Lipids

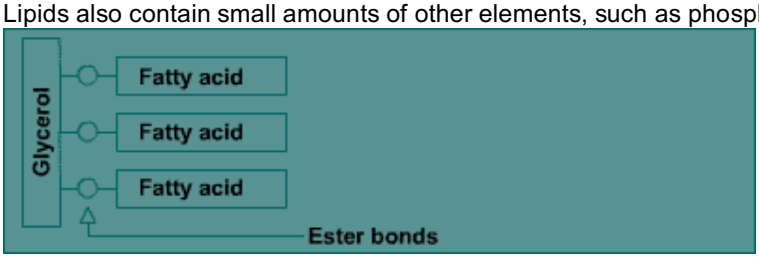
The word lipid indicates a wide range of compounds.These may conveniently be divided into two groups — the first consists of fats and oils, the second includes steroids and terpenes together with fat—soluble vitamins and some other compounds. Fats, oils and phospholipids are the most common lipids in living cells.

Lipids contain elements C, H and O with the ratio of H : O is greater than 2:1, example: $C_6H_{38}O_6$. Lipids are denser than carbohydrates (because of these extra H atoms) and therefore contain more chemical potential energy, than carbohydrates. A gram of lipid yields more kinetic energy (38 Kj) when oxidised than a gram of carbohydrate (17Kj).

Lipids are made up of two parts:

- Glycerol.
- Fatty acids.

Lipids are formed by dehydration synthesis of glycerol (alcohol) and 3 fatty acids. Lipids also contain small amounts of other elements, such as phosphorus.



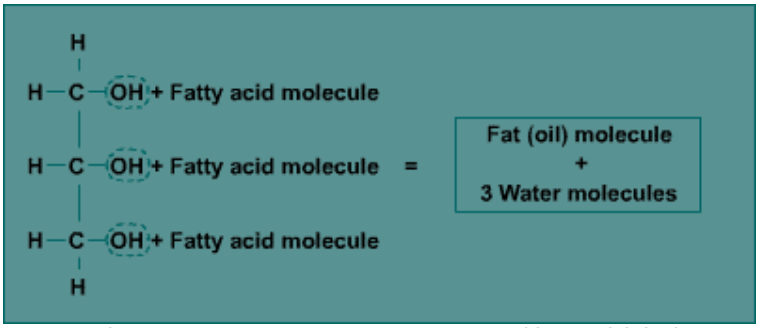
Lipids can be:

- **Fats:** Are solid at room temperature and are known as saturated fatty acids.
- **Oils:** Are liquid at room temperature T°. This is because the fatty acids in oils are smaller than those in fats, and because of the presence of one or more double bonds in some oils.

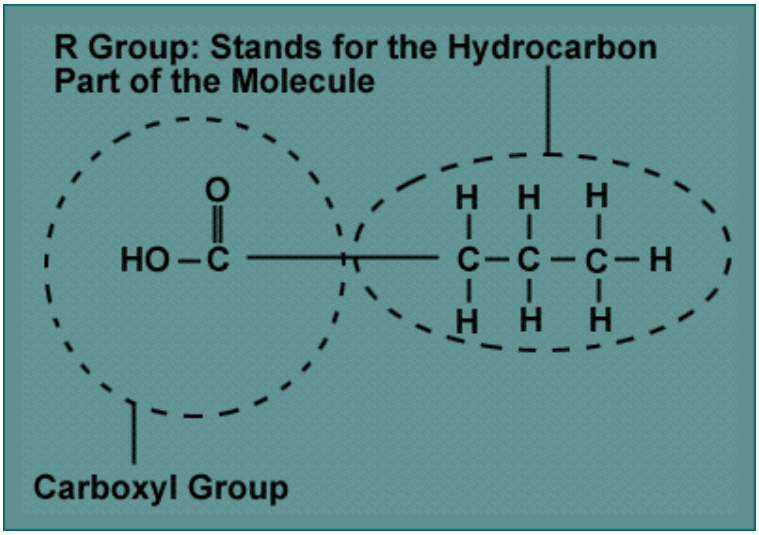
Structure of lipids

Lipids are formed by condensation reactions occurring between a molecule of glycerol (alcohol) and 3 fatty acid molecules, the fatty acids differ from each other in molecular size and the number of carbon - carbon bonds. The bonds formed are Ester bonds. The enzyme catalysing the reactions is called lipase. These molecules are called triglycerides and they have a distinctive E-shape.

