The Structure and Function of Lipids

Lipids are a diverse group of biological substances made up primarily of non-polar groups. As a result of their non-polar character, lipids typically dissolve more readily in non-polar solvents such as acetone, ether, chloroform, and benzene, than in water. This solubility characteristic is of extreme importance in cells because lipids tend to associate into non-polar groups and barriers, as in the cell membranes that form boundaries between and within cells. Besides having important roles in membranes, lipids are stored and used in cells as an energy source. Other lipids form parts of cellular regulatory mechanisms. Lipids link covalently with carbohydrates to form glycolipids and with proteins to form lipoproteins.
There are three major classes of lipids:

- Neutral lipids
- Phospholipids,
- and steroids

Neutral Lipids

Neutral lipids are commonly found in cells as storage fats and oils, are so called because at cellular pH, they bear no charged groups. Generally, they are completely non-polar, with no affinity for water. Almost all neutral lipids are a combination of fatty acids with the alcohol glycerol.
Fatty acids are long chains of carbon atoms with attached hydrogens and other groups. A carboxyl (-COOH) group at one end gives the molecule its acidic properties. Most naturally occurring fatty acids contain an even number of carbon atoms in their backbone chains. Although a few with odd numbers are found in all organisms, these make up only a minor fraction of the total.

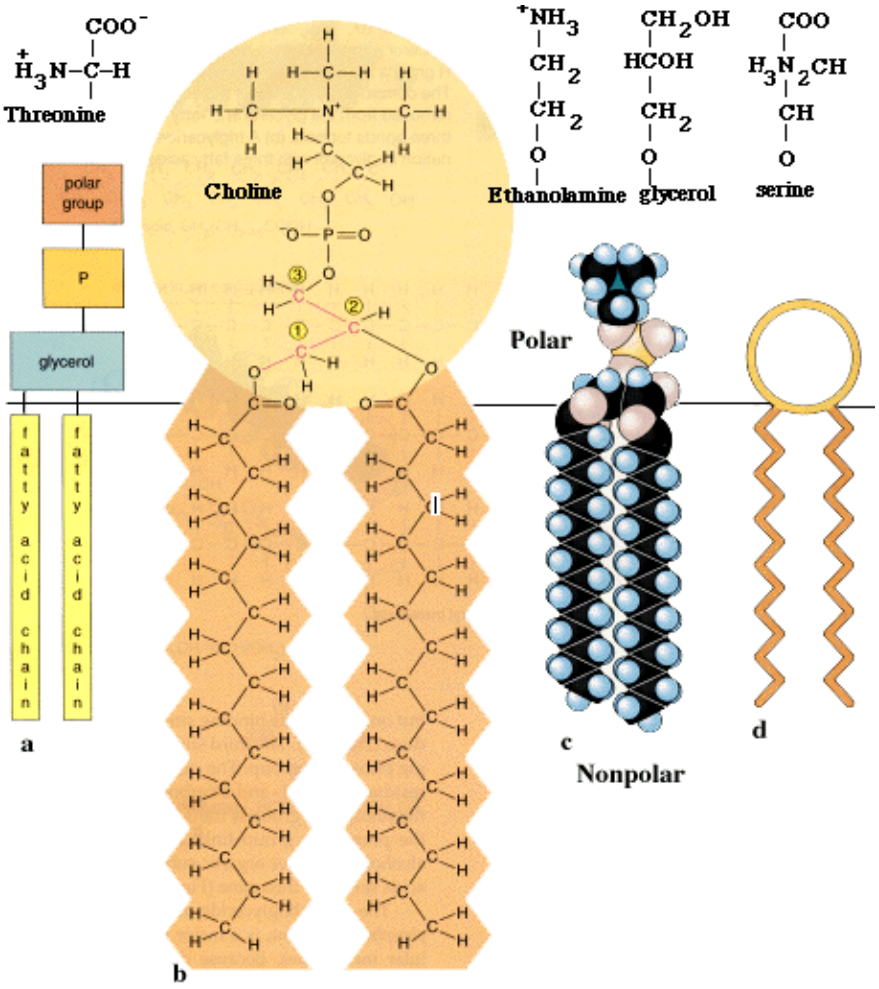
The backbone chains of fatty acids very in length from as few as 4 to 24 or more carbons. Most fatty acids found neutral lipids have even-numbered chains with 14 to 22 carbon; those with either 16 or 18 carbons occur most frequently. The polar -COOH group is enough to make the shortest fatty acid chains water soluble. As chain length increases, the fatty acid type become progressively less water soluble and take on oily or fatty characteristics.

If the carbon of a fatty acid chain binds the maximum possible number of hydrogen atoms, the fatty acid is saturated. If the number of hydrogen atoms bound by the carbons is less than the possible maximum, the fatty acid is unsaturated. At points where hydrogen atoms are missing from adjacent carbon atoms, the carbons share a double instead of a single bond. If double bonds occur at multiple sites (up to a maximum of about six), the fatty acid is polyunsaturated. Unsaturated fatty acids have lower melting points than saturated fatty acids and are more abundant in living organisms.

If three fatty acids bind to each of the three -OH sites the resulting compound is known as a triglyceride.

Phospholipids

The Primary lipids of biological membranes are Phospholipids. A group of phosphate-containing molecules with structures related to the triglycerides. In most common phospholipids, called phosphoglycerides, glycerol forms the backbone of the molecule but only two of its binding sites link to fatty acid residues. The third site links instead to a bridging phosphate group. The carbon linked to the phosphate group is called the 3-carbon; the carbons attached to fatty acid residues are the 1 and 2 carbons. The other end of the phosphate bridge links to another organic unit, most commonly a nitrogen-containing alcohol. Other organic units that may link at this position include the amino acids, serine and threonine and a sugar, inositol.



The colored blocks represent the arrangement of subunits in phospholipids (a). Structure (b) represents the formula for phosphatidy choline, a common membrane phospholipid. (c) the space-filling model of phosphatidyl choline and (d) is a diagram widely used to depict a phospholipid molecule. The circle represents the polar end of the molecule and the zigzag lines the non-polar carbon chains of the fatty acid residues.