LIPIDS

Fats

Waxes

Steroids

Hormones

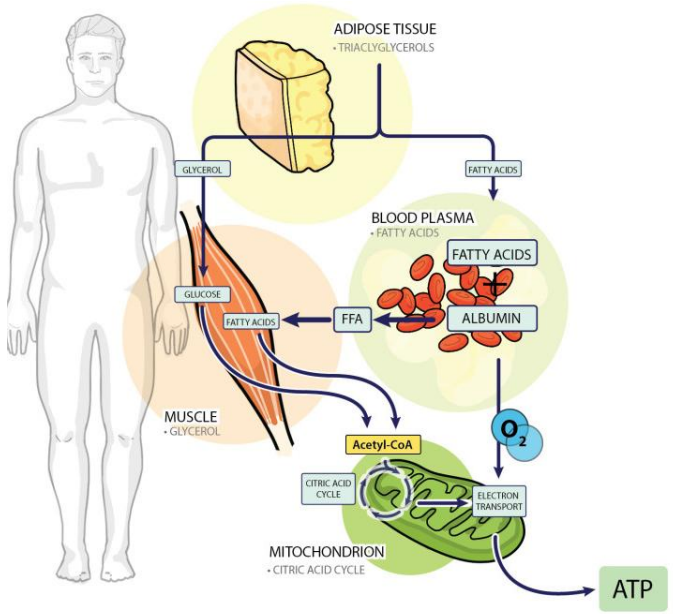
Phospholipids

FOOD LIPIDS

Dr. FG & Dr. DKY

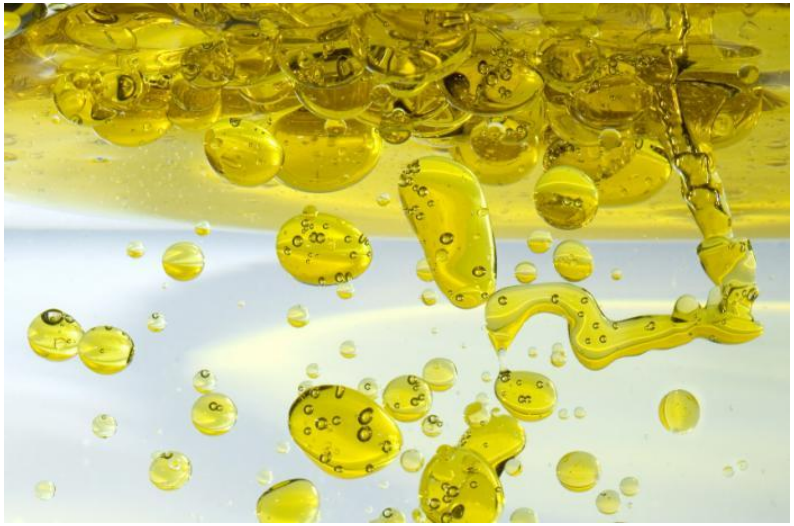
Roles of Food Lipids

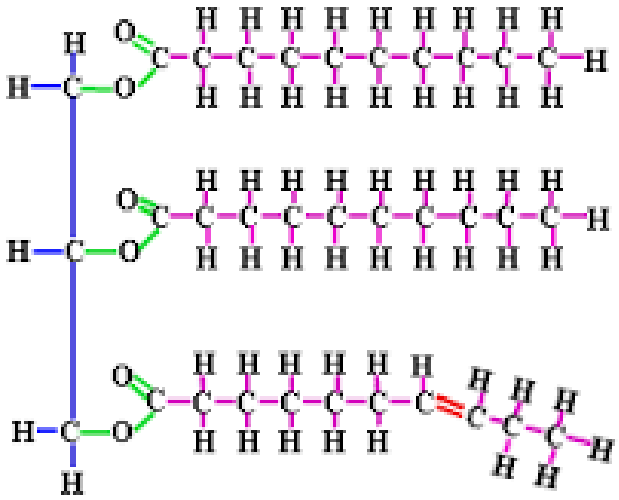
- Energy Source
- Main Flavor Source of Foods
- Mouth Feeling
- Texture of Foods
- Emulsifying Agents
- Carrier of Fat Soluble Vitamins
- Nerve System
- Thermal Insulation of Body
- Hormone and Cell Structure
- Mold Releasing and Anti-spattering Agent



Definition

The term lipid is used to describe a large group of naturally occurring fat-like substances.

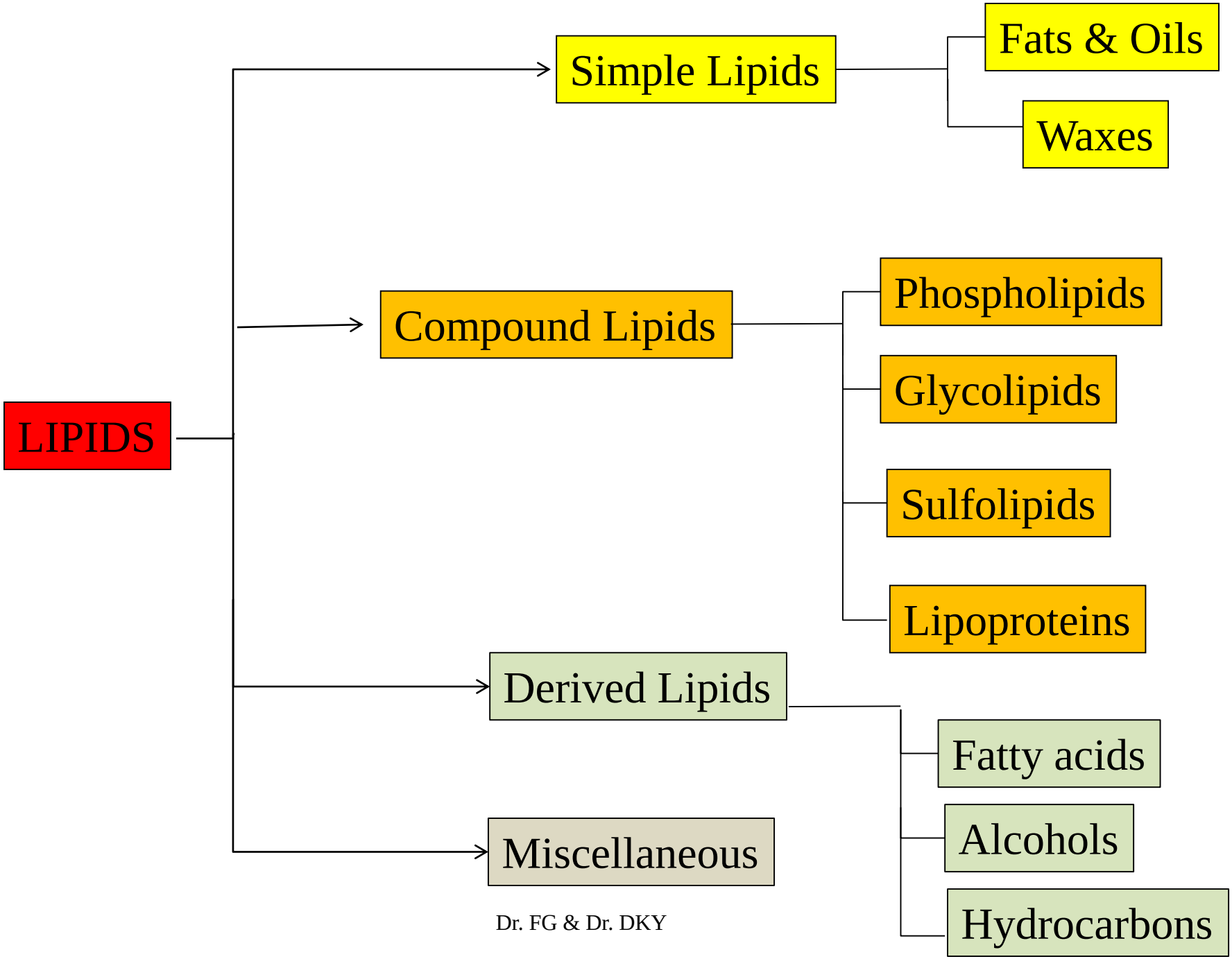




They are organic compounds which all contain carbon, hydrogen and a small amount of oxygen.

In general,
lipids are soluble in organic solvents such as chloroform and hexane,

but are not soluble in water.

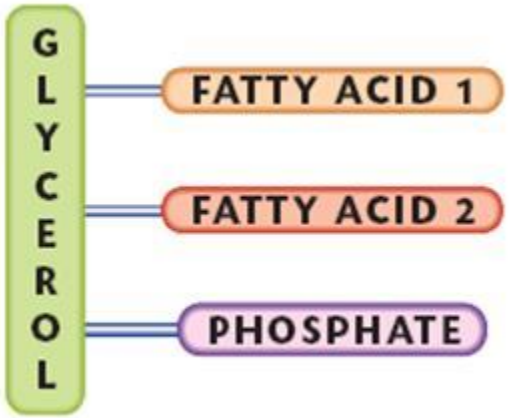

LIPIDS
Simple Lipids
Fats & Oils
Waxes
Compound Lipids
Phospholipids
Glycolipids
Sulfolipids
Lipoproteins
Derived Lipids
Fatty acids
Alcohols
Hydrocarbons
Miscellaneous

Phospholipids

Phospholipids are important substances concerned with the transport of lipid in blood stream.

Phospholipids are similar to fats in that they have a structure based on glycerol but instead of the three hydroxyl groups being combined with a fatty acid only two are so combined.

If one of the fatty acids is replaced by a **phosphate** molecule or a **phosphate** molecule is added top it then it is called a **phospholipid**.



Phospholipids

Lecithin (phosphatidyl choline) is one of the most significant phospholipids.

Lecithin is found in some foods, such as egg-yolk and crude soy bean oil.

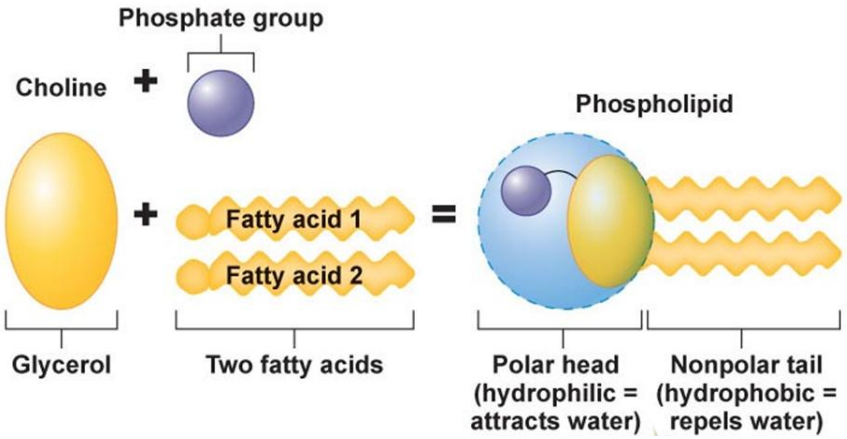
Phosphatidic Acid

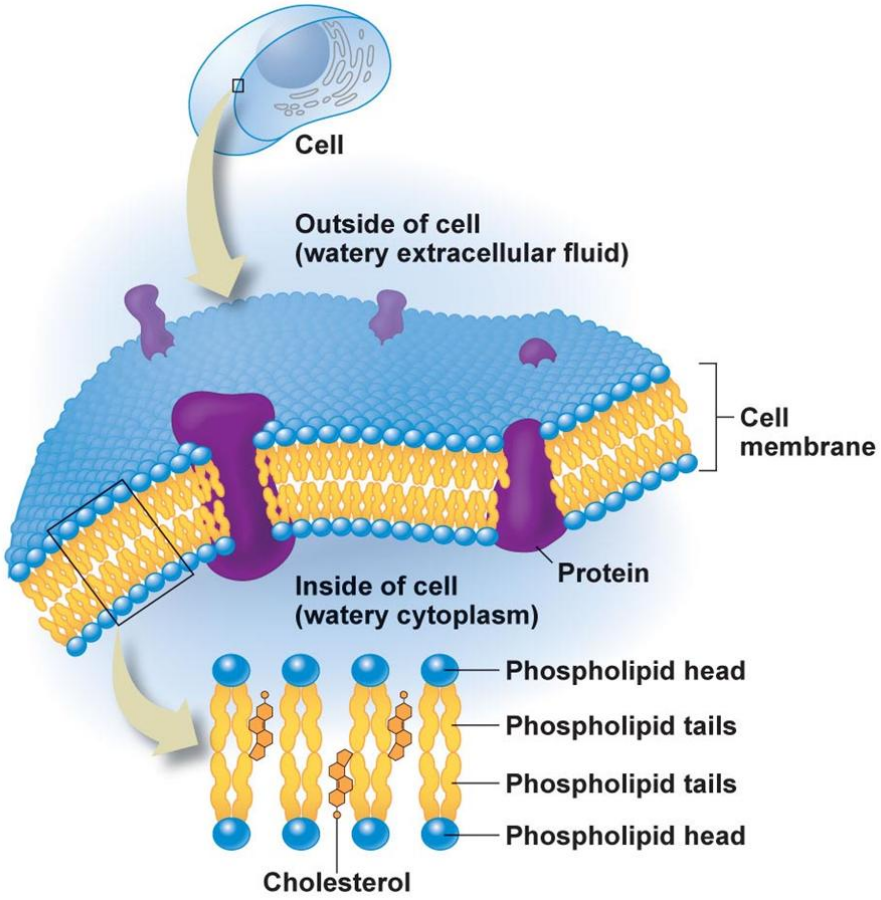
Choline

Phospholipids

Lecithin

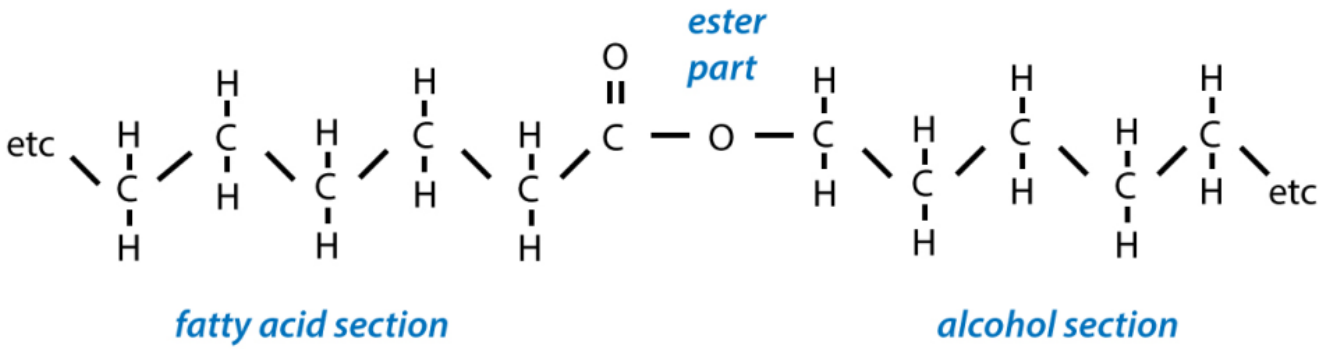
- A major phospholipid in the cell membrane
- Used as an emulsifier in foods





Waxes

Fatty acid + Long chain alcohol

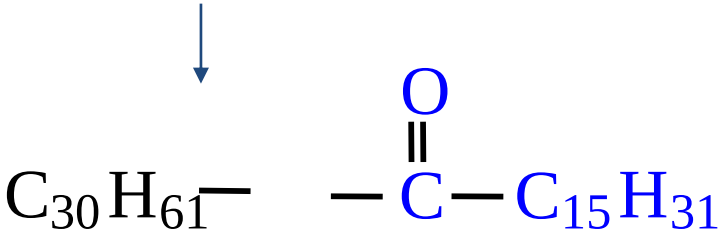


Important in fruits:

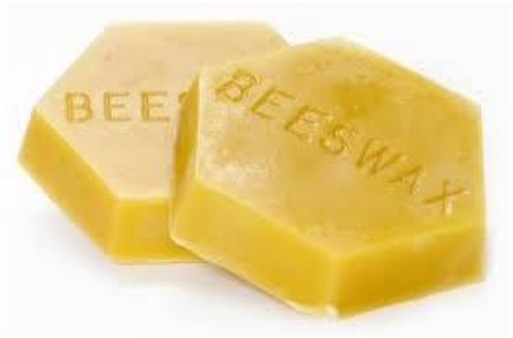
1. Natural protective layer in fruits, vegetables, etc.
2. Added in some cases for appearance and protection.

