The **lipids** are a large and heterogeneous group of substances of biological origin that are easily dissolved in organic solvents such as methanol, acetone, chloroform, and benzene. By contrast, they are either insoluble or only poorly soluble in water. Their low water solubility is due to a lack of polarizing atoms such as O, N, S, and P. Lipids can be classified into substances that are either *hydrolyzable* i.e., able to undergo hydrolytic cleavage or *nonhydrolyzable* (Fig. 1).

1. **Hydrolyzable lipids or complex lipids:** The simple **esters** include the *fats*, the *waxes* and the *sterol esters* (one sterol + one acyl residue).

- The **phospholipids** include the ***phosphatidic acids*** **and the *phosphatides.***
- In the **sphingolipids**, glycerol and one acyl residue are replaced by sphingosine. Particularly important in this group are the sugar-containing **glycolipids**
- The ***cerebrosides*** (one sphingosine + one fatty acid + one sugar).
- The components of the **hydrolyzable lipids** are linked to one another by **ester bonds**. They are easily broken down either enzymatically or chemically.

2. Non-hydrolyzable lipids or simple lipids: The **hydrocarbons** include the *alkanes* and *carotenoids*. The **lipid alcohols** are also **not hydrolyzable**. They include long-chained *alkanols* and cyclic *sterols* such as cholesterol, and *steroids* such as estradiol and testosterone. The most important **acids** among the lipids are ***fatty acids***

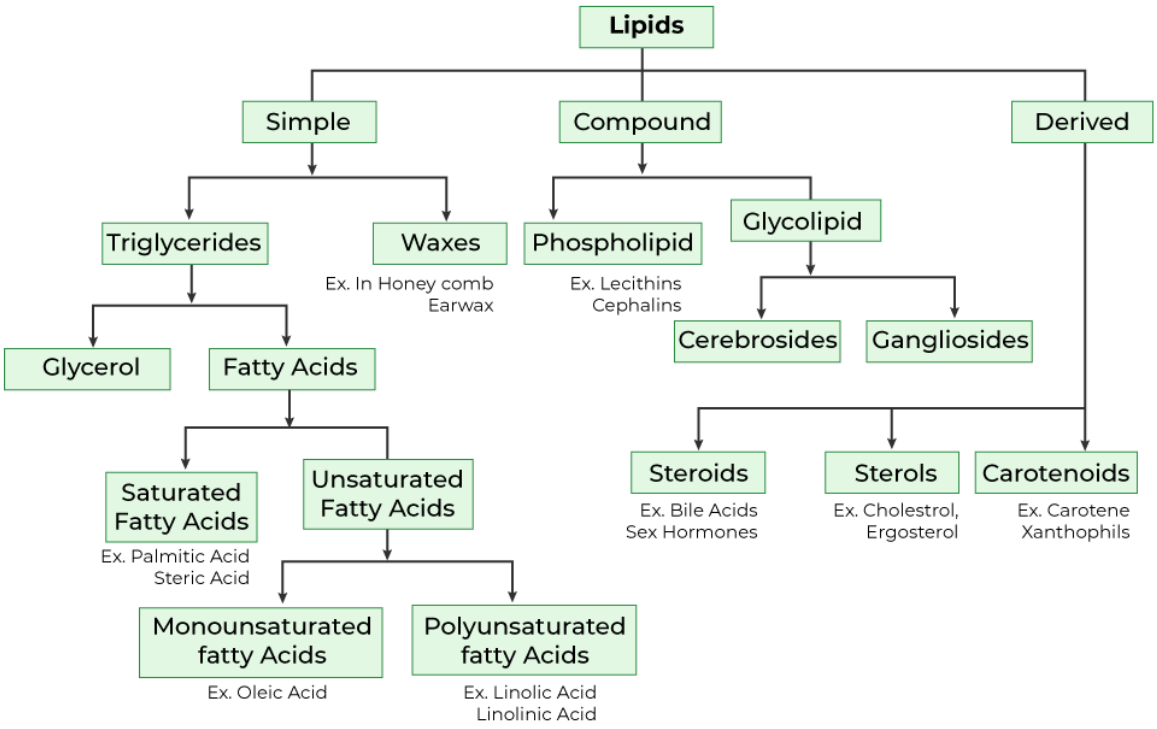

Fig. 1: Lipids classification.

