

Topic: Introduction to Fatty Acids

Subject: Biochemistry

Class: F.Y. B. Pharm. (Sem.-1)

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Programme: 2018-2021



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Learning Outcome

- Introduction to Lipids
- Introduction to common saturated and unsaturated fatty acids
- Introduction to triacyl glycerol, phospholipids, sphingolipids

Mapping of TLO with Course Outcome



Topic	TLO	Bloom Taxonomy	CO
<p>Introduction to common saturated and unsaturated fatty acids</p> <p>Introduction to triacyl glycerol, phospholipids, sphingolipids</p>	<p>Students will be able to</p> <p>Identify and draw structure of fatty acids</p> <p>Distinguish between sphingolipids and phospholipids</p>	<p>L1-Remembering- (List, Identify, Outline)</p>	<p>2</p>

Introduction to Fatty Acids

DR. Ripudaman



LIPIDS

- DEFINITION
- CLASSIFICATION (STRUCTURAL AND FUNCTIONAL)
- FUNCTIONS OF DIETARY LIPIDS
- CHEMICAL NATURE OF FATTY ACIDS
- NOMENCLATURE
 - Saturated Fatty acids
 - Unsaturated Fatty acids
 - Positional and geometric isomerism
 - Essential Fatty acids

DEFINITION

Heterogeneous group of organic compounds which are

- relatively insoluble in water,
- but soluble in organic solvents such as ether, benzene and chloroform.

CLASSIFICATION:(STRUCTURE)

1. Simple Lipids

a. Fats & Oils (TRIGLYCERIDES)

F.A. esters with Glycerol
(Triacyglycerols)

b. Waxes

F.A. esters of long chain mono-hydroxy alcohols (Cetylpalmitate)

CLASSIFICATION:(STRUCTURE)

Contd

2. Complex Lipids

a. Phospholipids (contain phosphate group)

Glycerophospholipids

Alcohol is Glycerol (e.g.phosphatidylcholine)

Sphingophospholipids

Alcohol is sphingosine (C18 amino alcohol)

b. Glycolipids

Contain F.A, Sphingosine and Carbohydrate

c. Other Complex Lipids

Sulfolipids, Aminolipids, Lipoproteins

CLASSIFICATION (Contd)

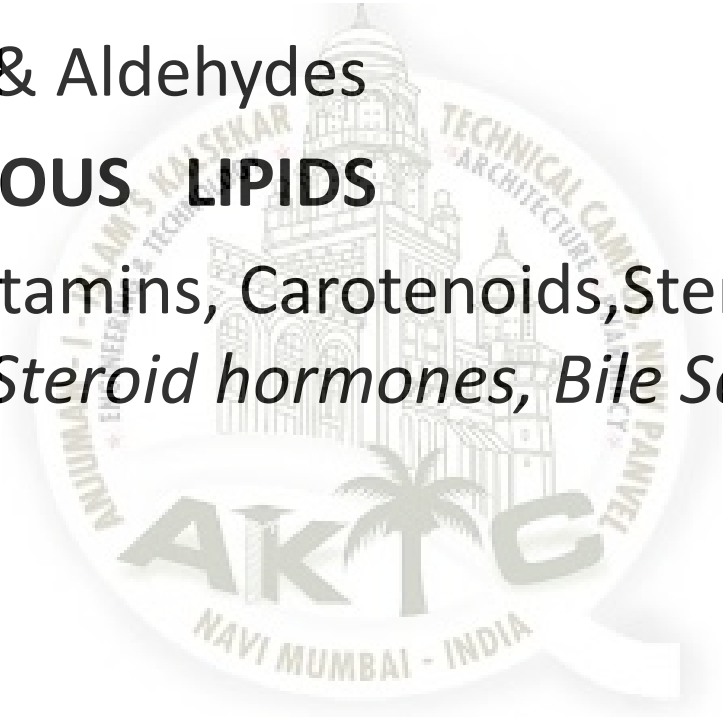
3. PRECURSOR & DERIVED LIPIDS

F.A, Alcohols & Aldehydes

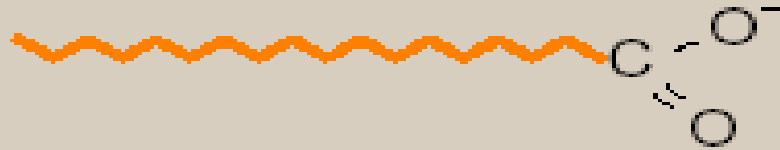
4. MISCELLANEOUS LIPIDS

Fat Soluble Vitamins, Carotenoids, Steroids
(*Cholesterol, Steroid hormones, Bile Salts*)

