



Molecular Biology

Lec : 6

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Lipids of biological importance- 2

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Majority of slides: Dr. Walaa Bayoumie El Gazzar

Properties of fatty acids

↳ 7 properties

1. Solubility

- Fatty acids are soluble in fat solvents
- Short chain FA are soluble in water, while the longer chain ones are insoluble in water

↑↑ F.A. chain → ↑↑ insolubility in water

2. Melting temperature

- The melting temperature of FA decreases with:
 - decreasing length of chain
 - increasing number of cis-double bonds

↓↓ MP → ↓↓ chain length
↑↑ cis-double bonds

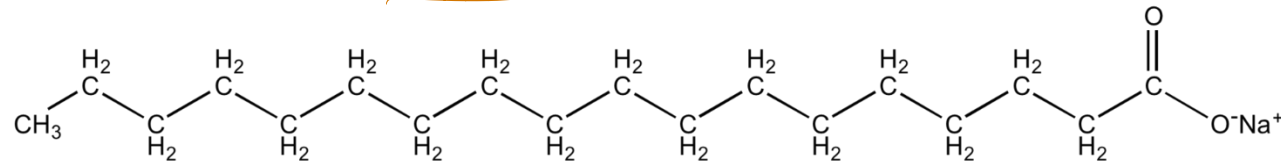
- Acetic (CH_3COOH) and oleic acids are liquids, while palmitic and stearic acids are solids at room temperature

3. Color, Odor and Taste

- Fatty acids are colorless

- ①
- The short chain FA have an irritating odor and a sour taste, while the long chain ones are odorless and tasteless

②



4. Soap (salt of fatty acid) formation

- The alkaline salts of long chain fatty acids are called soaps

* الأملاح التي تتكونها من فatty acids هي نفسها من Soaps

- Sodium and potassium soaps are soluble in water (used in soap)
- Calcium, magnesium and copper soaps are insoluble in water (grease)



↳ Results in ions that are water soluble

5. Esterification

أسترة

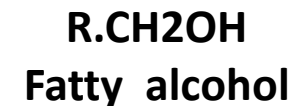
- Fatty acids can be esterified with:
 - glycerol to form TAG
 - with higher monohydric alcohols to form waxes

6. Reduction

addition of H_2
removal of O_2

- The carboxyl group of fatty acids can be reduced to aldehyde then to primary alcohol group, forming fatty aldehyde then fatty alcohol, respectively
- Fatty alcohols are components of plasmalogens

