Lipids

Over the years, lipids, or fats, have gained a bad reputation for being contributory to cardiovascular disease, stroke and obesity, with overwhelming detriment to health and well-being. While these facts are true, it is only when excess calories are ingested combined with a sedentary lifestyle (assuming no genetic determinants of diseases involving excessive blood lipids) that lipids become problematic. The fact is that numerous lipid molecules are essential for cell structure and function, and thus, for life. To this extent, lipids are essential nutrients for the body, and a balanced diet and active lifestyle combine to cause minimal concern for abnormal blood and cellular lipid profiles within the body. In short, the body needs lipids, or fats for survival, so having a proportion of the body that is fat is absolutely fine, and in fact needed, for health and well-being.

There are many types of **lipids** within the body, with this classification of molecules being defined by their **hydrophobic** (water repelling) property and solubility in organic solvents. Lipids are essential for the structure and function of all **membranes**, as well as function as energy dense fuel stores, and as both intra- and extra-cellular messenger/signal molecules. Lipids can also have additional specialized functions. For example, an important lipid (phospholipoprotein) molecule for the lung is surfactant which decreases surface tension surrounding alveoli. Another lipid, cholesterol, is essential for cell membrane structure and function (Figure 1).

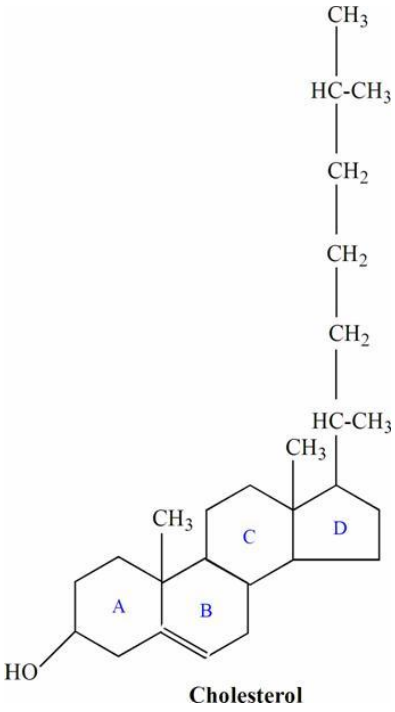

Figure 1. The chemical structure and formula of cholesterol.

Most lipids contain one or more **fatty acid** chains, which is a long hydrocarbon chain with a terminal carboxylic acid group. The main fatty acid in the body is **palmitate**, which contains a 16 carbon chain (Figure 2). The main lipid energy storage molecule within muscle is the **triacylglycerol** (Figure 3). Skeletal muscle fibers contain **lipid droplets** comprised almost entirely of triacylglycerols. Stores of triacylglycerols are also located between muscles and muscle fibers, surrounding some vital organs, and of course as subcutaneous fat (Figure 4). Figure 5 is a **magnet resonance image (MRI)** of the lower leg. An MRI is a hydrogen density image where the higher the hydrogen density of a tissue, the brighter the image. Thus, white regions of an MRI are high in hydrogen density (water, fat, bone marrow), gray regions have moderate hydrogen density (e.g. muscle), and black regions have very low hydrogen density (e.g. bone).

Lipids

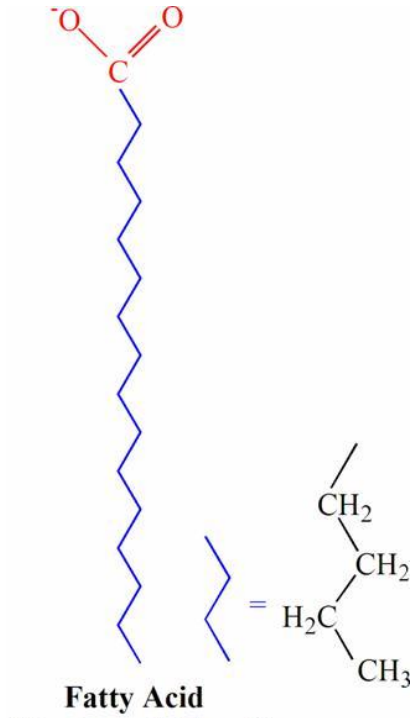

Figure 2. The fundamental chemical structure of fatty acids, using palmitate as the example.

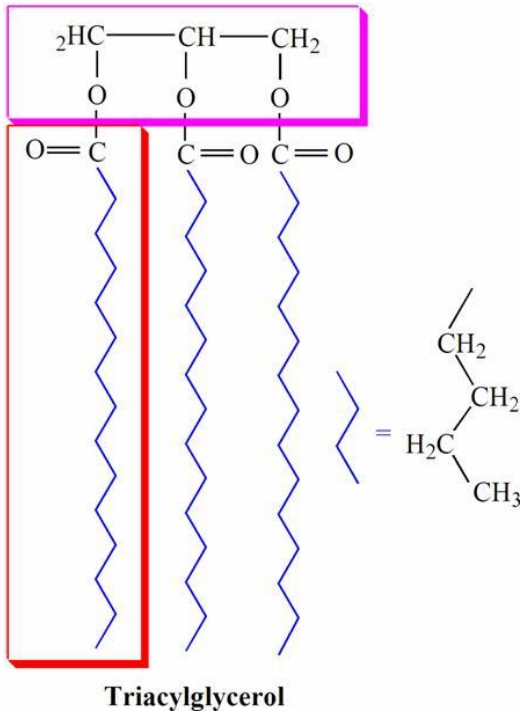

Figure 3. The fundamental chemical structure of triacylglycerols or triglycerides, consisting of 3 fatty acid chains (red color box) connected to a backbone structure of glycerol (magenta color box)

Figure 4. An electron micrograph of the lipid droplets that comprise almost the entire volume of an adipocyte. In skeletal muscle, lipid droplets are much smaller and are located between myofibrils and therefore also near many mitochondria.

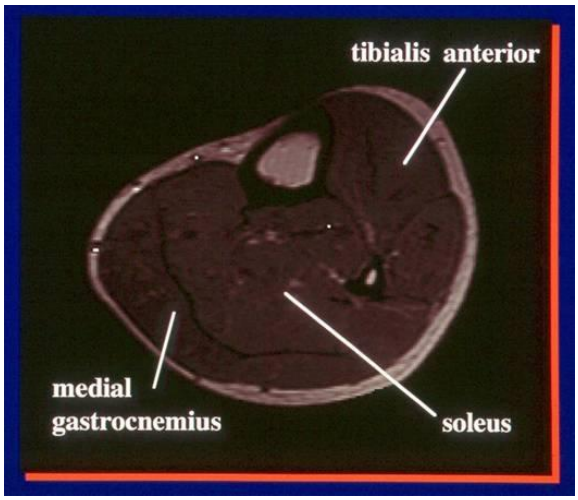

Figure 5. An MRI of the calf. The bright white components of an MRI represent tissue that contain dense concentrations of protons, such as water (blood) and fat.

Lipids

Glossary Words

lipids are molecules that are insoluble in water, but soluble in organic solvents, and having a high hydrogen atomic content.

hydrophobic means water “fearing”.

membranes are organized structures that surround cells and intracellular organelles.

fatty acid is a type of lipid characterized by a long hydrocarbon chain with a terminal carboxylic acid group.

palmitate is a 16-carbon fatty acid.

triacylglycerol is a lipid molecule that consists of three fatty acid molecules connected to a glycerol “backbone” via three ester bonds.

lipid droplets consist of triacylglycerol molecules within cells that are packaged into spherical shapes.

magnet resonance image (MRI) is the resulting image from use of magnetic resonance technology used to study tissue structure.