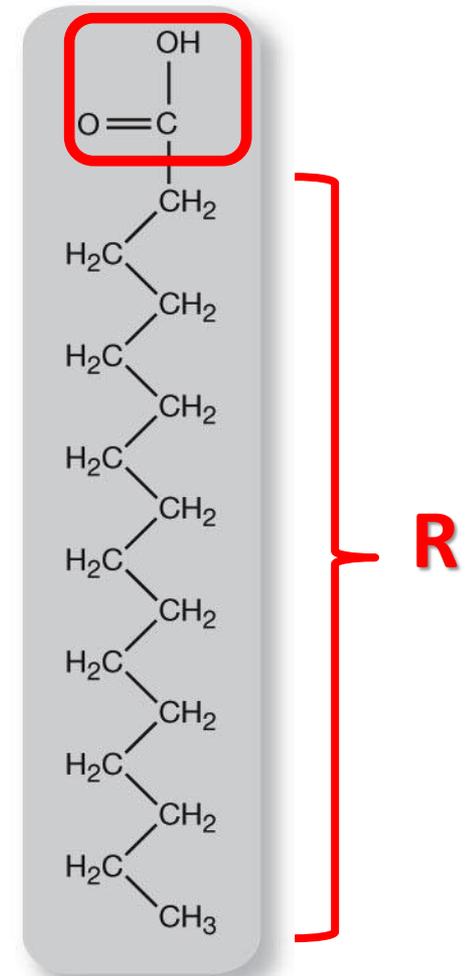


# UNIT-I

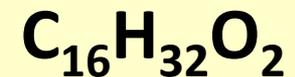
Biochemistry of Fatty acids and triglycerides

## i) Fatty acids

- general formula: **R.COOH**
- most have an **even number of C** - most commonly **16-18**
- fatty acids may be:
  - **saturated or**
  - **unsaturated**