Reduction
of a
fatty acid

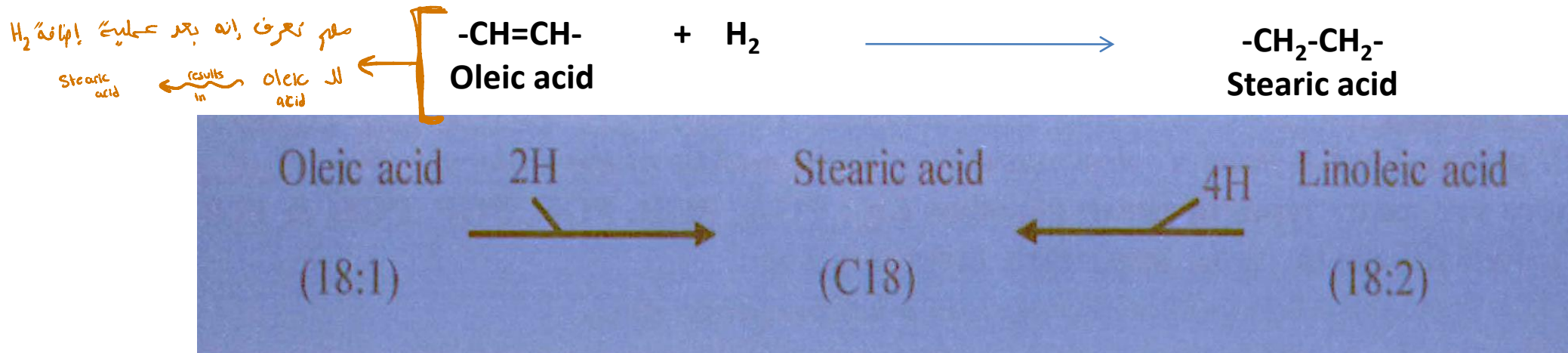


1-Removal of 1 oxygen atom

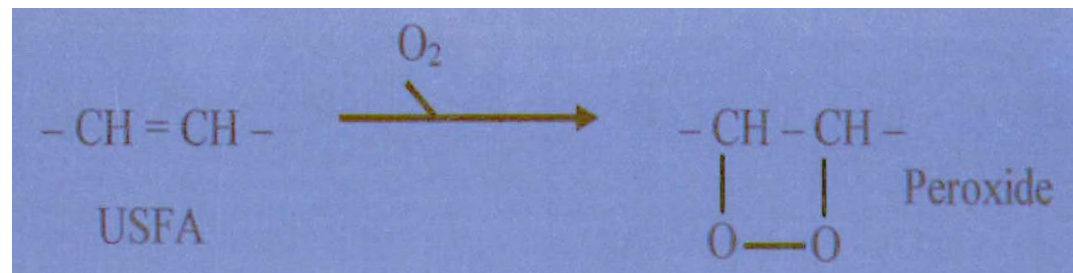
2- addition of a hydrogen atom

7. Addition of Hydrogen and Oxygen

- Unsaturated Fatty acids add 2 hydrogen atoms per double bond, forming the corresponding saturated fatty acids, e.g. oleic acid forms stearic acid.

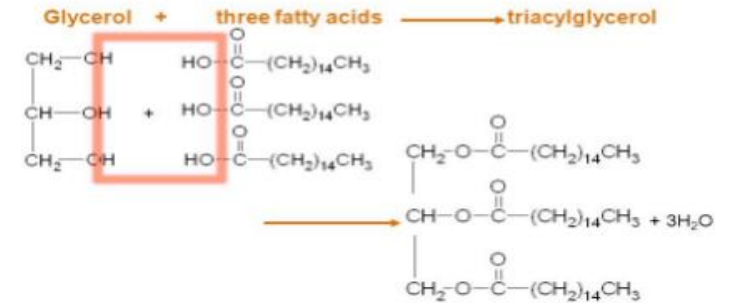


- The unsaturated fatty acids add oxygen, forming peroxide



Triacylglycerols (TAGs)

↳ Simple lipid



- TAGs are esters of glycerol with 3 fatty acids
- In nature it is rare to find a TAG molecule with the same FA in all 3 positions
- Most of the natural fats are mixed TAGs, containing 2-3 different fatty acids
- TAG is a good storage of energy (average 11kg of TAG in 70kg human → 99,000kcal), if hydrated glycogen would need 65kg

- **The FA esterified to:**
 - C-1 of glycerol is usually saturated
 - C-2 of glycerol is usually **unsaturated**
 - C-3 of glycerol may be saturated or unsaturated