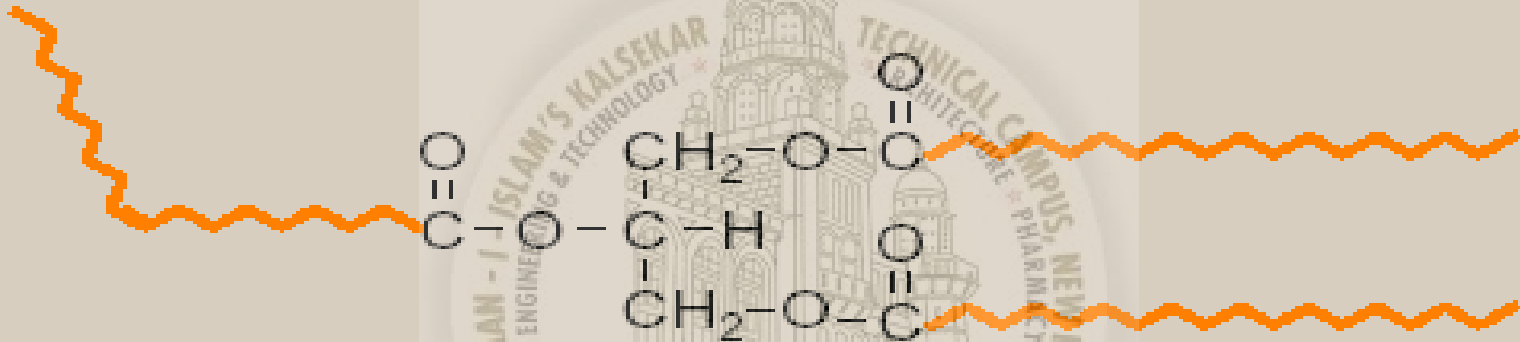
Eicosanoids



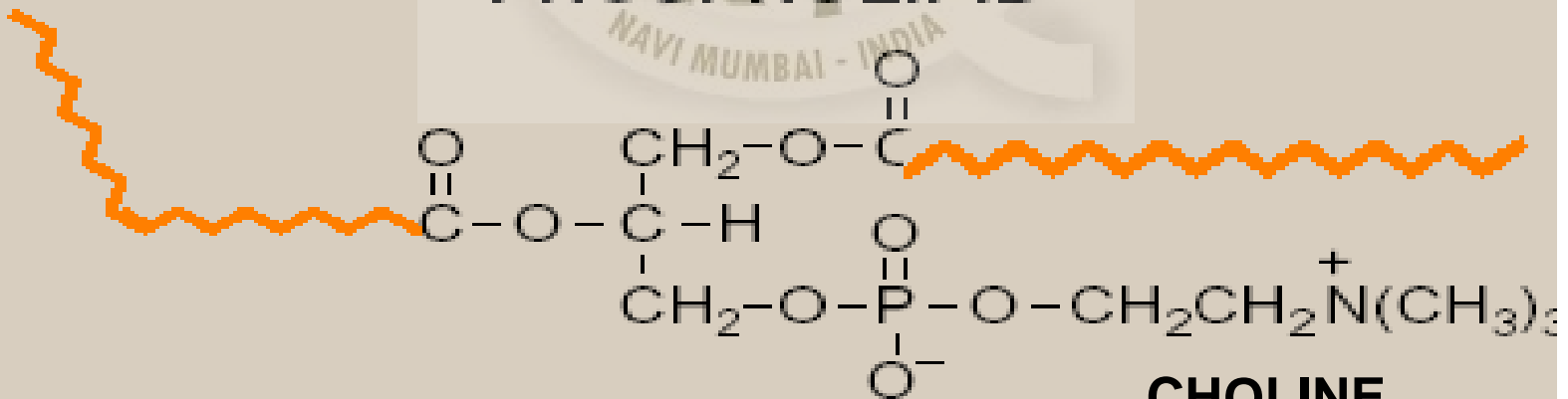
FATTY ACIDS



TRIACYLGLYCEROL

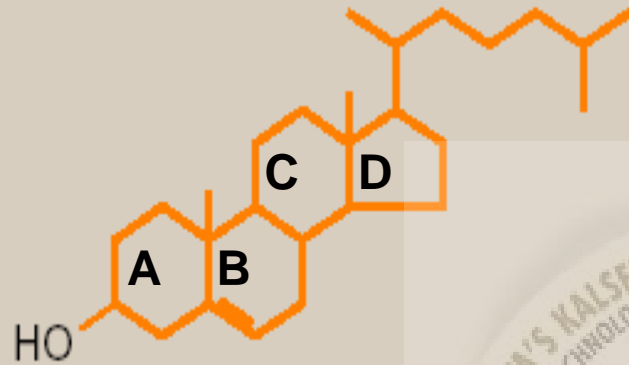


PHOSPHOLIPID

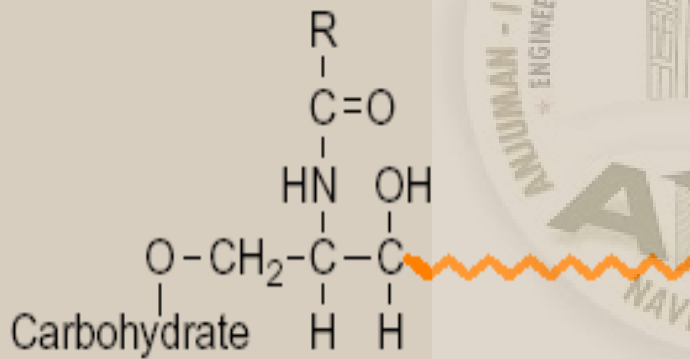


CHOLINE

STEROID (cholesterol)



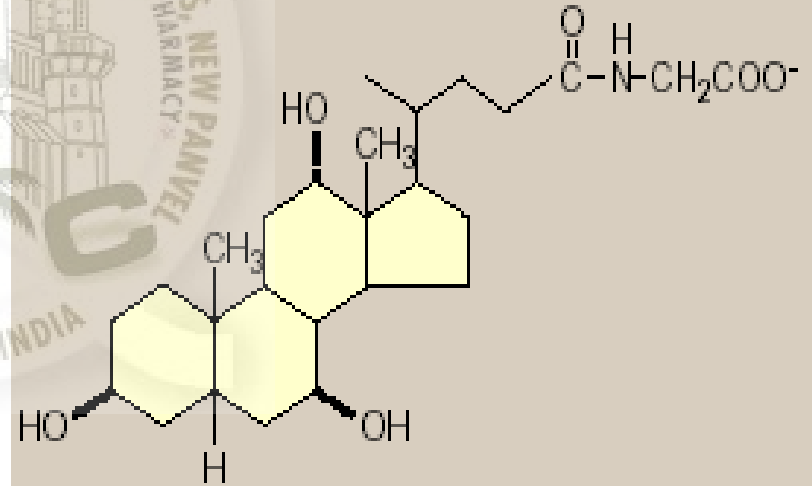
GLYCOLIPID



BILE SALTS

Cholic acid
(a bile acid)

Glycine



Glycocholic acid
(a bile salt)

CLASSIFICATION (Functional)

LIPIDS

- **FATTY ACIDS**
- **TRIGLYCERIDES**
- **PHOSPHOLIPIDS**
- **SPHINGOLIPIDS**

FUNCTIONS

- Metabolic fuel; component of several other classes of lipids
- Main storage form of fatty acids and chemical energy
- Components of membranes; sources of arachidonic acid, inositol trisphosphate (IP3), and diglyceride (DAG) for Signal Transduction
- Components of membranes; Imp. in signal transduction

