Nutritional Requirements

Approximately 40 nutrients are required by the human body. Nutrients are essential if they cannot be synthesized by the body and if a deficiency causes recognizable abnormalities that disappear when the deficit is corrected. Required nutrients include the essential amino acids, water-soluble vitamins, fat-soluble vitamins, minerals, and the essential fatty acids. The body also requires carbohydrate and water. Nutritional requirements are commonly expressed by recommended dietary allowances (RDAs).

Energy

The body requires energy to support normal functions and physical activity, growth, and repair of damaged tissues. Energy is provided by oxidation of dietary protein, fat, carbohydrate, and alcohol. Oxidation of 1 g of each provides 4 kcal of energy from protein and carbohydrate, 9 kcal from fat, and 7 kcal from alcohol.

In healthy adults, energy expenditure is primarily determined by three factors: physical activity, basal energy expenditure (BEE), and thermic effect of food (TEF). Physical activity has a major impact on energy expenditure. The BEE is the amount of energy required to maintain basic physiologic functions. It is measured while the subject is resting in a warm room, not having eaten for 12 hours. In healthy persons, the BEE (in kcal/24 h) can be estimated by the Harris-Benedict equation, which will correctly predict measured BEE in 90% of healthy subjects. In clinical practice, however, it is hard to measure BEE. Instead, energy expenditure is measured in individuals at rest without food for 2 hours. This measurement, the resting energy expenditure (REE), is about 10% greater than BEE. TEF, the amount of energy expended during and following the ingestion of food, averages approximately 10% of the BEE.

Protein

Protein is required for growth and for maintenance of body structure and function. Although the nutritional requirement is commonly stated in grams of protein, the true requirement is for nine essential amino acids plus additional nitrogen for protein synthesis. The essential amino acids are leucine, isoleucine, lysine, methionine, phenylalanine, threonine, tryptophan, valine, and histidine. The RDA for protein is 56 g/d for men and 45 g/d for women.

Fat

Dietary fat is the most concentrated source of food energy. Like energy from dietary carbohydrate, energy derived from fat can support protein synthesis. Dietary fat also provides the essential fatty acid linoleic acid. Other than the need for adequate quantities of linoleic acid, there is no specific requirement for dietary fat, because the diet provides adequate nutrients oxidizable for energy. Although average diets contain 40% of calories as fat, current recommendations are to limit dietary fat to 35% of total calories. Diets containing as little as 10% of total calories as fat appear to be safe and well tolerated.

Dietary fats are composed primarily of fatty acids and dietary cholesterol. Fatty acids contain either no double bonds (saturated), one double bond (monounsaturated), or more than one double bond (polyunsaturated). Saturated fatty acids are associated with increased serum cholesterol, whereas polyunsaturated and monounsaturated fatty acids lower serum cholesterol. Trans-fatty acids, a form of unsaturated fat found in partially hydrogenated vegetable oils, also raise serum cholesterol levels. Saturated fats are solid at room temperature and in general are derived from animal foods; unsaturated fats are liquid at room temperature and in general are derived from plant foods.

The polyunsaturated fatty acid linoleic acid is an essential nutrient, required by the body for the synthesis of arachidonic acid, the major precursor of prostaglandins. Deficiency of linoleic acid results in dermatitis, hair loss, and impaired wound healing. For individuals with average energy requirements, approximately 5 g of linoleic acid per day --2% of total calories-- is required to prevent essential fatty acid deficiency.

Cholesterol is a major constituent of cell membranes. It is synthesized by the body and is not an essential nutrient.

Diets that contain large amounts of cholesterol partially inhibit endogenous cholesterol synthesis but result in a net increase in serum cholesterol concentrations because of suppression of synthesis of low-density lipoprotein receptors. Average diets contain approximately 450 mg/d of cholesterol, but 300 mg or less per day is recommended.

Carbohydrate

A substantial portion of dietary energy is provided by carbohydrate. Average diets contain 45% of calories as carbohydrate. Dietary carbohydrates include simple sugars, complex carbohydrates (starches), and indigestible carbohydrates (dietary fiber). The bulk of dietary carbohydrates should be derived from starches as found in whole grains and from sugars as found in fruits and vegetables. Sucrose and other forms of added sugar such as high fructose corn syrup are concentrated sources of calories without other sources of essential nutrients and contribute to excess calorie consumption (empty calories). Sucrose consumption is also thought to be an important factor in the development of tooth decay. Starches, when unrefined, provide carbohydrate calories and vitamins, minerals, and dietary fiber.

Dietary fiber is that portion of plant foods that cannot be digested by the human intestine. Fiber increases the bulk of the stool and facilitates excretion. Diets high in dietary fiber are associated with a lower incidence of digestive and cardiovascular diseases. The more insoluble fibers, such as those found in wheat bran, have the greatest effect on colonic function. Soluble fibers such as those found in legumes, oats, and fruit result in lower blood sugar levels in diabetics and lower blood cholesterol.

Vitamins

Vitamins are a heterogeneous group of organic molecules required by the body for a variety of essential metabolic functions. They are grouped as water-soluble vitamins: thiamine, riboflavin, niacin, vitamin B6 (pyridoxine), vitamin B12 (cobalamin), folate, pantothenic acid, biotin, and vitamin C (ascorbic acid); and fat-soluble vitamins: A, D, E, and K. Disorders of vitamin metabolism are discussed below.

Minerals

The body also requires minerals, commonly grouped as the major minerals calcium, magnesium, and phosphorus; the electrolytes sodium, potassium, and chloride; and the trace elements iron, zinc, copper, manganese, molybdenum, fluoride, iodine, cobalt, chromium, and selenium.

Dietary Guidelines

Limit the intake of saturated fat, trans fat, cholesterol, added sugars, salt, and alcohol; balance calories from food and beverages with calories expended; engage in regular physical activity at least 30-60 minutes most days of the week; consume greater quantities (up to 9 servings per day) and more varieties of fruits and vegetables per day; consume at least half of the daily grains as whole grains; consume 3 cups per day of low fat milk or milk products; consume less than 10% of calories as saturated fat, less than 300 mg/d of cholesterol, and as little trans-fatty acids as possible; consume fiber-rich fruits, vegetables, and whole grains; use little added sugars or caloric sweeteners; consume less than 2300 mg of sodium per day; use alcohol sensibly and in moderation; and prepare food safely.

Digestion

Dietary fats, proteins, and carbohydrates are hydrolyzed and solubilized by pancreatic and biliary secretions. Fats are broken down by pancreatic lipase to monoglycerides and fatty acids that form micelles (electrically charged particles) with bile salts. Micelles are important for the solubilization and absorption of fat-soluble vitamins (A, D, E, K). Proteins are hydrolyzed by pancreatic proteases to di- and tripeptides and amino acids.

Pancreatic insufficiency may be caused by chronic pancreatitis, cystic fibrosis, or pancreatic cancer. Pancreatic enzymes may also be inactivated within the intestinal lumen by acid hypersecretion (Zollinger-Ellison syndrome). Significant pancreatic enzyme insufficiency generally results in significant steatorrhea (due to malabsorption of triglycerides) --often more than 20-40 g/24 h-- resulting in weight loss, gaseous distention and flatulence, and large, greasy, foul-smelling stools.