C. Derived lipids: As the name implies they are formed from simple and compound lipids by hydrolysis. They are fatty acids, steroids, glycerol and retinol.

Fatty acids: They are acids derived from fats. They are monocarboxylic acids (head) containing long hydrocarbon side chain (tail). They are occurring mainly as ester in natural fats and oils but do occur in the unesterfied form as free fatty acids, a transport form found in the plasma. Based on the nature of hydrocarbon side chain, they are divided into:

a. Saturated fatty acids: In which hydrocarbon side chain saturated (no double bond).

b. Unsaturated fatty acids: In which hydrocarbon side chain is unsaturated (one or more double bonds are present).

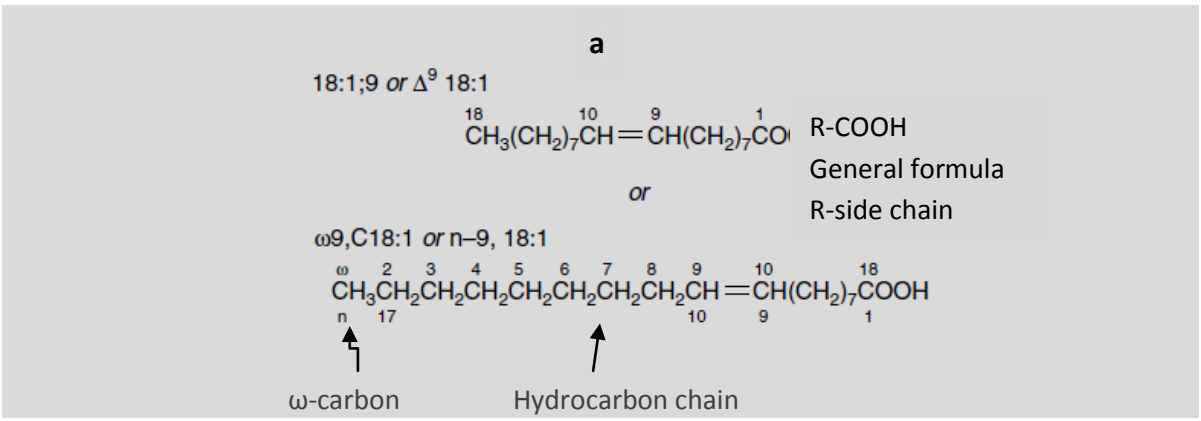
Fatty acids are also divided based on hydrocarbon chain length. They are:

a. Short chain fatty acids contain less than 6 carbon atoms.
b. Medium chain fatty acids contain 6-12 carbon atoms.
c. Long chain fatty acids contain 13-20 carbon atoms.
d. Very long chain fatty acids contain 22-30 carbon atoms.

Fatty acids of natural fats contain an even number of carbon atoms. Small amounts of fatty acids with odd number of carbon atoms also occur.

Cis-trans isomerism

Because of double bonds, unsaturated fatty acids exhibit *cis-trans* isomerism. In the *cis* isomer, bulky groups are located on the same side of the double bond where as in *trans* isomers they are on the opposite side of the double bond. All the naturally occurring unsaturated fatty acids are *cis*-isomers.



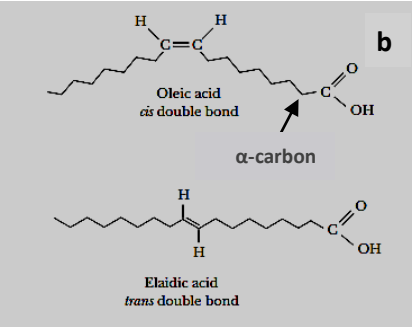


Fig. 2.4 (a) General formula of a fatty acid
(b) *Cis-trans* isomerism of unsaturated fatty acid

Function

Cis and *trans* isomers are not interchangeable in cells. Only *cis* isomers cat fit into cell membrane because of bent at double bond.

Nomenclature of fatty acids

Saturated fatty acids

Saturated fatty acids have both trivial names and systematic names. Consist of two parts. Name of hydrocarbon chain forms first part,. "oic" substituted in place of "e" of the hydrocarbon name forms second part. For example, systemic name for a saturated fatty acid containing 8 carbon atoms *i*,*e*., (octane + oic + acid) → octanoic acid. The trivial name of octanoic acid is caprylic acid. Examples of saturated fatty acids with systemic names, trivial names and with source are given in Table 2.2.