Waxes

Beeswax (myricyl palmitate),



Sunflower wax



Sterols

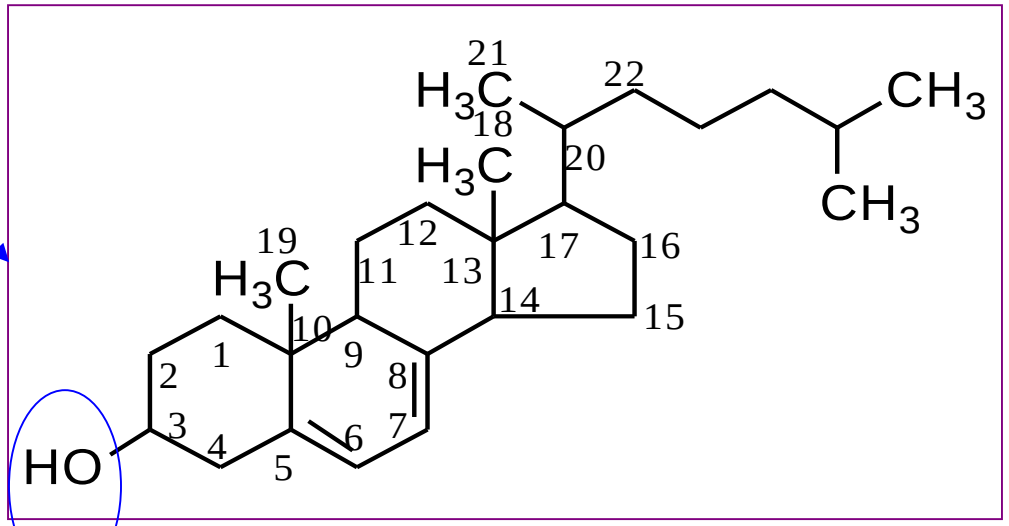
Male & female sex hormones

Bile acids

Vitamin D

Adrenal corticosteroids

Cholesterol



https://www.youtube.com/watch?v=VGHD9e3yRIU

Cholesterol

Cholesterol is

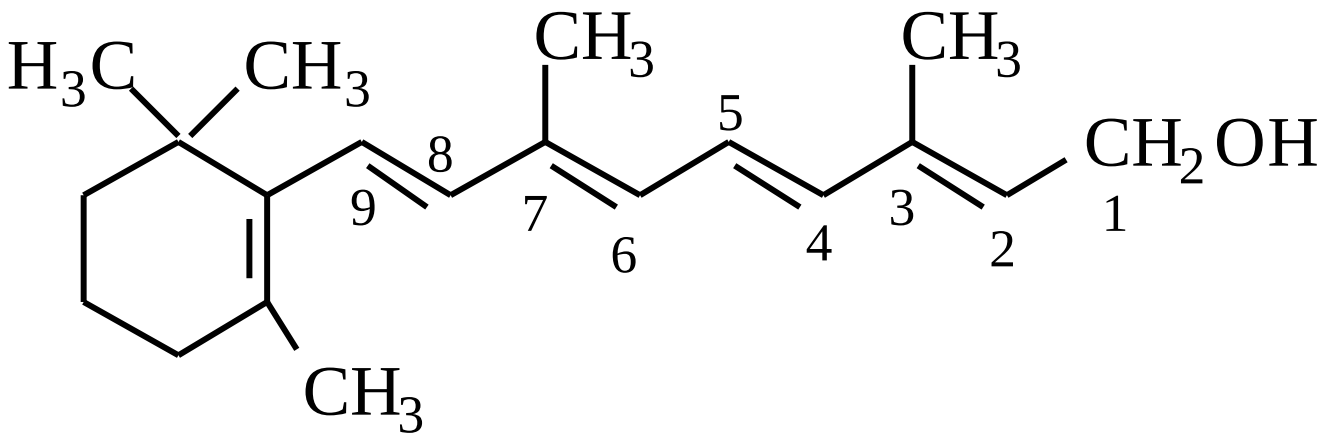
- a white fat like substance
- present in the body tissues
- found in animal foods (brain, kidney, liver, egg-yolk,..)

The body obtains some cholesterol from the diet but some is also made in the body, especially by the liver.

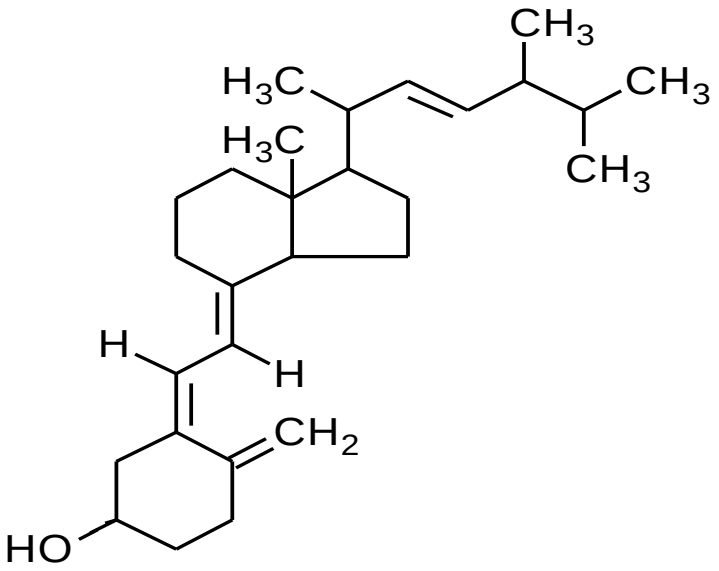
LDL cholesterol sometimes is called **“bad” cholesterol**. A high LDL level leads to a build-up of cholesterol in your arteries. (Arteries are blood vessels that carry blood from your heart to your body.)
HDL cholesterol sometimes is called **“good” cholesterol**. This is because it carries cholesterol from other parts of your body back to your liver. Your liver removes the cholesterol from your body.

Fat Soluble Vitamins

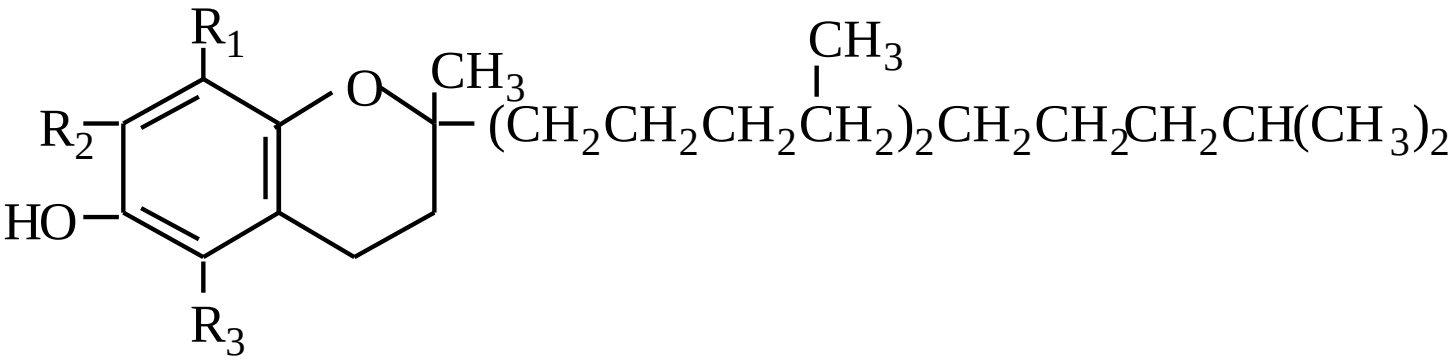
Vitamin A



Vitamin D_2



Vitamin E



Oils and Fats

Functions of fats in food:

1. Provide energy (9 kcal/gm)
2. Contribute flavor, aroma, and tenderness
3. Provide satiety
4. Carry fat-soluble vitamins (A, D, E & K)
5. Provide a source of essential fatty acids

Fats and oils are used

• in cooking

• as salad oils

• as spreads

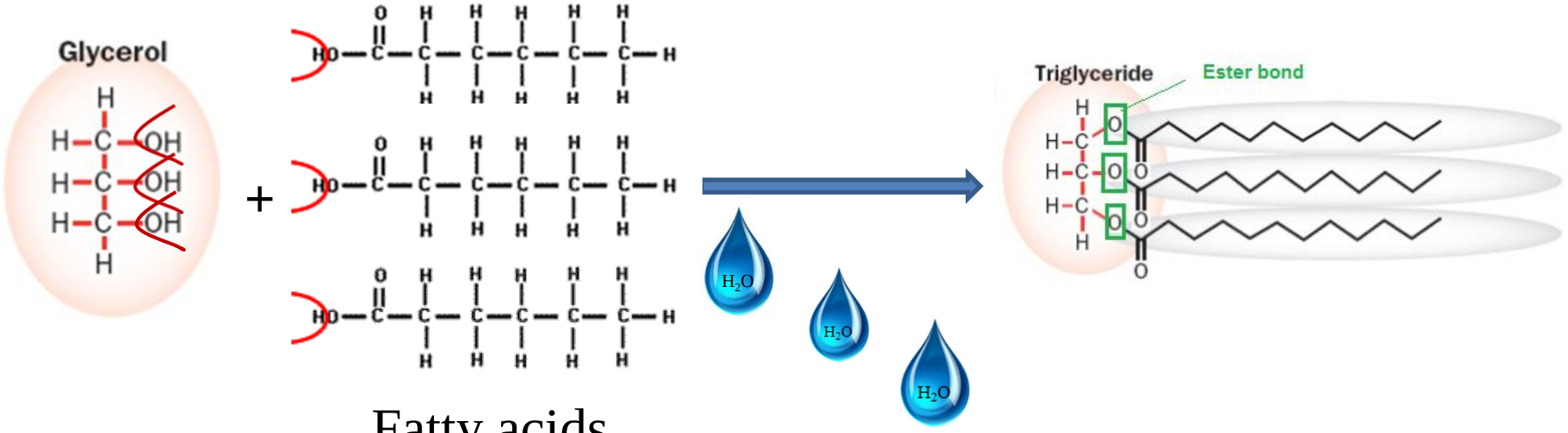
• as ingredients in manufactured and cooked foods

Oils and Fats

Chemically they belong to a class of **esters** which results from the reaction of **acids** and **alcohols**.

Fats and Oils – Triglycerides

The three hydroxyl groups of the **glycerol** molecule can each combine with a **fatty acid** molecule and the resulting **ester** is called a **TRIGLYCERIDE**.

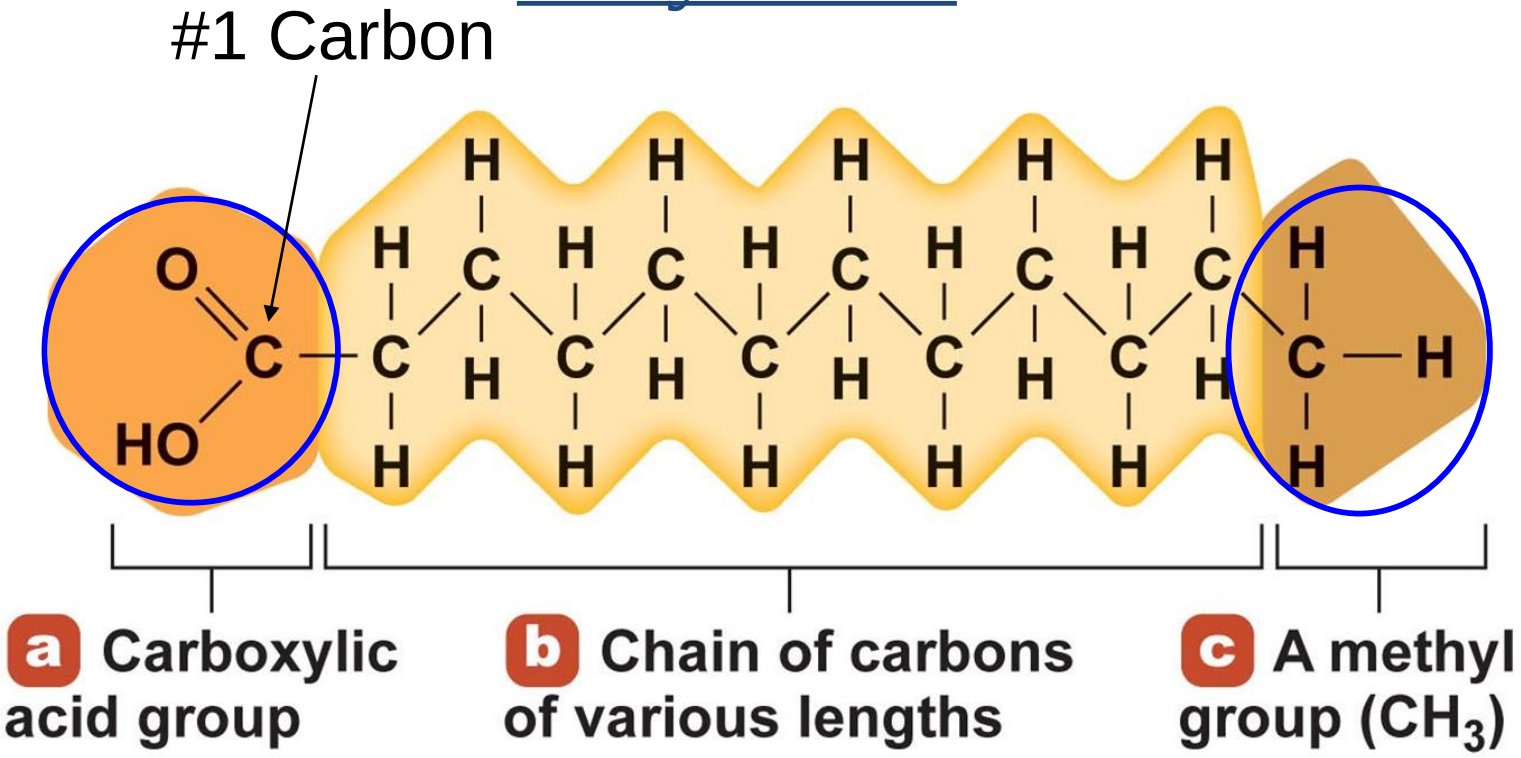


Oils and Fats

Chemically oils and fats are the same; the only distinction between them is that at normal air temparatures oils are liquid while fats are solid.

- ✓ The nature of fatty acids plays an important role in determining the character of oils and fats

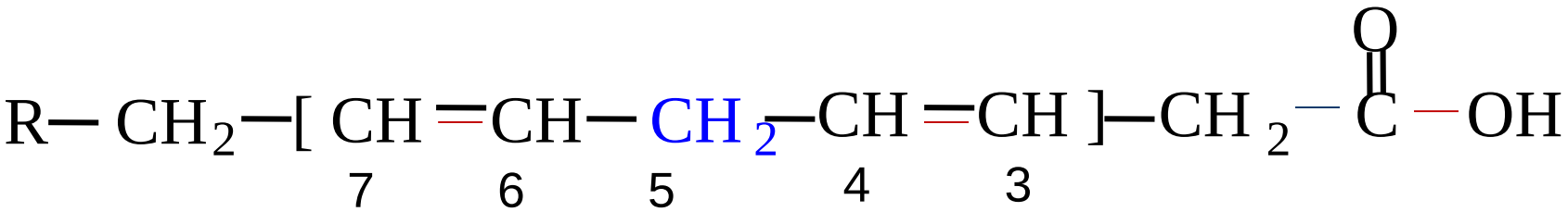
Fatty Acids



Fatty acids are known as **carboxylic acids** because they contain the carboxyl group (-COOH)

The length of carbon chain varies, and the number of carbon atoms is an even number between 4 and 24

Naturally-occurring Fatty Acids



1. Cis form
2. Not conjugated --- isolated double bond.
3. Even numbered fatty acids.

Types of Fatty Acids

Fatty acids are classified into three classes according to their saturation

- Fatty acids that possess **no** double bonds are ***saturated*** (have maximum number of H atoms).

