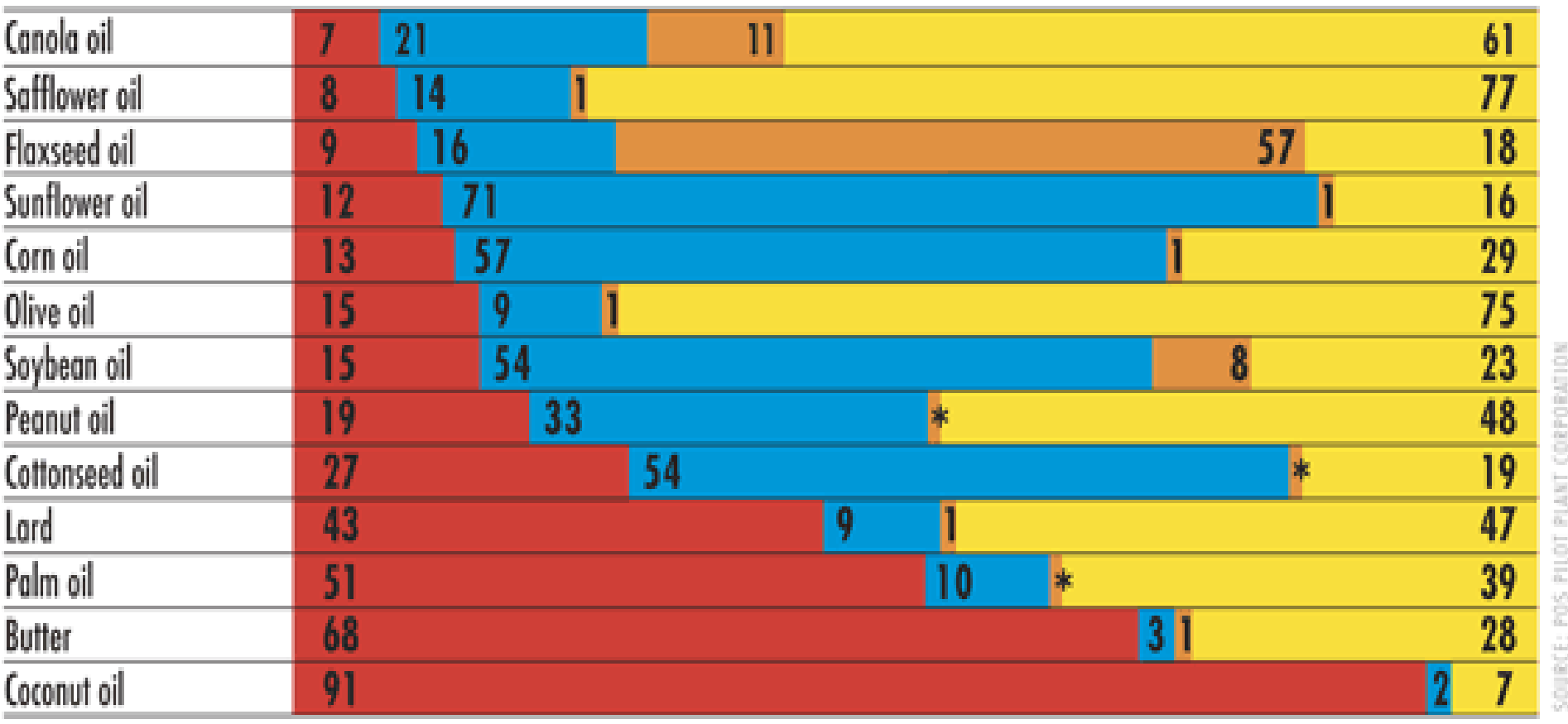
Contents Of Fatty acids	Sources Of Oils
Highest Content of MUFA	Olive Oil , Mustard Oil
Highest content of PUFA	Safflower, Sunflower, Flax seed Oil
Highest content of SFA	Coconut Oil

Oils Rich In SFAs	Oils rich in MUFAs	Oils rich in PUFAs
Coconut Oil	Olive Oil (75%)	Flax seeds/ Linseed Oil
Palm Oil	Sunflower Oil (85%)	Soya /Safflower Oil
Butter	Ground nut / Pea nut Oil	Almond Oil
Animal Fat	Almond Oil	Rice Bran
	Sesame Oil	Walnuts Oil
	Beef Fat (Tallow Fat) 50%	Corn Oil
	Lard (Pork Fat) 40%	Marine Fish