Alcohol molecule (glycerol):



A typical fatty acid molecule,e.g Butanoic acid (CH_3H_7COOH).

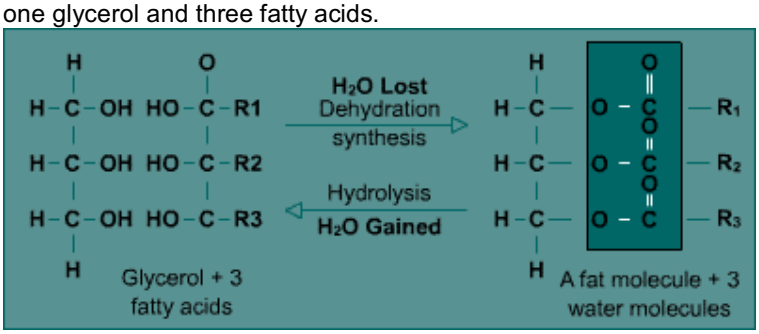


Two types of fatty acids are found:

Saturated fatty acids (in saturated fats)
Example: Stearic acid
All the available bonds of the carbon atoms are filled with hydrogen atoms. In other words, there are no carbon - to - carbon double bonds. Fats which are solid at room temperature contain saturated fatty acids. E.g butter or lard
Unsaturated fatty acids(in unsaturated fats)
Example: Oloeic acid.
The presence of double bonds - allow more hydrogen atoms to be added to it.

Formation of lipids

A triglyceride forms by the condensation of one glycerol and three fatty acids in the presence of lipase. A Hydrogen ion is removed from the glycerol molecule and an OH^- group from the fatty acid. These unite to form water. Ester bonds are formed. Note that this is a reversible reaction by hydrolysis, when a lipid is hydrolysed into one glycerol and three fatty acids.



Physical properties of lipids

- Lipids are insoluble in water, due to their long hydrocarbon chains, but in organic solvents such as ether, benzene and chloroform they will dissolve.
- They can be emulsified by alkalis e.g. soap. Fats are hydrophobic (does not mix with water) — less dense than water. (float)
- At high temperatures, they form blue smoke called acrolein (formed from glycerol in the fat molecule).

When looking for lipids, try and recognise them by:

- Looking for the glycerol at one end.
- Count the H:O - there should be far more H than O, example: $C_{20}H_{3}8O_{6}$.

Biological importance

- A reserve energy source — mass for mass they yield approximately twice as much energy on combustion as do carbohydrates. This is due to the fact that a fat has a greater proportion of H atoms to O atoms than a carbohydrate and is therefore capable of a greater degree of oxidation.
- Much energy is released during cellular respiration of fats, which may be used by desert animals and those that hibernate. Fats and oils are also used as good stores in some plant seeds.
- Form a heat — insulating layer, example: subcutaneous fat, since fat is a poor conductor of heat. In whales and seals this is known as blubber.
- Phospholipids play an important role in the structure of the plasma membranes.
- Lipids may act as a source of metabolic water. When respired they yield water and carbon dioxide. Some desert animals are so efficient in their conservation of water that they obtain their water from the foods they eat or from the metabolism of fat (camels).
- Fats form waxes which waterproofs the cuticles of plants and the integuments of animals, and cerumen in mammalian ears (ear wax) which has a protective function.
- Fats and oils are insoluble in water, and are therefore osmotically inactive. This makes them a useful storage form. In plants fat is stored in seeds, for example: peanuts.
- Protect against mechanical injury, for example: fat around internal animal organs such as the heart and kidneys.
- Fats are important for the absorption of fat-soluble vitamins A,D,E and K by mammals.
- Lipids occur in the Myelin sheath of nerves as an insulating layer around nerve fibres.