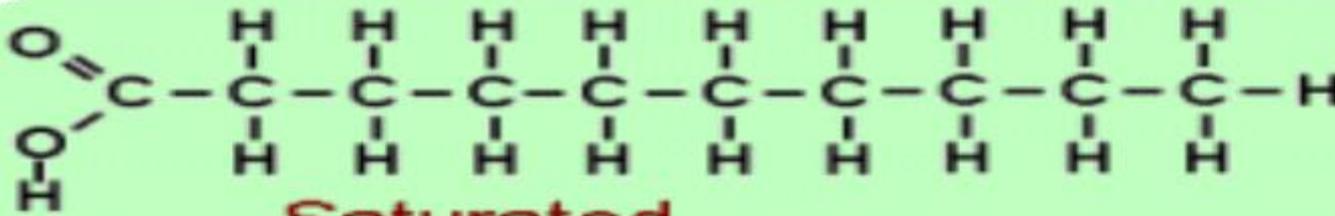


Palmitic acid

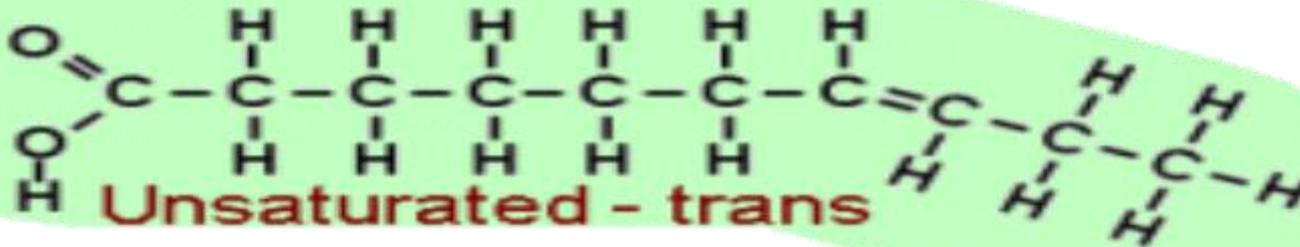


# Fatty Acids

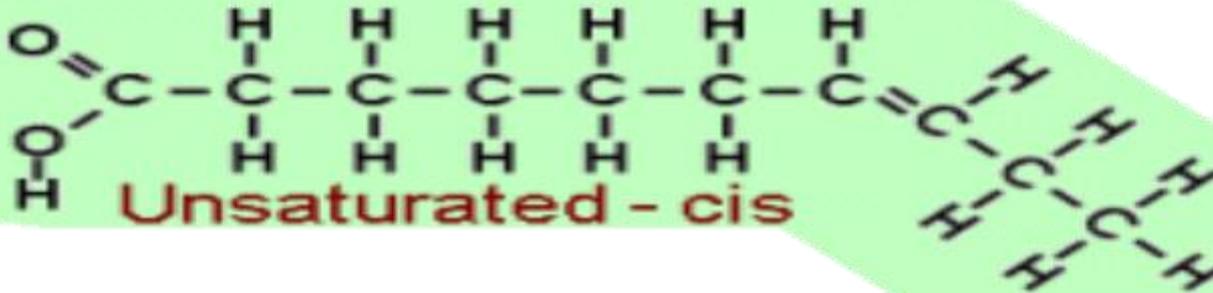
carboxyl



Saturated



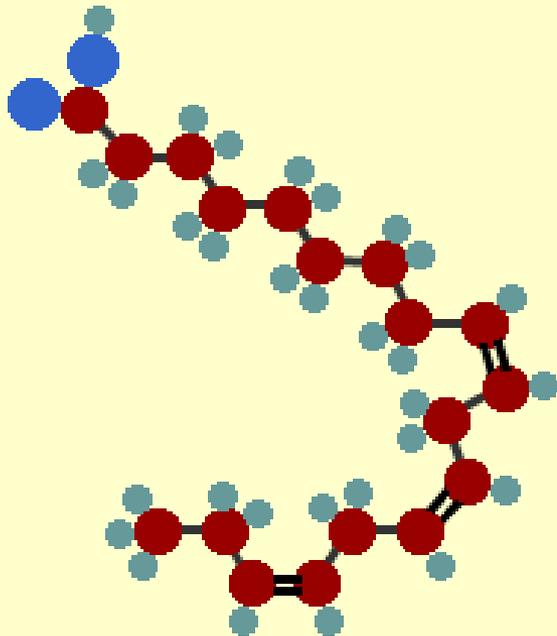
Unsaturated - trans



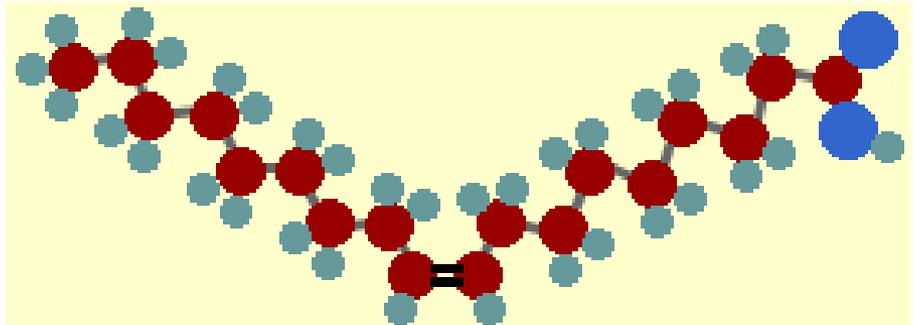
Unsaturated - cis



**The more double bonds present, the more bent the molecule is**



**Linolenic acid**



**Oleic acid**

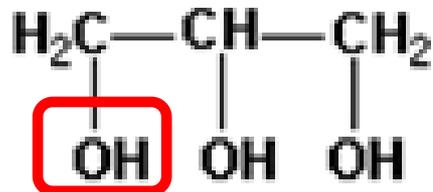
# Classification of fatty acids

1. On basis of saturation
  - A. Saturated fatty acid: Palmitic Acid(16:0), stearic acid (18:0)
  - B. Unsaturated fatty acid: oleic acid (18:1  $\Delta^9$ ), linoleic acid (18:2  $\Delta^{9,12}$ )  
linolenic acid (18:3  $\Delta^{9,12,15}$ ), Arachadonic acid (20:4  $\Delta^{5,8,11,14}$ )
  - C. branched chain: sebum, phytanic acid in butter
2. On basis of no of carbon atom
  - A. even chain fatty acid
  - B. odd chain fatty acid
3. Hydroxy FA: saturated ( $\beta$ -OH butyric acid) and unsaturated(ricinolic acid)
4. Cyclic FA: chaulmoogric acid
5. On Nutritional basis
  - A. Essential FA:
6. On chain length basis
  - A. short chain: 2-6 carbon
  - B. medium chain: 6-14 carbon
  - C. Long chain: more than 14 carbon

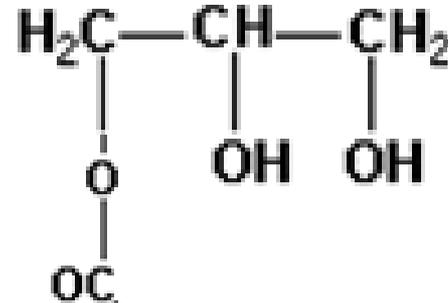
# Properties of fatty acid

- Upto 10 carbon are liquid at room temperature
- Melting point is influenced by length and degree of unsaturation
- Water solubility decreases with chain length
- Soluble in alcohol
- With Na, K they form salts or soap
- With O<sub>2</sub>, unsaturated fatty acid gives complex reaction and form unstable peroxides and decomposes into short chain FA and aldehydes
- Pka of fatty acid –COOH group is 4;8 so they ionized at physiological ph
- Unsaturated fatt acid exhibit geometric isomerism (cis & trans)

A **glyceride** forms when an  $-OH$  in glycerol is replaced by an organic acid



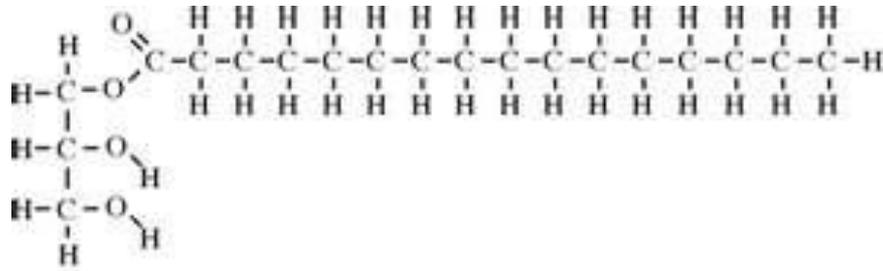
glycerol



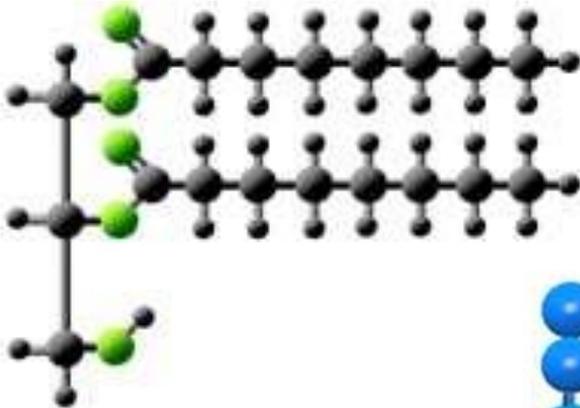
**Fatty acid**



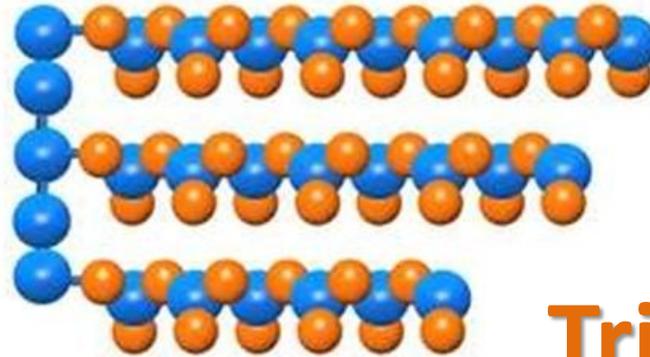
# Types of glycerides:



**Monoglyceride**

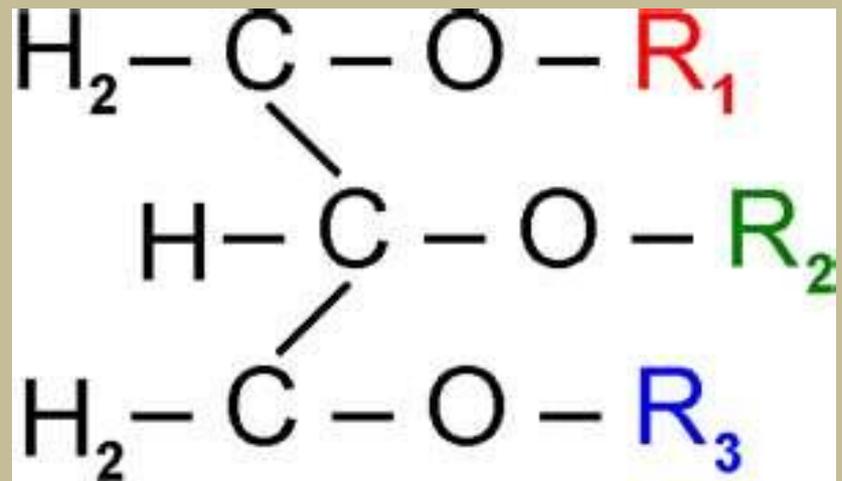
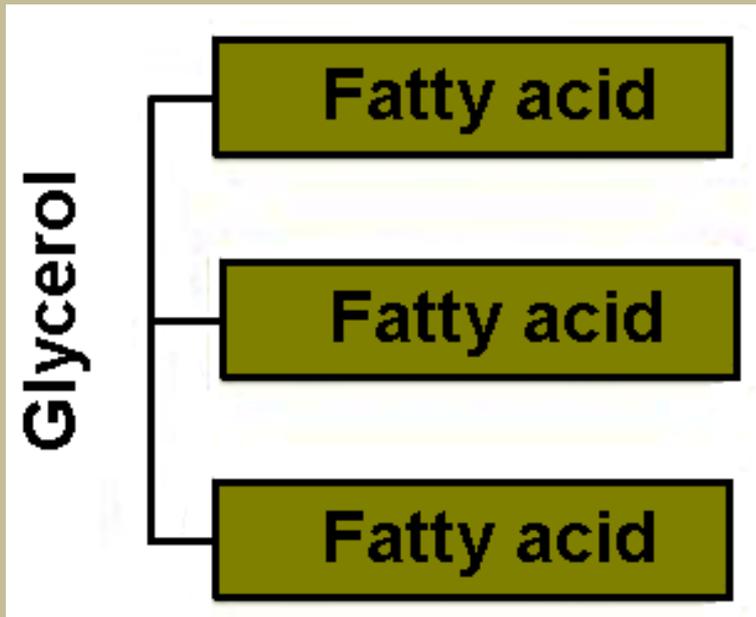