Percentage (%) of total fat kcals

Comparison of Dietary Fats



SOURCE: POS PILOT PLANT CORPORATION

*Trace

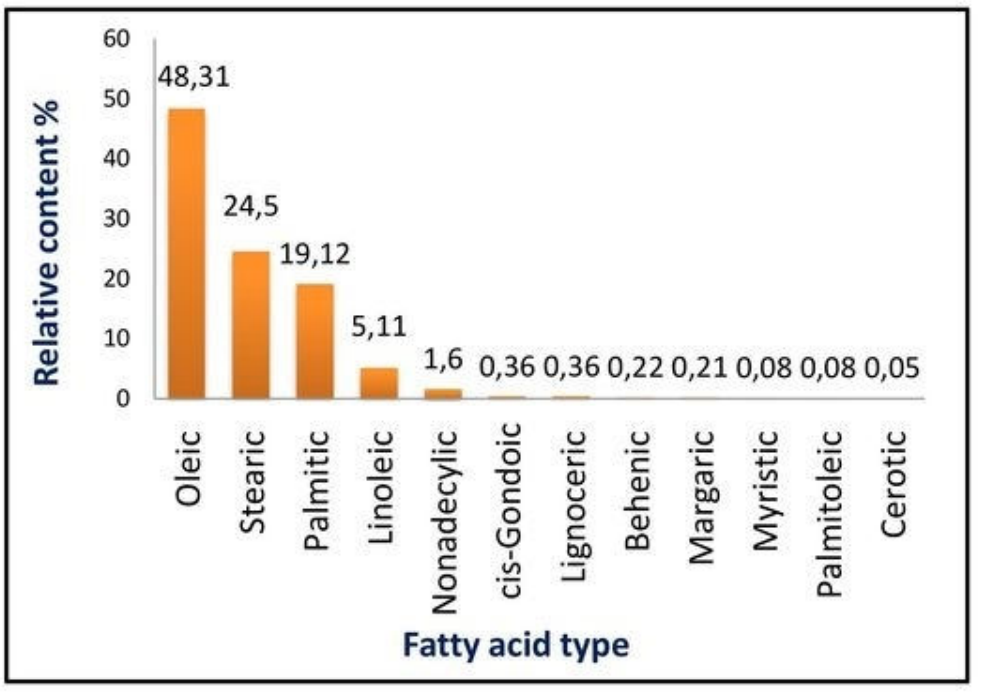
Fatty acid content normalized to 100%

Fatty Acids	Carbons	Double bonds	Abbreviation	Source
Acetic	2	0	2:0	bacterial metabolism
Propionic	3	0	3:0	bacterial metabolism
Butyric	4	0	4:0	**butterfat**
Caproic	6	0	6:0	**butterfat**
Caprylic	8	0	8:0	**coconut oil**
Capric	10	0	10:0	**coconut oil**
Lauric	12	0	12:0	**coconut oil**
Myristic	14	0	14:0	palm kernel oil
Palmitic	16	0	16:0	**palm oil**
Palmitoleic	16	1	16:1	**animal fats**
Stearic	18	0	18:0	**animal fats**
Oleic	18	1	18:1	olive oil
Linoleic	18	2	18:2	grape seed oil
Linolenic	18	3	18:3	flaxseed (linseed) oil
Arachidonic	20	4	20:4	peanut oil, fish oil

Determination of fatty acid profile

Fatty acid		Relative content (%)
Myristic	C14:0	0.08
Palmitic	**C16:0**	**19.12**
Palmitoleic	C16:1	0.08
Margaric	C17:0	0.21
Stearic	**C18:0**	**24.50**
Oleic	**C18:1**	**48.31**
Linoleic	**C18:2**	**5.11**
Nonadecylic	C19:0	1.60
cis-Gondoic	C20:1	0.36
Behenic	C22:0	0.22
Lignoceric	C24:0	0.36
Cerotic	C26:0	0.05

Fatty acids (from highest to least as a %)



Total saturated fatty acids = **46.14%**

Total MUFA = **48.75%**

Total PUFA = **5.11%**

S/U = **0.86**

53.86% total unsaturated fatty acids

Fatty acid Composition of Human Body

Fatty acid	Percentage
Oleic acid	**50% (MUFA)**
Palmitic acid	35% (SFA)
Lionleic acid	10% (PUFA)
Stearic acid	5% (SFA)

- Thus most **abundant Fatty acids** present in **human Lipids** are:
  - **–Oleic acid (50%)**
  - **–Palmitic acid(35%)**

Ideal Requirement Of Fatty Acids To Human Body

- It is ideal to **consume ratio** of:
- **1 : 1 : 1**
- **SFA MUFA PUFAs**
- respectively **from the diet to maintain good health**.

