

Chapter 5

The Lipids:

Triglycerides
Phospholipids
Sterols

Lipids

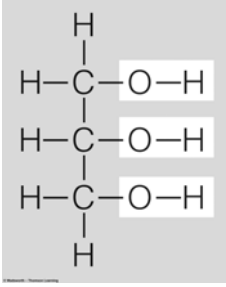
A class of nutrients that includes:

Triglycerides
- A combination of one molecule of *glycerol* and three molecules of *fatty acids*

Phospholipids

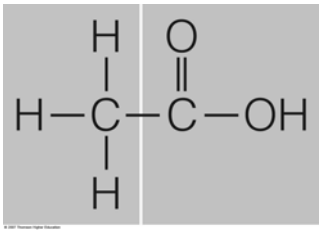
Sterols

Glycerol



Acetic Acid

Methyl end



Acid end

Fig. 5-1, p. 140

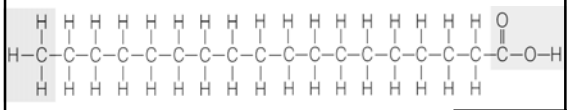
Characteristics of Fatty Acids

Length of the carbon chain:

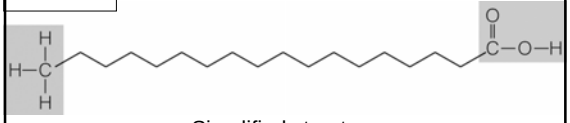
- Long-chain fatty acids are found primarily in meat, fish, and vegetable oils
- Short-chain fatty acids are found primarily in dairy products

Fatty Acids

Length of carbon chain:



Stearic acid – 18-carbon, saturated

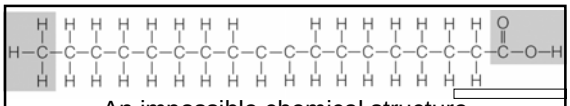


Simplified structure

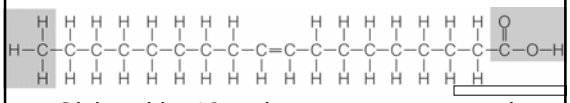
Characteristics of Fatty Acids (2)

Degree of unsaturation:

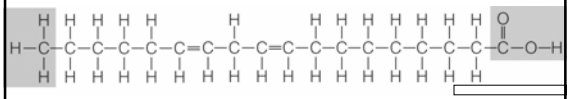
- Saturated fatty acids carry the maximum number of hydrogen atoms
- Unsaturated fatty acids have varying numbers of hydrogen atoms missing, resulting in double bonds



An impossible chemical structure



Oleic acid – 18-carbon, monounsaturated



Linoleic acid – 18-carbon, polyunsaturated

Characteristics of Fatty Acids (3)

Location of double bonds:

- Omega number:
  - Omega-3 fatty acid
  - Omega-6 fatty acid

Essential Fatty Acids

Linolenic acid, an omega-3 fatty acid



Linoleic acid, an omega-6 fatty acid

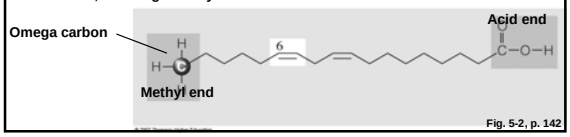
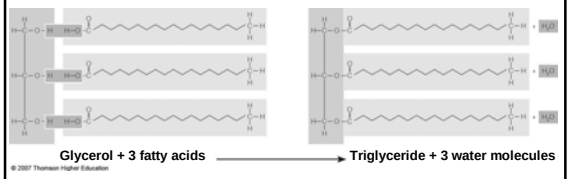


Fig. 5-2, p. 142

Condensation of Glycerol & Fatty Acids to Form a Triglyceride

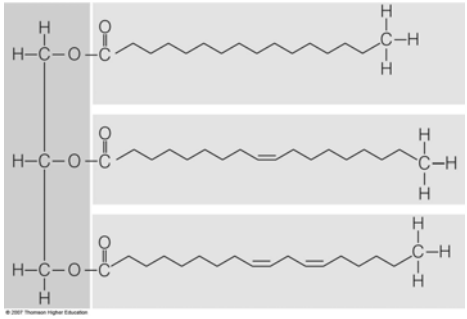


Glycerol + 3 fatty acids → **Triglyceride + 3 water molecules**

An H atom from glycerol and an OH group from a fatty acid combine to create water, leaving the O on the glycerol and the C at the acid end of each fatty acid to form a bond.

