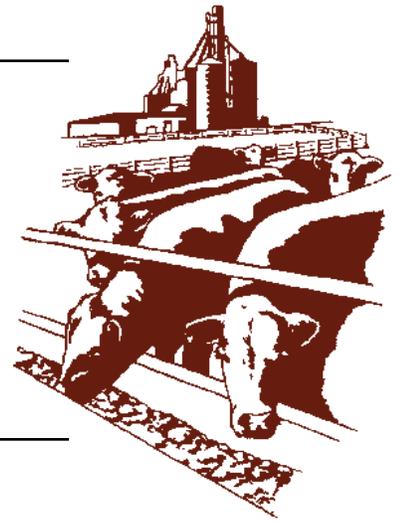




Beef Cattle Handbook



BCH-11100

Product of Extension Beef Cattle Resource Committee

Facts From The Meat Board: Nutrition

Series No. FS/N 002

Cholesterol: What It Is and How It Functions in the Human Body

Cholesterol, in the terminology of a chemist, is "a pearly, fatlike steroid alcohol," $C_{27}H_{45}OH$ (1). It is found in all foods of animal origin. It also is synthesized within the human body. Cholesterol in *food* is called *dietary cholesterol*. Cholesterol within the human body can be called *serum*, *plasma* or *blood cholesterol*. Sometimes cholesterol also is referred to as *lipoproteins*. Lipoproteins function as the carrier packages of cholesterol and fats (called lipids) which are moved through the blood to cells in the body(5).

The distinction between *dietary* and *body* cholesterol is important, the average American female consumes about 300 mg cholesterol per day (2), whereas the human body manufactures, on average, 700 mg of cholesterol in a day (3). Most healthy individuals have no problem with this. Their internal mechanism regulates cholesterol production to what is needed (4). Cholesterol is synthesized primarily in the liver and in the cells which line the small intestine. The amount produced results from the quantity needed by the body, balanced by the amount available from the diet (5).

The Balancing Act: How the Body Regulates Cholesterol

In normal humans, a built-in feedback system maintains cholesterol blood levels (6). When dietary cholesterol decreased, the body is directed to synthesize more cholesterol to make up for this decrease. Similarly, when dietary cholesterol increases, serum cholesterol levels may increase by as much as 30 percent, but then return to normal as the body adapts to this increase supply by reducing synthesis (6).

The term *metabolism* refers to the physical and

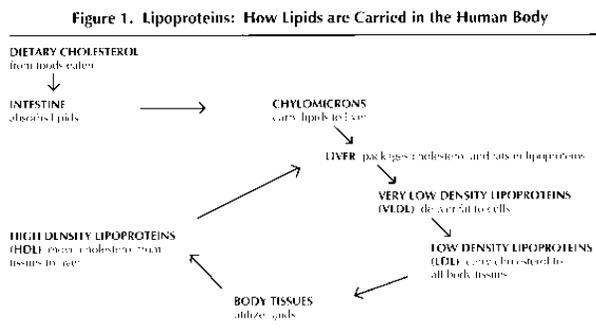
Table 1. Cholesterol Content of Commonly Eaten Animal Foods¹

Food	Cholesterol (mg)
Veal (calf liver)	280
Simmered, 3 oz	
Egg, whole	213
Boiled, 1 large	
Shrimp	166
Boiled, 3 oz	
Veal Cutlet	96
Pan fried, 3 oz	
Lamb leg, sirloin half	78
Roasted, 3 oz	
Chicken Broiler (skinless)	76
Roasted, 3 oz	
Ground Beef (80% lean)	74
Broiled medium, 3 oz	
Pork Loin Chop (lean only)	68
Broiled, 3 oz	
Beef Top Loin (lean only)	67
Broiled, 3 oz	
Turkey (white and dark)	65
Roasted, 3 oz	
Flounder/Sole	58
Baked, 3 oz	
Boneless Ham (5% fat)	45
Roasted, 3 oz	
Tuna (white)	35
Canned in water, 3 oz	
Cheddar Cheese, 1 oz	30
2% Milk, 1 cup	18

chemical processes (such as energy release from food) by which living tissue is produced and maintained (1). The body's supply of cholesterol comes both from food and from body synthesis, using fats and carbohydrates as the building blocks. Thus, the study of cholesterol metabolism is complicated (5).

The normal human body can absorb as much as 300 - 500 mg cholesterol per day (7). On average, most men absorb 30 - 40 percent of dietary cholesterol in the intake range of 40 - 2000 mg per day (7). Reabsorbed cholesterol is also utilized from secretions in bile and cells sloughed off from the intestinal walls. Absorbed cholesterol is transported by the blood as part of various circulating bodies such as *chylomicrons* and *very low-density lipoproteins* (VLDLs).

Lipoproteins are designed to be carriers of water-insoluble components such as cholesterol and fats (5). Whereas VLDLs are a concentrated source of fat for cellular energy, *low-density lipoproteins* (LDLs) are a concentrated source of cholesterol (about 45 percent) (7). LDLs are responsible for delivering most of the cholesterol to other cells in the body for incorporation into cell walls and for other uses (5). In the reverse transport system, *high-density lipoproteins* (HDLs), which contain about 50 percent protein, move cholesterol from body tissues back to the liver (7)



The complex regulation of blood cholesterol levels involves two body processes, the amount of cholesterol absorbed from dietary sources and the amount of cholesterol excreted via bile in the feces. Cholesterol secreted into the bile that is not reabsorbed is excreted instead, constituting the amount lost from the body. These three factors interact in an elaborate process using blood levels to determine how much cholesterol the body needs to synthesize (5).

