3.4 Biological Molecules – Lipids

Learning objectives

By the end of this section, you will be able to:

- *Be able to name different types of lipids*
- *Explain what characteristic all lipids have in common*
- *Explain how lipids function differently*
- *Be able to define and explain all bolded terms*

Lipids

Lipids include a diverse group of compounds. All lipids share one major characteristic: they are all hydrophobic (or at least have a hydrophobic region, as in phospholipids). Lipids are mostly hydrocarbons, meaning they have large proportions of nonpolar carbon-carbon or carbon-hydrogen bonds. As a result, they do not interact well with water. Because lipids are very structurally diverse and are not made from a single subunit, the terms monomer and polymer may not be applied when discussing lipids. Lipids are also smaller in molecular size when compared to polymers of carbohydrates, proteins, and nucleic acids and therefore some sources do not consider them large macromolecules.

Lipids perform many different functions. For example, they can be used for long-term energy storage, provide insulation from the environment, and act as a water-proofing material (Figure 3.17). Lipids are used as the building blocks for many hormones that help organisms regulate different physiological processes within the body. They are also an essential component of the plasma membrane. Lipids include fats, phospholipids, steroids, and waxes.

Figure 3.17 Hydrophobic lipids in the fur of aquatic mammals, such as this river otter, protect them from the elements. (credit: Ken Bosma / Concepts of Biology OpenStax)

Fats

Many cells store energy for long-term use in the form of **fats. Triglycerides**, an example of a fat molecule, is a naturally occurring fat that can be found in many of the foods we consume. Humans and other animals store most fat in our bodies as triglycerides (Figure 3.18). A glycerol molecule is an organic compound with three carbon atoms, five hydrogen atoms, and three hydroxyl (–OH) groups. Each fatty acid consists of a long chain of hydrocarbons with an attached acidic carboxyl group, hence the name “fatty acid."

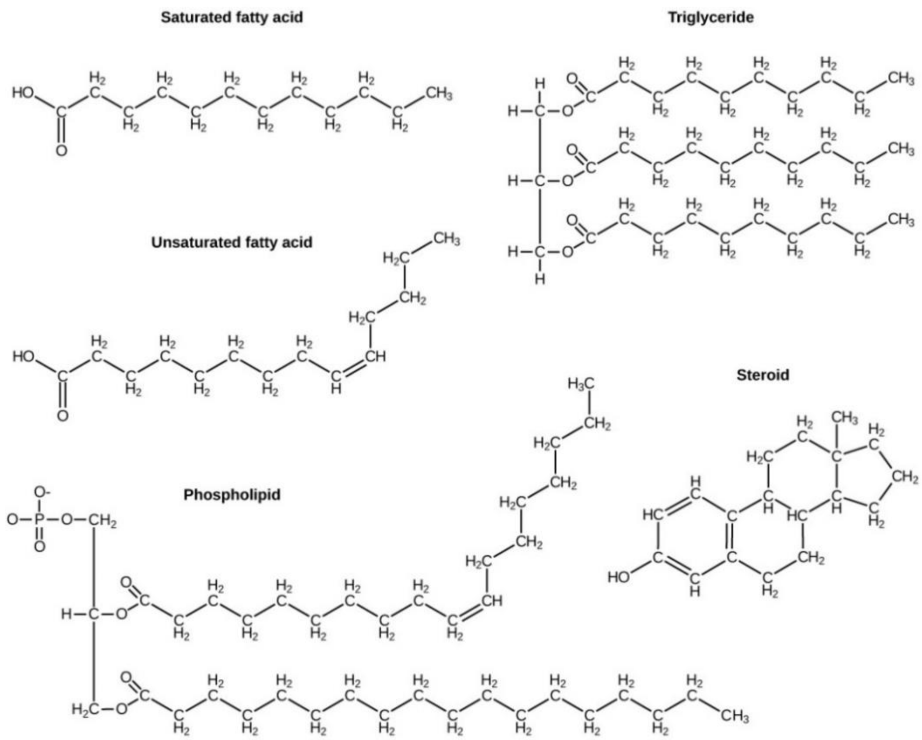


Figure 3.18 Lipids include fats, such as triglycerides, which are made up of fatty acids and glycerol; other examples of lipids are phospholipids and steroids. (credit: Fowler et al. / Concepts of Biology OpenStax)

Fatty acids may be saturated or unsaturated (Figure 3.18 and 3.19). If there are only single bonds between neighboring carbon atoms, the fatty acid is "saturated." **Saturated fatty acids** are saturated with hydrogen. In other words, the number of hydrogen atoms attached to the carbon skeleton is maximized.

When the hydrocarbon chain contains a double bond, it is called an **unsaturated fatty acid** (Figure 3.18 and 3.19). They are called unsaturated fatty acids because when carbon atoms form double bonds between them, the two carbon atoms in that bond each has one less hydrogen atom attached to it. Therefore, it is said to be "unsaturated."