◊BIOLOGICAL ROLES:

1. Storage form of energy (triacylglycerol)
2. Structural components of bio-membranes (phospholipids and cholesterol)
3. Metabolic regulators (steroid hormones and prostaglandins)
4. Act as surfactants, detergents and emulsifying agents (amphipathic lipids)
5. Act as electric insulators in neurons (galactoceramide)
6. Provide insulation against changes in external temperature (subcutaneous fat)
7. Give shape and contour to the body
8. Protect internal organs by providing a cushioning effect (pads of fat)
9. Help in absorption of fat soluble vitamins (A, D, E and K)
10. Improve taste and palatability of food.

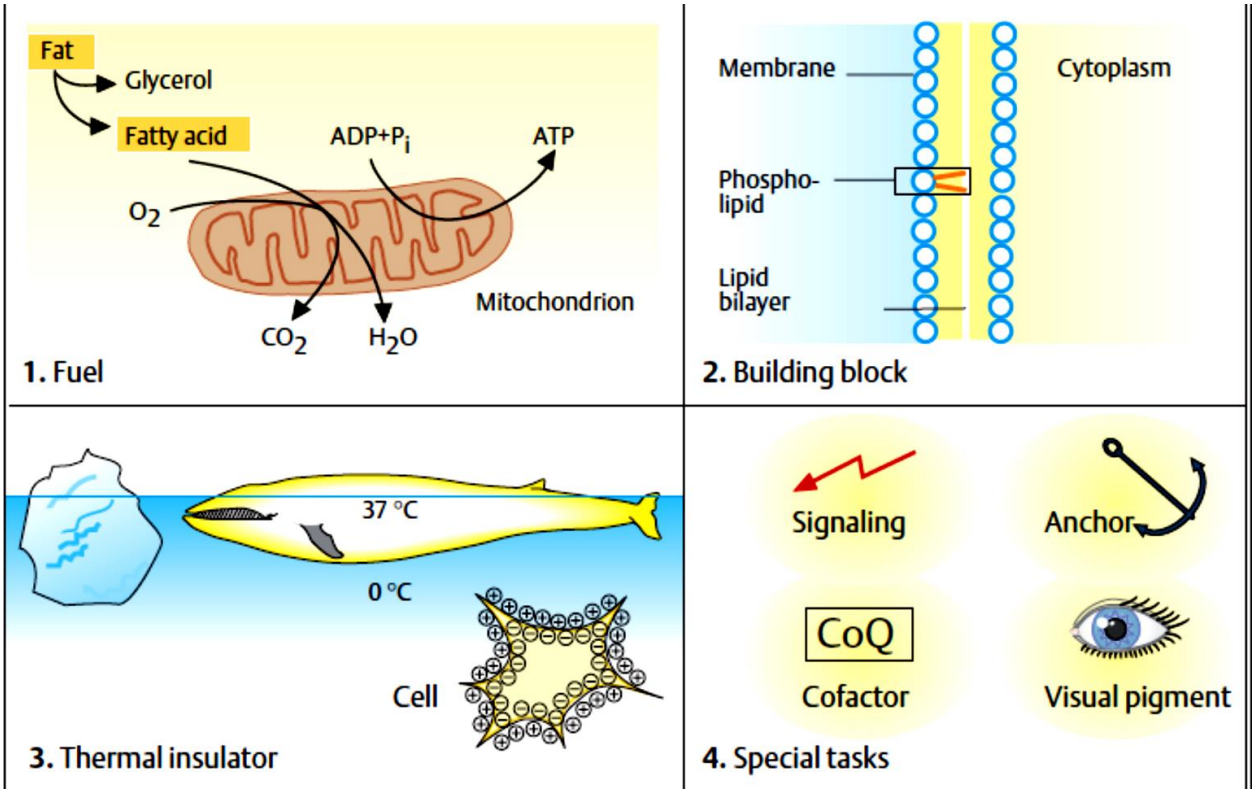

Fig. 2: Biological role.

Fatty Acids And Fats:

A. Carboxylic Acids:

Fatty acids are also found in small amounts in unesterified form. In this case, they are known as *free fatty acids* (FFAs). As free fatty acids have strongly amphipathic properties, they are usually present in protein-bound forms.