How Cholesterol Functions in the Body

If the human body could not synthesize cholesterol, it would be an essential nutrient required daily from food sources. Some nutritionists consider dietary cholesterol as necessary, or essential, for infants, whose bodies may not be able to synthesize enough cholesterol during their rapid growth phase. Specifically, cholesterol is needed for the formation of myelin, the protective sheath that surrounds nerve fibers and assists in the ability to trans-

Table 2. Composition of Lipoproteins

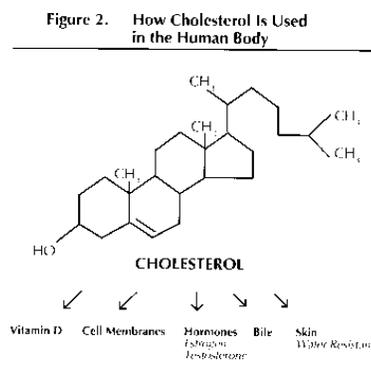
Lipoproteins	Chylomicrons	VLDL	LDL	HDL
*Protein	2%	10%	25%	48%
*Phospholipid	8%	18%	25%	28%
*Cholesterol (free)	5%	6%	7%	3%
†Cholesterol (ester)	5%	15%	35%	17%
†Triglyceride	84%	50%	8%	4%

*Outer membrane
†Core

Source: Adapted from M. E. Shills and V. R. Young: *Modern Nutrition in Health and Disease*, 7th edition; Philadelphia, Lea and Febiger, 1988. Reproduced with permission.

mit nerve messages (5).

Cholesterol has many roles in the human body, in addition to its important role in the maintenance of the nervous system, which includes the brain, cholesterol is needed for the production of bile acids, sex hormones (estrogen and testosterone) and vitamin D (4,8). It also is an integral constituent of the membrane surrounding every cell in the human body (4,8). Because cholesterol is one of the few substances in the body that is not water soluble, its presence in the cell membrane along with phospholipids and certain insoluble proteins is essential for cell protection. This structural function prevents the cell from being disrupted by the fluids on either side of the membrane (6).



Cholesterol is highly resistant to the action of a great many acids and solvents. A large amount of cholesterol and other lipids migrate to the skin, making the skin highly resistant to water-soluble substances and chemical agents that otherwise might easily penetrate the body (6).

Table 3. Composition of the cell Membrane

	Per cent
Proteins	55
Phospholipids	25
Cholesterol	13
Other lipids	4
Carbohydrates	3

Source: Guyton, A. C. *Textbook of medical physiology, 7th ed., 1986 (6)*

Summary

An individual's serum cholesterol is not simply a sum of all of the dietary cholesterol eaten in food. Serum cholesterol is affected by what is synthesized inside the body and by what is absorbed by the intestine and the amount excreted by the body. Cholesterol plays an important role in many body functions. It serves the nervous system and is needed to produce bile acids, sex hormones and vitamin D. It also helps protect cell membranes.

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Glossary:

Cholesterol: A soft waxy substance. It is made in sufficient quantity by the body for normal body function. It is present in all parts of the body, including the nervous system, muscle, skin, liver, intestines and heart.

Chylomicrons: Lipid and protein packages formed in the intestine after eating to carry the water-insoluble lipids in the blood. Chylomicrons are a type of lipoprotein composed of a lot of fat and little protein that has a very low density.

Dietary Cholesterol: Cholesterol that is in the food you eat. It is present only in foods of animal origin.

High Density Lipoproteins (HDL): Lipoproteins that contain a small amount of cholesterol and carry cholesterol away from body cells and tissues to the liver for excretion from the body. Low levels are associated with an increased risk of coronary heart disease. Therefore, the higher the HDL level, the better.

Lipids: Fats and fatlike substances that do not dissolve in water. This broad category includes fats and oils, cholesterol, waxes and steroids (hormones). Many lipids are found in the body as well as in foods.

Lipoproteins: Protein-coated packages that carry fat and cholesterol through the blood. Lipoproteins are classified according to their density.

Low Density Lipoproteins (LDL): Lipoproteins that contain the largest amount of cholesterol in the blood. LDL is responsible for depositing cholesterol in the artery walls. High levels of LDL are associated with an increased risk of coronary disease and are therefore referred to as "bad cholesterol."

Phospholipids: Substances with a structure very similar to triglycerides, but containing a phosphorus unit in place of one of the three fatty acids. Because many phospholipids can dissolve in both water and oil substances, they are important components of cell membranes.

Serum Cholesterol: Cholesterol that is manufactured in the liver and absorbed from the food you eat. It is carried in the blood for use by all parts of the body.

Triglycerides: The scientific name for the most common lipids found in the human body and foods, the fats and oils. The name triglyceride describes the structure, tri for three components (fatty acids) attached to a molecule of glycerol.

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