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Lipids or Fats

Fats are greasy substances that are not soluble in water. They are soluble in some solvents such as ether, benzene, and chloroform. They provide a more concentrated source of energy than carbohydrates; each gram of fat contains 9 Kcalories. This is slightly more than twice the calorie content of carbohydrates. Fat-rich foods are generally more expensive than carbohydrate-rich foods. Like carbohydrates, fats are composed of carbon, hydrogen, and oxygen but with a substantially lower proportion of oxygen. The word lipid is derived from lipos, a Greek word for fat. Lipids have something in common with carbohydrates: the same chemical elements that make up carbohydrates-carbon, hydrogen, and oxygen also make up fatty acids. **However, carbohydrates and lipids have two important structural differences:**

1. Lipids are more complex, with more carbon (C) and hydrogen (H) atoms and fewer oxygen (O) atoms.
2. The common structural units of lipids are fatty acids, whereas the common structural units of carbohydrates are simple sugars.

Food Sources

Fats are present in both animal and plant foods. The animal foods that provide the richest sources of fats are meats, especially fatty meats such as bacon, fatty fish such as tuna and salmon; whole, low-fat, and reduced-fat milk; cream; butter; cheeses made with cream; egg yolks.

The plant foods containing the richest sources of fats are cooking oils made from olives sunflower, safflower, or sesame seeds or from corn, peanuts, or soybeans, margarine, nuts, avocados, coconut, and cocoa butter.

Classification

1- Simple lipids which include:

- Oils: unsaturated fatty acid, liquid at room temperature.

- Fats: saturated fatty acid, solid at room temperature.

2- Compound lipids which include:

- Phospholipids: compounds of fatty acids, phosphoric acid and nitrogenous base (lecithins, cephalins, sphingomyelins).

- Glycolipids: compounds of fatty acids combined with carbohydrates and nitrogenous base (cerebrosides, gangliosides).

- Lipoproteins: lipids in combination with protein (apolipoprotein).

3- Derived lipids: which include:

- Fatty acids-Triglycerides-Glycerol-Sterols (cholesterol and ergosterol) – **Fat soluble vitamins (A, D, E, K).**

Fatty acids: are organic compounds of carbon atoms to which hydrogen atoms are attached. They are classified in two methods:

1- About its necessary for the body essential or nonessential.

a- Essential fatty acids (EFAs) are necessary fats that humans cannot synthesize so EFAs must be obtained through food. EFAs are long-chain polyunsaturated fatty acids derived from linoleic, linolenic, and oleic acids. There are two families of EFAs: omega-3 and omega-6.

b- Nonessential fatty acids (NEFAs) are the omega-9 fatty acids because the body can manufacture a modest amount.

2- The other method of classification of fatty acids is by their degree of saturation with hydrogen atoms.

a- Saturated fatty acids: are usually found in animal foods, the most saturated food fats are two oils from plants coconut oil, which is 88% saturated, and palm kernel oil, which is 80% saturated. All other saturated fats are of animal origin as found in meat; butter; whole, reduced-fat, and low-fat milk; and other dairy products.

b- Monounsaturated fatty acids: Food lipids that have a high proportion of fatty acids with a pair of hydrogen atoms missing, creating one double bond. These lipids are generally from plant sources. Canola oil (isolated from rapeseed) and olive oil are primarily monounsaturated fats.

c- Polyunsaturated fatty acids: When fatty acids have four or more spaces unfilled with hydrogen atoms, creating two or more double bonds, they are polyunsaturated fats. Many of these fats are from plant sources and include commonly used cooking oils such as corn oil and safflower oil.

Hydrogenation: Process producing a more saturated (or solid) fat. This process turns polyunsaturated vegetable oils into saturated fats margarine is made in this way.When polyunsaturated vegetable oils are exposed to hydrogen gas, hydrogen atoms are added at many of the double bonds forming a solid fat.

