

and Fea etc.

➤ Lipids

Characteristics

- i. Lipids are group of different types of organic compounds.
- ii. Lipids contain carbon, hydrogen, oxygen, nitrogen and phosphorus.
- iii. Lipids contain less amount of oxygen than carbohydrates and proteins.
- iv. Lipids are non-polar and hydrophobic compounds i.e. insoluble in water.
- v. Lipids are easily soluble in organic solvents e.g. ether, acetone, alcohol etc.

➤ CLASSIFICATION OF LIPIDS

Lipids are classified into various groups:

1. Triglycerides
2. Phospholipids
3. Waxes
4. Steroids
5. Terpenoids

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1. Triglycerides (Tri-three, glycosides-Glycerol)

Triglycerides are also known as Acylglycerol. Triglycerides are generally called "Fats".

Composition of triglycerides

Triglycerides are composed of:

- i. Glycerol.....one molecule
- ii. Fatty acids.....three molecules

Glycerol

It is an alcohol, consist of three carbon atoms. Hydroxyl (OH) group is attached to each carbon. Hydroxyl groups are polar in nature; hence glycerol is soluble in water.

Fatty acid

Fatty acid consist of a hydrocarbon, at one end of which a single carboxyl group (-COOH) is attached.

General structure of fatty acid: $\text{COOH}-\text{-----R}$

Fatty acids contain even number of carbon atoms e.g. 2, 4, 6, 8, 10, 12, 14, 16, 18 up to 28.

Types of Fatty acids

There are two types of fatty acids

1. Saturated fatty acids
2. Unsaturated fatty acids

1. Saturated Fatty acids:

- i. Saturated fatty acids, has no double bonds between carbon atoms.
- ii. Saturated fatty acids can not accommodate any more hydrogen atoms.
- iii. Saturated fatty acids are solid at room temperature.
- iv. Saturated fatty acids are stored in animals as fats.

For Example: Palmatic acid (16-C)

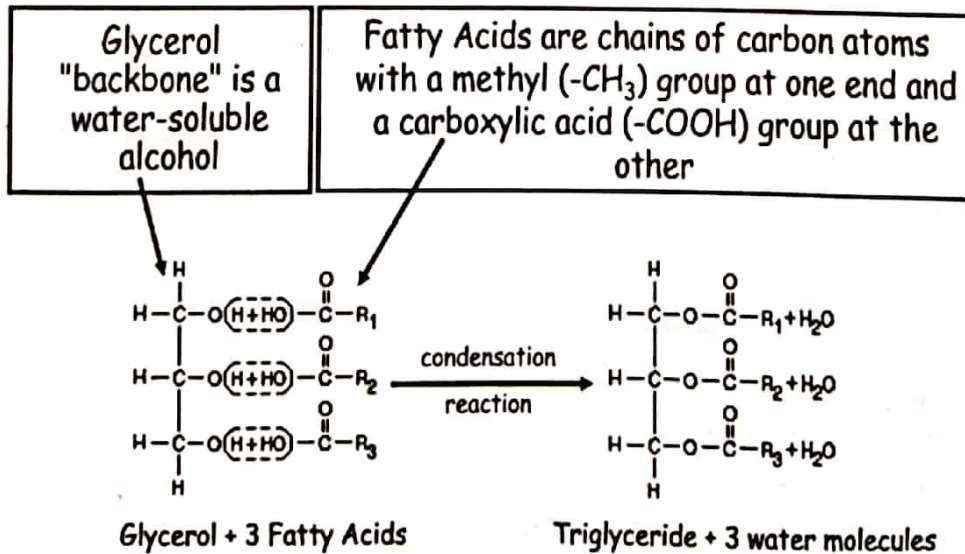
2. Unsaturated Fatty acids:

- i. Unsaturated fatty acids have one or more double bonds between carbon atoms. (C=C).
- ii. Unsaturated fatty acids contain less number of hydrogen atoms i.e. can accommodate any more hydrogen atoms.
- iii. Unsaturated fatty acids are usually liquid at room temperature.
- iv. It is stored in plant seeds.

For Example: Oleic acid (18-C)

Condensation of glycerol with fatty acids.....Triglycerides

Triglycerides are esters of glycerol and fatty acids



Structures linked by ester bonds (R-COOR') and water is released

R₁, R₂, R₃..... indicate fatty acids molecules.

Ester bond is the bond formed in between glycerol and fatty acids. As a result of condensation reaction, three water molecules are formed.