Contd

- **CHOLESTEROL**
 - Component of membranes; precursor of bile salts and steroid hormones
- **BILE SALTS**
 - Lipid digestion and absorption; main product of cholesterol metabolism

FUNCTIONS CONTD

- **STEROID HORMONES**
 - Intracellular signals that regulate gene expression in target cells
- **EICOSANOIDS**
*Prostaglandins,
Thromboxanes,
Leukotrienes*
 - Regulators of physiological /immunological functions.
Local hormones
 - Vision; calcium metabolism; antioxidants; blood coagulation
- **VITAMINS**
A,D,E,K



FATTY ACIDS

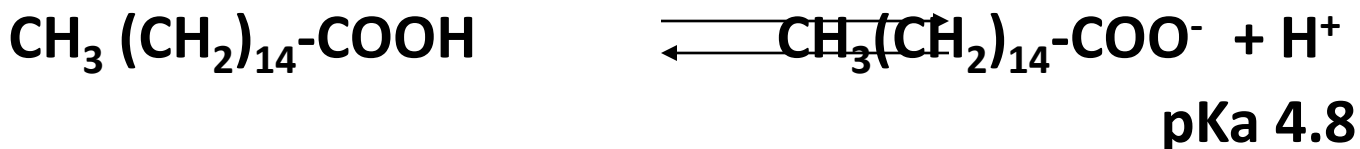
- Monocarboxylic
- Usually straight-chain having even number (2-26) of carbon atoms
- Most common are C12-C22
- Short-Chain (2-4 C atoms)
- Medium- Chain (6-10 C atoms)
- Long-Chain (12-20 C atoms)
- Very long-Chain (C22 and above)