Glycerides: the chemical group name for fats; fats are formed from a glycerol base with one, two, or three fatty acids attached to make monoglycerides, diglycerides, and triglycerides, respectively; glycerides are the principal constituents of adipose tissue, and they are found in animal and vegetable fats and oils.

Cholesterol: is a sterol. It is a true fat substance that exists in animal foods and body cells. It does not exist in plant foods. Cholesterol is essential for the synthesis of bile, sex hormones, cortisone, and vitamin D and is needed by every cell in the body. The body manufactures 800 to 1,000 mg of cholesterol a day in the liver. Cholesterol is a common constituent (part) of one's daily diet because it is found so abundantly in egg yolk, fatty meats, shellfish, butter, cream, cheese, whole milk, and organ meats (liver, kidneys, brains, sweetbreads). Cholesterol is thought to be a contributing factor in heart disease because high serum cholesterol, also called **hypercholesterolemia (**unusually high levels of cholesterol in blood).

Functions

Dietary lipids not only support nutrition and health but also add to the joy of eating. Following are descriptions of these important functions in the body:

1. Provide energy, lipids are a concentrated source of fuel to store and use as needed. Food lipids yield 9 kcal/g when oxidized by the body as compared with carbohydrates and protein, which yield only 4 kcal/g.

2. Supply essential fatty acids, the essential fatty acids linoleic acid and α-linolenic acid must be obtained in food because they cannot be made by the body or made in the amounts needed.

3. Support absorption of the fat-soluble vitamins, lipid must be present in the food mix in the small intestine to provide a vehicle for absorption of the fat-soluble vitamins (A, E, D, K).

4. Add to food palatability, lipids add flavor and a pleasant mouth feel to food. Our food choices are strongly influenced by taste and textures from lipids enhance our sensory response.

5. Promote satiety, a meal containing lipids satisfies the appetite for a longer period than a meal containing only carbohydrate and protein. Particular brain cells respond to the mouth feel of fat and influence the region of the brain controlling satiety.

6. Thermal insulation, the layer of lipid deposited directly beneath the skin helps maintain body temperature.

7. Protection of vital organs, a net like padding of adipose tissue surrounds vital organs such as the kidneys, protecting them from mechanical shock and providing structural support.

8. Transmission of nerve impulses, lipid layers surrounding nerve fibers provide electrical insulation and transmit nerve impulses.

9. Formation of membranes, lipids are structural components of cell membranes and help transport nutrients, metabolites, and waste products in and out of cells.