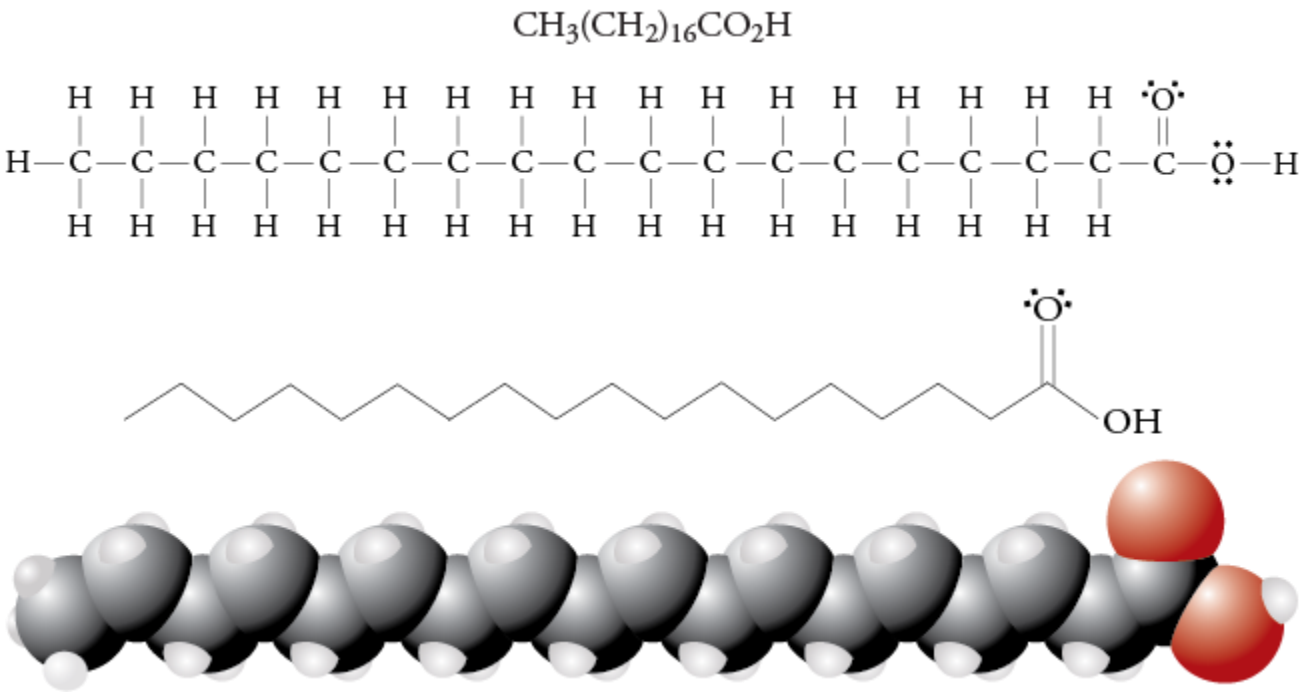
  Saturated fatty acids are linear in structure

- Fatty acids **with one double bond** are ***monounsaturated***
- Fatty acids **with more than one double** are ***polyunsaturated***

  Unsaturated fatty acids are bent in structure

Type of Fatty Acid	Double Bonds	Diagram
Saturated	None	
Monounsaturated	One	
Polyunsaturated	Multiple (>1)	

Saturated Fatty Acids



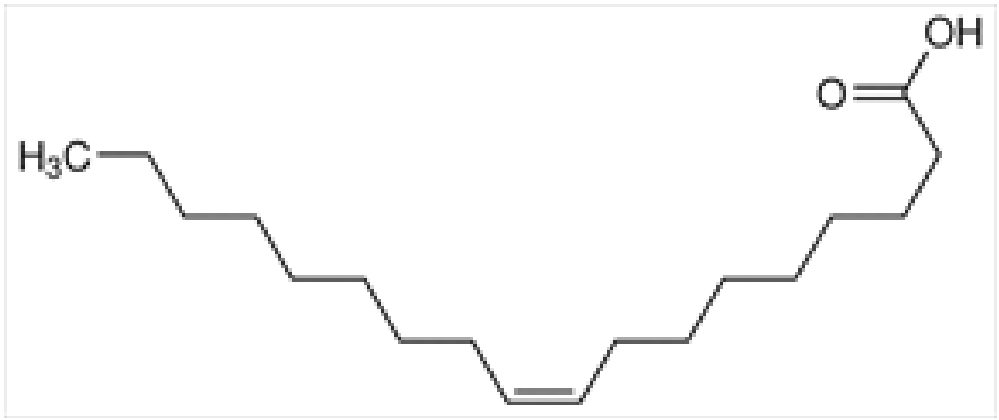
Stearic acid

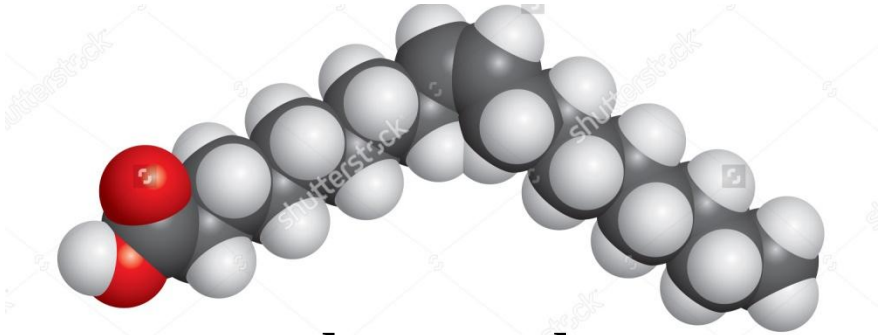
Saturated Fatty Acids

Common Name	Systematic Name	Formula	Common source
Butyric	Butanoic	CH3(CH2)2COOH	butterfat
Caproic	Hexanoic	CH3(CH2)4COOH	butterfat, coconut and palm nut oils
Caprylic	Octanoic	CH3(CH2)6COOH	coconut and palm nut oils, butterfat
Capric	Decanoic	CH3(CH2)8COOH	coconut and palm nut oils, butterfat
Lauric	Dodecanoic	CH3(CH2)10COOH	coconut and palm nut oils, butterfat
Myristic	Tetradecanoic	CH3(CH2)12COOH	coconut and Palm nut oil, most animal and plant fats
Palmitic	Hexadecanoic	CH3(CH2)14COOH	practically all animal and plant fats
Stearic	Octadecanoic	CH3(CH2)16COOH	animal fats and minor component of plant fats
Arachidic	Eicosanoic	CH3(CH2)18COOH	peanut oil

Monounsaturated Fatty Acids

$H_3C-(CH_2)_7-CH=CH-(CH_2)_7-COOH$





Oleic acid

Monounsaturated Fatty Acids

Common Name	Systematic Name	Formula	Common source
Palmitoleic	Cis 9-hexadecenoic	C15H29COOH	Breast milk, plant and animal fats
Oleic	Cis 9-octadecenoic	C17H33COOH	plant and animal fats
Elaidic	Trans 9-Octadecenoic	C17H33COOH	animal fats

Polyunsaturated Fatty Acids (PUFA)

Linoleic acid:	Cis, cis, 9, 12 - Octadecadienoic acid
Linolenic acid:	Cis, cis, cis 9, 12, 15 - Octadecatrienoic acid
Arachidonic acid:	Cis, cis, cis, cis 5, 8, 11, 14 - Eicosatetraenoic acid

Linoleic Acid

↓

Linolenic Acid

↓

Arachidonic Acid

Polyunsaturated Fatty Acids

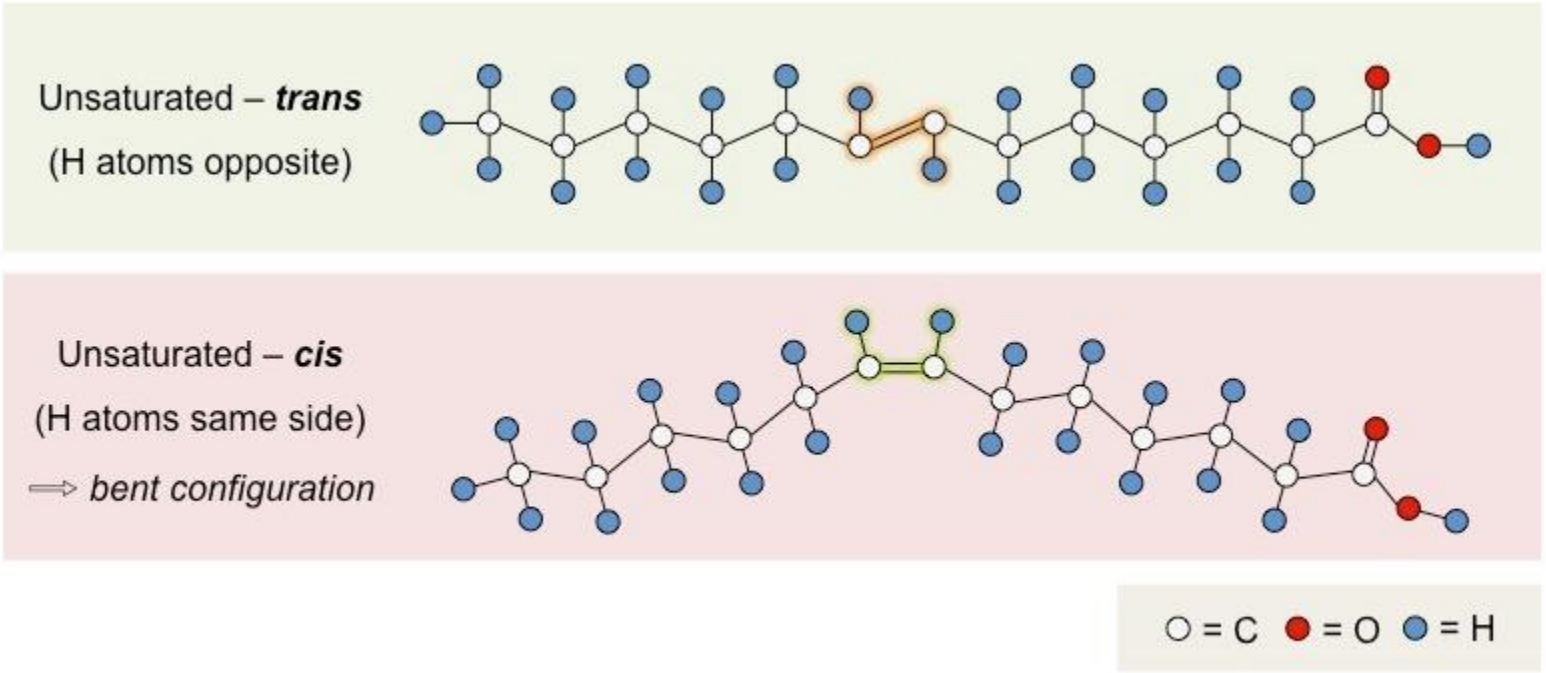
Common Name	Systematic Name	Formula	Common source
	A. with two double bonds		
Linoleic	9,12-Octadecadienoic	C17H31COOH	peanut, linseed, and cottonseed oils
	B. with three double bonds		
Linolenic	9,12,15-Octadecatrienoic	C17H29COOH	linseed and other seed oils
Eleostearic	9,11,13-Octadecatrienoic	C17H29COOH	peanut seed fats
	C. with four double bonds		
Moroctic	4,8,12,15-Octadecatetraenoic	C17H27COOH	fish oils
Arachidonic	5,8,11,14-Eicosatetraenoic	C19H31COOH	traces in animal fats

Cis And Trans Fatty Acids

Unsaturated fatty acids may occur in two distinct structural configurations – *cis* and *trans* isomers

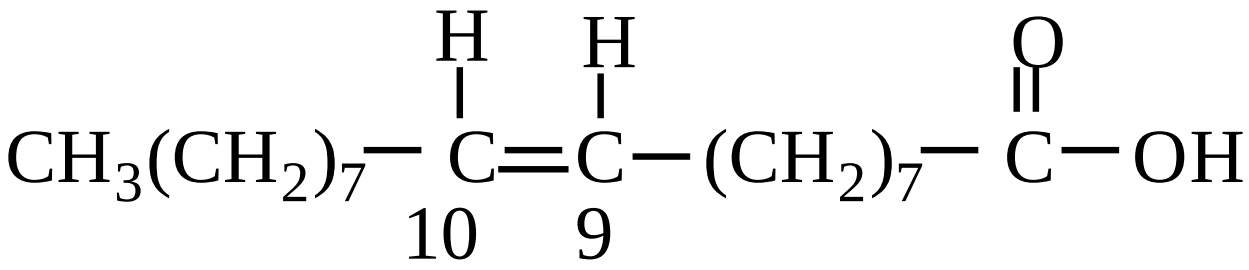
Cis: The hydrogen atoms attached to the carbon double bond are on the same side

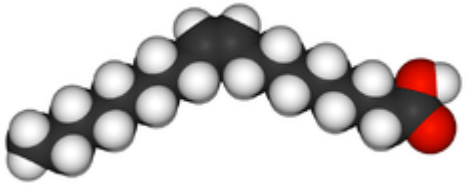
Trans: The hydrogen atoms attached to the carbon double bond are on different sides



Cis and Trans Fatty Acids

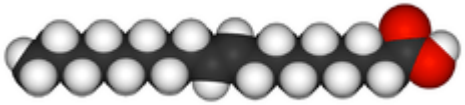
Naturally occurring unsaturated fatty acids have *cis* forms.



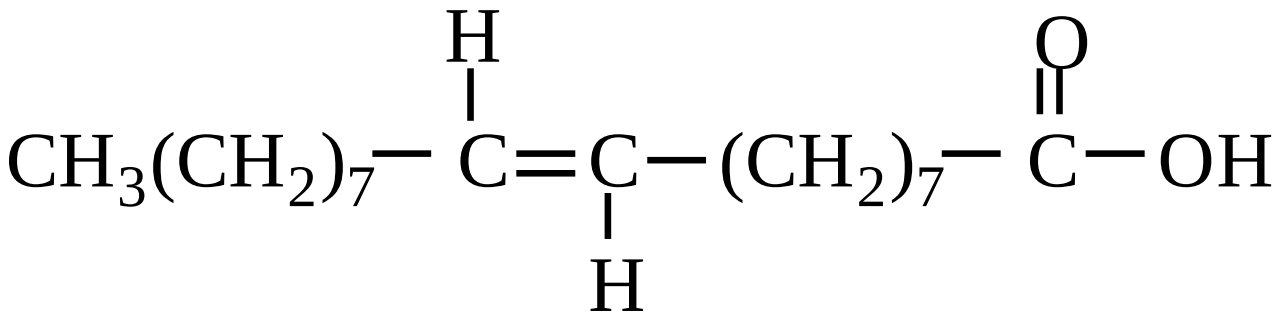


Non linear in structure

Cis 9 - Octadecenoic Acid (oleic)



linear in structure

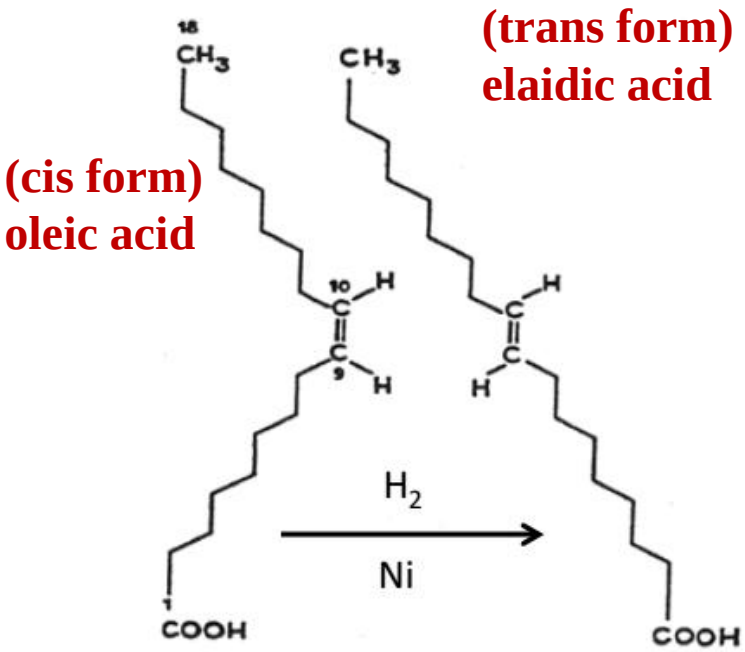


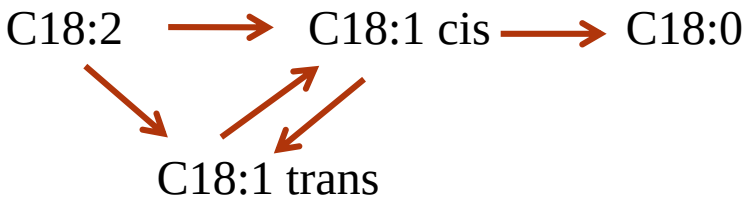
Trans 9 - Octadecenoic Acid (elaidic acid)

