LIPIDS

Lipids are *heterogeneous group of organic compounds* which are *insoluble in water* and *soluble in organic solvents* like ether, benzene .

for example :- cooking oil, butter, cholesterol , essential oil etc

CLASSIFICATION

- **Simple lipids**

(esters of fatty acids with various alcohols)

- **Neutral or true fats**

(esters of fatty acids and glycerol)

- **Waxes**

(esters of fatty acids with alcohol other than glycerol)

- **Compound and conjugated lipids**

(esters of fatty acids with alcohol but some other types of substances)

- **Phospholipids**

(nitrogen containing base and phosphate group in addition to fatty acid and glycerol)

- **Glycolipids**

(which has fatty acid, amino acid and carbohydrate)

- **Lipoproteins**

(which have lipids and proteins)

- **Derived lipids**

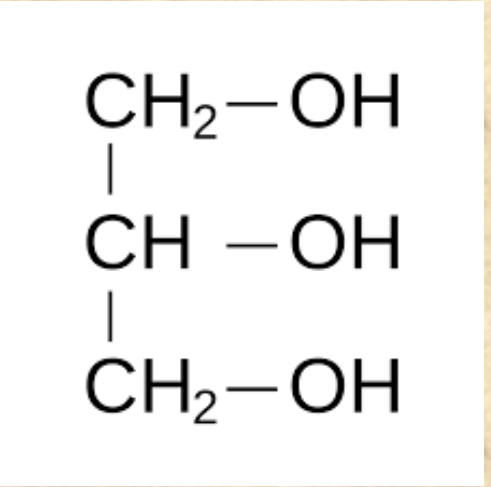
(formed from the hydrolysis of simple and compound lipids)

Neutral or true fats

Neutral fats molecule is only made up of *two components* i.e. *one molecule of alcohol* called *glycerol* and *three* molecules of *same or different fatty acid.*

- **Glycerol**

It is a three carbon compound which has *three hydroxy (OH)* groups .



Fatty acids

A fatty acid molecule is an unbranched chain of carbon atomswith *carboxyl group(--COOH)* at one end and *hydrogen* at all other sites.

The carboxyl group gives the molecule its acidic properties.

fatty acids are *polar in nature* as it can dissociate into positively charged hydrogen ion*(H+)* and *negatively charged (--COO)* group.

But dissociation cannot occur when fatty acid is a part of fat molecule, therefore has no charge and hence called neutral fat.

Types of fatty acids

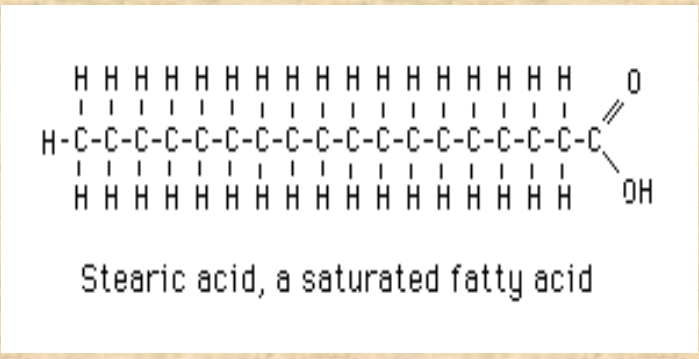
SATURATED FATTY ACIDS

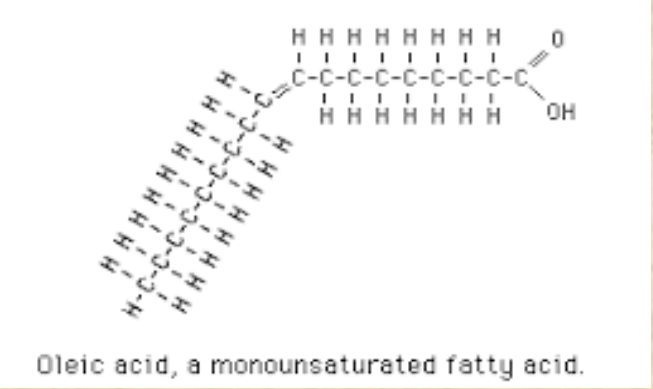
- all the carbon atoms are linked *by single bonds* and bear hydrogen atoms.
- general formula $C_nH_{2n}O_2$
- are *straight chains*.
- have *higher melting point* than unsaturated fatty acids
- *solid* at room temperature
- *less abundant* in living organisms
- Occur in most *animal fats.*
- *no cis and trans* configuration.