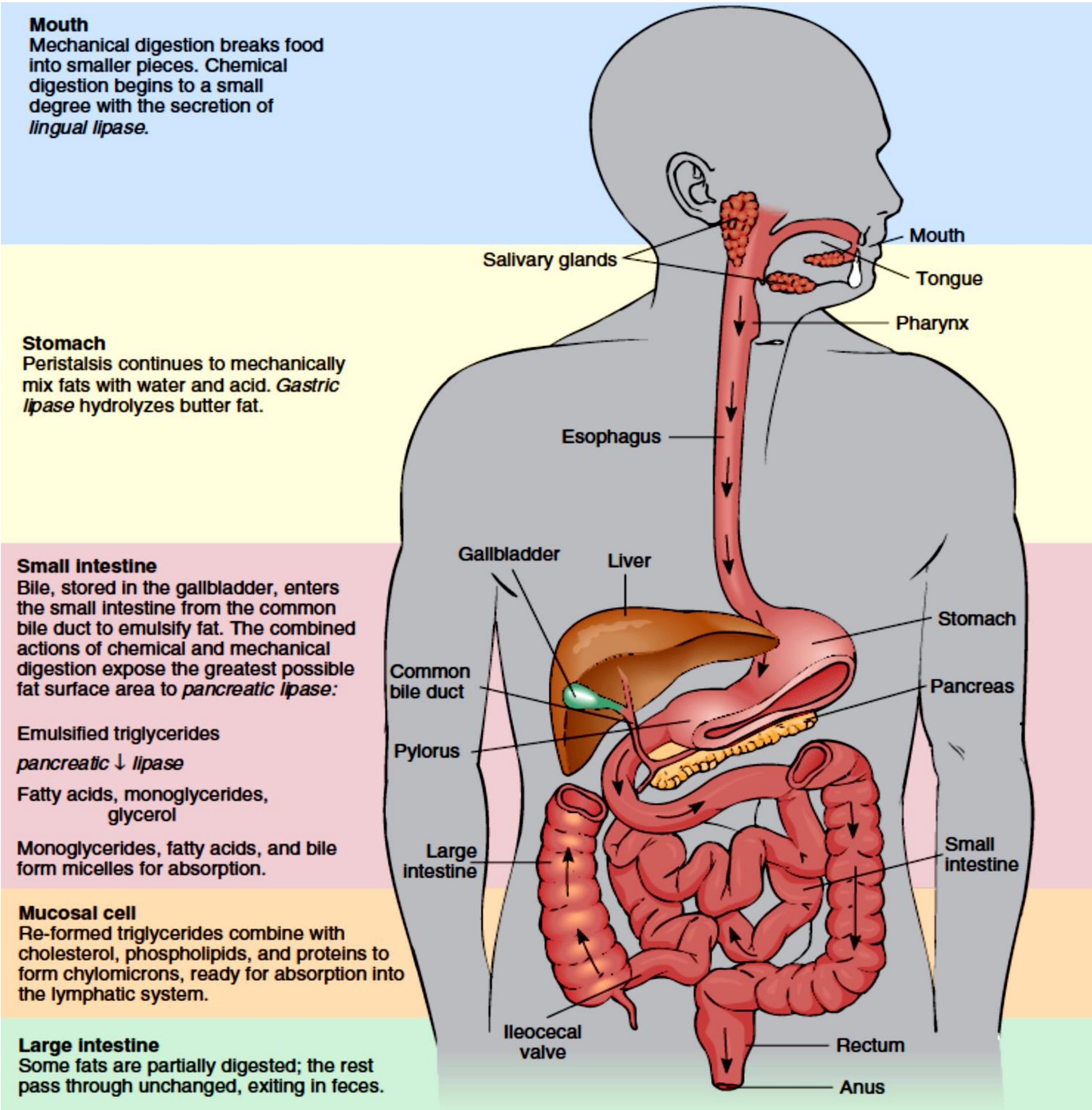
10. Carrier of fat-soluble materials, lipids transport the fat soluble vitamins A, D, E, and K to the cells for metabolic use.

Digestion and Absorption

Although 95% of ingested fats are digested, it is a complex process. The chemical digestion of fats occurs mainly in the small intestine. Fats are not digested in the mouth. They are digested only slightly in the stomach, where gastric lipase acts on emulsified fats such as those found in cream and egg yolk. Fats must be mixed well with the gastric juices before entering the small intestine. In the small intestine, bile emulsifies the fats, and the enzyme pancreatic lipase reduces them to fatty acids and glycerol, which the body subsequently absorbs through villi. Fats are insoluble in water, which is the main component of blood. Therefore, special carriers must be provided for the fats to be absorbed and transported by the blood to body cells. In the initial stages of absorption, bile joins with the products of fat digestion to carry fat. Later, protein combines with the final products of fat digestion to form special carriers called **lipoproteins.** The lipoproteins subsequently carry the fats to the body cells by way of the blood. Lipoproteins are classified as **very-low-density lipoproteins (VLDLs), low-density lipoproteins (LDLs),** and **high-density lipoproteins (HDLs),** according to their mobility and density. Lipoprotein lipase acts to break down the triglycerides into free fatty acids and glycerol. Without this enzyme, fat could not get into the cells. Very-low-density lipoproteins are made primarily by the liver cells and are composed of 55% to 65% triglycerides. They carry triglycerides and other lipids to all cells. As the VLDLs lose triglycerides, they pick up cholesterol from other lipoproteins in the blood, and they then become LDLs. Low-density lipoproteins are approximately 45% cholesterol with few triglycerides. They carry most of the blood cholesterol from the liver to the cells. Elevated blood levels greater than 130 mg/dl of LDL are thought to be contributing factors in atherosclerosis. Low-density lipoprotein is sometimes termed bad cholesterol. High-density lipoproteins carry cholesterol from the cells to the liver for eventual excretion. The level at which low HDL becomes a major risk factor for heart disease has been set at 40 mg/dl. Research indicates that an HDL level of 60 mg/dl or more is considered protective against heart disease. High-density lipoproteins are sometimes called good cholesterol. Exercising, maintaining a desirable weight, and giving up smoking are all ways to increase one's HDL.