Cis and Trans Fatty Acids

Trans bonds result from

- an industrial process called hydrogenation





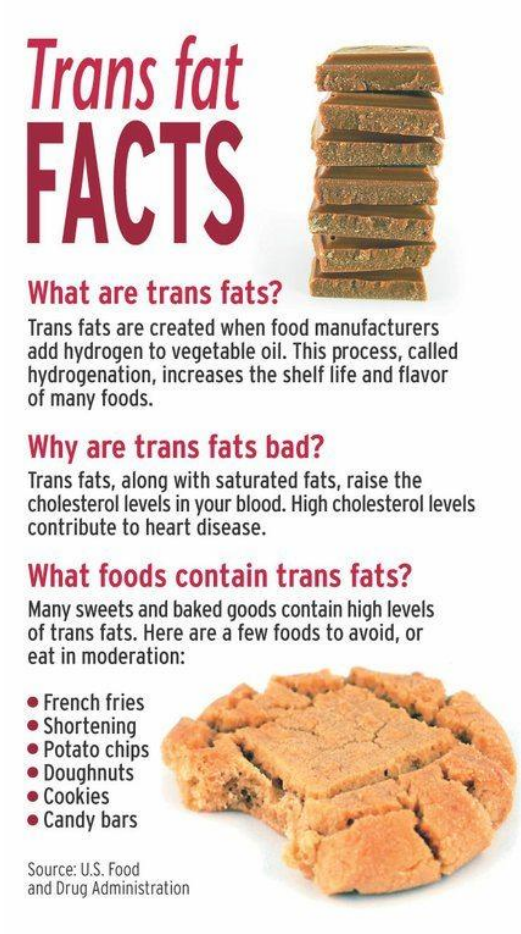
- high temperature applications (deodorization, frying, etc..)
- microbial action (occur in milk fat and meat)

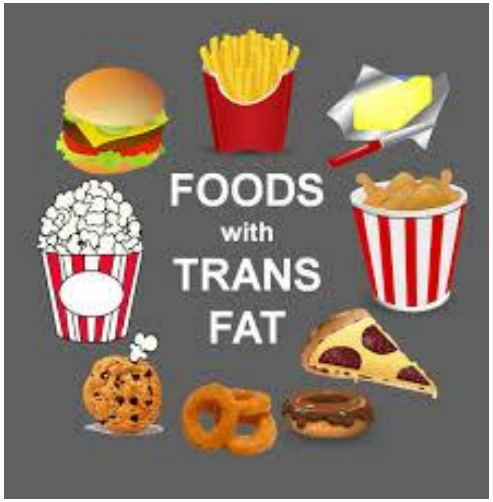
Cis and Trans Fatty Acids

Old theory: Enzymes can recognize the difference between *cis* and *trans* forms, acting on the *cis* but not *trans*.
New theory: Trans fat is metabolized but competitively inhibits the metabolism of other fatty acids (essential fatty acids)

	Cis Fat	Trans Fat
Health Effect	Generally good for health unless consumed in unreasonably high quantities.	Detrimental — lowers good cholesterol and increases the level of bad cholesterol in the body. Harmful to heart health could cause cardiac death.
Occurs naturally	Yes	While some natural trans fats occur in meat and dairy products, the majority of trans fats come from processed foods (i.e., hydrogenated oils).
Arrangement of atoms	The chains of carbon atoms are on the same side of the double bond, resulting in a kink.	Hydrogen atoms are on the opposite side of the double bonds of the carbon chain, making the fat molecule straight.
Melting Point	Usually low. Some cis fats are liquid at room temperature.	Usually high. Trans fats, like saturated fats, are solid at room temperature.

Trans Fats and Health



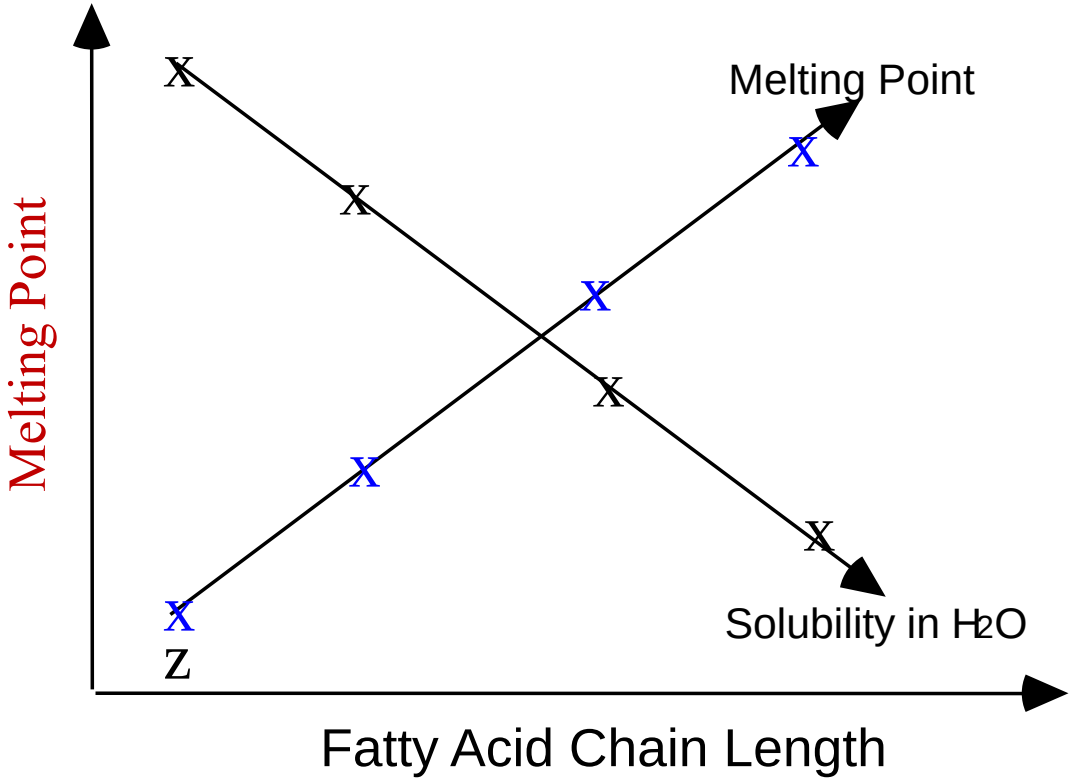


Fatty Acids according to their chain length

Fats vary in the length of their carbon chains, leading to another classification scheme based on their number of carbon pairs:

- **Short-chain fatty acids (SCFAs):** Less than eight carbons- These are produced in the large bowel as a result of bacterial fermentation of soluble fibre.
- **Medium-chain fatty acids (MCFAs):** Eight to 14 carbons- Coconut oil is composed of approximately 66% medium-chain fatty acids.
- **Long-chain fatty acids (LCFAs):** 16 or more carbons- most important fatty acids for human being like ALA, LA, EPA, DHA etc.

Fatty Acids Melting Points and Solubility in Water



Characteristics of Fatty Acids

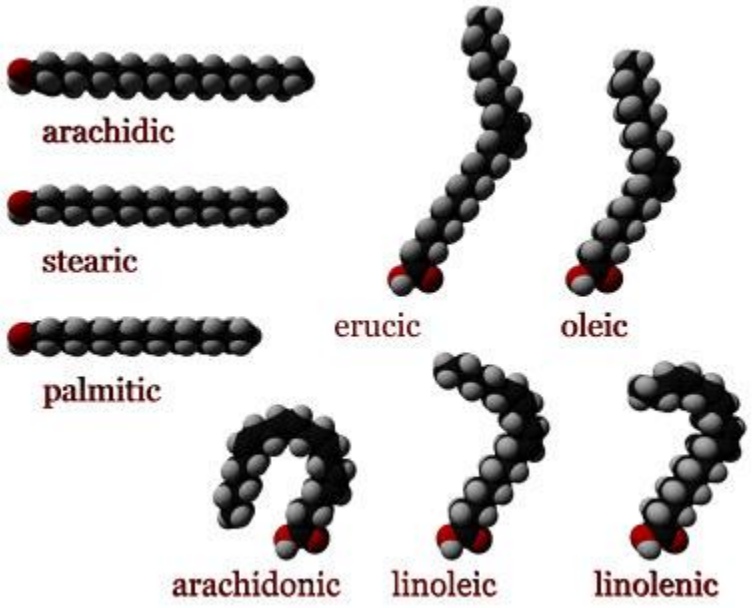
Fatty Acids	M.P.(C)	mg/100 ml in H2O*
C4	- 8	-
C6	- 4	970
C8	16	75
C10	31	6
C12	44	0.55
C14	54	0.18
C16	63	0.08
C18	70	0.04

* Solubility

Effects of Double Bonds on the Melting Points

All natural fats contain both saturated and unsaturated fatty acids (combined with glycerol)
The degree of unsaturation of a fat is important in determining its properties.

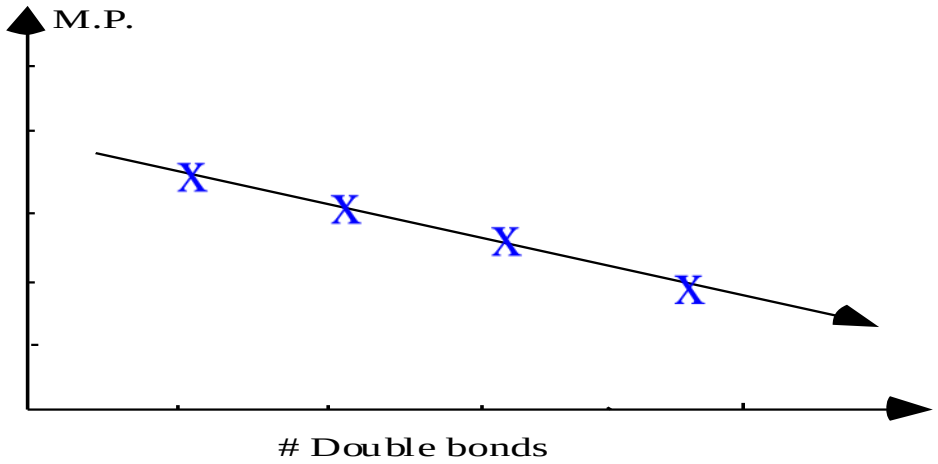
The more double bonds that a carbon-hydrogen chain possesses the greater is **its degree of unsaturation**.



Effects of Double Bonds on the Melting Points

unsaturation/saturation increases, melting point decreases

F. A.	M. P. (C)
16:0	60
16:1	1
18:0	63
18:1	16
18:2	-5
18:3	-11
20:0	75
20:4	-50

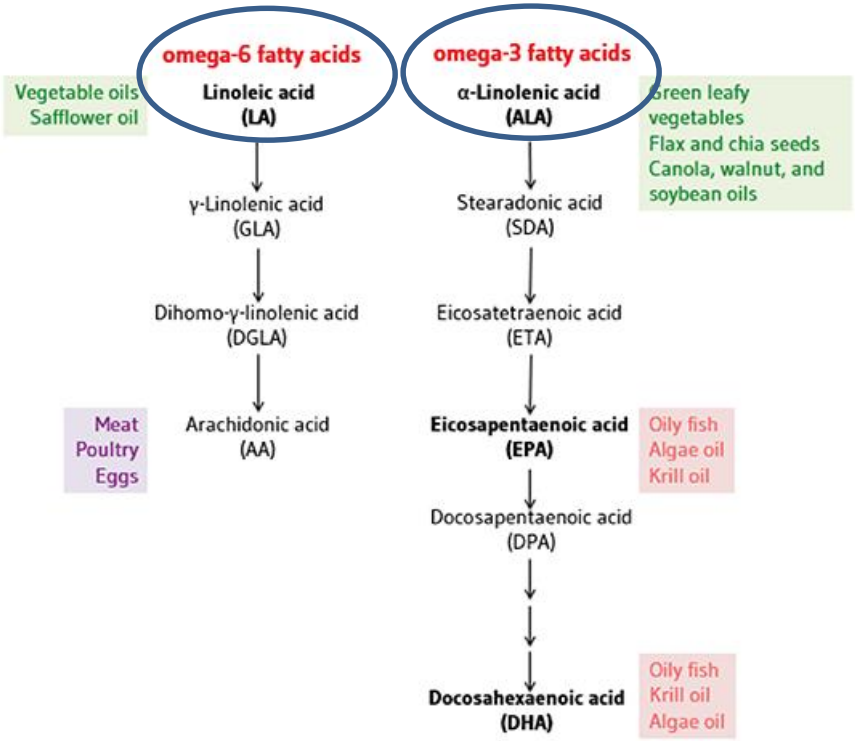


Essential Fatty Acids

Polyunsaturated fatty acids (PUFA) are of particular interest in human nutrition because certain of them cannot be made by the body and so must be supplied by food.

Linoleic acid (LA), an omega-6 fatty acid, and α-linolenic acid (ALA), an omega-3 fatty acid, are considered essential fatty acids (EFA) because they cannot be synthesized by humans.

Essential Fatty Acids



Due to low efficiency of conversion of ALA to

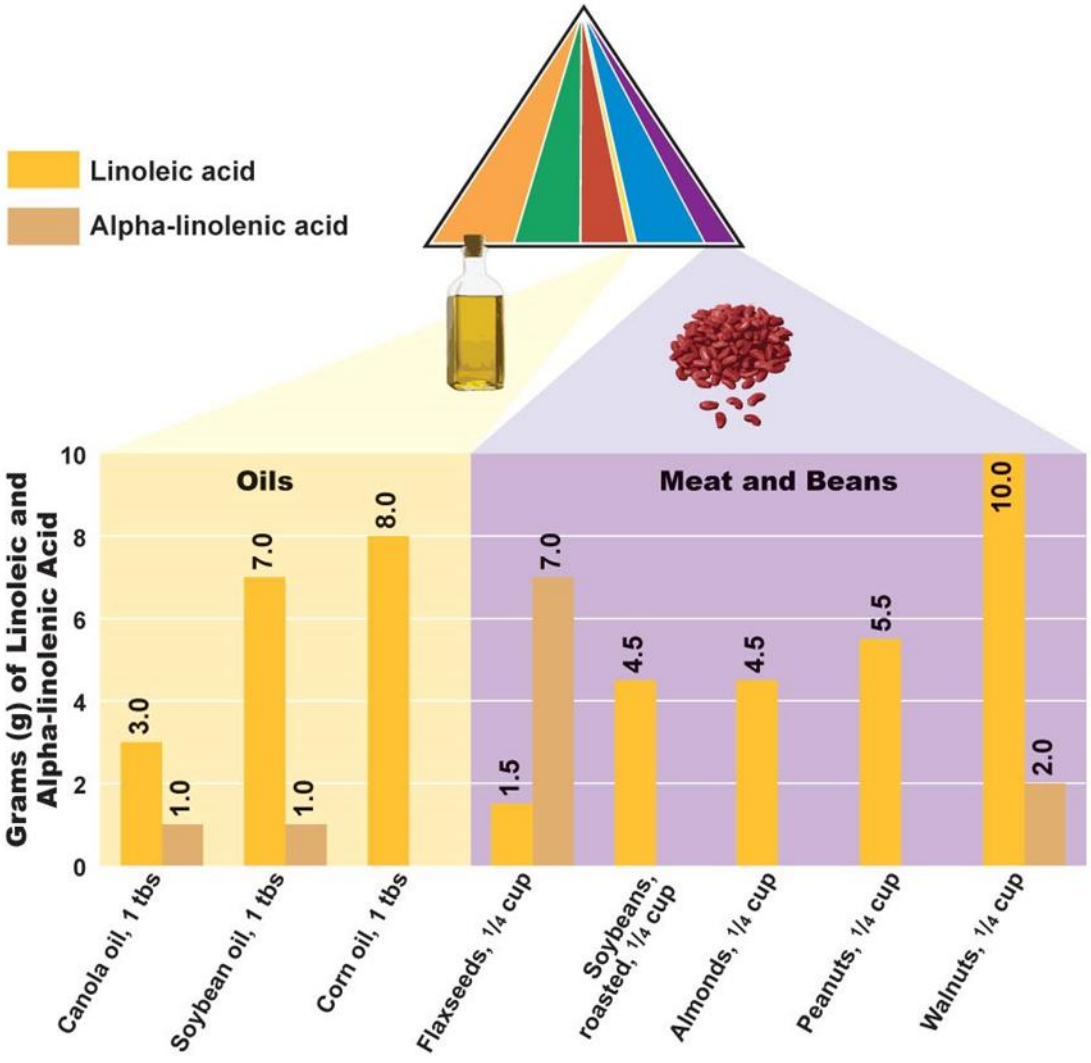
EPA and

DHA,

it is recommended to obtain EPA and DHA from additional sources.