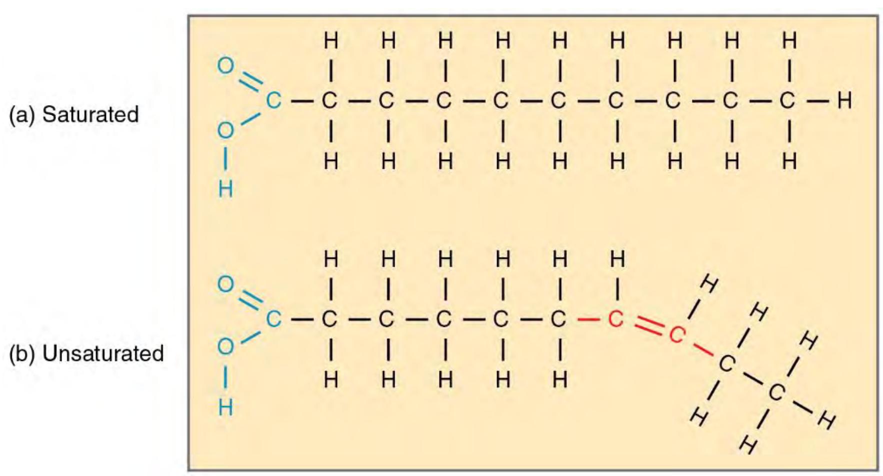
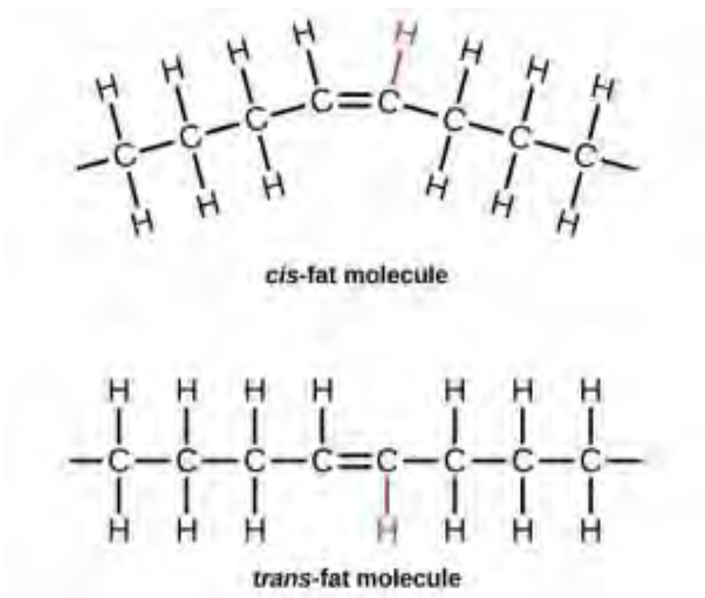


Figure 3.19 Fatty acids: Saturated vs. Unsaturated (credit: Betts et al./ Anatomy and Physiology OpenStax)

Most unsaturated fats are liquid at room temperature and are called **oils**. Examples of unsaturated fats include olive oil and canola oil. Saturated fats tend to get packed tightly together and are solid at room temperature. Examples of saturated fats include palmitic acid, which can be found in meat, and butyric acid, which is found in butter. Unsaturated fats help to improve blood cholesterol levels, whereas saturated fats contribute to plaque formation in blood vessels, which increases the risk of a heart attack.

Mammals store fats in specialized cells called adipocytes, where globules of fat occupy most of the space in the cell. In plants, fats or oils are stored in seeds and used as sources of energy during embryonic development.



In the food industry, oils can be artificially hydrogenated to make them semi-solid. Hydrogenation leads to less spoilage and increases its shelf life. During the hydrogenation process the orientation around the double bonds is changed, which changes the chemical properties of the molecule. This forms a ***trans*-fat** (Figure 3.20).

Figure 3.20 A trans-fat is made from changing the chemical properties of a cis-fat. (credit: Fowler et al. / Concepts of Biology OpenStax)

Some types of margarine, peanut butter, and shortening are examples of artificially hydrogenated *trans*-fats. Recent studies have shown that an increase in *trans*-fats in the human diet may lead to increased levels of low-density lipoprotein (LDL), or “bad” cholesterol. High levels of LDL can lead to plaque formation in the blood vessels, resulting in heart disease. Many fast-food restaurants have recently eliminated the use of *trans*-fats. In the U.S., food labels are now required to list their *trans*-fat content.

Fats are often perceived as being bad. It is true that eating an excess of fried foods, and other “fatty” foods lead to weight gain. However, fats do have essential functions. Omega-3 fatty acids are essential in brain function and healthy growth and development. They also may prevent heart disease and reduce the risk of cancer. Fats also serve as long-term energy storage and provide insulation for the body. “Healthy” unsaturated fats in moderate amounts should be consumed regularly.