Chapter 4: Fats or Lipids: From Plate to Waist

The basic units of lipid substructure include (1) fatty acids and (2) glycerol.

The lipid family is a diverse group of molecules. Many lipids, such as the fats, are hydrophobic so they must be broken into small hydrophilic units for digestion.

Lipid Classification

Lipids (especially the triglycerides) may be classified based upon their length, their shape and their degree of saturation. They are classified as being in one of these categories of chemical reactivity:

<table>
<thead>
<tr>
<th>Saturated</th>
<th>Unsaturated</th>
<th>Polyunsaturated</th>
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The classification of lipids also places the various members of the family into these structural groupings:

<table>
<thead>
<tr>
<th>Fatty Acids</th>
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<tbody>
<tr>
<td>Chains of carbons that are 4 to 22 carbons in length. The 18-carbon lengths are most common in foods.</td>
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<tr>
<td>Fatty acids molecules have two ends (1) the acid (COOH-) end and (2) the methyl (CH₃-) end. The 18-carbon lengths include stearic acid, oleic acid, linoleic acid and linolenic acid.</td>
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<tr>
<td>Two of these 18-carbon lengths are essential: linoleic and linolenic acid.</td>
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<table>
<thead>
<tr>
<th>Linoleic</th>
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<tbody>
<tr>
<td>Alpha-Linolenic</td>
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Fatty acids exist as either cis- or trans- forms.

| Cis- |
| Trans- |

Eicosanoids

These are fatty acid derivatives. They include the prostaglandins, thromboxanes and leukotrienes. They are hormone-like substances that affect smooth muscles.

They regulate blood pressure, blood clotting, cramps, some forms of headaches and many other smooth muscle-related functions.
**Triglycerides**

Fats. Consist of glycerol and three fatty acids. Triglycerides carry all four fat-soluble vitamins (A, D, E and K) with them into the body structure.

**Phospholipids**

*Lecithins* are the best-known phospholipids. They are composed of glycerol and two fatty acids and a molecule of *choline* combined with *phosphate* instead of a third fatty acid.

Since phospholipids have choline/phosphate combo instead of a third fatty acid they can act as *emulsifiers* in foods. They are also an important part of the cell membrane structure.

The *liver* produces all necessary lecithin. A dietary supplement is not necessary. Hey, it’s your money!

**Steroids (Sterols)**

These lipids are not long-chain molecules but rather ring structures. Organ meats are the richest source of cholesterol.

All the members of this lipid group are variations of the structure of *cholesterol*, which is an important molecule in cell membrane structure.

Variations of cholesterol include *sex hormones*, *cortisone* and *vitamin D*.

Even on a totally cholesterol free diet, your liver will manufacture cholesterol because it is a vital molecule.

**Hydrogenation of Lipids**

The process of *hydrogenation* protects foods against *oxidation*, which prolongs shelf life and changes the texture of the food. Partial hydrogenation makes oils into spreadable solids (margarine).

Disadvantages of hydrogenation include:

1. hydrogenation increases the degree of saturation of the substance and
2. the remaining unsaturated molecules change from cis- to trans- forms.

Trans- forms are less healthy and may contribute to heart disease.

**Lipid Digestion**

Infants produce quantities of active *lipases* in their mouth. Adults do not produce significant amounts of lipases in their salivary glands.

There is only a limited amount lipase activity in the salivary glands that are specifically located at the base of the adult’s tongue. Lipids are digested almost entirely in the small intestine of adults. Hard fats, however, do reach body temperature in their mouths.

The hormone *CCK* signals the gall bladder to release *bile* when fatty materials enter the small intestine. The *pancreas* releases lipases that complete the digestive process.

Bile can be absorbed into the bloodstream after digesting fats or it can pass into the large intestine and be processed with the *feces*. 
Soluble pectins and gums from eating fruits, oats and legumes are most effective in lowering blood cholesterol by binding bile and fat complexes in the intestine.

**Process of Lipid Absorption**

| Small molecules such as glycerol and individual fatty acids can pass separately into the blood stream. |
| Larger molecular units such as long-chain fatty acids merge to form spherical micelles that pass directly by diffusion into intestinal cells. |
| Micelles within cells merge to form lipoproteins known as chylomicrons (lipid packages with protein escorts) that enter the lymphatic system. |
| Chylomicrons transport diet-derived lipids into the blood at the heart via the thoracic duct of the lymphatic system. |

Other lipids used by the body are formed indirectly into lipids by cells in the body, such as certain liver cells. Lipoproteins that assist in this function include:

| VLDL |
| LDL |
| HDL |

**NOTE:** To improve the ratio of LDL to HDL, try this:

- Weight control and an increase in physical activity.
- Replacing your intake of saturated fats with mono- or polyunsaturated ones.
- Increasing the amount of soluble fiber in your diet.
- Watching your intake of antioxidants.
- Reducing/eliminating your rate of alcohol consumption.

**Fat Alternatives**

The first classes of fat-replacements were protein based (*Simplesse*, FDA approval given in 1990). The newer generation of such products is usually carbohydrate-based (*Oatrim* and *Z-trim*).

The use of synthetic fat replacements such as *Olestra* has been increasing since January 1996 when the FDA approved its use as an additive in snack foods.

It is currently considered safe (on the **GRAS** list), but the potential for health concerns still exist and are under investigation.

**Lipid-Related Disorders**

| Cancer |
Cardiovascular Disease (CVD)

Hypertension

Obesity

Discussion Topics/Questions:

*Something fishy-omega-3 fatty acids* - p. 89
*Healthwise-which is better: butter or margarine?* - p. 92
*What are fat blockers and do they work?* - p. 101
*Who’s more susceptible to heart disease, men or women?* - p. 109
*Why is the Mediterranean diet so widely recommended?* - p. 111