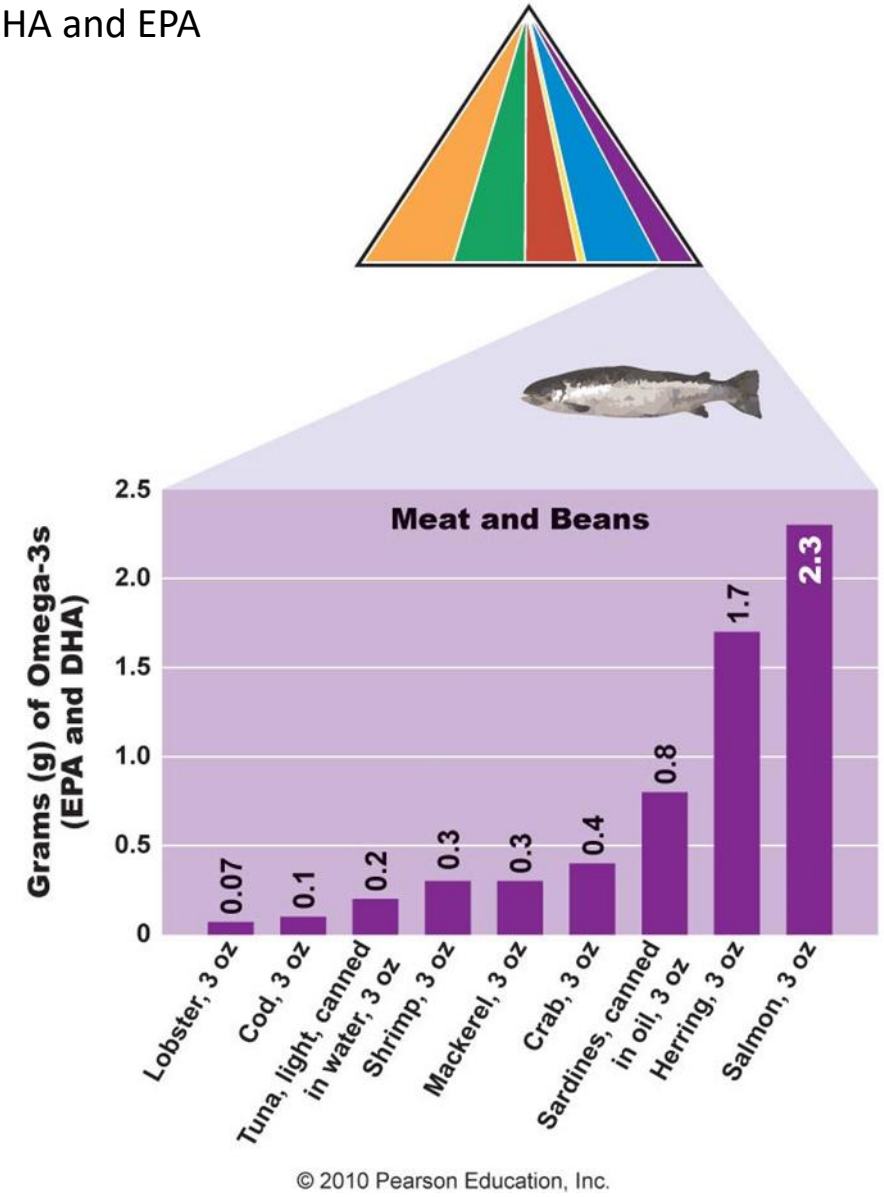
Essential Fatty Acids

Best Food Sources of Essential Fatty acids



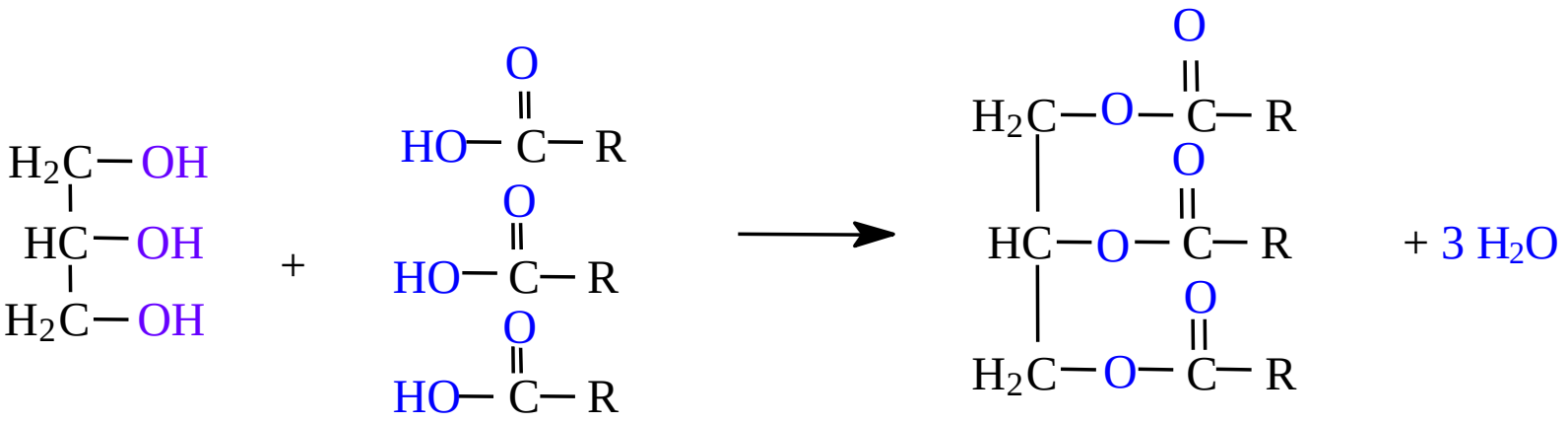
Essential Fatty Acids

Food Sources of DHA and EPA



Oils and Fats

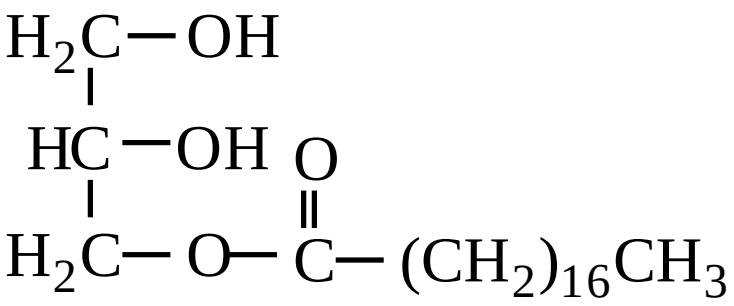
Triglycerides



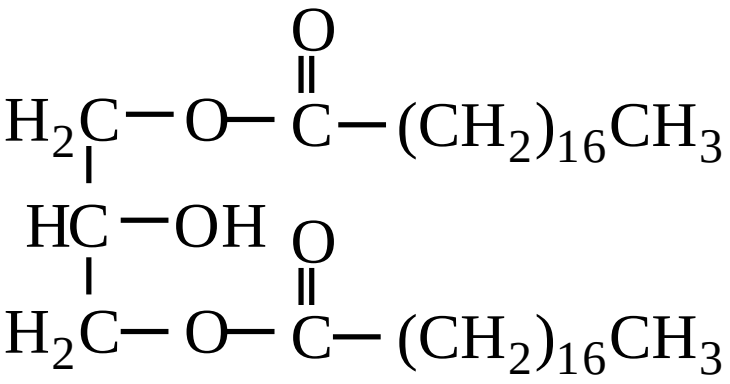
Glycerol 3 Fatty Acids Trigyceride

Oils and Fats

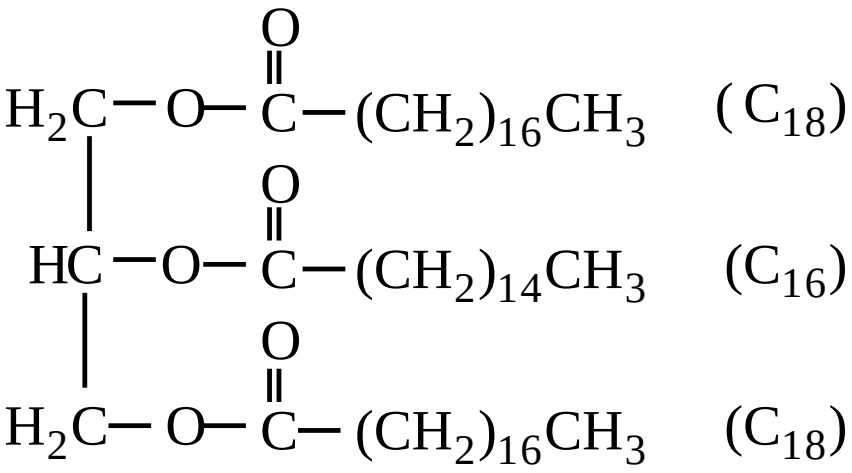
Glycerides



Monoglyceride (α - monostearin)



Diglyceride (α, α' - distearin)



Triglyceride (β - palmityl distearin)

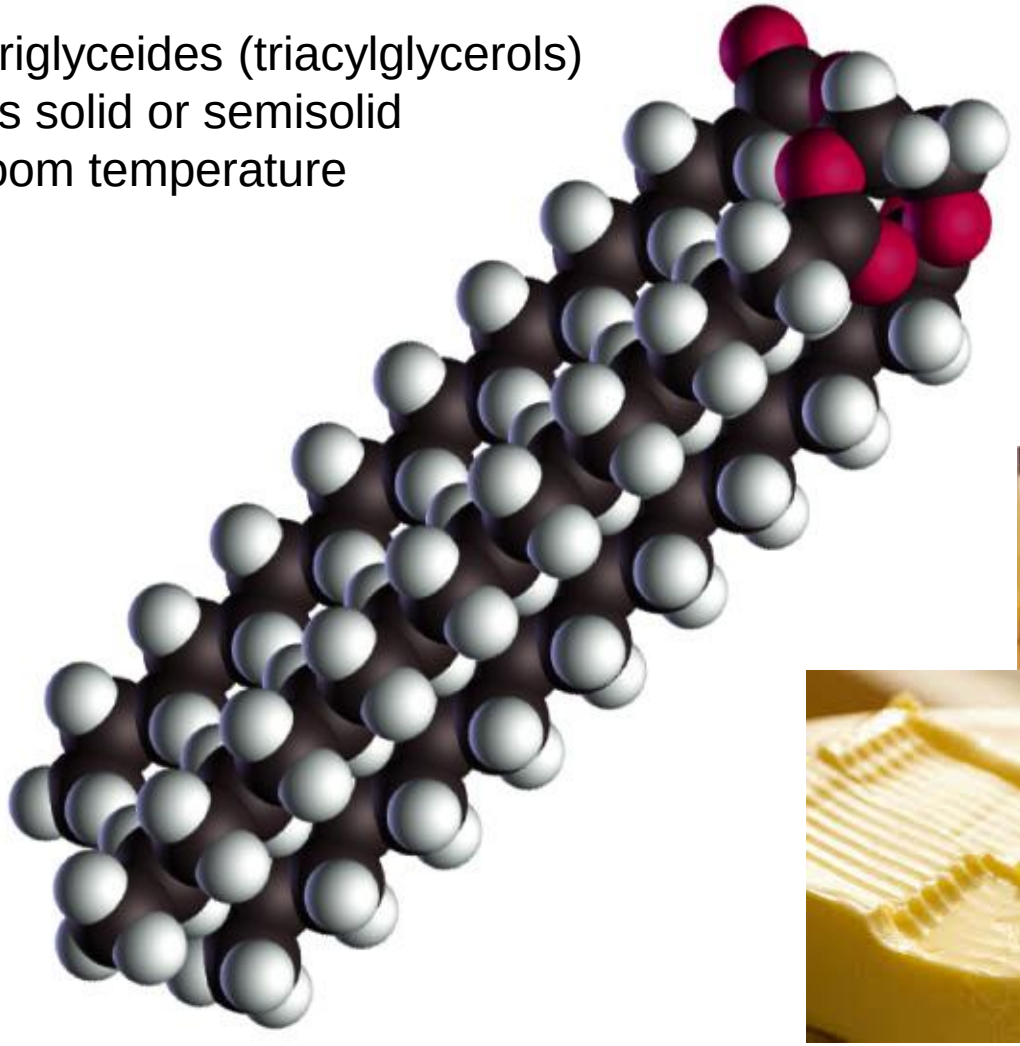
Oils and Fats

Fatty Acids (%) of Fats and Oils

Fatty Acids	Butter	Coconut	Cottonseed	Soybean
4	3			
6	3			
8	2	6		
10	3	6		
12	3	44		
14	10	18	1	
16	26	11	4	12
16:1	7		1	
18:0	15	6	3	2
18:1	29	7	18	24
18:2	2	2	53	54
18:3	2			8

Oils and Fats

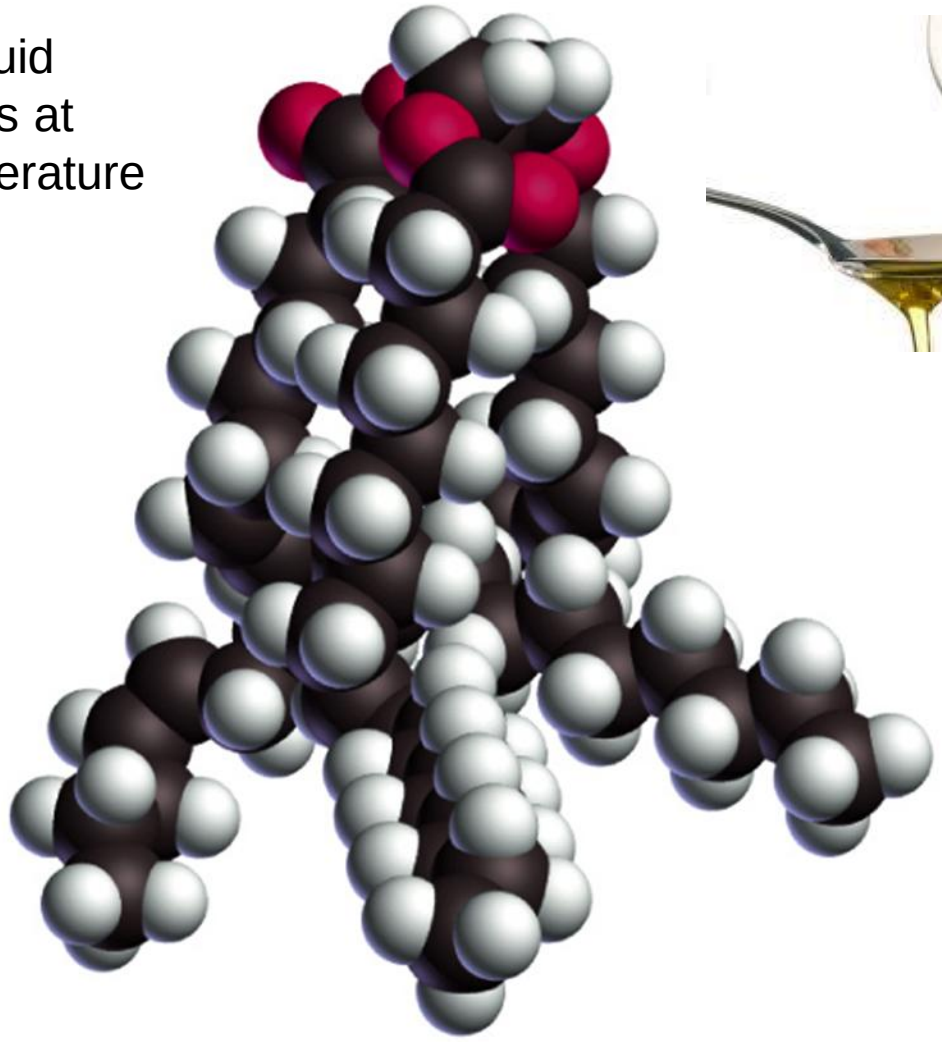
Fats are triglyceides (triacylglycerols) existing as solid or semisolid state at room temperature