**Diglyceride**



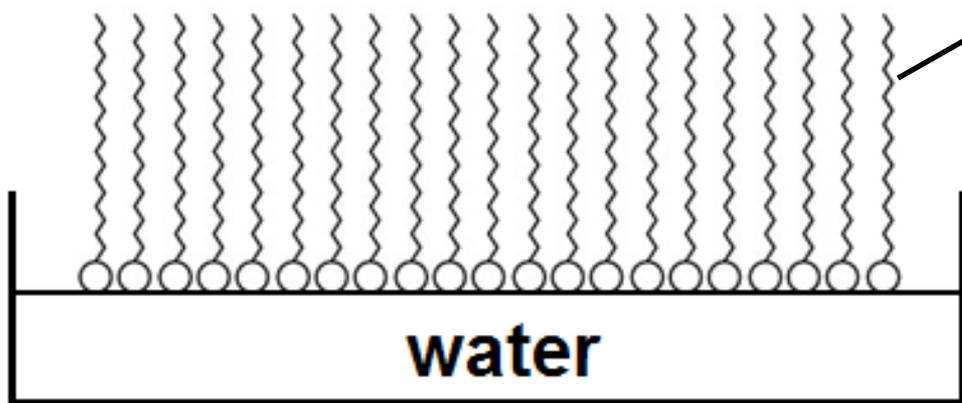
**Triglyceride**

# Why are fats and oils classified as **triglycerides**?



# Triglycerides:

- are non-polar and float on water

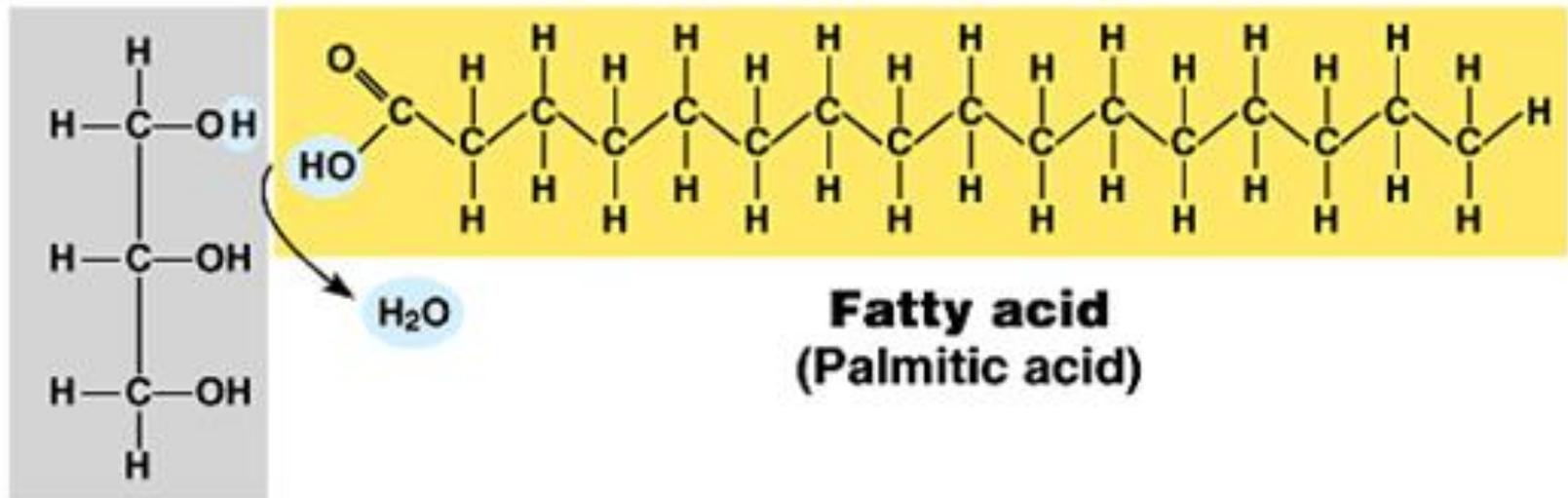


Non-polar tail -  
Hydrophobic

Polar head -  
Hydrophilic



