The acids which are combined with glycerol in the naturally occurring fats are called fatty acids. These acids contain even number of carbon atoms linked together in long chains which are in general un-branched.

The chain contains from six to about twenty carbon atoms in plant triglycerides and the most frequent number being 16 or 18. The long chain molecule possesses the carboxyl group at one end, while the remainder part consists of carbon and hydrogen atoms only.

Classification of Fatty Acids:

The fatty acids can be classified into four groups as follows:

- ✓ Saturated fatty acids
- ✓ Unsaturated fatty acids
- ✓ Branched chain fatty acids, and
- ✓ Cyclic fatty acids.

Saturated Fatty Acids:

Saturated fatty acids are those which contain only single bonds in their hydrocarbon chain.

The general formula is:

R — COOH

Where R is CH_3 $(CH_2)n$; n varies from zero in acetic acid to 24 in cerotic acid and to 86 in mycolic acid.

The most commonly occurring saturated fatty acids of the higher plants are palmitic acid (C_{16}) and stearic acid (C_{18}). Other major saturated fatty acids found in plant lipids are shown in table.

Table: Major saturated fatty acids and their sources

S. No.	fatty acids name	Structure	Source
1.	Butyric acid	CH_3 $(CH_2)_2COOH$	Butter
2.	Caproic acid	CH_3 $(CH_2)_4COOH$	Butter, palm oil, coconut oil
3.	Caprylic acid	CH_3 $(CH_2)_6COOH$	palm oil, coconut oil
4.	Capric acid	CH_3 $(CH_2)_8COOH$	palm oil, coconut oil
5.	Lauric acid	CH_3 $(CH_2)_{10}COOH$	Plants o f lauraceae, palm oil, coconut oil
6.	Myristic acid	CH_3 $(CH_2)_{12}COOH$	Seed fats of mace, butter, coconut oil
7.	Palmitic acid	CH_3 $(CH_2)_{14}COOH$	Plant fats, palm oil, Peanut oil
8.	Stearic acid	CH_3 $(CH_2)_{16}COOH$	Plant and animal fats
9.	Arachidic acid	CH_3 $(CH_2)_{18}COOH$	Peanut oil
10.	Behenic acid	CH_3 $(CH_2)_{20}COOH$	Plant lipids

11.	Lignoceric acid	$CH_3 (CH_2)_{22}COOH$	Plant lipids
12.	Cerotic acid	$CH_3 (CH_2)_{24}COOH$	Beewax, wool

Unsaturated Fatty Acids:

Unsaturated fatty acids are those which contain one or more double bonds in their hydrocarbon chain.

The general formula is:

R-CH = CH $(CH_2)n$ - COOH

These fatty acids are also characterized by the presence of cis-trans isomerism at their double bonds. The most common examples of unsaturated fatty acids are mentioned in table. Oleic and linoleic unsaturated fatty acids are widely distributed in plants.

Table: Major Unsaturated fatty acids and their sources

S. No.	fatty acids name	Structure	Source
1.	Butyric acid	$CH_3 (CH_2)_5CH = CH_2(CH_2)_7COOH$	Sardine oil
2.	Oleic acid	$CH_3 (CH_2)_7CH = CH(CH_2)_7COOH$	Olive oil, peanut oil, linseed oil
3.	Linoleic acid	$CH_3 (CH_2)_4CH = CHCH_2CH= CH(CH_2)_7COOH$	Olive oil, peanut oil, linseed oil, soyabean oil
4.	ɣ- linoleic acid	$CH_3 (CH_2)_4CH = CHCH_2CH= CHCH_2CH =CH(CH_2)_4COOH$	linseed oil
5.	Parinaric acid	$CH_3CH_2CH=CHCH=CHCH= CH(CH_2)_7COOH$	Plants lipids
6.	Erucic acid	$CH_3(CH_2)_7CH= CH(CH_2)_{11}COOH$	Rapeseed oil
7.	Arachidonic acid	$CH_3 (CH_2)_4CH= CHCH_2CH= CHCH_2CH= CHCH_2CH= CH(CH_2)_3COOH$	Peanut oil

Properties of Fatty Acids and Fats:

Physical Properties:

1. Fats and fatty acids are soluble in organic solvents, such as petroleum ether, benzene and chloroform. They are insoluble in water.
2. Saturated fatty acids are solid at room temperature, while unsaturated fatty acids are liquid.
3. Unsaturated fatty acids show cis-trans isomerism due to presence of double bonds.

4. They are bad conductors of heat.
5. Saturated glycerides containing fats require high temperature for melting, whereas unsaturated glycerides containing fats require relatively lower temperature for its melting.

Chemical Properties:

Hydrolysis:

Fats undergo hydrolysis when treated with mineral acids, the alkalies or fat splitting enzyme lipase or hydrolases to yield glycerol and the constituent fatty acids.

Hydrolysis by alkalies, such as NaOH or KOH leads to the formation of sodium or potassium salts of fatty acids. The salts are known as soaps and process of its formation is saponification.

Hydrogenation:

Oils containing unsaturated fatty acids can be hydrogenated in presence of high temperature, pressure and finely divided nickel. By this process the oils are converted into solid fats (glycerides of saturated fatty acids). This reaction forms the basis of the industrial production of hydrogenated oil (vegetable ghee).

Hydrogenolysis:

Oils and fats are converted into glycerol and a long chain aliphatic alcohol when excess of hydrogen is passed through them under pressure and in presence of copper-chromium catalyst. This splitting of fat by hydrogen is called hydrogenolysis.

Halogenation:

When unsaturated fatty acids are treated with halogens, such as iodine and chlorine, they take up iodine or other halogens at their double bond site. This process of taking of iodine is called halogenation which is an indication of unsaturation. Iodine number is the percentage of iodine absorbed by a fat.

Rancidity:

Oils and fats on long storage in contact with heat, light, air and moisture, develop an unpleasant odour. Such oils and fats are known as rancid oils and fats.

The rancidity develops due to certain chemical changes taking place in the fat.

These changes include:

1) Enzymatic hydrolysis,

2) Air oxidation of unsaturated fatty acids, and

3) β- Oxidation of saturated fatty acids.

In all above mentioned changes, hydrolysis of fats is caused by enzyme lipase which is produced by microorganisms present in them. To check the rancidity, it becomes essential to protect oils and fats from air, light and moisture during storage.

Emulsification:

The process of breaking of large-sized fat molecules into smaller ones is called emulsification. In animals, this process is brought about by bile juice liberated from liver. Other emulsifying agents are water, soaps, proteins and gums.