a fat

Oils and Fats

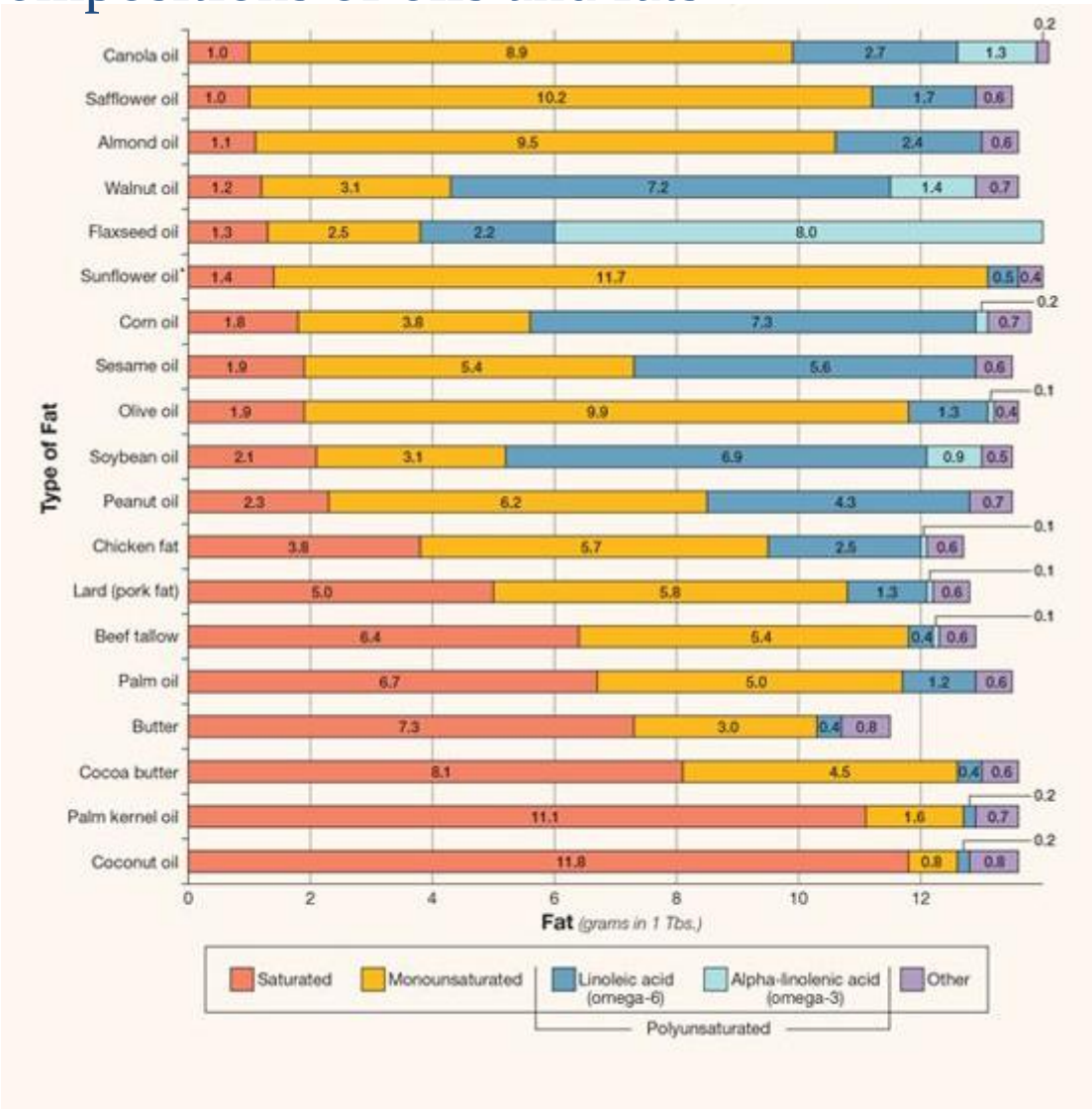
Oils are liquid triglycerides at room temperature



an oil

Oils and Fats

Fatty acid compositions of oils and fats



Oils and Fats

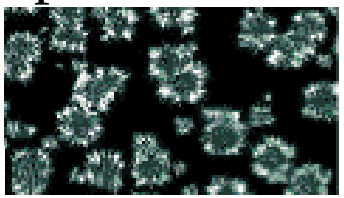
Physical nature of oils and fats

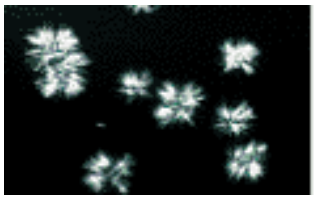
- Fats may either be liquid, plastic or solid at room temperature.
- A plastic fat is moldable because it contains both liquid oil and solid crystals of triglycerides.
- Its texture depends on the ratio of solid to liquid triglycerides; the more liquid triglycerides (more unsaturated f.a. containing), the softer the fat will be, and the more solid triglycerides (more saturated f.a. containing), the harder it will be.
- Fats do not melt at a fixed temperature, but over a range of temperatures. For example; sunflower seed oil -18 to -16, olive oil -3 to 0, palm oil 33 to 40, butter 28 to 35.

Oils and Fats

Physical nature of oils and fats

- In this range they are plastic;
  - that is they are soft and can be spread but they do not flow
  - their properties are intermediate between those of a solid and liquid
- They are plastic, because fat is a mixture of different triglycerides, each triglyceride having its own melting point.
- The melting point of fats is also affected by the fact that many triglycerides can exist in several crystalline forms, that is they are polymorphic.





Each crystalline form has its own melting point. So, the way in which an oil is cooled affects the texture and consistency of the product formed.

Oils and Fats

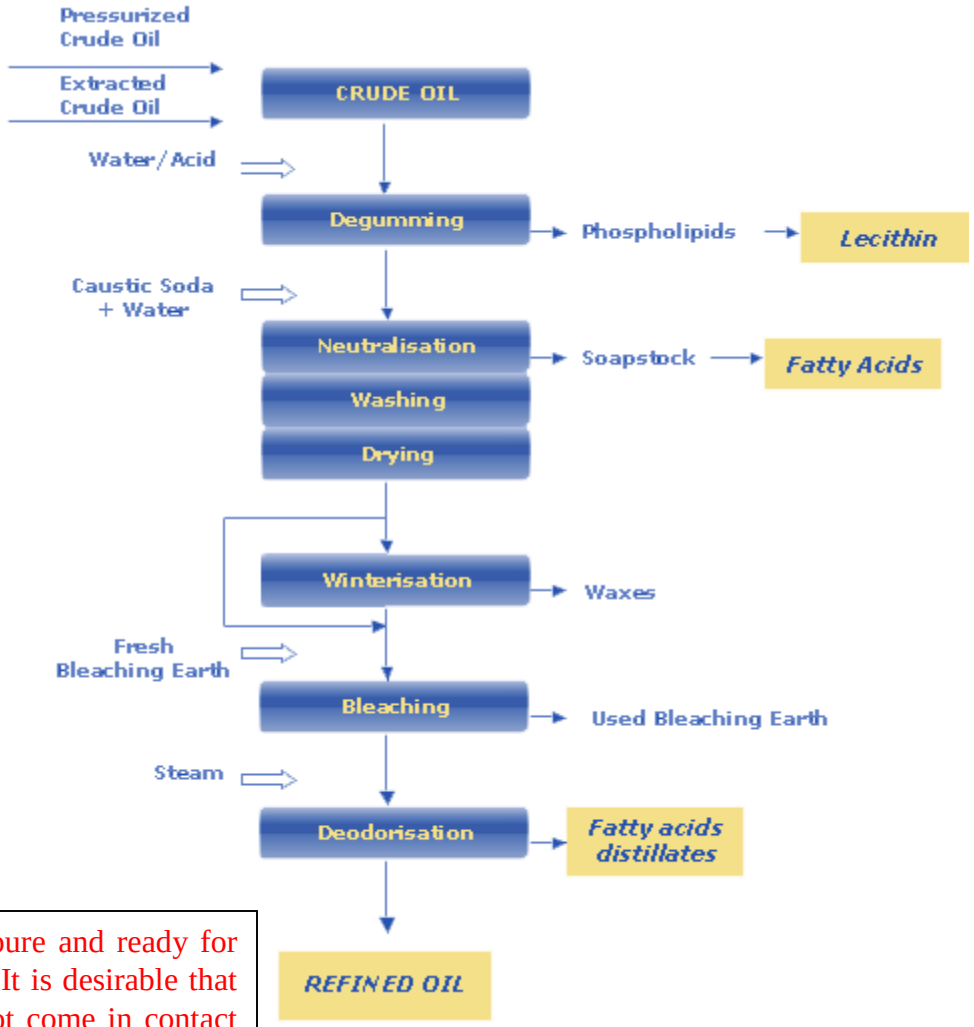
Refining of crude oils

Most vegetable oils, contain a number of impurities such as moisture, free fatty acids, gums, waxes, coloring matter, odorous compounds and etc.

These impurities affect taste, odor, color, clarity, and are removed during refining.

Oils and Fats

Refining of crude oils



The oil is now pure and ready for use or blending. It is desirable that the oil should not come in contact with moisture, air and light.

Function/Aim

- Removal of phospholipids
- Removal of free fatty acids
- Removal of moisture
- Removal of waxes
- Removal of undesirable color pigments
- Removal of odorous volatile compounds

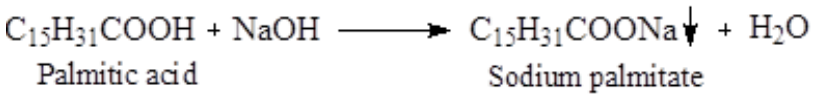
Oils and Fats

Neutralization

All crude oils contain a small proportion of ffa and low grade oils.

- The acids are removed by neutralizing the oil with a solution of caustic soda (NaOH), which converts the fatty acids into insoluble soap.
- The soap is then removed by centrifugation.

If the acid impurity is palmitic acid, for example, insoluble sodium palmitate is formed:

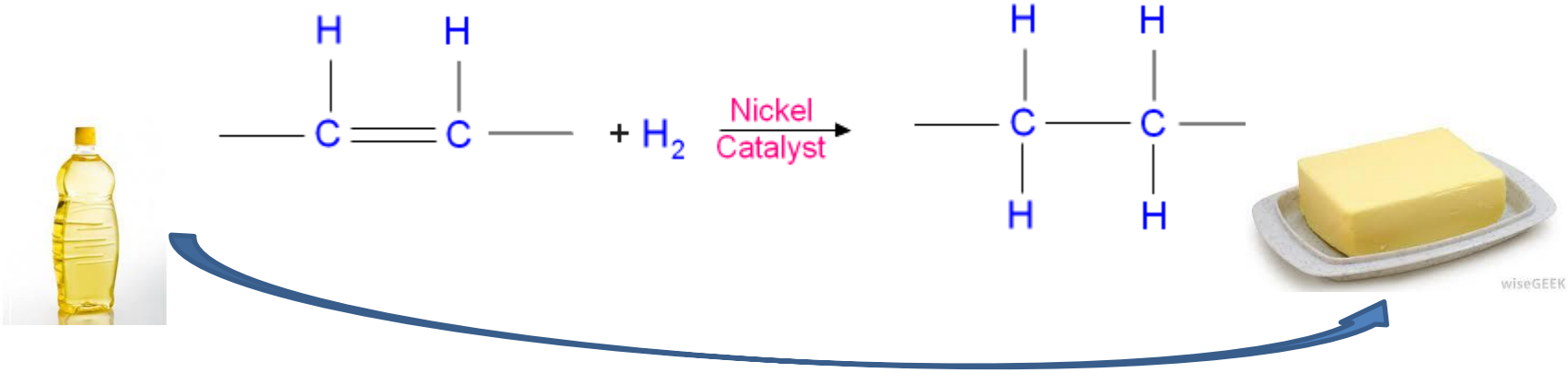


free fatty acid soap

Oils and Fats

Hydrogenation

- Hydrogenation is the process where an oil is converted into a fat, that is, by which it is hardened.
- Hydrogenation is simply the addition of hydrogen to the double bonds of unsaturated fatty acids combined with glycerol in an oil.



- converts unsaturated fatty acids into saturated fatty acids
- increases stability
- but also converts cis forms into trans forms

RANCIDITY

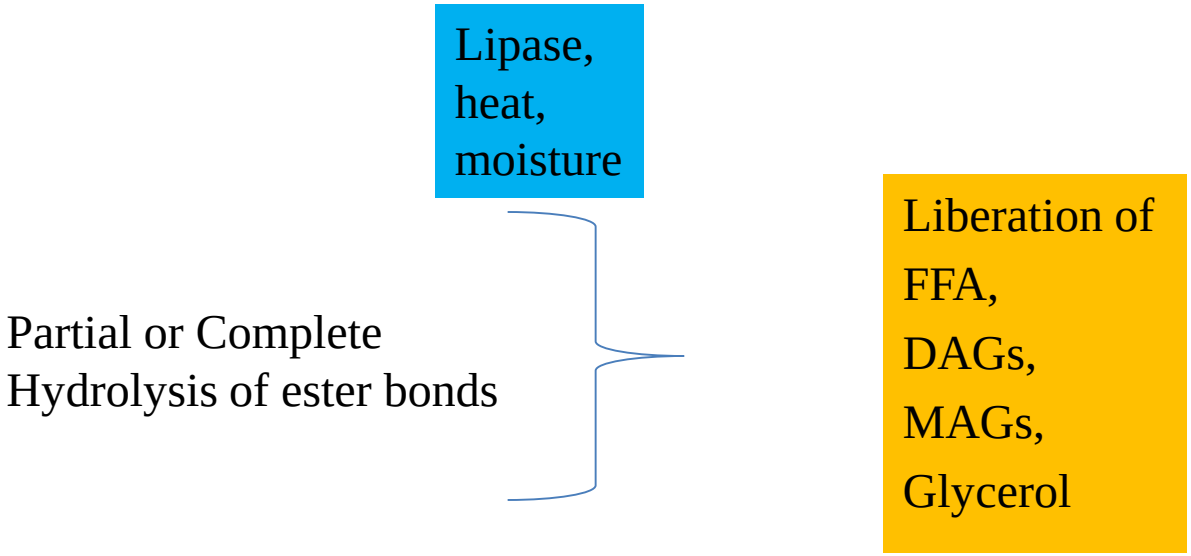
Oils and fats are liable to spoilage which results in the production of unpleasant odors and flavors, such spoilage is usuallly described by the general term rancidity.

TYPES OF RANCIDITY

- Hydrolytic rancidity
  - Enzyme action (lipase), heat, moisture
  - Free fatty acids provide aroma
- Oxidative rancidity
  - Radical oxidation
  - Aldehydes and other compounds provide aroma

HYDROLYTIC RANCIDITY

- Hydrolytic rancidity occurs as a result of partial or complete hydrolysis of triglyceride molecules.
- It is brought about by the presence of moisture in foods.
- Hydrolysis is accelerated by the presence of enzymes and microorganisms

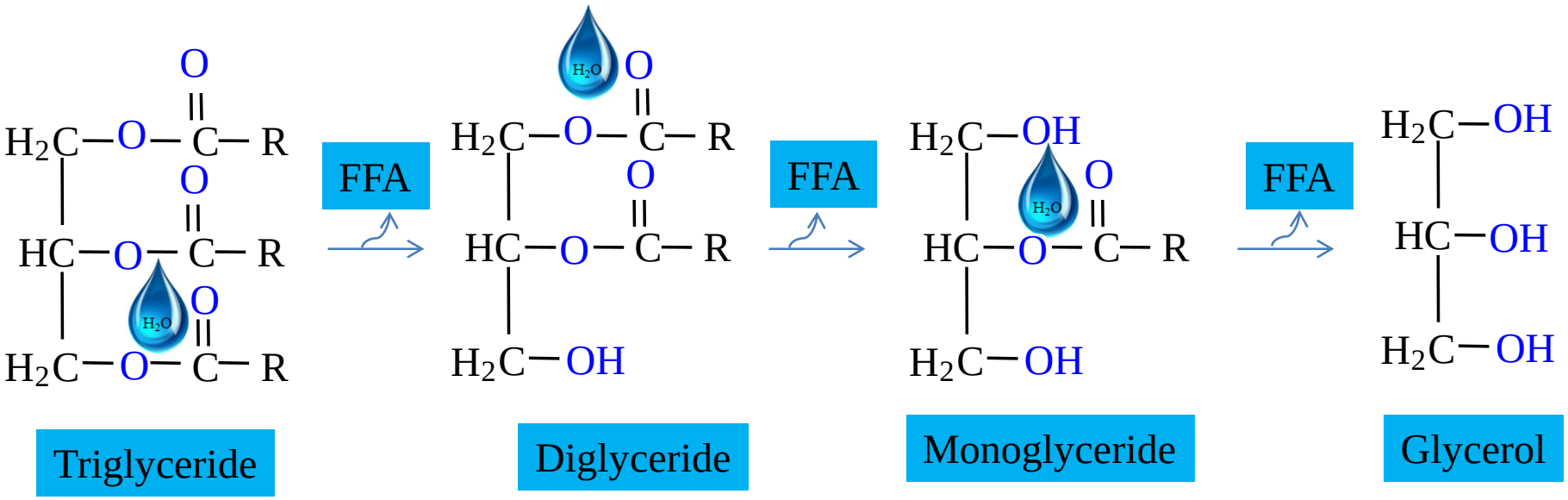


Free fatty acid (FFA) or acid value is the measure (indicator) of hydrolytic rancidity. It is measured by the quantity of potassium hydroxide required to neutralize the free acids present in oil.

HYDROLYTIC RANCIDITY

Flavor and odor produced are dependent on fatty acid composition of the triglycerides

- FFA (4-14 C atom) gives unpleasant flavor and odor



For example: milk fat

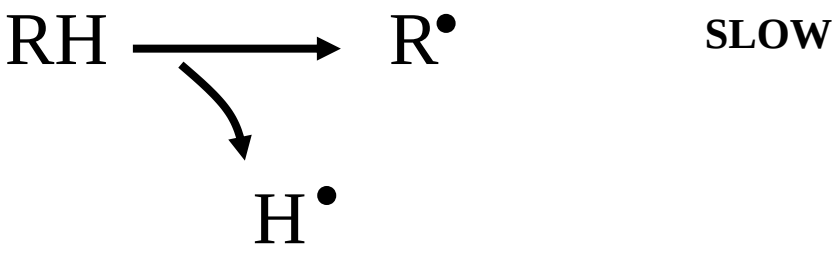
OXIDATIVE RANCIDITY

- It is the most common and important type of rancidity
- It is caused by the reaction of unsaturated oils with oxygen
- Oxidation of oils takes place by means of a CHAIN REACTION.