Three fatty acids attached to a glycerol form a triglyceride and yield water. In this example, all three fatty acids are stearic acid, but most often triglycerides contain mixtures of fatty acids (as shown in Figure 5-5).

Fig. 5-4, p. 143



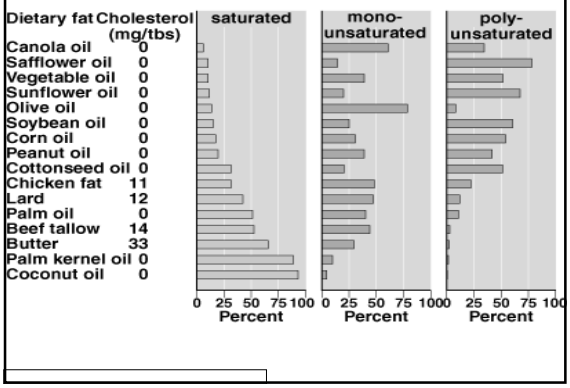
This mixed triglyceride includes a saturated fatty acid, a monounsaturated fatty acid, and a polyunsaturated fatty acid, respectively.

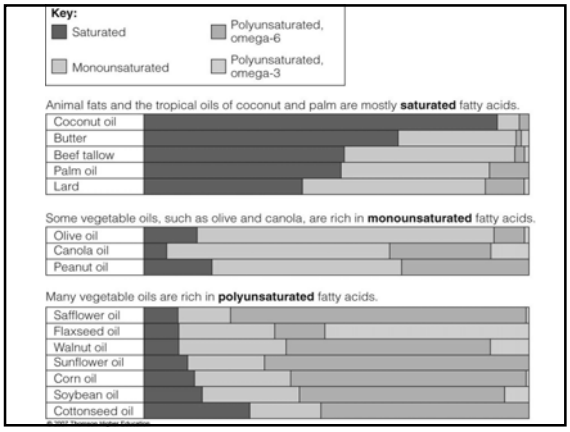
Fig. 5-5, p. 143

Triglycerides

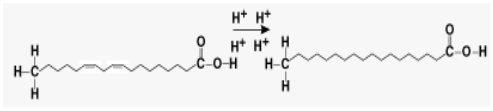
- How does the degree of *unsaturation* of a fat affect the properties of that fat?
  - Saturated ones are usually solids at room temperature.
  - Unsaturated ones usually are liquid at room temperature.

A Look at the Composition of Various Fats





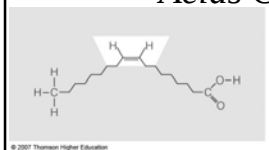
The Process of Hydrogenation



Polyunsaturated fatty acid

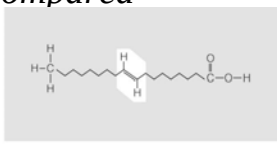
Hydrogenated (saturated) fatty acid

Cis- and Trans-Fatty Acids Compared



***cis*-fatty acid**

A *cis*-fatty acid has its hydrogens on the same side of the double bond; *cis* molecules fold back into a U-like formation. Most naturally occuring unsaturated fatty acids in foods are *cis*.



***trans*-fatty acid**

A *trans*-fatty acid has its hydrogens on the opposite sides of the double bond; *trans* molecules are more linear. The *trans* form typically occurs in partially hydrogenated foods when hydrogen atoms shift around some double bonds and change the configuration from *cis* to *trans*.

Fig. 5-8, p. 145