Essential fatty acids are fatty acids that have to be supplied in the diet. Without exception, these are all polyunsaturated fatty acids: the C20 fatty acid *arachidonic acid* (20:4;5,8,11,14) and the two C18 acids *linoleic acid (Omega-6)* (18:2;9,12) and *linolenic acid (Omega-3)* (18:3;9,12,15).

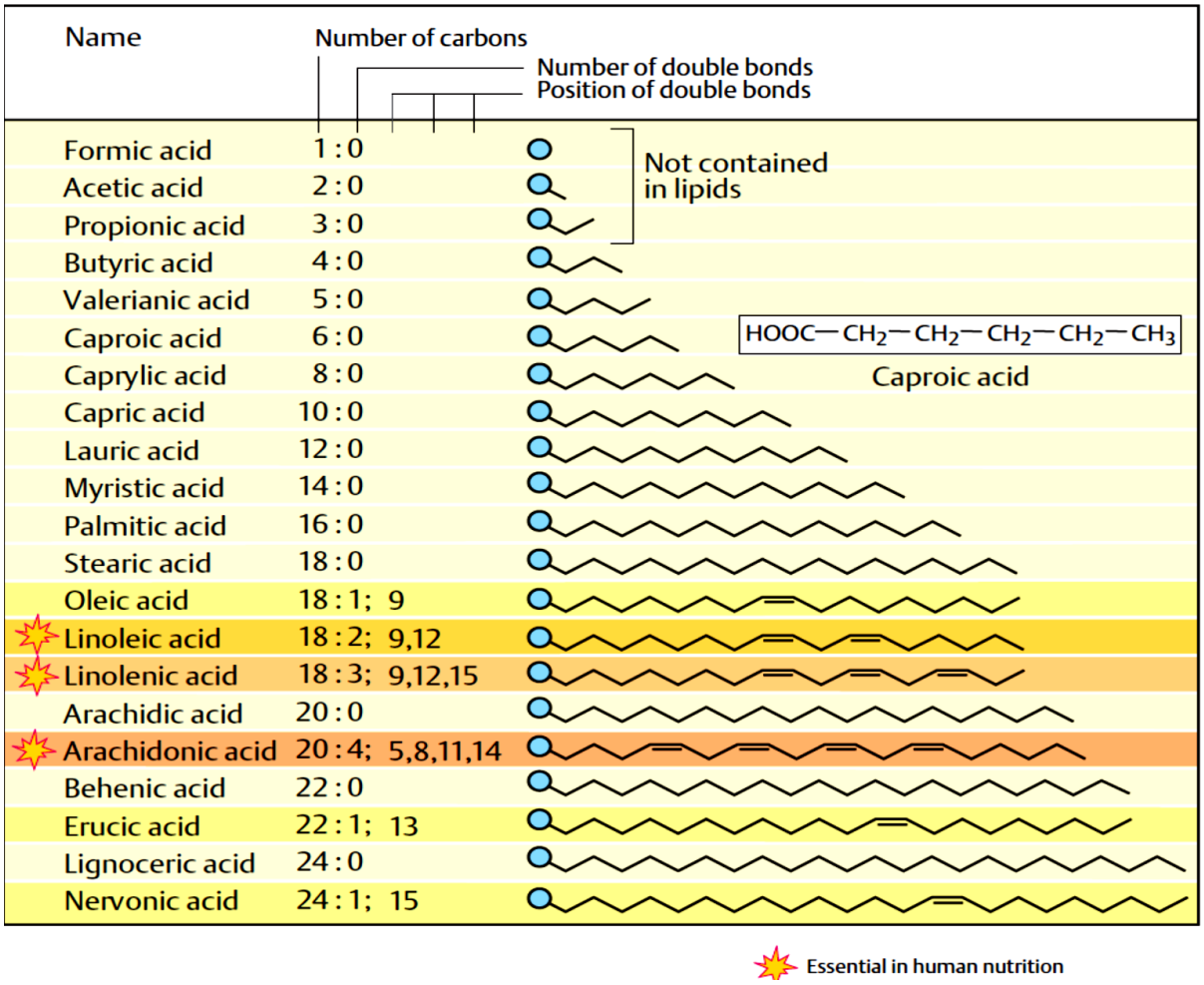

Fig. 3: Carboxylic acids.