Saturated Fatty Acids

Most Commonly occurring are

- Myristic Acid (14:0)
- Palmitic Acid (16:0)
- Stearic Acid (18:0)

Since the carboxylic group is ionized at physiological pH, they exist as carboxylate ion
e.g. **palmitate**



UNSATURATED FATTY ACIDS

Contain carbon to carbon double bonds.

MUFA

- Mono-unsaturated (1 double bond)

OLEIC ACID 18:1 (high concentrations in olive oil)

PUFA

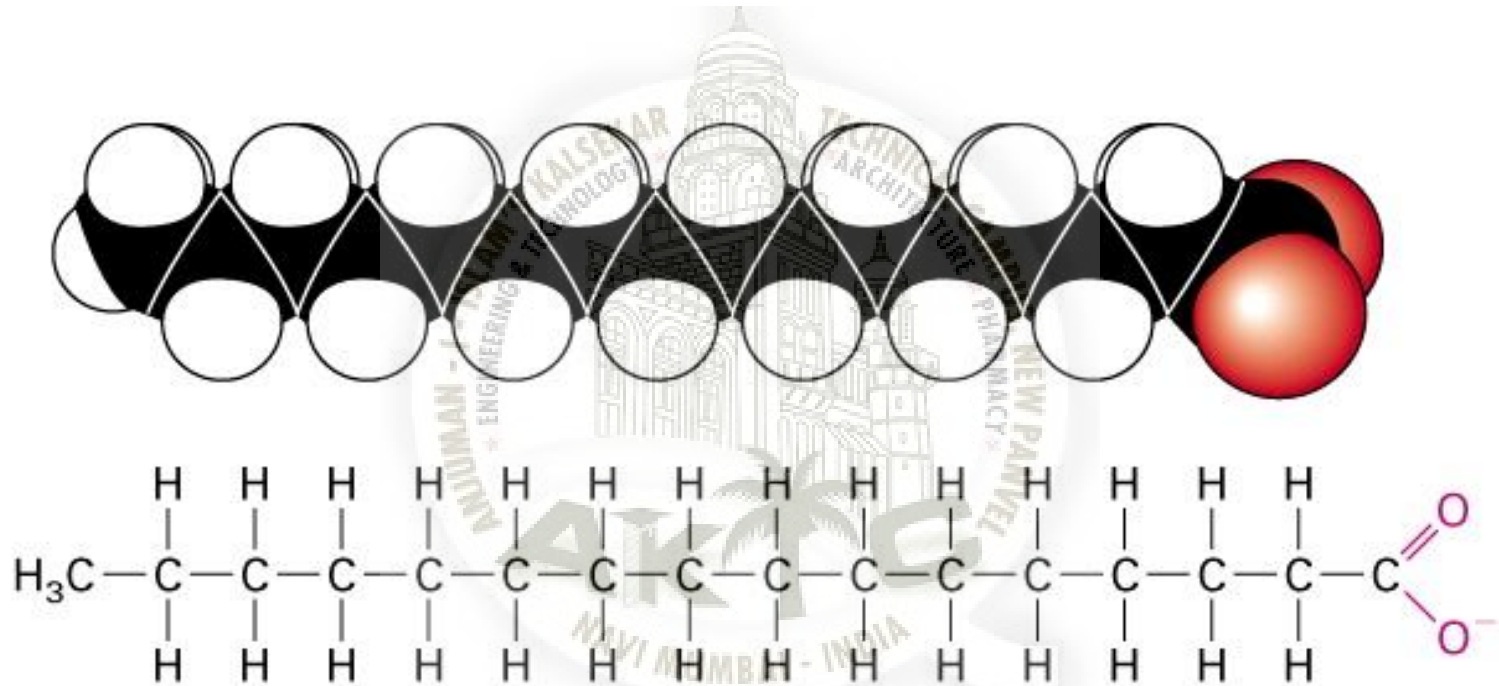
- Polyunsaturated (> 1 double bond)