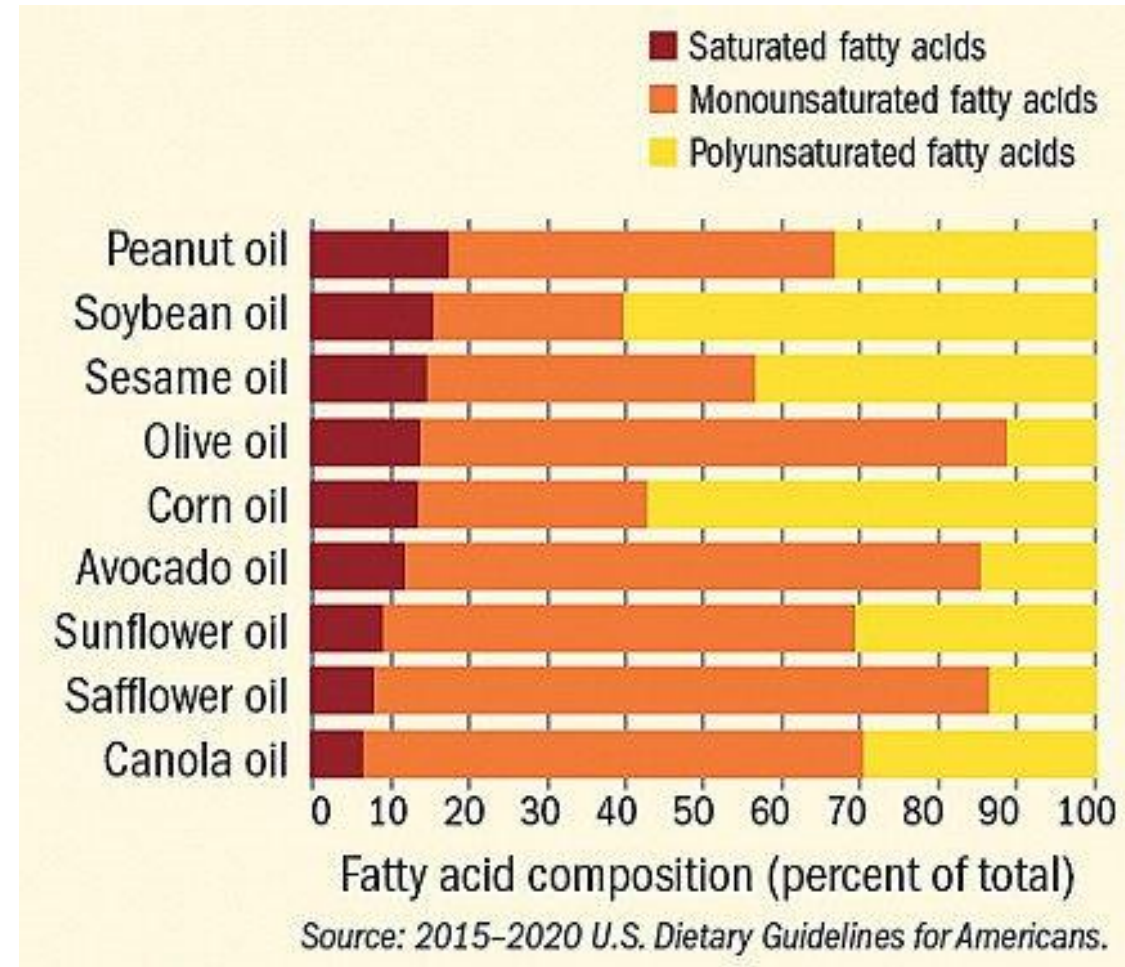
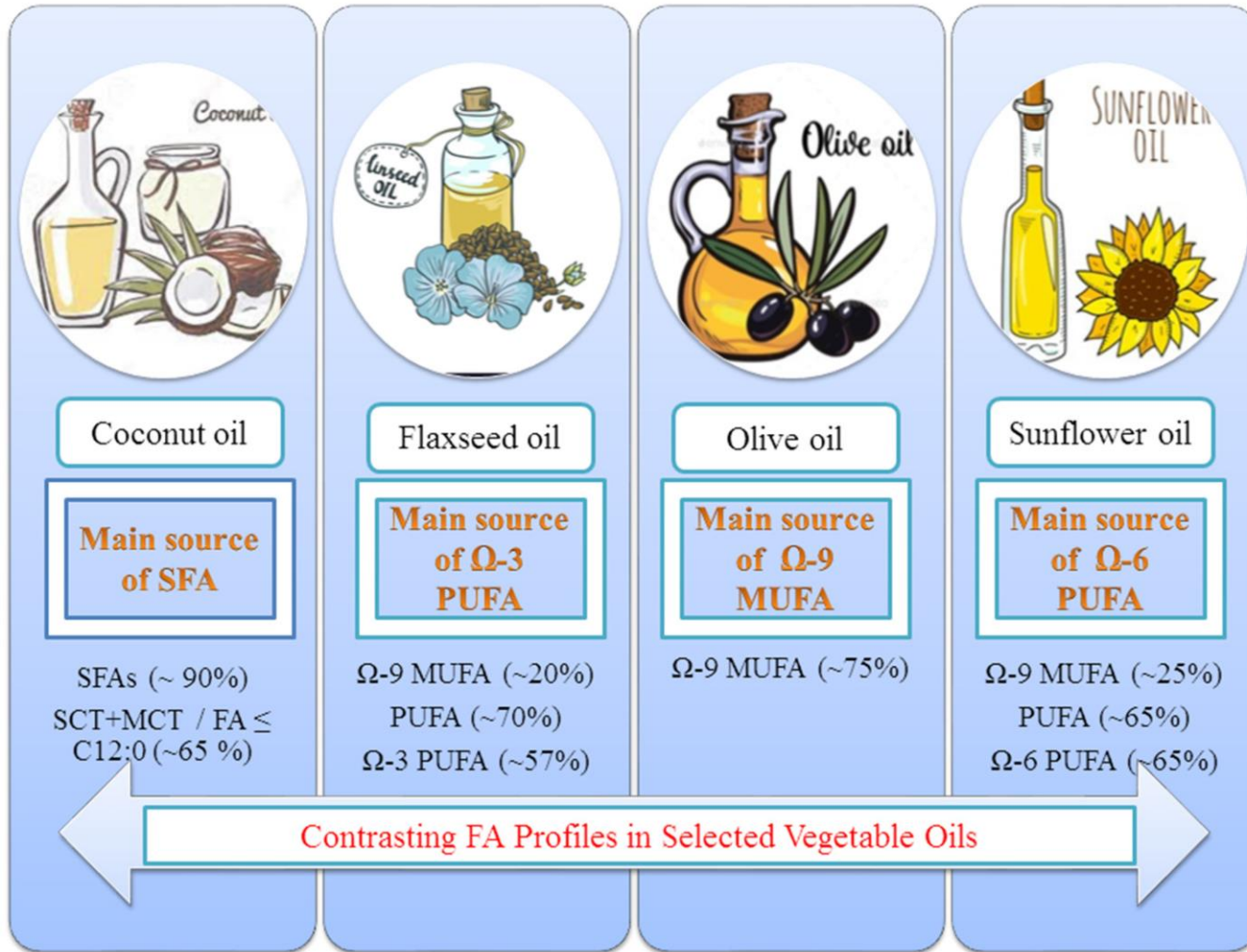
Usually 1, 3 are same FA
- **Fats are solid triacylglycerols, e.g. milk fat (ghee, butter and cream) and margarine (artificial butter)**
 - Their solid state is due to their high content of the saturated fatty acids (about 50%)
 - Palmitic and stearic acids are the most common saturated fatty acids
 - Oleic acid is the most common unsaturated fatty acid