B. Fats:

Fats are esters of the trivalent alcohol *glycerol* with three fatty acids. When a single fatty acid is esterified with glycerol, the product is referred to as a *monoacylglycerol* (fatty acid residue = acyl residue) (Fig. 4).

Formally, esterification with additional fatty acids leads to *diacylglycerol* and ultimately to *triacylglycerol*, the actual fat (formerly termed "triglyceride"). As triacylglycerols are uncharged, they are also referred to as ***neutral fats***.

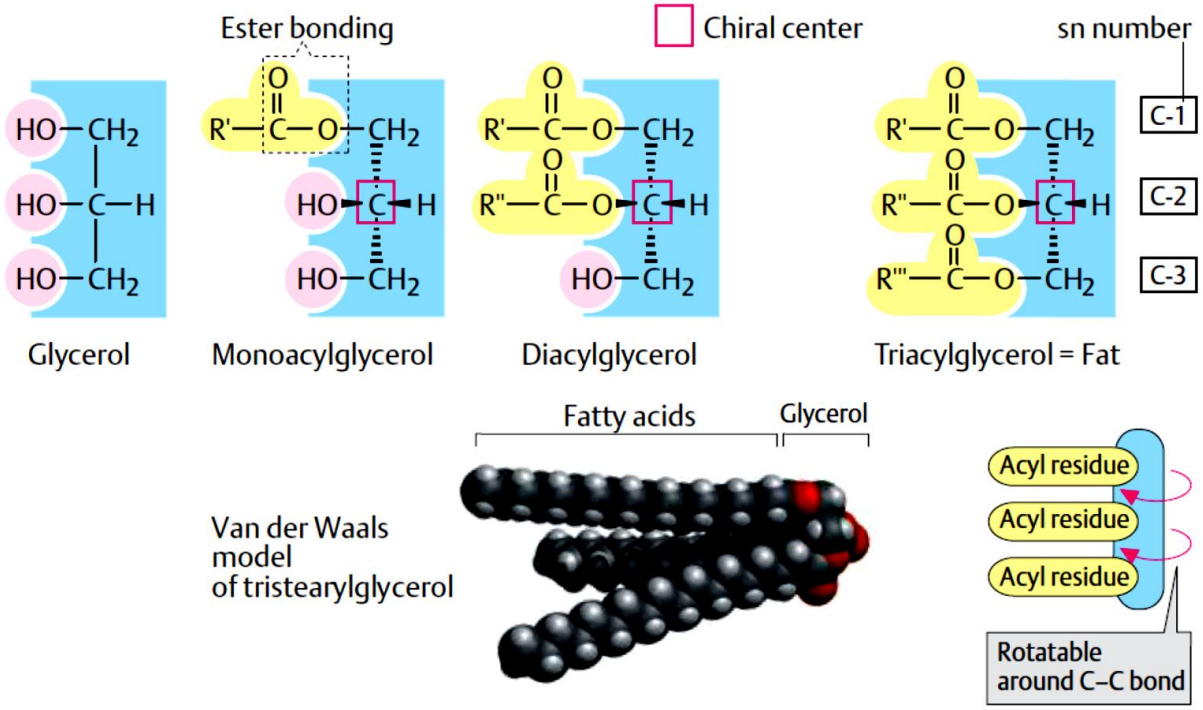

Fig. 4: structures of fats.

♦Sterol:

The three most important groups of steroids are the *sterols*, *bile acids*, and *steroid hormones*. The most important sterol in animals is **cholesterol**.

Cholesterol is present in all animal tissues, and particularly in neural tissue. It is a major constituent of cellular membranes, in which it regulates fluidity. The storage and transport forms of cholesterol are its esters with fatty acids. In lipoproteins, cholesterol and its fatty acid esters are associated with other lipids. Cholesterol is a constituent of the bile and is therefore found in many gallstones.

◊BILE ACIDS:

Bile acids are synthesized from cholesterol in the liver. **Cholic acid** and **chenodeoxycholic acid** are *primary bile acids* that are formed by the liver.