LINOLEIC ACID, 18:2

α -LINOLENIC ACID, 18:3

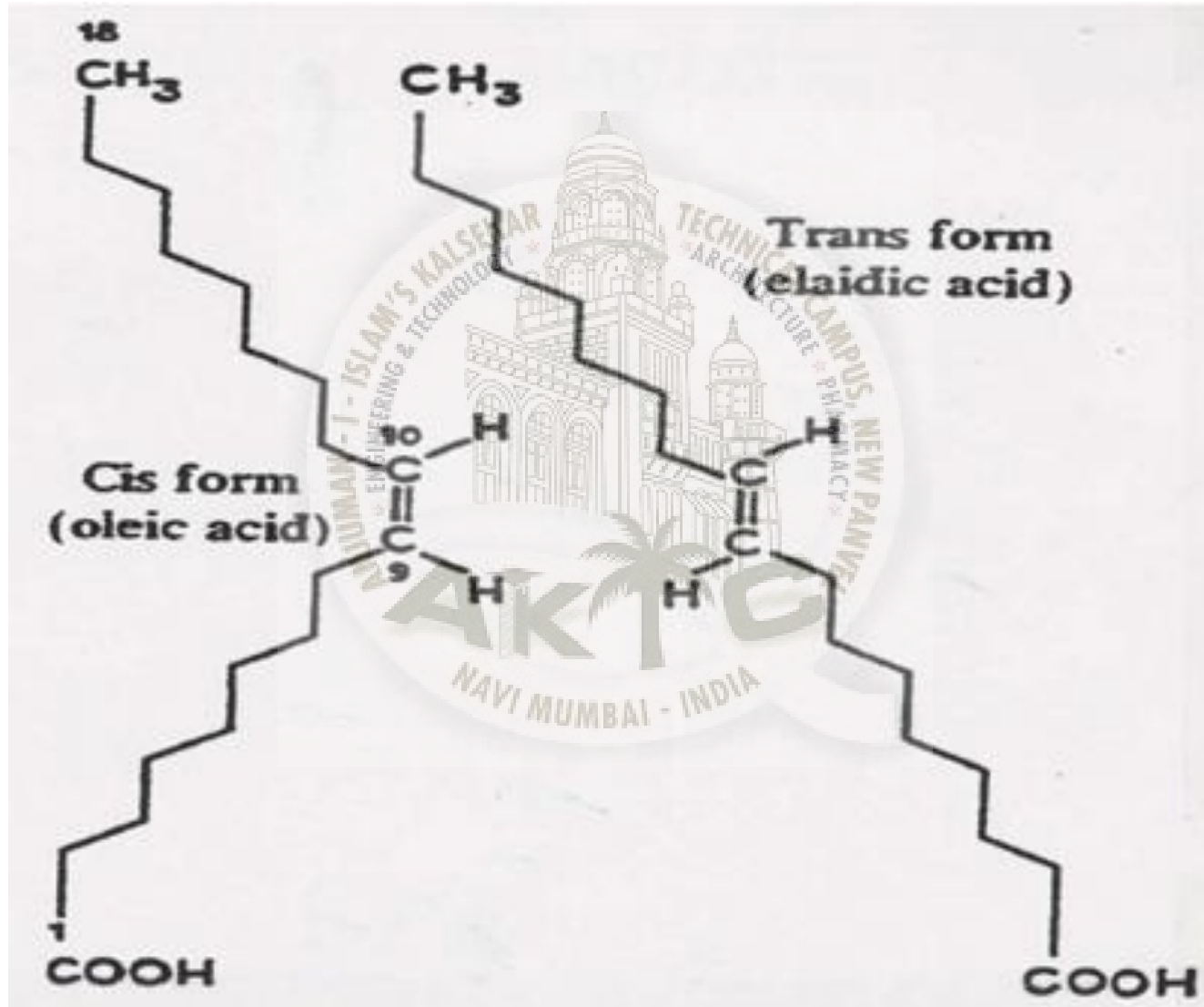
ARACHIDONIC ACID 20:4

STRUCTURE OF SATURATED FATTY ACIDS



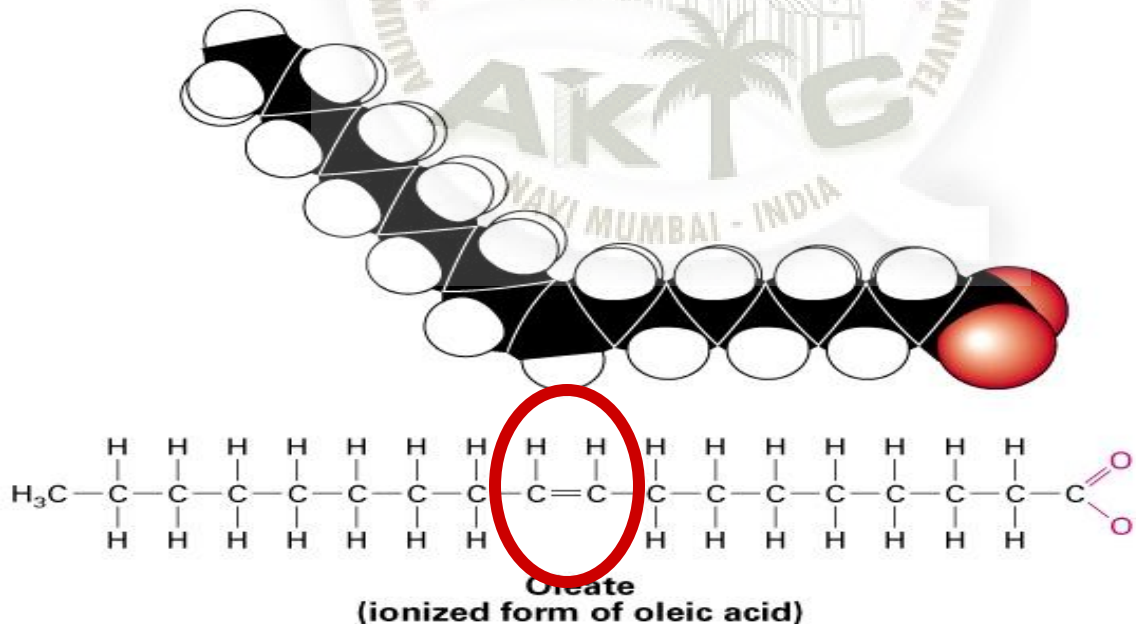
Palmitate
(ionized form of palmitic acid)

POSITIONAL AND GEOMETRIC ISOMERISM IN UNSATURATED FATTY ACIDS



POSITIONAL AND GEOMETRIC ISOMERISM IN UNSATURATED FATTY ACIDS

- *cis* configuration mostly present in naturally occurring fatty acids
- *cis* double bond causes a bend. Therefore the hydrocarbon chain cannot be packed as tightly as in trans fatty acids
- Melting points of fatty acids with *cis* double bonds are lower than the corresponding *trans* fatty acids



