# Lipids

**Slide 2** If something feels greasy or oily when you touch it, it is either a lipid or contains lipid components. Lipids are carbon containing compounds that are generally insoluble in water. These substances are hydrophobic or "water fearing" compounds. Because they are classified according to their property – being insoluble in water – as opposed to structure, the term 'lipid' encompasses a diverse group of molecules.

**Slide 3** There are three main types of lipids:1) **Fats** and **oils,** generally associated with energy storage. 2) **Phospholipids,** the main component of cell membranes found in all organisms. They also form organelle membranes in eukaryotic cells. Most membranes have two lipid layers (review cell membrane) and 3) **Other lipids** such as steroids and some pigments. For example, cholesterol is a sterol and a component of animal membranes. It is also a precursor molecule for some of the sex hormones and vitamins found in vertebrates.

**Slide 4** Many lipid molecules consist of two parts: 1) A polar group which is the hydrophilic or "water loving" component. The phosphate molecule of a phospholipid is frequently bonded to a small polar molecule such as choline, enhancing the hydrophilic properties of the molecule. Other lipids, such as cholesterol, often contain a hydroxyl group as the polar component of the molecule. 2) The second part is the non-polar group which is the hydrophobic or "water fearing" component. The non-polar group is composed mostly of fatty acid chains. These are molecules with a carboxyl group at one end which is attached to a hydrocarbon tail that varies in the number of carbon molecules and the number of double bonds that are present.

**Slide 5** Fatty acid chains are important constituents of lipids. Synthesis of fatty acid chains begins with a condensation reaction between acetyl-CoA and malonyl ACP. Two carbon units derived from acetyl-CoA, are then added in a stepwise fashion until the chain reaches a predetermined length, usually somewhere between 12 to 20 carbons long. In eukaryotes fatty acids are synthesized in endoplasmic reticulum and plant plastids. In prokaryotes lipids are synthesized on the inner surface of the existing cell membrane.

**Slide 6** Fatty acid molecules are joined to a second molecule, usually a glycerol molecule, through the process of dehydration synthesis (or condensation reaction) forming an ester linkage.

**Slide 7** When three fatty acids are joined to a glycerol molecule, a triacylglycerol (or triglyceride) is produced. Triacylglycerols are fat or oil molecules, the main type of stored lipid. Note that there are no hydrophilic regions associated with this molecule.

**Slide 8** Animal fats are solid at room temperature because they contain saturated fatty acids – there are no double bonds between the carbon atoms present in the fatty acid chain. This configuration allows the molecules to be closely packed together forming a solid at room temperature.

**Slide 9** On the other hand, plant and fish fatty acids are liquid at room temperature. The fatty acid chains associated with the triacylglycerol, contain one or more double-bonded carbon atoms that produce 'kinks' in the fatty acid chain. These kinks allow for loosely packed molecules that remain liquid at room temperature. Unsaturated fats contain one or more double-bonded carbon atoms in the fatty acid chain: a monounsaturated fat has one double bond between two carbon atoms, a polyunsaturated fat has more than one double bond in the fatty acid chain.

**Slide 10** Phospholipids, the main component of membranes found in all organisms, are another important type of lipid. Phospholipid molecules are produced when two fatty acid chains (compared to three fatty acid chain in the stored lipids) join to a glycerol molecule with a phosphate group. The hydrophilic component contains a glycerol, phosphate and small polar molecule such as choline; the hydrophobic component is comprised of the fatty acid chains. Phospholipids spontaneously form a bilayer with the fatty acid chains sandwiched between two hydrophilic layers. Addition of proteins to the bilayer allows the membrane to be selectively permeable and maintain the internal environment in the cell.

**Slide 11** Finally, let's consider some other lipids such as sterols, pigments and waxes. The basic structure of sterol molecules is four fused rings with a hydroxyl group attached at the carbon-3 position. Addition of other functional groups produces different molecules that are components of the membrane or may act as signaling molecules within an organism. For example, cholesterol is important in stabilizing the membrane. It can also be remodeled into different molecules such as vitamin D, sex hormones and bile salts, through subtle changes to the functional groups of the molecule.

**Slide 12** Chlorophyll pigments that produce the green color of plants and carotenoids that produce the yellow/orange color of egg yolks and pumpkin are also lipids. Vitamin A is produced by splitting molecules of the carotenoid pigment beta-carotene.

**Slide 13** Some other lipids such as cutin, waxes and suberin are molecules that are made of long-chain fatty acids and acyl lipids. In combination they form a protective barrier between the surface of an organism and the environment. Examples of these protective barriers are evident as water is repelled from the surface of plants, hair, feathers and beeswax.