# Fatty acids link to glycerol as a water molecule is lost

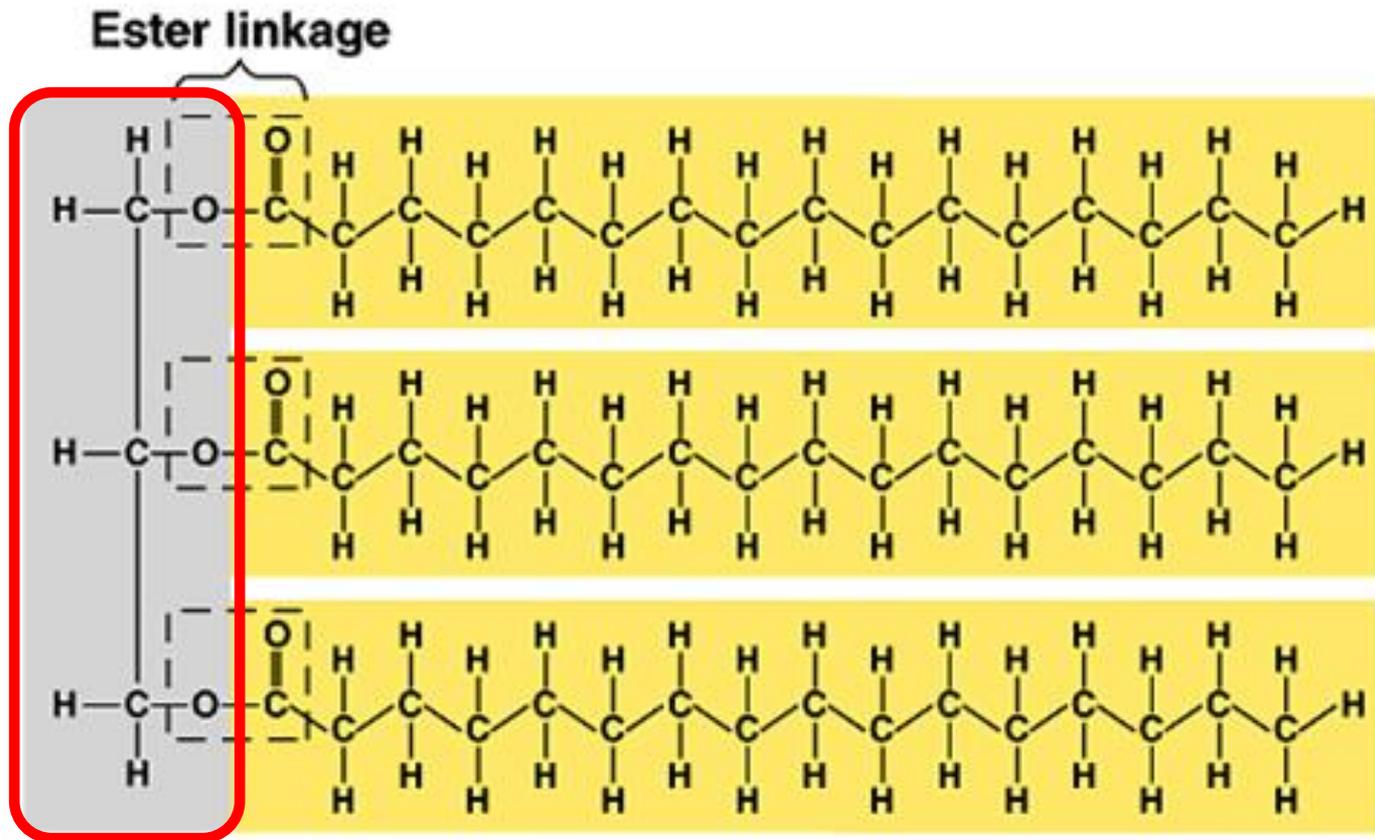


**Glycerol**

**Fatty acid  
(Palmitic acid)**

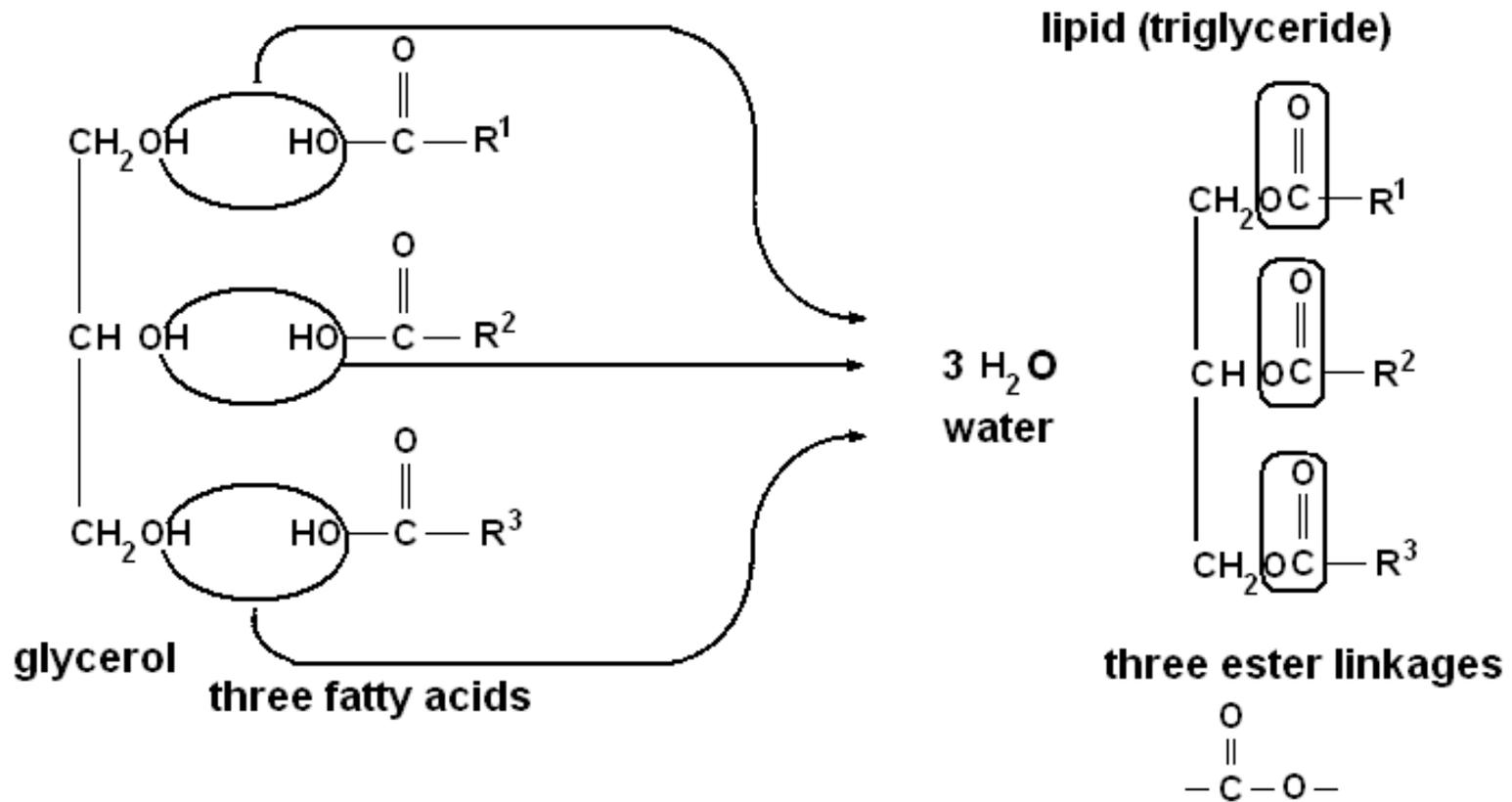
(a) **Condensation**

# Fats & oils are made of one glycerol and three fatty acids



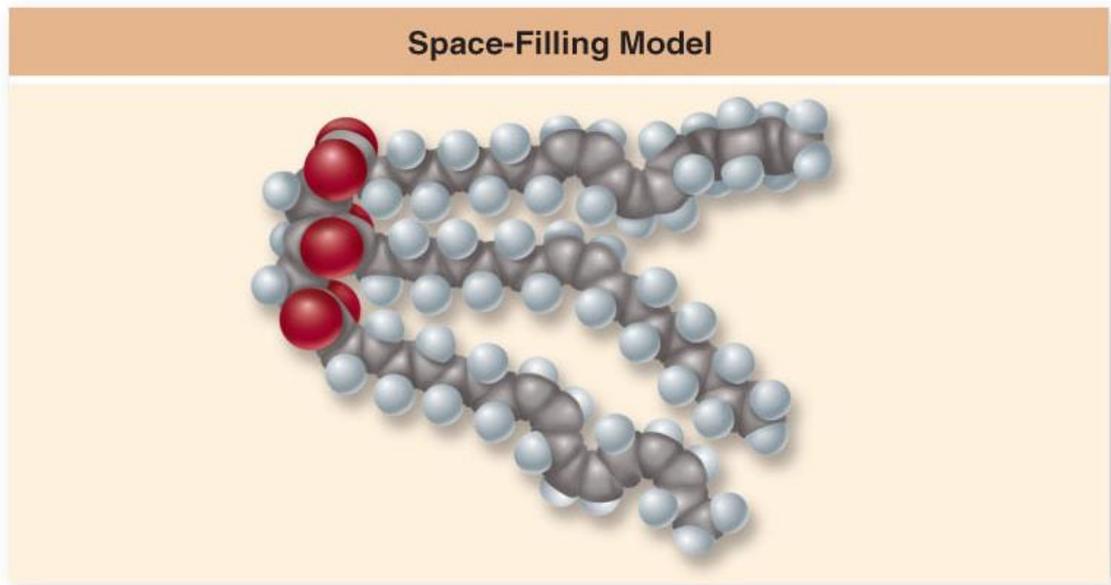
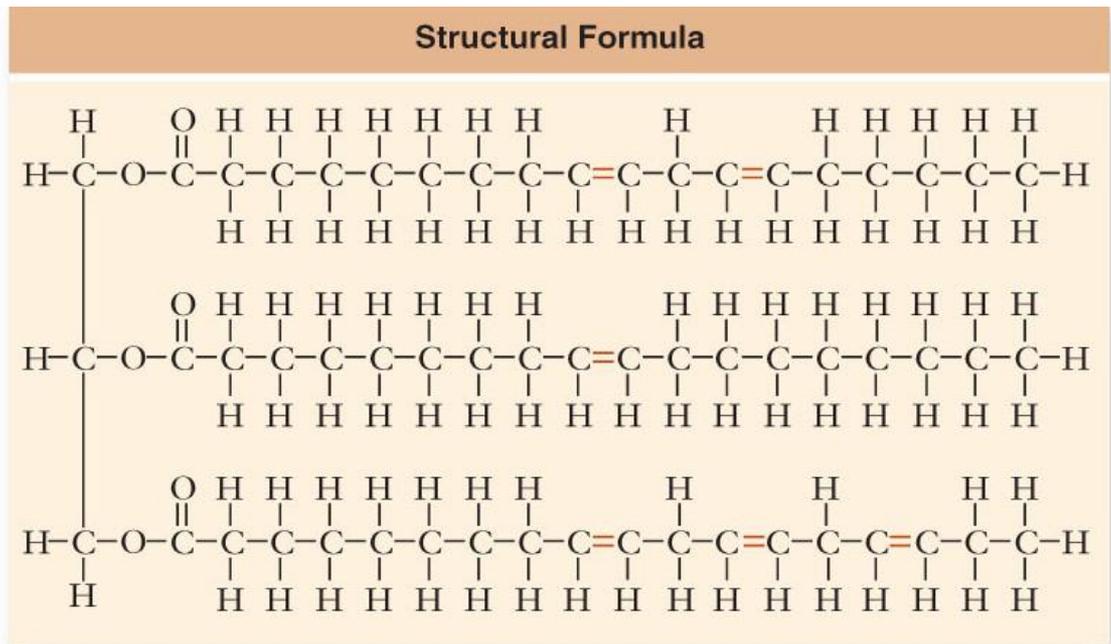
(b) Triglyceride