POSITIONAL AND GEOMETRIC ISOMERISM IN UNSATURATED FATTY ACIDS (CONTD)

		MELTING TEMPERATURE
Stearic acid	18:0	69°C
Elaidic acid	18:1 <i>trans</i> Δ^9	44°C
Oleic acid	18:1 <i>cis</i> Δ^9	13°C

Trans Fatty acids, unlike **Cis** isomers, increase plasma cholesterol levels (total and LDL) and decrease HDL-cholesterol

Current concerns about trans fatty acid intake and attempt to ↓ their dietary intake

NOMENCLATURE

Fatty acids

Common (trivial) names

Systematic names (derived from parent hydrocarbons)

- Saturated fatty acids end with **anoate**

Palmitate is hexadecanoate

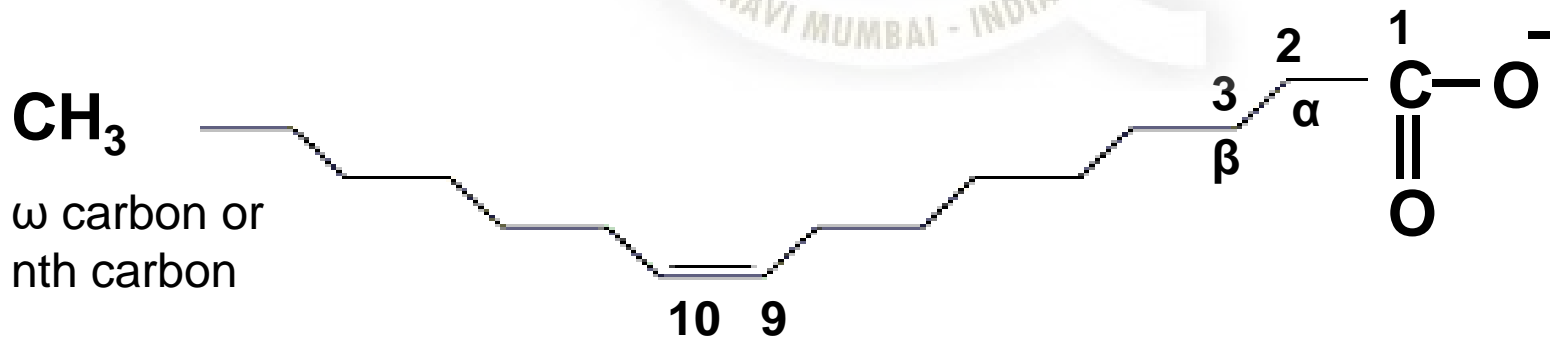
- Unsaturated fatty acids end with **enoate**