- **Oils are liquid triacylglycerols, e.g. olive, cottonseed, linseed, and maize oils**
 - Their liquid state is due to their high content of the unsaturated fatty acids (about 85% in most oils)
 - Linoleic acid is the most common unsaturated fatty acid in most oils
 - In olive oil, oleic acid is the most common

Importance

- **Cis unsaturated fatty acids :**
 - Either mono or polyunsaturated

	Monoenoic acids	Polyenoic acids	
		ω6 PUFAs	ω3 PUFAs
Sources	are present in all animal and vegetable oils. Olive oil is a particular rich source.	are present in nuts, olives, various oils as sunflower, cottonseed and corn oil.	are present in plant oils as flaxseed and canola and in fish oil.
		Linoleic acid (18:2) is the precursor of ω 6 family	α -Linolenic acid (18:3) is the precursor of ω 3 family
Biomedical importance	Intake has beneficial health effects as: -Decreased plasma cholesterol	Intake of ω 6 PUFAs may lead to: -decreased plasma cholesterol	Intake of ω 3 PUFAs may reduce the incidence of cardiovascular disease as they: -lower the blood pressure, -lower plasma triacylglycerol levels -decrease the tendency to thrombosis



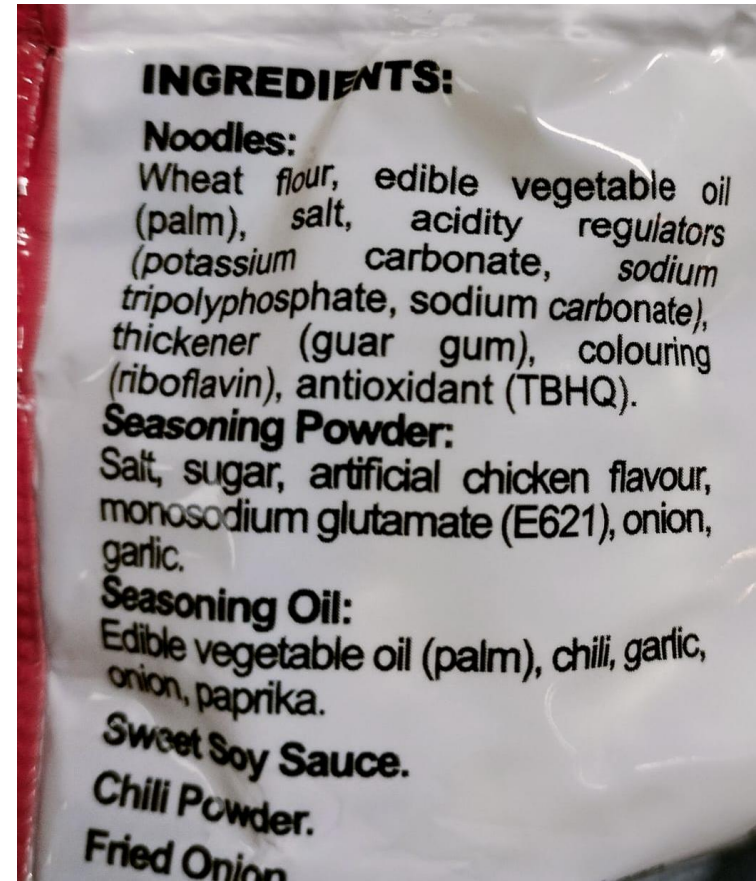
Smoke point
Antioxidants
Oleic acid (MUFA)
Flavour

For information only

Name	Saturated fatty acids(%)	Mono-unsaturated fatty acids(%)	PUFA (%)
Coconut oil	(*)86	12	2
Groundnut oil	18	46	36
Gingelly oil (Til oil)	13	50	37
Palm oil	42	52	6
Corn oil	13	25	62
Cotton Seed oil	26	19	55
Seasame oil	12	48	40
Mustard oil (rapeseed)	34(**)	48	18
Safflower oil (Kardi)	9	12	79
Sunflower oil	12	24	64
Butter	75	20	5
Ox (Tallow)	53	42	5
Pig (Lard)	42	46	12
Fish oil	30	13	57

(*) these saturated fatty acids are medium chain fatty acids.

(**) contains erucic acid, 22 C, 1 double bond)



Olive oil

Saturated 14%

Monounsaturated: 73%

Properties of Triacylglycerols

↳ also 7 properties

1. Solubility

- TAGs are insoluble in water, but soluble in fat solvents

2. Melting temperature

- TAGs rich in saturated have a high melting temperature, and are solids (**fats**)

↑↑ MP ~ if ↑ in saturated F.A

- TAGs rich in unsaturated fatty acids have a low melting temperature and are liquids (**oils**)