Table 2.2

Common Biological Fatty Acids				
Number of Carbons	Common Name	Systematic Name	Symbol	Structure
Saturated fatty acids				
12	Lauric acid	Dodecanoic acid	12:0	$CH_3(CH_2)_{10}COOH$
14	Myristic acid	Tetradecanoic acid	14:0	$CH_3(CH_2)_{12}COOH$
16	Palmitic acid	Hexadecanoic acid	16:0	$CH_3(CH_2)_{14}COOH$
18	Stearic acid	Octadecanoic acid	18:0	$CH_3(CH_2)_{16}COOH$
20	Arachidic acid	Eicosanoic acid	20:0	$CH_3(CH_2)_{18}COOH$
22	Behenic acid	Docosanoic acid	22:0	$CH_3(CH_2)_{20}COOH$
24	Lignoceric acid	Tetracosanoic acid	24:0	$CH_3(CH_2)_{22}COOH$

In fatty acid, the carbon atoms are numbered from the carboxylic carbon. The carbon atom adjacent to the carboxyl carbon is known as the α-carbon, the

one adjacent to α-carbon is known as β-carbon atom and so on. The end methyl carbon is called ω-carbon. (Fig. 2.4b).

Unsaturated fatty acids

They have trivial names, ω-end name and shorthand forms.

Systematic name

Like saturated fatty acid, the name of hydrocarbon forms first part of systematic name of unsaturated fatty acids, but 'enoic' substituted in place of 'ne' of name of hydrocarbon forms second part. Number of double bonds are written before 'enoic' and symbol showing position of double bond and isomerism around double between two parts or in the beginning, for example, systematic name for a mono unsaturated fatty acid palmitoleic (trivial name) containing 16 carbon atoms and one double bond between 9 and 10 carbon atoms is (Hexadecanoic + Δ^9-*cis*-mono+enoic+acid→ Hexadecanoic –Δ^9-*cis*-monoenoic acid or *cis*-9-Hexadecanoic acid. Usually unsaturated fatty acids end as 'enoic acid'.

Ω-end series

Unsaturated fatty acids are also named according to the location of double bonds For example; palmitoleic acid containing a double bond between 9 and 10 carbon atoms is named as ω-7 fatty acids.

Shorthand forms

Number of carbon atoms, number of double bonds and location of double bonds of unsaturated fatty acids are represented with short form. For example palmitoleic acid is written as 16:1, Δ^9 in shorthand form. First numeral indicates number of carbon atoms, later number of double bonds and Δ^9 indicates position of double bond.Examples of unsaturated fatty acids with trivial names, ω-end names are given in table 2.3 whereas structures and shorthand names are given in table 2.4.

Table 2.3 Unsaturated fatty acids with their source

Number of C Atoms and Number and Position of Double Bonds	Family	Common Name	Systematic Name	Occurrence
Monoenoic acids (one double bond)				
16:1;9	ω7	Palmitoleic	*cis*-9-Hexadecenoic	In nearly all fats.
18:1;9	ω9	Oleic	*cis*-9-Octadecenoic	Possibly the most common fatty acid in natural fats.
18:1;9	ω9	Elaidic	*trans*-9-Octadecenoic	Hydrogenated and ruminant fats.
Dienoic acids (two double bonds)				
18:2;9,12	ω6	Linoleic	all-*cis*-9,12-Octadecadienoic	Corn, peanut, cottonseed, soybean, and many plant oils.
Trienoic acids (three double bonds)				
18:3;6,9,12	ω6	γ-Linolenic	all-*cis*-6,9,12-Octadecatrienoic	Some plants, eg, oil of evening primrose, borage oil; minor fatty acid in animals.
18:3;9,12,15	ω3	α-Linolenic	all-*cis*-9,12,15-Octadecatrienoic	Frequently found with linoleic acid but particularly in linseed oil.
Tetraenoic acids (four double bonds)				
20:4;5,8,11,14	ω6	Arachidonic	all-*cis*-5,8,11,14-Eicosatetraenoic	Found in animal fats and in peanut oil; important component of phospholipids in animals.
Pentaenoic acids (five double bonds)				
20:5;5,8,11,14,17	ω3	Timnodonic	all-*cis*-5,8,11,14,17-Eicosapentaenoic	Important component of fish oils, eg, cod liver, mackerel, menhaden, salmon oils.

Table2.4 structures and ω-names of unsaturated fatty acids