The position of the double bond (counting from the –COOH toward CH₃ group) and its geometric configuration (cis or trans) is indicated

The palmitoate will be called cis- Δ^9 –hexadecenoate.

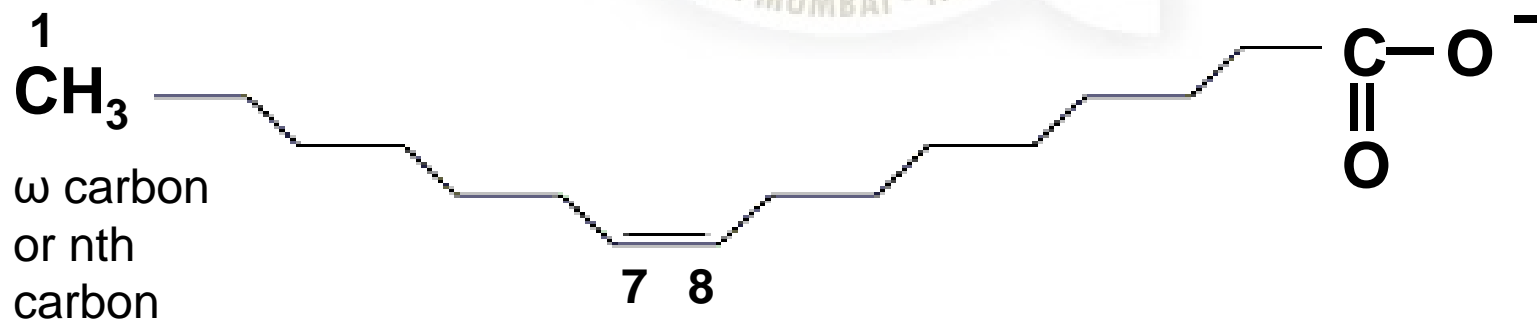
There are 2 systems to number the position of carbon to carbon double bonds

1. **The Δ system**, according to which one starts counting from carboxyl carbon as C1 and goes toward the methyl carbon *e.g.* Palmitoleate will be called 16:1 Δ^9



NOMENCLATURE (CONTD)

2. The ω - (or n-) system which starts counting from the CH_3 carbon as C1. The position of the first double bond is indicated
e.g. palmitoleate will be 16:1 ω -7 (n-7)



ESSENTIAL FATTY ACIDS

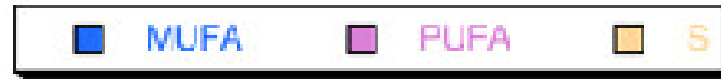
- **Linoleic acid** 18:2 $\Delta^{9,12}$ or 18 :2 ω -6 (n-6)
- **α -Linolenic acid** 18 :3 $\Delta^{9,12,15}$ or 18:3 ω -3 (n-3)
- These fatty acids cannot be synthesized by the human body and therefore have to be provided in the diet.
- Insufficient amounts in the diet result in EFA Deficiency (very rare) infants: scaly dermatitis, growth retardation
Also present in **CYSTIC FIBROSIS** patients (Vignette 2)

Other Important PUFA'S

- **Arachidonic Acid** 20:4 ω -6
Present in animal tissues
A common precursor of eicosanoids
- **Eicosapentaenoic Acid** 20:5 ω -3
Present in fish oils. Also a precursor of different class of eicosanoids
- **Docosahexaenoic acid** 22:6 ω -3
Present in fish oils
- Omega 3 fatty acids are important components of developing brain and retina

Health benefits of ω -3 Fatty acids

- Higher intakes associated with low risk of cardiovascular disease
- Higher intakes can reduce the risk of sudden heart attacks in individuals with cardiovascular disease
- Reduce blood triglyceride levels
- May be helpful in treatment of depression and other psychiatric diseases
- May reduce joint tenderness and requirements of anti-inflammatory medications in patients with arthritis