- Naturally there is **no single oil which** has all **3 types of fatty acids in ideal proportion.**

- Hence it is always **advisable to mix a combination of oils and consume**.

Transportation Of Fatty Acids In Human Body

- **Bound form /Esterified Forms Of Fatty acids** are **Transported through various Lipoproteins.**

Fatty acids Transportation In body

- **More than 90%** of the fatty acids found in plasma are in the form of **Fatty acid esters.**
  - **Fatty acids Esters/Esterifed form of Fatty acids exist as:**
  - **Triacylglycerol**
  - **Cholesteryl esters**
  - **Phospholipids**

- **Unesterified/Free Fatty acids (FFA)** are very less amount in body.

- **Long Chain FFA are transported i**n the blood circulation in **association with Albumin.**

Functions Of Fatty Acids

1. Secondary Source Of Energy
2. Components Of Biomembranes
3. PUFA (Arachidonic Acid) Precursor for Eicosanoid Biosynthesis

4. Esterification of Cholesterol and its Excretion
5. PUFAs build and protect Brain and Heart
6. PUFAs prevents early ageing, prolongs Clotting time.

- PUFAs of membrane play role in:(Less compact)
  - **–Membrane fluidity**
  - **–Selective permeability**

Functions Of PUFAS /Omega 3, and 6 FAs

- Components of **cell biomembranes**
- More **associated to Human brain and Heart**
- **Involve in Growth ,development and functioning of Brain**

- **Omega Fatty acids Reduces risk of Heart disease:**
  - **Reduces Platelet aggregation** by stimulating Prostaglandins and Prostacyclin's .
  - **Reduces blood clotting and Thrombus formation by Lowering the production of Thromboxane .**

- **Omega 3 Fatty acids have pleiotropic effects (more than on effect):**
  - **Cardio protective effect**
    - **Lowers Blood pressure**
    - **Anti-Inflammatory**
    - **Anti-Atherogenic**
    - **Anti-Thrombotic**

- **PUFAs Lowers Risk Of Atherosclerosis**

- Since **double bonds of PUFAs** are unstable and **easily cleavable**.
- PUFAs get easily metabolized and do **not get accumulated** in the blood arteries and capillaries.
- Thus PUFAs have **low risk of Atherosclerosis** and **Cardio vascular disorders.**

- **Fish (rich in Omega 3 Fatty acids) Eaters has Healthy Brain and Heart**

- **Brain development with an efficient nervous function**.

- **Protected from Heart attacks.**

- **Deficiency of Essential Fatty acids :**
  - **Affects every cell ,organ and system**
  - **Growth retardation**
  - **Problems with reproduction**
  - **Skin lesions**
  - **Kidney and Liver disorders**
  - **Brain disorders/Behavioral disorders.**

Deficiency Of PUFAs/ Omega 3,6 Fatty acids

- Deficit of omega fatty acids **affect the normal growth ,development and functioning of brain.**
- Persons may suffer from **mental illness** like:
  - **Depression**
  - **Attention deficit**
  - **Dementia=Alzheimer's Disease**

- Deficiency of **Omega 3 Fatty acids** :
  - **Alters the cell membrane structure**.
  - Increases the **risk of**
    - **Heart attack**
    - **Cancer**
    - **Rheumatoid Arthritis**

Phrynoderma /Toad Skin is due to PUFA deficiency.

- **Phrynoderma /Toad Skin Symptoms**

- **The skin becomes dry with lesions (Scaly Dermatitis).**
- **Presence of horny erruptions on the posterior and lateral parts of limbs, back and Buttock.**
- **Loss of hair**
- **Poor wound healing**
- **Acanthosis and Hyperkeratosis**

- **Deficiency of PUFAs lower:**
  - Oxidative Phosphorylation-ATP generation
  - Fibrinolytic Activities

Fatty Acids At Glance

Name of Biomolecule	Fatty acids
Class	Derived Lipids
Structural Features	Organic acids ,Hydrocarbon Chain (C2-26) Terminal Mono Carboxylic Acid
Sources of FAs to body	From Exogenous and Endogenous
Distribution in Body	FAs mostly in esterified form, Associated with Simple and Compound Lipids. Distributed in all tissues.
Functional aspects	Energy, Biomembrane components
Interrelationships	Fatty acids associated to other form of Simple and Compound Lipids