UNSATURATED FATTY ACIDS

- at one or more places carbon atoms are joined *by double bonds* and lack hydrogen atoms.
- general formula $C_nH_{2n-2}O_2$
- have a *bend* at double bond.
- have *lower melting point* than saturated fatty acids.
- *liquid* at room temperature
- *more abundant* in living organisms
- occurs in most *plant fats.*
- double bond may *have cis or trans* configuration

EXAMPLES: -





POLYSATUTATED FATTY ACIDS

The fatty acids having *more than one double bonds* . The oils having such fatty acids is called *polyunsaturates.*

These are recommended for persons with high blood cholesterol or cardiovascular diseases .

EXAMPLE: Sunflower oil .

Formation of fats

The three hydroxyl *(--OH) groups of glycerol* molecule *join* with the carboxyl *(--COOH) groups of three fatty acid* molecules to form a fat or a glyceride molecule

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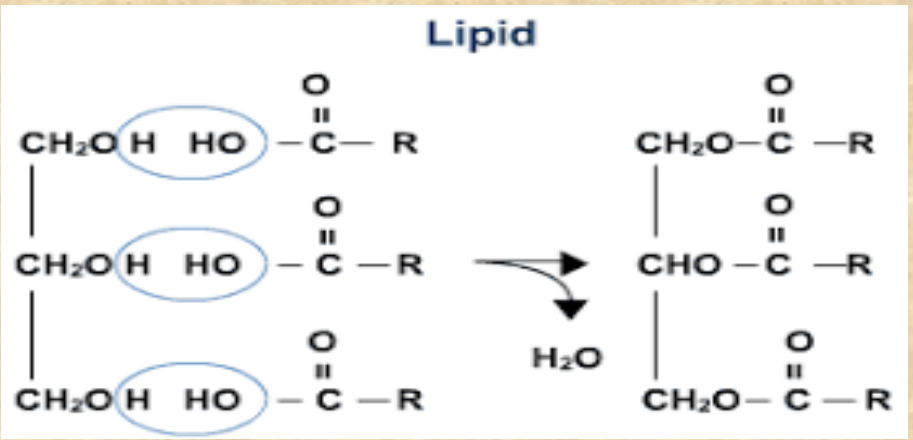
The chemical linkage between the glycerol and fatty acid is called *ester bond* and the process of formation of this bond is called *esterification.*

Also, *three molecules of water are eliminated* , one for each linkage.

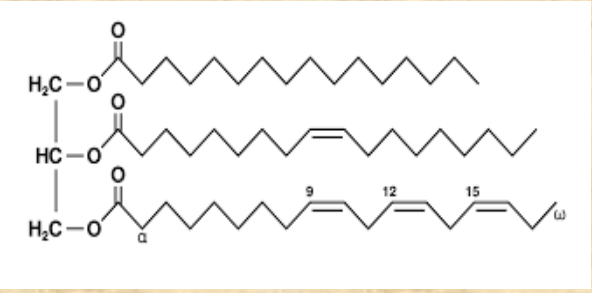


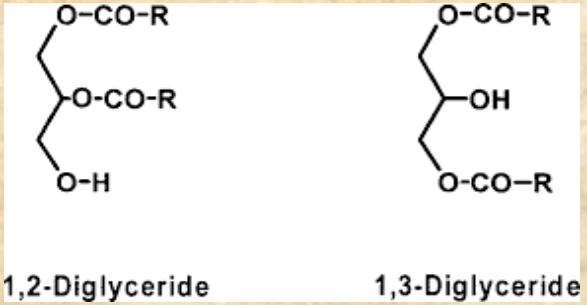
Here **R represents** carbon chains which can have same as well as different no of carbon atoms.