Coconut Oil



Soy Oil (~ Corn Oil)



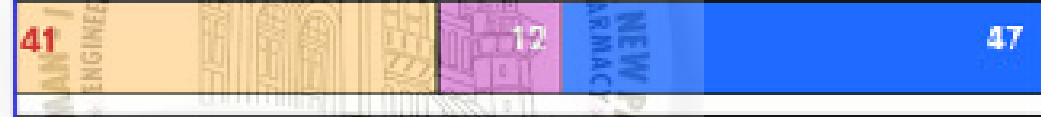
Butter Fat



Beef Tallow



Lard



Peanut Oil



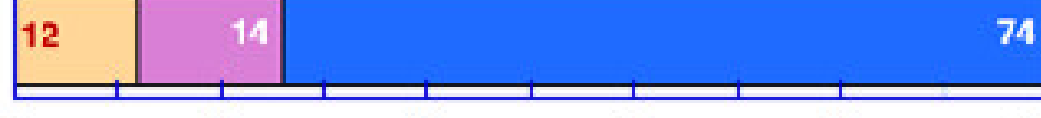
Canola Oil



Olive Oil



Avocado Oil



0 20 40 60 80 100

Per Cent Fatty Acid

**Amount of saturated fat
(grams per tablespoon)**

Type of fat

**Amount of unsaturated fat
(grams per tablespoon)**

 Saturated fat

0.8

Safflower oil



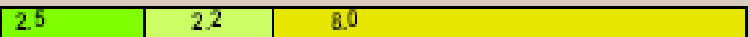
1.0

Canola oil



1.3

Flaxseed oil



1.4

Sunflower oil



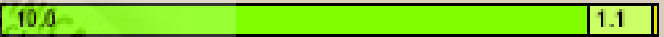
1.7

Corn oil



1.6

Olive oil



1.9

Sesame oil



2.0

Soybean oil



2.3

Peanut oil



2.7

Salmon fat



3.2

Cream, cheese



3.5

Cottonseed oil



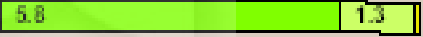
3.8

Chicken fat



5.0

Lard (pork fat)



6.4

Beef tallow



7.2

Butter



8.1

Cocoa butter



11.1




Palm kernel oil



11.8

Coconut oil



 Monounsaturated fat
 Polyunsaturated fat (n-6)
 Polyunsaturated fat (n-3)

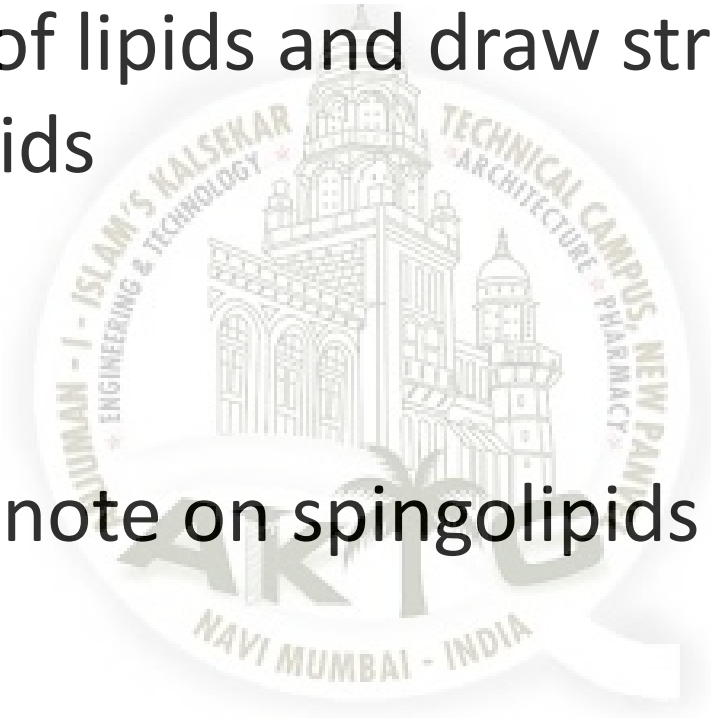
Lippincott's

References

- **Biochemistry of Lipids, Lipoproteins and Membranes by J E Vance and Dennis E Vance**
- **“Lipid Chemistry” by Khetarpaul Neelam and Khetarpaul Vipul**

Review Question for attainment of TLOs/CO

- Definitions of lipids and draw structures of any two fatty acids
- Write short note on spingolipids



THANK YOU!