Triglycerides have twice the amount of energy per gram than that of carbohydrates and proteins.

Explanation: The energy is present in C-H bonds, more the C-H bonds more will be the energy. As fatty acids contain more C-H bonds that is why triglycerides contain more energy.

Difference between Oil and Fats

Oil	Fats
i. Oils are liquid at room temperature	i. Fats are solid at room temperature
ii. Oils have low boiling point	ii. Fats have high boiling point
iii. Oils contain mostly unsaturated fatty acids. e.g. Palmitic acid (16C), Oleic acid (18-C)	iii. Fats contain mostly saturated fatty acids. e.g. Stearic acid (18-C)

Oil $\xrightarrow{\text{hydrogenation}}$ Ghee

Oleic acid $\xrightarrow{\text{hydrogenation}}$ Stearic acid

Plants usually store lipids in seeds as oils, while animals store lipids as fats in various body organs (Cell).

2. Phospholipids

Composition: Phospholipids is composed of:

- Glycerol: one molecule
- Fatty acids: Two molecules
- Phosphoric acid: one molecule.

When a nitrogen containing group i.e. choline ($\text{CH}_2\text{-CH}_2\text{-(CH}_2\text{)}_3\text{ N}^+$) is attached with phosphate end of phospholipids, it is known as phosphatidyl choline (Lecithin).

Phospholipids have two parts:

- Head:** Head is polar in nature.
It is soluble in water (Hydrophilic).

- Tails:** Tails is non-polar in nature.
It is insoluble in water (Hydrophobic)

Plasma membrane is chemically Lipoprotein molecules.

Plasma membrane \rightarrow proteins + Lipids

Lipids \rightarrow Phospholipids (Phosphatidyl choline - Lecithin)

3. Waxes

Waxes are derived lipids. Composition: Waxes are composed of:

- Long chain fatty acid..... one molecule
- Long chain alcohol having a single hydroxyl group (-OH) e.g. cetyl alcohol ($\text{C}_{16}\text{H}_{33}\text{OH}$)

Characteristics of Waxes

- Waxes have high melting point, hence solid at room temperature.
- They are hydrophobic in nature.
- They show stability and are resistant to degradation.
- They form a water-proof layer on the surfaces of plant parts e.g. leaves, fruits etc. and in this way reduce the rate of transpiration.
- Waxes also form a waxy layer, which cover animal bodies e.g. sheep, insects etc.

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4. Steroids

- i. Steroids come under the category of lipids.
- ii. Steroids are actually derived lipids.

Composition

Steroids do not contain alcohol and fatty acids.

Steroids are composed of four fused carbon rings containing 17-carbon atoms.

Each steroid have the same basic backbone, the difference is due to the different functional groups attached.

Example of Steroids: **Cholesterol**: It is an important component of animal cell membranes. Cholesterol is also a precursor (basic) molecule of some hormones such as aldosterone, sex hormones and vitamin D.

Aldosterone:

It helps to regulate the sodium ions in the blood.

Sex hormones:

Sex hormones e.g. testosterone, progesterone, estrogens help to maintain male and female characteristics.

5. Terpenoids OR Terpenes

Terpenoids are lipid derivatives.

Composition: Terpenoids do not contain fatty acids. It is composed of units known as isoprenoid units or isoprene units.

Isoprene unit- five carbon unit. Isoprene units join together by condensation process and give rise to different types of compounds e.g. carotenoids and rubber etc.

Classification of terpenoids

Terpenoids are classified on the basis of number of carbon:

1. Monoterpenes (10-C)
2. Sesquiterpenes (15-C)
3. Diterpenes (20-C)
4. Triterpenes (30-C)
5. Tetraterpenes (40-C) Example Carotenoids.
6. Polystyrenes (many carbons) Example Rubber

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Carotenoids are the example of Tetraterpenes. Carotenoids are pigments in plants. It is yellow-orange and red-brown pigments. B-Carotene is a type of carotene. It is present in carrots and rice etc.

The breakdown of β -carotene in human body yields two molecules of vitamin A.

Functions of Lipids

Following are the functions of lipids:

1. **Structural building material:** Lipids act as structural building material e.g. cell membrane is composed of Lipo-protein molecules.
2. **Source of energy:** Lipids contain twice the amount of energy than carbohydrates and proteins. The energy is present in C-H bonds, greater the number of C-H bonds, greater will be the amount of energy e.g. Glyceraldehydes (3-C) sugar contains less energy as compared to fatty acids e.g. Oleic acid (18-C).