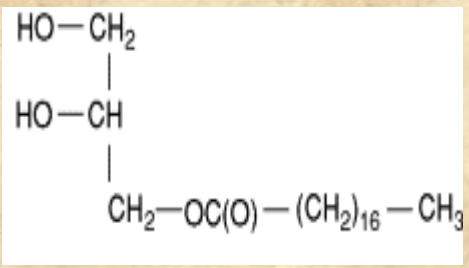
16 - carbon : palmatic acid->tripalmitin
18- carbon : stearic acid->tristearin

Types of fats

- Triglycerides:- A true fat having *three molecules of fatty acid* is called triglyceride. These are common in cells.
- Diglycerides :- A true fat having *two* molecules of fatty acid. Occurs as intermediates in certain biosynthetic reactions.
- Monoglycerides:- A true fat having *one* molecule of fatty acid. Similarly, occurs as intermediates in certain biosynthetic reactions.







Properties

- True fats are in soluble in water but soluble in organic solvents.
- They have low specific gravity and float on water.
- They have well defined melting points and solidifying temperatures.
- All the fats are greasy.
- The neutral fats are hydrolyzed in the cell by the action of lipases.
- The *glycerol end* of the fat molecule *is hydrophilic* and the *fatty acid* end is *lippophilic* , which means that glycerol is polar and dissolves in water where as fatty acid end is non polar and dissolves in fats.

Functions

- **Reserve food material**

  Neutral fats serve as food reserves in both plant and animals .In animals they are stored in connective tissue around the kidney, under the dermis of mammals .In plants, fat is stored in seeds to provide nourishment to germinating embryo.

- **Fuel :**

  The neural fats form concentrated fuel, producing more than twice of energy per gram than the amount produced by carbohydrates

- **Insulation coat :**

  Fats form an insulating layer under the skin and increases the tolerance to cold . Animals like polar bear and whales also has very thick layer of adipose tissue called blubber, under the skin for

  insulation

- **Shock absorbing cushions:**

  Provide shock absorbing and protective layer around internal organs like kidneys , eyeballs and gonads

Some of lipids serve as hormones, some as vitamins and others function as parts of enzymes.

WAXES

These are the lipids which are composed of *long chain fatty acids and long chain alcohol of high molecular* weight instead of glycerol.

EXAMPLES :-

- **Bees wax** –it is the secretion of the abdominal glands of worker bees. It consists of palmitic alcohol and myricyl alcohol.
- **Lanolin or wool fat**:-secretion of cutaneous glands and resembles alcohol. It consists of palmatic , oleic or stearic acid and cholesterol .
- **Spermaceti**(sperm oil):-It is an oil from the large head cavity of the sperm whale whale. It consists of palmatic acid and cetyl alcohol.

- **Plant waxes** :-these form a coating on plant organs to prevent wetting , reducing transpiration and check the entry of microorganisms.

PROPERTIES:-

Waxes are greasy and solid at room temperature .

FUNCTIONS:-

Waxes form a protective coating on animal furs and plant stems, leaves and fruits.

Energy Yield from β-Oxidation

- Yield of ATP per mole of stearic acid (C_{18}).

Step	Chemical Step	Happens	ATP
1	Activation (stearic acid -> stearyl CoA)	Once	-2
2	Oxidation (acyl CoA -> trans-enoyl CoA) produces $FADH_2$	8 times	16
4	Oxidation (hydroxy-acyl CoA to ketoacyl CoA) produces $NADH + H^+$	8 times	24
	Oxidation of acetyl CoA by the common metabolic pathway, etc.	9 times	108
		TOTAL	146

Energetics of palmitic acid oxidation: calculate the ATP production when (16 carbon) is completely oxidized.

Mechanism			ATP yield
1. β-oxidation	7 cycles	I step liberates 2 ATP(2x7)	14
		III step gives 3 ATP(3x7)	21
2. From 8 acetyl CoA		Oxidized by citric acid cycle, each acetyl CoA provides 12 ATP	96
Total energy from one molecule of palmitate			131
Energy utilized for activation in the I step			-2
		Net yield of oxidation of one molecule of palmitate	**129**

Palmitic acid
$C_{16}H_{32}O_2$