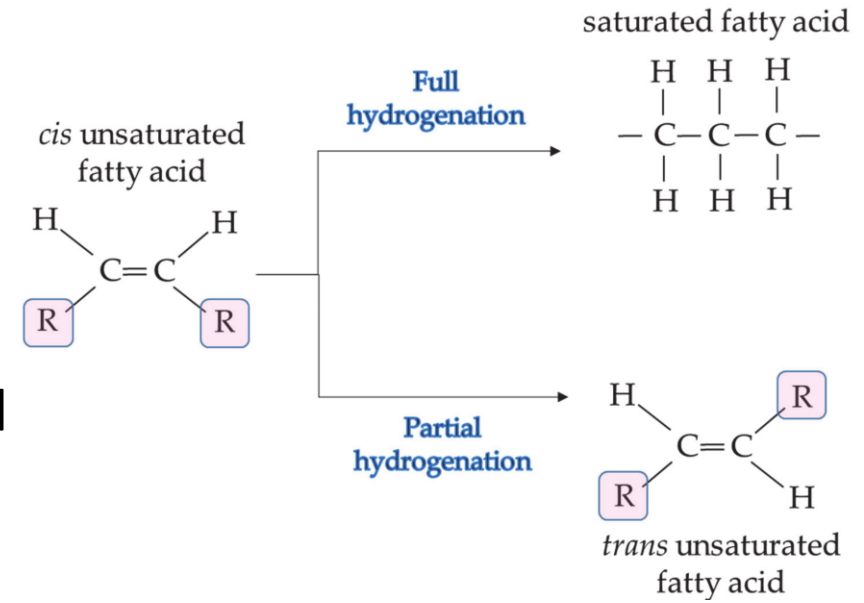
↓↓ MP ~ if ↑ in unsaturated F.A

3. Color, Odor & Taste

- Pure triacylglycerols are colorless, odorless, and tasteless
- Carotenoids are responsible for the yellow color of human adipose tissue and of cow's milk and butter
→ yellow color reason of adipose tissue [if absent adipose tissue → colorless]
- The flavor of the different types of fat is due to certain organic acids

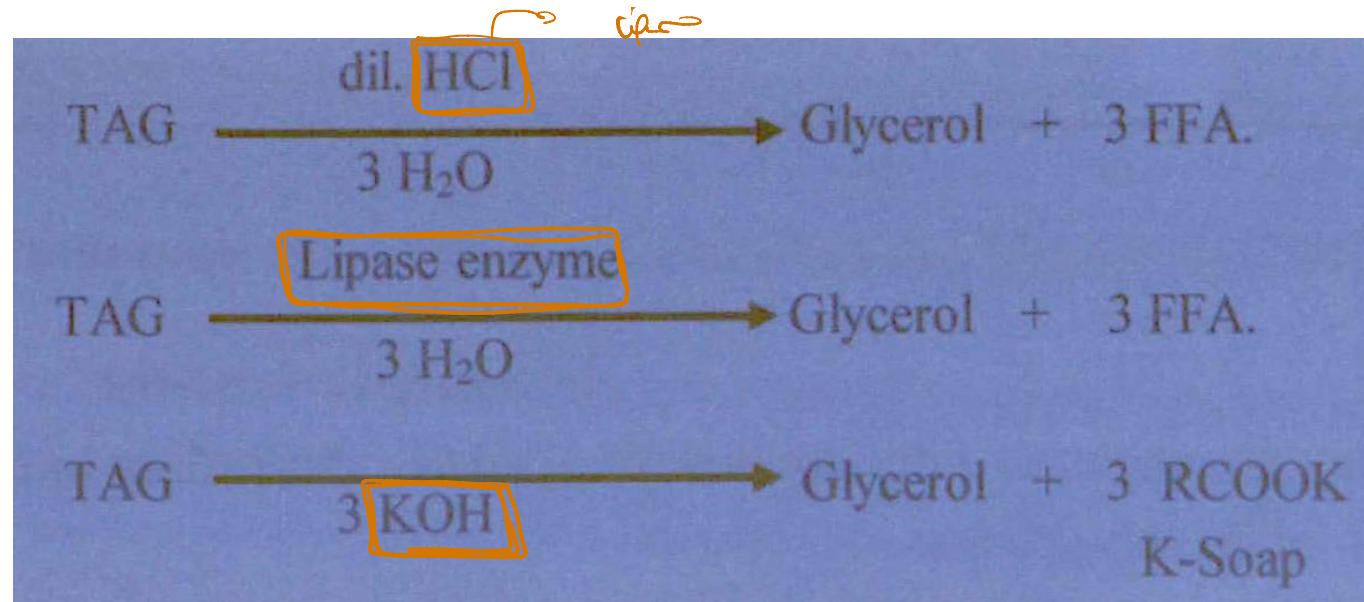
4. Addition of Hydrogen

- The unsaturated fatty acids of oils can add hydrogen, in the presence of nickel as catalyst, forming saturated fatty acids
→ catalyst
- This process is called hydrogenation or hardening, and is used commercially in the preparation of solid fats and margarine