# Formation of a triglyceride



formed by **esterification / condensation**

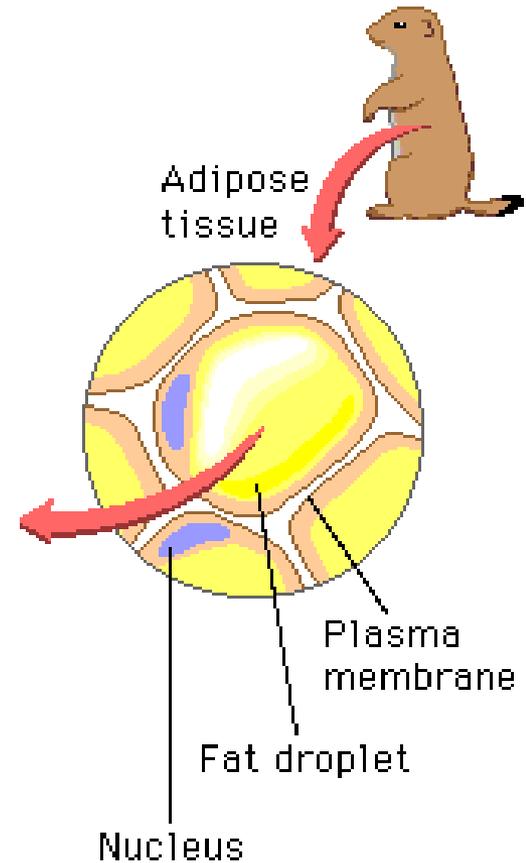
**Fatty acids  
may be  
different in  
a  
triglyceride**



*b.*

# Functions of Triglycerides

## 1. Store energy in animals + Yield energy



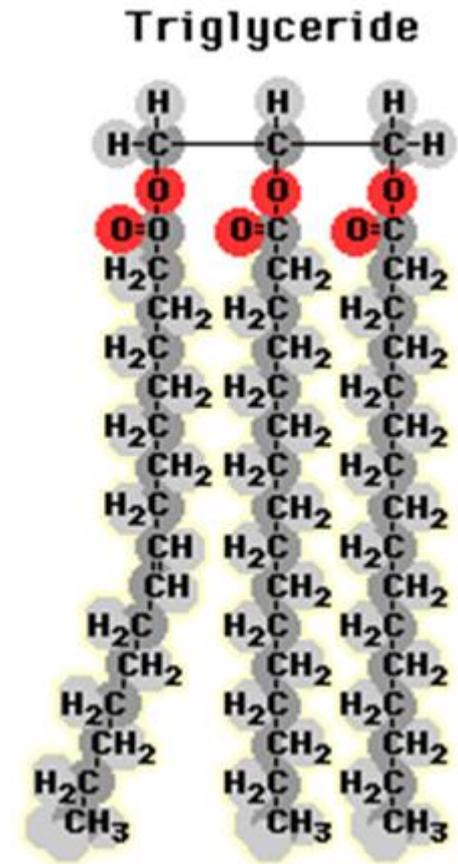
# Comparison of energy yield from:

Triglycerides:  $37 \text{ kJ g}^{-1}$

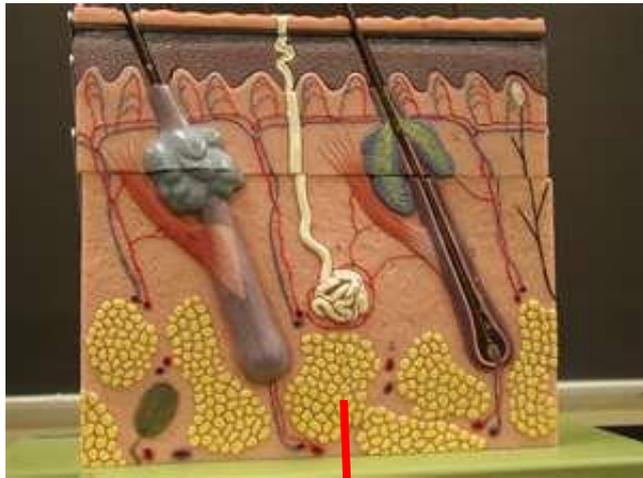
Carbohydrates:  $17 \text{ kJ g}^{-1}$

**MORE energy from  
triglycerides:**

**Due to more hydrogen.**



## 2. Animals store extra fat when hibernating: acts as an insulator.

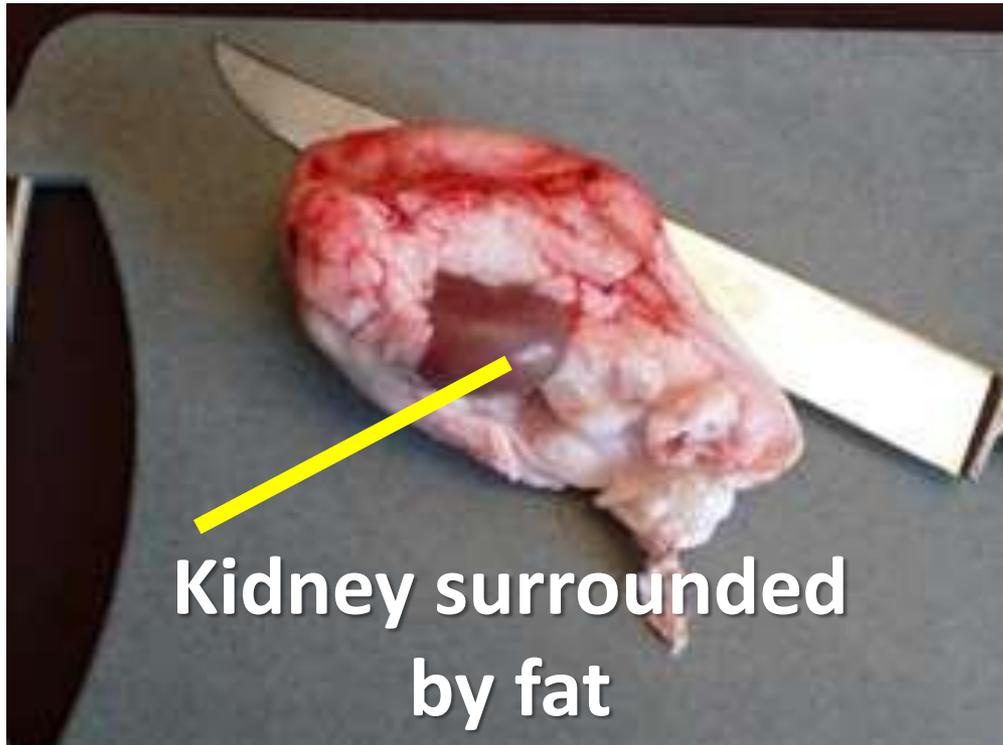


**Subcutaneous fat**



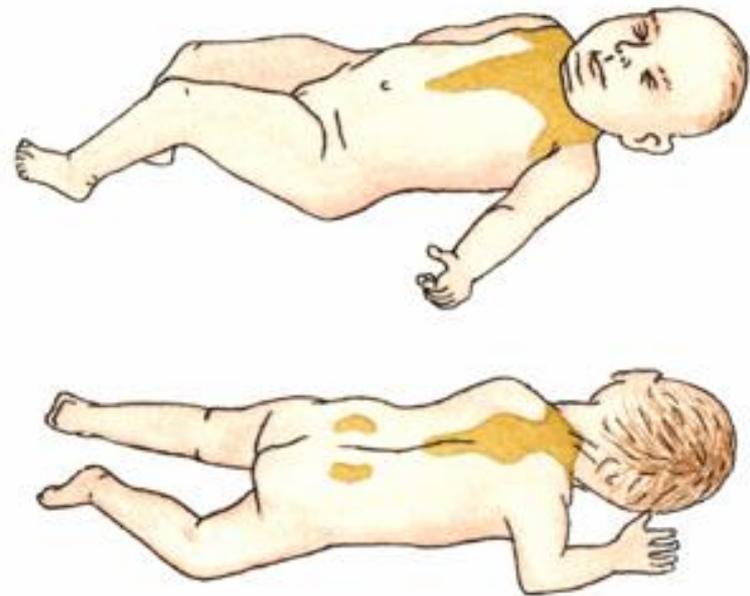
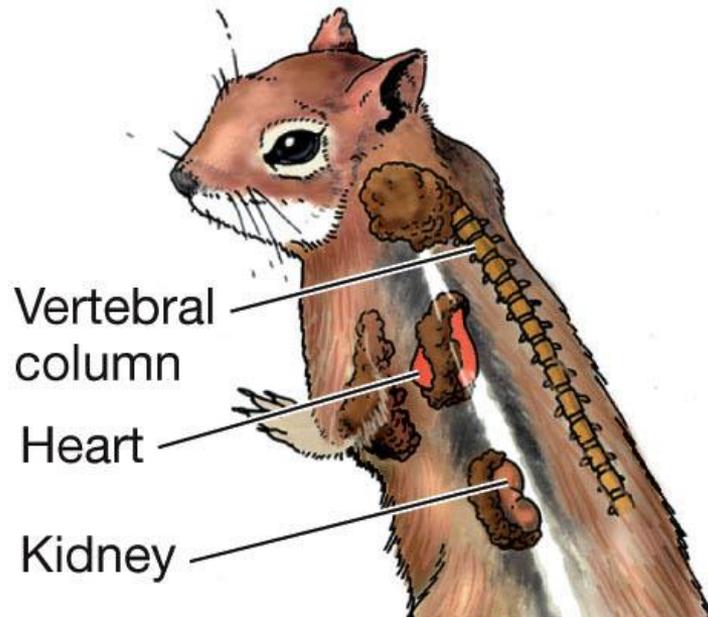
## 2. Fat around organs:

- protect against bumps
- keeps them warm



### 3. Brown adipose tissue (brown fat)

- releases heat but no ATP
- heat maintains core temperature in:
  - small mammals
  - in newborn humans, particularly during cold exposure without shivering

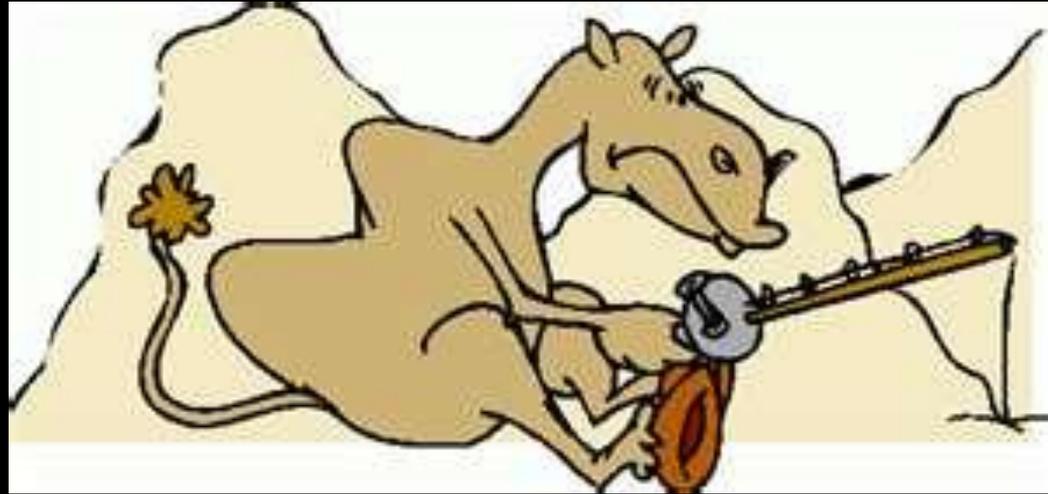


## 4. In aquatic mammals blubber contributes to buoyancy.



# What is present in the hump? Why?

**FAT**



When fat is metabolised, it yields:

1. **energy**
2. more than 1 g of **water** for each 1 g of fat by respiration.