Metabolism and Elimination

The liver controls fat metabolism. It hydrolyzes triglycerides and forms new ones from this hydrolysis as needed. Ultimately, the metabolism of fats occurs in the cells, where fatty acids are broken down to carbon dioxide and water, releasing energy. The portion of fat that is not needed for immediate use is stored as adipose tissue. Carbon dioxide and water are by-products that are used or removed from the body by the circulatory, respiratory, and excretory systems.



Vitamins

Vitamins are organic (carbon-containing) compounds that are essential in small amounts for body processes. Vitamins themselves do not provide energy. Vitamins are classified based upon their ability to dissolving, there are ten water-soluble and four fat-soluble vitamins.

Classification

1- Fat-soluble vitamins. The fat-soluble vitamins **A (retinol), D (calciferol) , E (tocopherol), and K (menaquinone and phylloquinone)** are chemically similar. They are not lost easily in cooking but are lost when mineral oil is ingested and very dependent upon the processes of normal lipid digestion and absorption.

2- Water-soluble vitamins. Water-soluble vitamins generally have limited storage ability in the body and are more susceptible to removal from the body in the urine (with the exception of vitamin B12). Therefore, it is logical to think that signs of a deficiency of a water-soluble vitamin may appear more rapidly than would fat-soluble vitamins' symptoms when they are lacking from the diet. This class include **B-complex and vitamin C (ascorbic acid)**. B-complex include Thiamin (B_1), Riboflavin (B_2), Niacin (B_3), Pantothenic acid (B_5), Pyridoxine (B_6), Cobalamin (B_{12}), Biotin (vit. H), Folacin (folic acid or folate) and Choline.

Functions

Vitamins have different functions in various animal species. Vitamins regulate metabolism, help convert fat and carbohydrates into energy and assist in forming bones and tissues.

Minerals

Minerals represent about 5 to 6 percent to total body weight in humans and function in many different ways. Some minerals such as sodium, potassium, and chloride function as electrolytes, while other minerals, such as copper, zinc, iron, chromium, selenium, and manganese can be incorporated into enzyme molecules. Some minerals such as calcium, phosphorus, and fluoride can play a vital structural role in strengthening bones and teeth. After water, minerals are the primary inorganic component of the body; by and large they're the left-over (ash) after cremation of a body, as they will not combust like most organic molecules or evaporate like water.

Water

We thirst for water to maintain good hydration status for optimal health. In fact it is easy to argue that water is our most important nutrient. Each day we must match water intake with losses in order to risk dehydration. Although humans can live about 30 to 45 days without food, it is possible to live only 10 to 14 days without water. Water is a component of all body cells and constitutes from 50% to 60% of the body weight of normal adults. The percentage is higher in males than females because men usually have more muscle tissue than women. The water content of muscle tissue is higher than that of fat tissue. The percentage of water content is highest in newborns (75%) and decreases with age. The access amount of water may be cause water intoxication. We need about 30 ml of water for each kilogram.

References

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