- Initiation
  - A radical is formed
- Propagation
  - Radicals react and transfer their unpaired electron to other compounds
- Termination
  - Two radicals combine to stop the reaction

OXIDATIVE RANCIDITY

Initiation

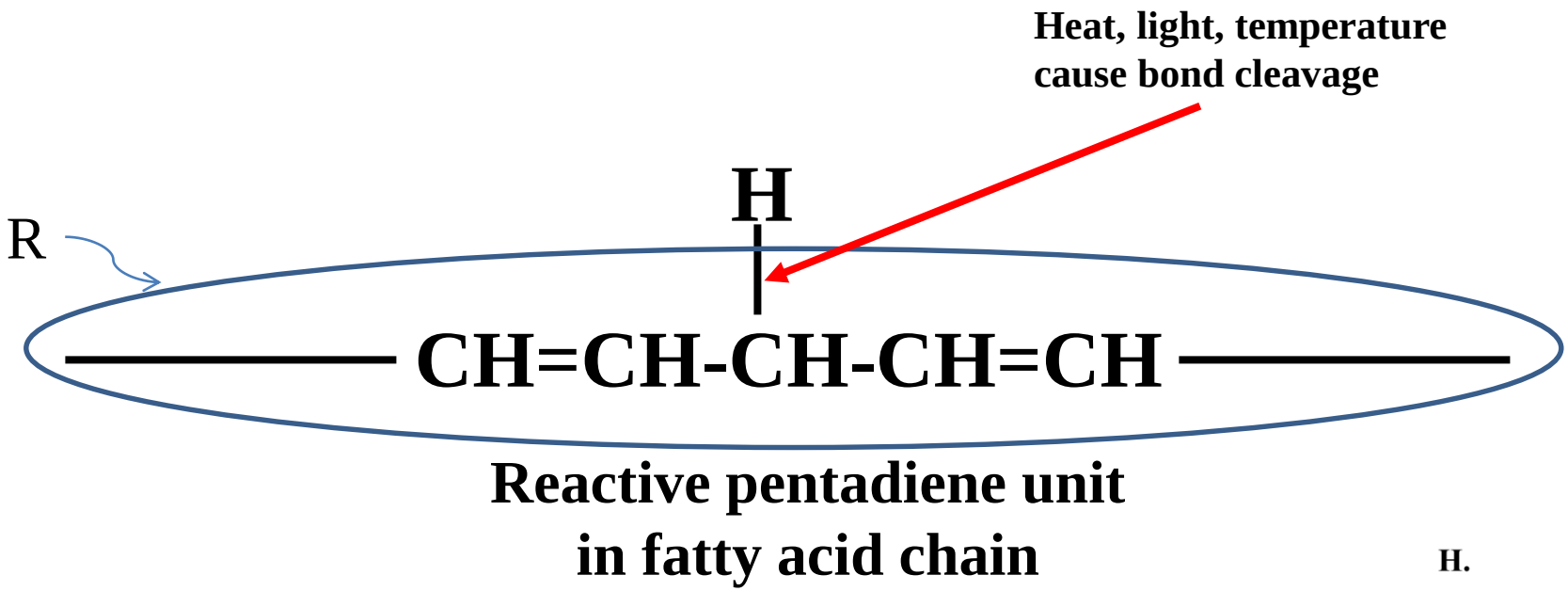


A hydrogen atom is removed from an unsaturated triglyceride. Free radicals (R•), which are groups containing an unpaired electron, are extremely unstable and immediately react with another molecule to form a more stable substance.

OXIDATIVE RANCIDITY

Initiation

This reaction only occurs under the influence of catalyst (metals such as copper) and in the presence of heat and light



Reactive pentadiene unit in fatty acid chain

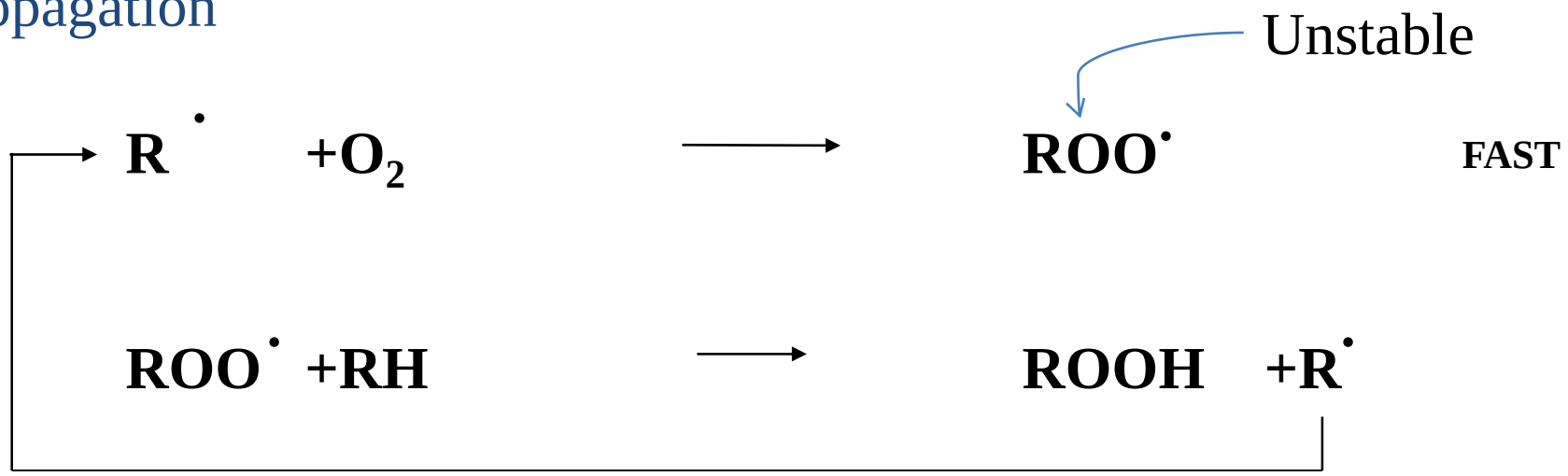
H.

CH=CH-ĊH-CH=CH

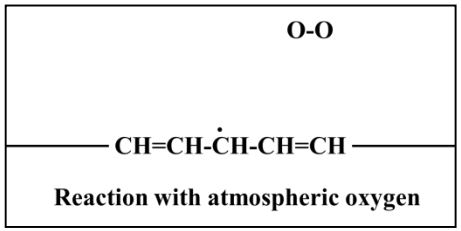
Bond is completely broken

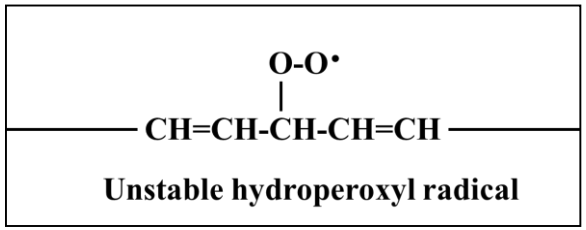
OXIDATIVE RANCIDITY

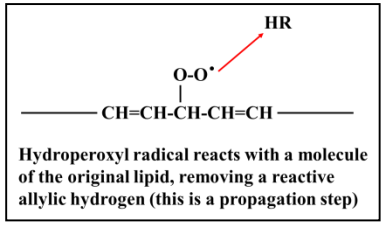
Propagation

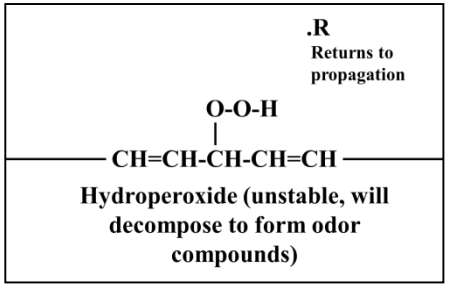


As the reaction proceeds hydroperoxide is continually formed and, being unstable.





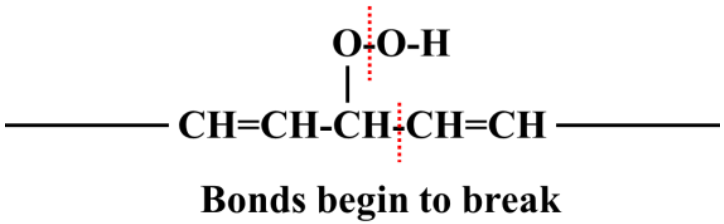




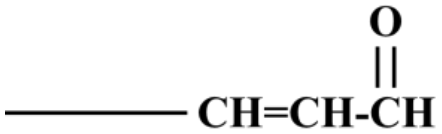
OXIDATIVE RANCIDITY

Propagation

Hydroperoxide breaks down to form ketones and aldehydes, which are responsible for the off-flavors of rancid fats



These aldehydes are the source of the rancid smell in lipid oxidation.



OXIDATIVE RANCIDITY

Termination

The propagation can be followed by termination if the free radicals react with themselves to yield non-active products.

$$R^{\bullet} + R^{\bullet} \longrightarrow R\text{-}R$$

$$R^{\bullet} + ROO^{\bullet} \longrightarrow ROOR$$

$$ROO^{\bullet} + ROO^{\bullet} \longrightarrow ROOOOR$$

It is a polymerization reaction. Produce high molecular weight compounds and cause foaming and increased viscosity.

Frying oils

OXIDATIVE RANCIDITY

How can We measure Oxidative rancidity?

- Peroxide value (primary oxidation products)
- p-Anisidine value (secondary oxidation products)
- Thiobarbituric acid test
- ..

Because peroxides are easily determined in fats, the peroxide value (PV) is frequently used to measure the progress of oxidative rancidity.

- Measured on the basic ability of peroxides to liberate iodine from potassium iodide.
- The amount of iodine produced is directly proportional to the peroxide value.
- Expressed in terms of milliequivalents per kilogram of fats.

OXIDATIVE RANCIDITY

The effect of antioxidants

- Antioxidants are added to control Oxidative Rancidity.
  Antioxidants do not prevent oxidation, but they slow it down, thereby extending the induction period and hence the shelf life of fat-containing foods.

Mechanism of antioxidants in oxidation

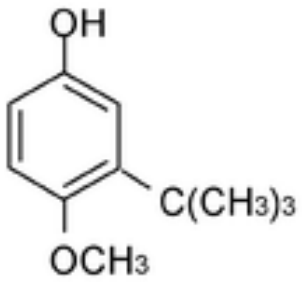
$$R^{\bullet} + AH \longrightarrow RH + A^{\bullet}$$

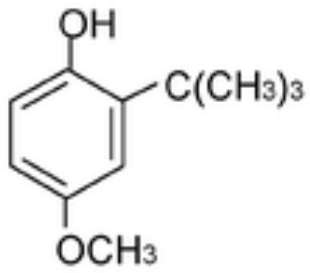
$$ROO^{\bullet} + AH \longrightarrow ROOH + A^{\bullet}$$

Free radical Antioxidant

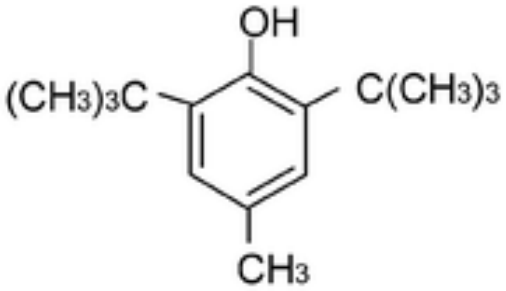
OXIDATIVE RANCIDITY

Commonly used antioxidants



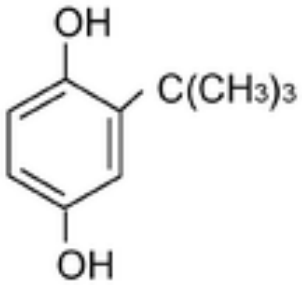


BHA

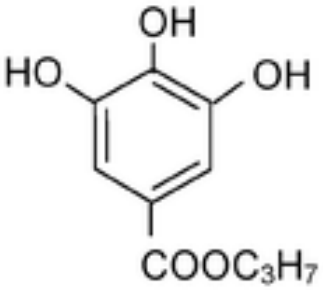


BHT

Synthetic Antioxidants



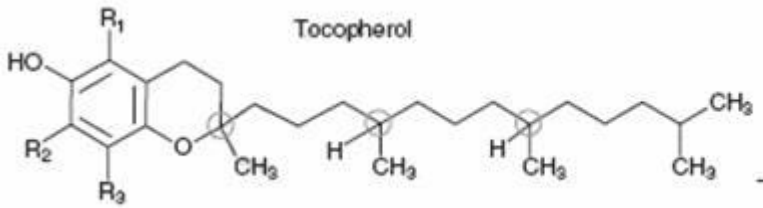
TBHQ



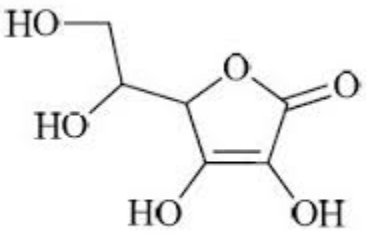
PG

OXIDATIVE RANCIDITY

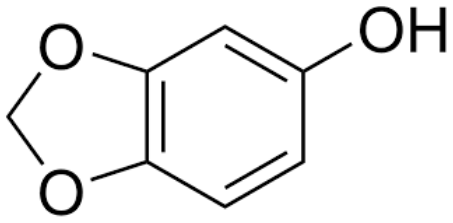
Antioxidants



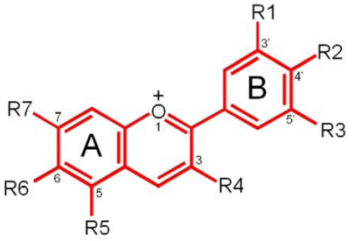
	R1	R2	R3
α	CH_3	CH_3	CH_3
γ	H	CH_3	CH_3
β	CH_3	H	CH_3
δ	H	H	CH_3



ascorbic acid

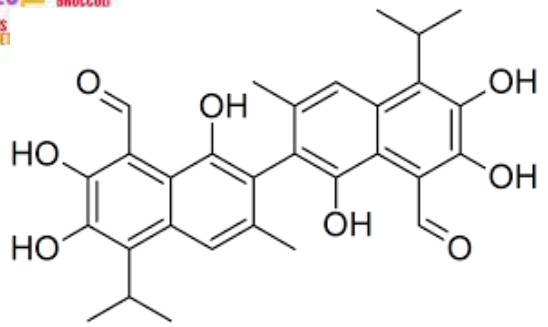


Sesamol



Anthocyanidin	R_1	R_2	R_3	R_4	R_5	R_6	R_7
Aurantinidin	-H	-OH	-H	-OH	-OH	-OH	-OH
Cyanidin	-OH	-OH	-H	-OH	-OH	-H	-OH
Dephinidin	-OH	-OH	-OH	-OH	-OH	-H	-OH
Europinidin	$-OCH_3$	-OH	-OH	-OH	$-OCH_3$	-H	-OH
Luteolinidin	-OH	-OH	-H	-H	-OH	-H	-OH
Pelargonidin	-H	-OH	-H	-OH	-OH	-H	-OH
Malvidin	$-OCH_3$	-OH	$-OCH_3$	-OH	-OH	-H	-OH
Peonidin	$-OCH_3$	-OH	-H	-OH	-OH	-H	-OH
Petunidin	-OH	-OH	$-OCH_3$	-OH	-OH	-H	-OH
Rosinidin	$-OCH_3$	-OH	-H	-OH	-OH	-H	$-OCH_3$

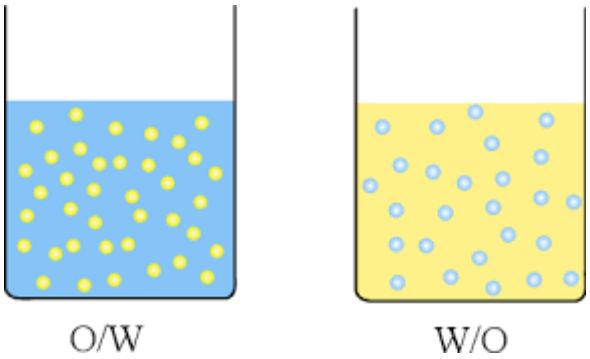
Anthocyanin



Gossypol

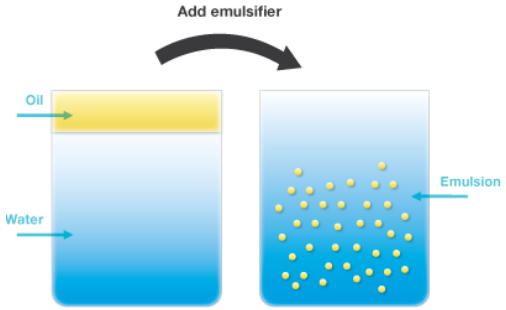
EMULSIONS AND EMULSIFYING AGENTS

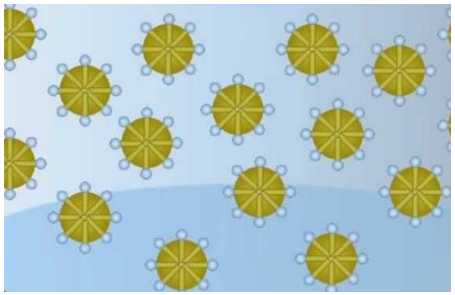
When oil is added to water it forms a separate layer above water, We say they are immiscible.