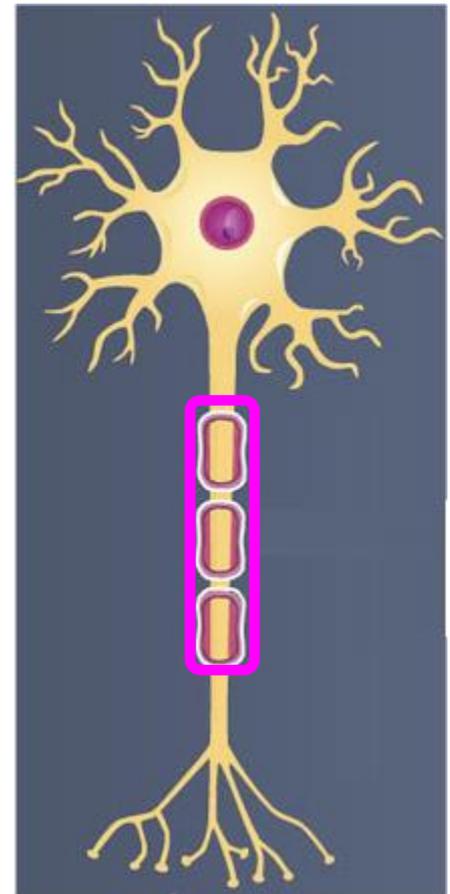
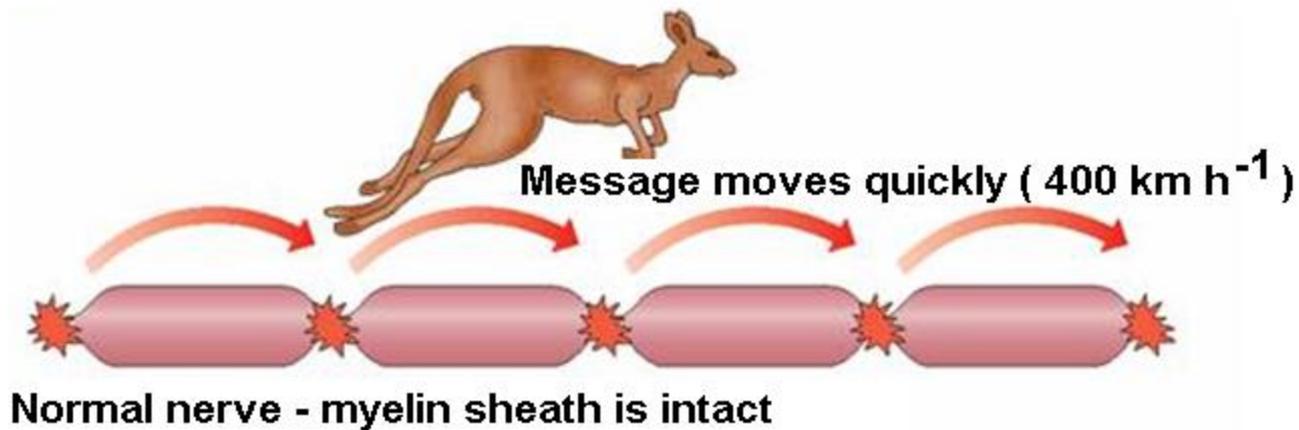
5. Water is produced when fats are oxidised - this metabolic water is important in desert animals.



1. Eating
2. Metabolism

A kangaroo rat never drinks. Mention TWO ways how it can get water.

6. Nerves are covered with a myelin sheath for insulation of the fibre and for fast conduction of impulses.



# Properties of triacylglycerol

- Hydrolysis  
into free fatty acid and glycerol by lipase
- Saponification  
hydrolysis by alkali to produce glycerol and soap called saponification

# Rancidity

- Appearance of unpleasant smell and taste of fats and oils due to degradation of them
- Moisture, air, bacteria cause rancidity

## Types

- Oxidative: because of oxidation of fatty acid (unsaturated) with formation of dicarboxylic acid, aldehyde, ketones etc through the formation of peroxides intermediates
- Hydrolytic: partial hydrolysis of triacylglycerol by hydrolytic enzymes (bacteria)

# Antioxidants

- Substance that prevent oxidation and rancidity of fat and oils are called antioxidants
- E.g.
- Hydroquinones, Vit-E,
- Butylated hydroxyanisol (BHA) and butylated hydroxytoluene (BHT) are used as food preservatives

# Tests for purity of lipids

- To detect the presence of adulteration

## 1. Melting point (MP)

for even chain saturated fatty acid the MP is directly proportional to chain length. Small amount of unsaturated fatty acid decrease the MP of lipid

## 2. Iodine no

the no of grams of iodine reacted or absorbed by 100 gm of fat or oil

it is directly proportional to unsaturated fatty acid content because double bond takes up more iodine

It is measure of unsaturation of fats

e.g. Butter: 25-28, ground nut oil: 85-100, beef: 35-42

Lard: 47-66

### 3. Saponification number

no of miligram of KOH require to hydrolyse or saponify one gram of fat or oil.

it is high for the fats containing short chain fatty acid or it is inversely proportional to the molecular weight of fat

it is a measure of average molecular weight (chain length) of fatty acid present in fat

e.g. Lard: 195-203, beef: 196-200

cocconut oil: 250-260

### 4. Acid number

no of mg of KOH required to completely neutralize free fatty acid present in 1 gm of fat

Important to determine the degree of rancidity due to free fatty acids

e.g. Butter: 0.4, beef:0.25

## 5. Acetyl no

no of mg of KOH required to neutralize the acetic acid formed by saponification or hydrolysis of 1 gm of acetylated fat or oil

it is measure of no of hydroxy groups in fat

e.g. Lard: 2.6, butter: 1.9-8.6

castor oil: 146-150

## 6. Polenske no

the no of ml of 0.1 N KOH required to neutralize the insoluble fatty acids (those not volatile with steam distillation) from 5 gm of fat

It is a measure of non-volatile (long chain) fatty acids present in a fat

## 7. Reichert – Meissl number (RM no)

It is the number of milliliters of 0.1 N KOH required to neutralize the soluble volatile fatty acids derived from 5 g of fat.

it measures the quantity of short chain fatty acids in the fat molecule.

e.g. Butter: 26-33, cottonseed oil: 0.95

Butter contain good concentration of volatile fatty acid like butyric acid, caproic acid, caprylic acid