5. Hydrolysis

- Hydrolysis of triacylglycerols into glycerol and fatty acids

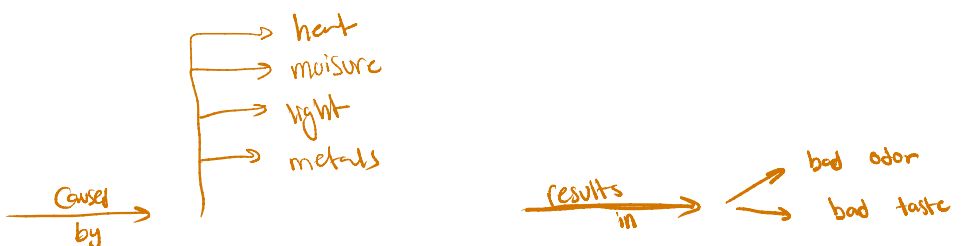


7. Lipid Peroxidation

→ NOT good to
the body at all

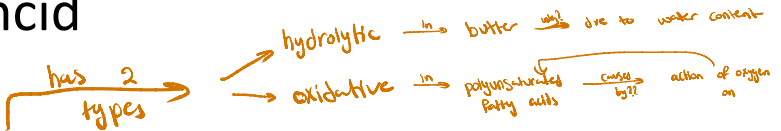
- Lipid peroxidation, or auto-oxidation, results from the action of oxygen on polyunsaturated fatty acids
 - In-vitro^{مختبر}, it leads to rancidification^{زنجاع} of fat
 - In-vivo^{body}, it leads to the formation of free radicals, which may be related to the development of cancer, atherosclerosis, and inflammation
 - **Read in book (Harper) about Lipid peroxidation, how to control and reduce it**

8. Rancidity



If fat is exposed to moisture, oxygen, heat, light, and certain metals such as copper, it develops a bad flavor (odor and taste) and is said to be rancid

Rancidity may be hydrolytic or oxidative:



Hydrolytic rancidity occurs in butter because of its water content

- Due to partial hydrolysis from action of enzymes
- Liberates free fatty acids and, since butter is relatively rich in the short chain fatty acids, a bad flavor results
- Bacterial enzymes also help hydrolysis in natural butter

Oxidative rancidity results from the action of oxygen on polyunsaturated fatty acids

- Forming peroxides that break into short chain aldehydes and acids, giving fat a bad flavor
- Peroxides are destructive to the fat-soluble vitamins, particularly vitamin A
- Oxidative rancidity is inhibited by antioxidants as vitamin E (oils with high PUFA have added antioxidants), phenols

Nutrition Facts		Amount/serving	% DV*	Amount/serving	% DV*
Total Fat		14g	22%	Cholest.	0mg 0%
Serving Size: 1 Tbsp (14g)		Saturated Fat 2g 9%		Sodium 0mg 0%	
Servings 32		Trans Fat 0g		Total Carb. 0g 0%	
Calories 120		Polyunsat. Fat 8g		Protein 0g	
Fat Cal. 120		Monounsat. Fat 4g			
*Percent Daily Values (DV) are based on a 2,000 calorie diet.		Vitamin E 10%		Not a significant source of dietary fiber, sugars, vitamin A, vitamin C, calcium, and iron.	

INGREDIENT: CORN OIL.

Distributed by
ACH Food Companies, Inc.
 Memphis, TN 38016
 PRODUCT OF USA

Breakaway quality sealed for freshness.
 MAZOLA is a registered trademark of ACH.

CAUTION: Oil burns if overheated. If oil smokes, reduce heat.
 • Do not leave unattended when heating.
 • Do not put water on hot or flaming oil.
 • Do not pour hot oil into any plastic bottle.
 • Do not place container near heat or flame.
IF OIL CATCHES FIRE, TURN OFF HEAT AND COVER UNTIL COOLED. DO NOT USE WATER.

Waxes

- Waxes are esters of higher monohydric alcohols, e.g., cholesterol with fatty acids
- **Lanolin** is the ester of cholesterol with palmitic, stearic or oleic acids
 - It provides a waterproof coat on the wool fibers of the fur-bearing animals
- **Vitamins A (retinol)** and **D (calciferol)** are found in nature in the form of their esters with palmitic or stearic acids
- **Beeswax:** ester of palmitic acid and mericyl alcohol (C30)