If oil and water are shaken vigorously the two liquids become dispersed in each other and the dispersion is called as EMULSION.

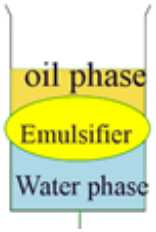
In order for oil and water to form a stable emulsion a third substance, EMULSIFIER must be present.

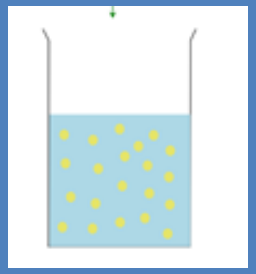
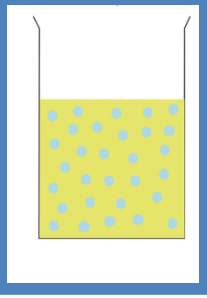




EMULSIONS AND EMULSIFYING AGENTS

Types of emulsions

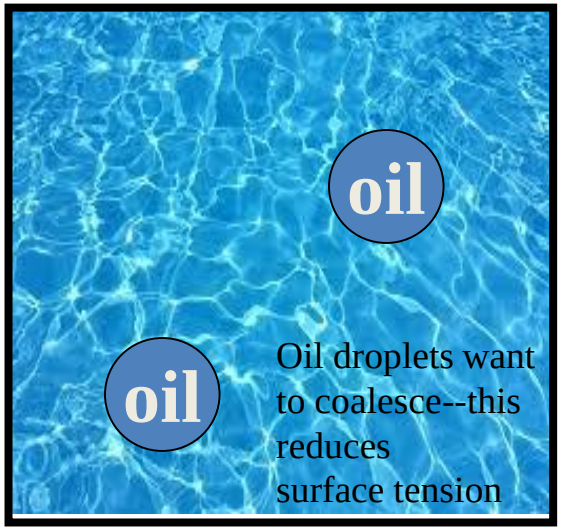


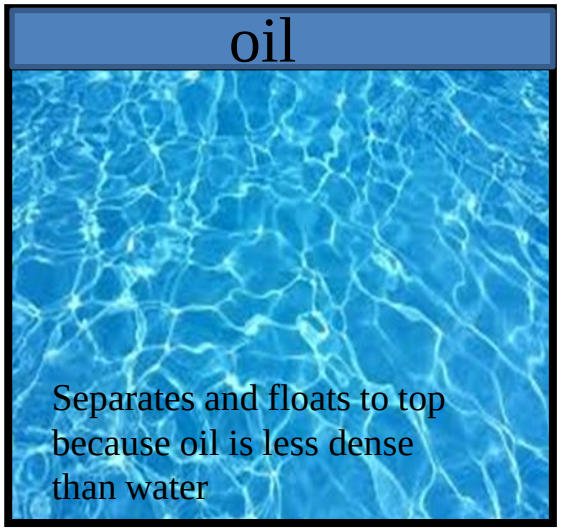
Oil in water (o/w) emulsions	Water in oil (w/o) emulsions
	
The continuous phase is water	The continuous phase is oil
Needs high HLB emulsifiers	Needs low HLB emulsifiers
Examples: Milk (casein) Mayonnaise (lecithin) Ice-cream (casein)	Examples: Butter (casein) Margarine (casein, lecithin)

EMULSIONS AND EMULSIFYING AGENTS

Oil-in-water emulsion

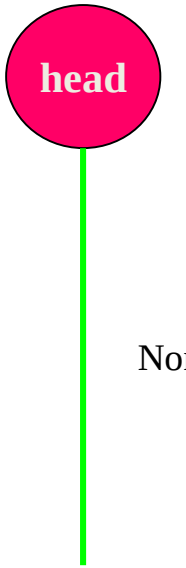
Two oil droplets dispersed in water





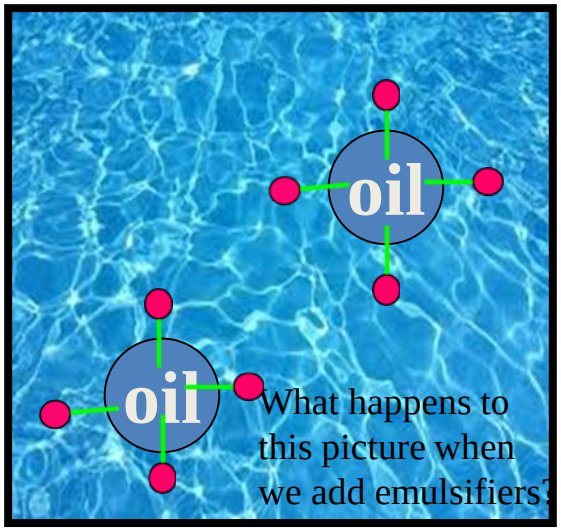
EMULSIONS AND EMULSIFYING AGENTS

Emulsifiers are substances whose molecules contain both hydrophilic (polar) group and a hydrophobic (non-polar) group.

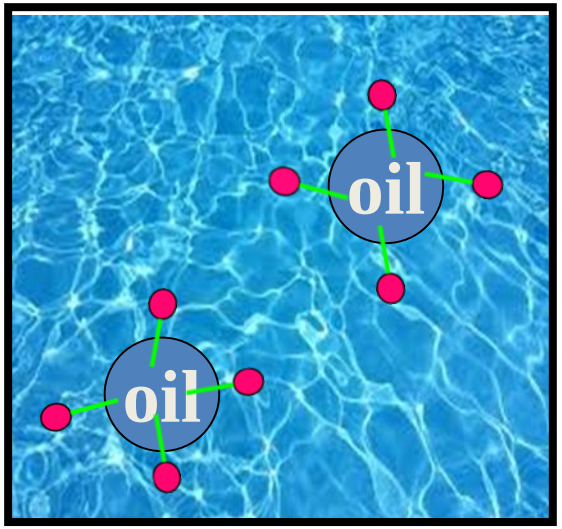


Polar head, likes water

Non-polar tail, likes oil



EMULSIONS AND EMULSIFYING AGENTS



This system is stabilized due to a lowering of surface tension by the EMULSIFIER

- Now the water sees only the polar emulsifier heads head
- The oil droplets can see only the nonpolar emulsifier tails. —
- So, there is no driving force for separation of the phases

EMULSIONS AND EMULSIFYING AGENTS

Types of Emulsifiers

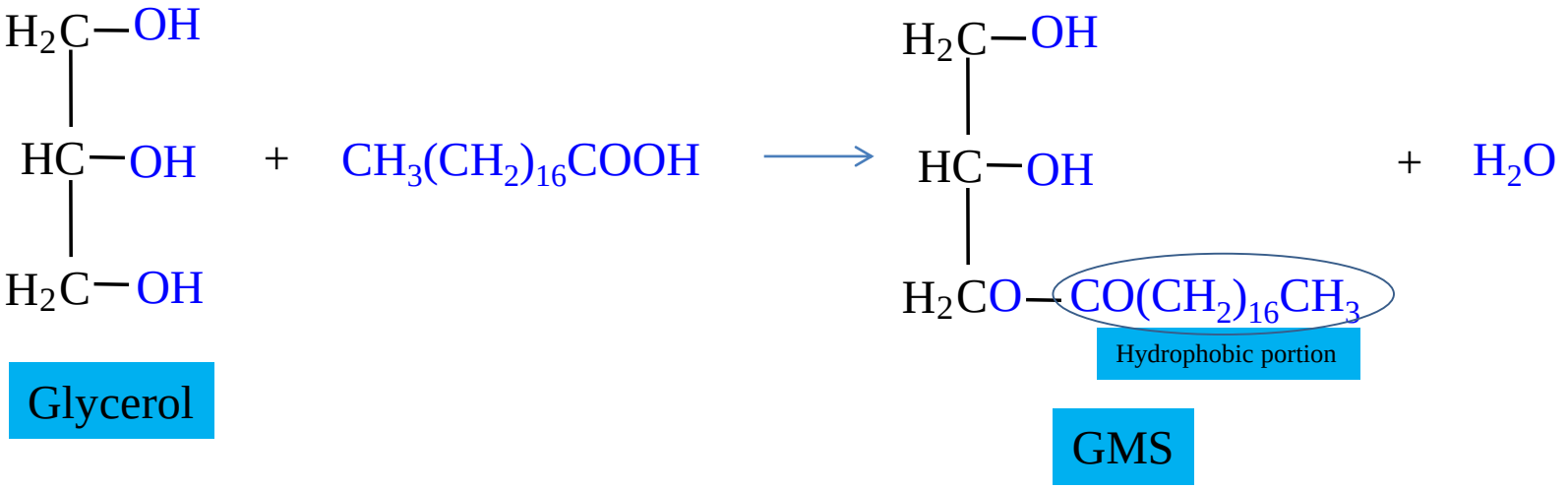
- **Natural emulsifying agents**
  - Proteins
  - Complex carbohydrates (agar, pectin, gums, ..)
  - Phospholipids (lecithin)
- **Synthetic emulsifiers**
  - Sorbitan esters-SPANS (hydrophobic, form w/o emulsions)
  - Polysorbates-TWEENS (hydrophilic, form o/w emulsions)
  - Soaps
  - Mono-, di glycerides (Atmul-Glyceryl monostearate-GMS)

EMULSIONS AND EMULSIFYING AGENTS

Types of Emulsifiers

Lecithin, which is a phospholipid, is an important natural emulsifier. It is present in **egg-yolk** and many **crude vegetable oils**. Mainly extracted from soya bean oil in degumming process.

GMS (Glyceryl monostearate) is a monoglyceride, formed when one hyroxyl group of glycerol is esterified with stearic acid.

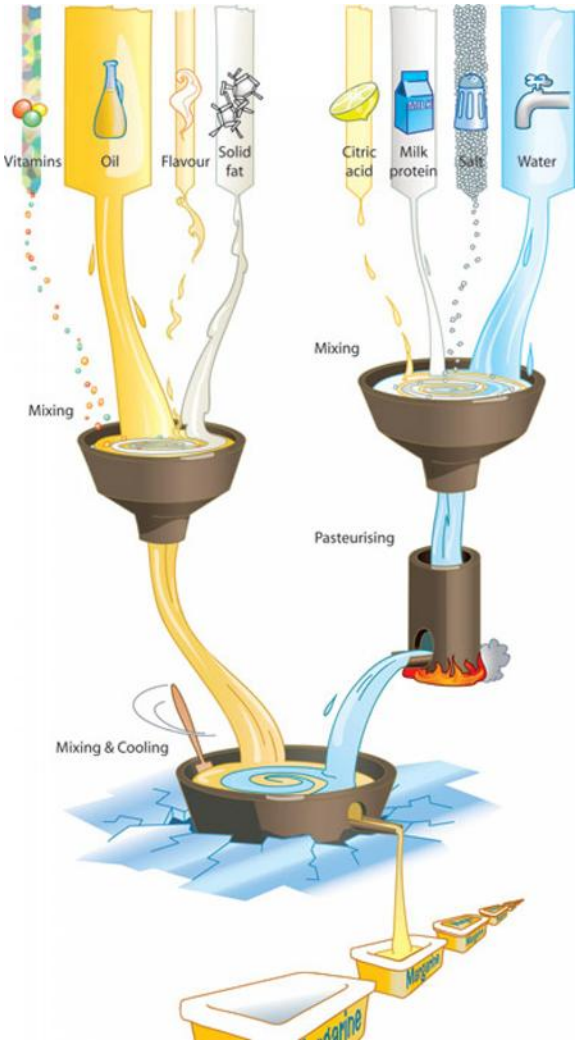


MARGARINE

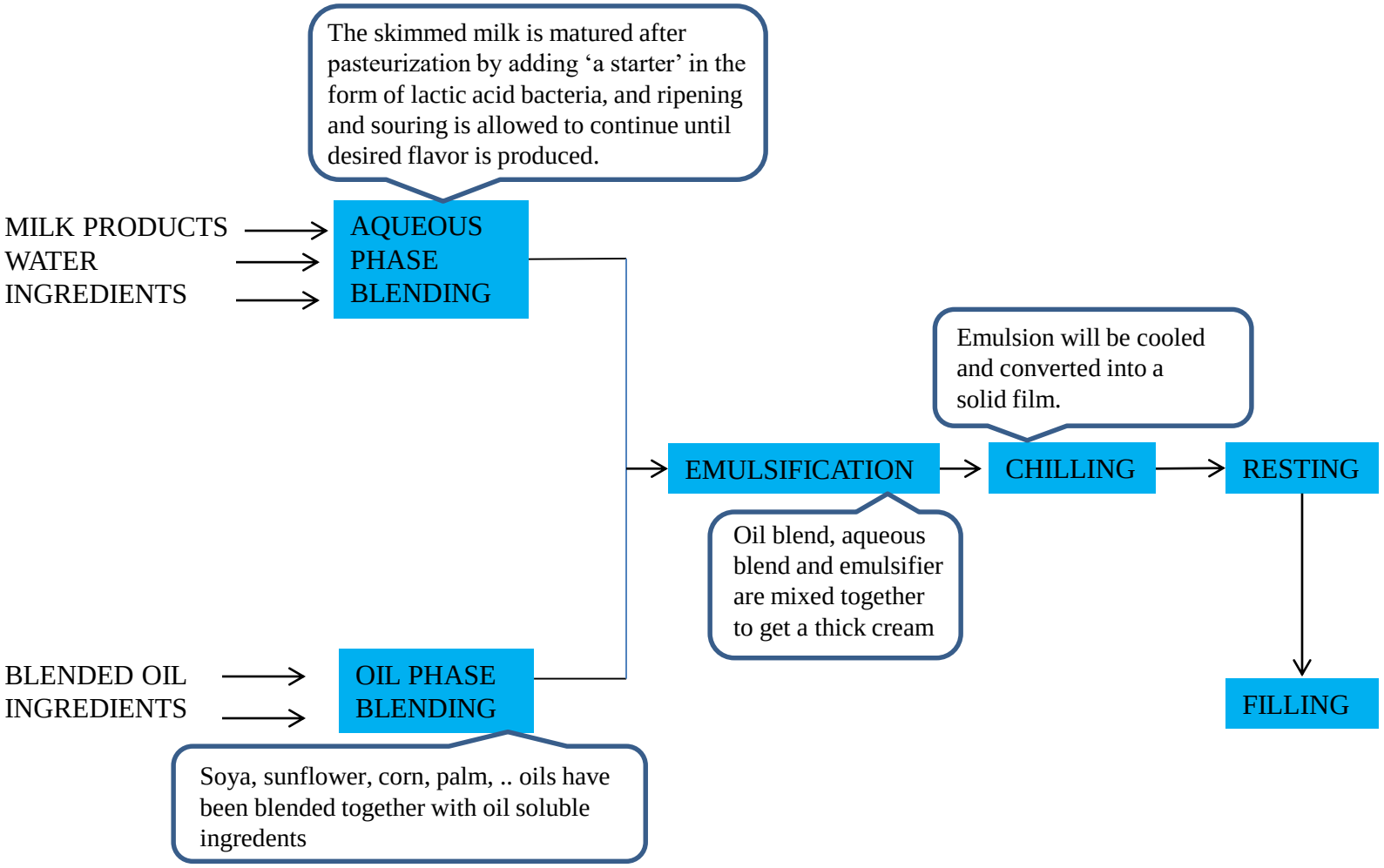
Margarine, an emulsion, was first created in 1869 by a French chemist named Hippolyte Mège-Mouriès.

It was originally made from beef fat and was intended to be a cheaper and less perishable option to regular butter.

By invention of hydrogenation, vegetable oils such as cottonseed and soybean oils replaced the animal fats.



MARGARINE MANUFACTURING



QUESTIONS

1. What is the difference between fats and oil ?

Answer:

Both of them in triacylglycerol structure.
However fats are solid at room temperature while oils are liquid.

2. Classify the fatty acids according to their saturation and carbon chain length

Answer:

According to saturation:

- Saturated
- Monounsaturated
- Polyunsaturated

According to chain lenght:

- Short chain
- Medium chain
- Long chain

3. What is the specific name of spoilage for fats and oils ?

Answer:

Rancidity

4. Give examples for w/o and o/w emulsions.

Answer:

w/o: margarine
o/w: milk