95e Nutrient Requirements and Dietary Assessment

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Nutrients are substances that are not synthesized in sufficient amounts in the body and therefore must be supplied by the diet. Nutrient requirements for groups of healthy persons have been determined experimentally. The absence of essential nutrients leads to growth impairment, organ dysfunction, and failure to maintain nitrogen balance or adequate status of other nutrients. For good health, we require energy-providing nutrients (protein, fat, and carbohydrate), vitamins, minerals, and water. Requirements for organic nutrients include 9 essential amino acids, several fatty acids, glucose, 4 fat-soluble vitamins, 10 water-soluble vitamins, dietary fiber, and choline. Several inorganic substances, including 4 minerals, 7 trace minerals, 3 electrolytes, and the ultratrace elements, must also be supplied by diet.

The amounts of the essential nutrients that are required by individuals differ by age and physiologic state. Conditionally essential nutrients are not required in the diet but must be supplied to individuals who do not synthesize them in adequate amounts, such as those with genetic defects, those with pathologic conditions such as infection or trauma with nutritional implications, and developmentally immature infants. For example, inositol, taurine, arginine, and glutamine may be needed by premature infants. Many other organic and inorganic compounds that are present in foods, such as pesticides and lead, also have health effects.

ESSENTIAL NUTRIENT REQUIREMENTS

Energy For weight to remain stable, energy intake must match energy output. The major components of energy output are resting energy expenditure (REE) and physical activity; minor components include the energy cost of metabolizing food (thermic effect of food, or specific dynamic action) and shivering thermogenesis (e.g., cold-induced thermogenesis). The average energy intake is ~2600 kcal/d for American men and ~1800 kcal/d for American women, though these estimates vary with body size and activity level. Formulas for roughly estimating REE are useful in assessing the energy needs of an individual whose weight is stable. Thus, for males, REE = 900 + 10m, and for females, REE = 700 + 7m, where is m mass in kilograms. The calculated REE is then adjusted for physical activity level by multiplying by 1.2 for sedentary, 1.4 for moderately active, or 1.8 for very active individuals. The final figure, the estimated energy requirement (EER), provides an approximation of total caloric needs in a state of energy balance for a person of a certain age, sex, weight, height, and physical activity level. **For further discussion of energy balance in health and disease, see Chap. 97.**

Protein Dietary protein consists of both essential and nonessential amino acids that are required for protein synthesis. The nine essential amino acids are histidine, isoleucine, leucine, lysine, methionine/cystine, phenylalanine/tyrosine, threonine, tryptophan, and valine. Certain amino acids, such as alanine, can also be used for energy and gluconeogenesis. When energy intake is inadequate, protein intake must be increased, because ingested amino acids are diverted into pathways of glucose synthesis and oxidation. In extreme energy deprivation, protein-calorie malnutrition may ensue (Chap. 97).

For adults, the recommended dietary allowance (RDA) for protein is ~0.6 g/kg desirable body mass per day, assuming that energy needs are met and that the protein is of relatively high biologic value. Current recommendations for a healthy diet call for at least 10–14% of calories from protein. Most American diets provide at least those amounts. Biologic value tends to be highest for animal proteins, followed by proteins from legumes (beans), cereals (rice, wheat, corn), and roots. Combinations of plant proteins that complement one another in biologic value or combinations of animal and plant proteins can increase biologic value and lower total protein requirements. In healthy people with adequate diets, the timing of protein intake over the course of the day has little effect.

Protein needs increase during growth, pregnancy, lactation, and rehabilitation after injury or malnutrition. Tolerance to dietary protein is decreased in renal insufficiency (with consequent uremia) and in liver failure. Normal protein intake can precipitate encephalopathy in patients with cirrhosis of the liver.

Fat and Carbohydrate Fats are a concentrated source of energy and constitute, on average, 34% of calories in U.S. diets. However, for optimal health, fat intake should total no more than 30% of calories. Saturated fat and trans fat should be limited to <10% of calories and polyunsaturated fats to <10% of calories, with monounsaturated fats accounting for the remainder of fat intake. At least 45–55% of total calories should be derived from carbohydrates. The brain requires ~100 g of glucose per day for fuel; other tissues use about 50 g/d. Some tissues (e.g., brain and red blood cells) rely on glucose supplied either exogenously or from muscle proteolysis. Over time, adaptations in carbohydrate needs are possible during hypocaloric states. Like fat (9 kcal/g), carbohydrate (4 kcal/g), and protein (4 kcal/g), alcohol (ethanol) provides energy (7 kcal/g). However, it is not a nutrient.

Water For adults, 1–1.5 mL of water per kilocalorie of energy expenditure is sufficient under usual conditions to allow for normal variations in physical activity, sweating, and solute load of the diet. Water losses include 50–100 mL/d in the feces; 500–1000 mL/d by evaporation or exhalation; and, depending on the renal solute load, ≥1000 mL/d in the urine. If external losses increase, intakes must increase accordingly to avoid underhydration. Fever increases water losses by ~200 mL/d per °C; diarrheal losses vary but may be as great as 5 L/d in severe diarrhea. Heavy sweating, vigorous exercise, and vomiting also increase water losses. When renal function is normal and solute intakes are adequate, the kidneys can adjust to increased water intake by excreting up to 18 L of excess water per day (Chap. 404). However, obligatory urine outputs can compromise hydration status when there is inadequate water intake or when losses increase in disease or kidney damage.

Infants have high requirements for water because of their large ratio of surface area to volume, their inability to communicate their thirst, and the limited capacity of the immature kidney to handle high renal solute loads. Increased water needs during pregnancy are ~30 mL/d. During lactation, milk production increases daily water requirements so that ~1000 mL of additional water is needed, or 1 mL for each milliliter of milk produced. Special attention must be paid to the water needs of the elderly, who have reduced total body water and blunted thirst sensation and are more likely to be taking medications such as diuretics.

Other Nutrients **See Chap. 96e for detailed descriptions of vitamins and trace minerals.**

DIETARY REFERENCE INTAKES AND RECOMMENDED DIETARY ALLOWANCES

Fortunately, human life and well-being can be maintained within a fairly wide range for most nutrients. However, the capacity for adaptation is not infinite—too much, as well as too little, intake of a nutrient can have adverse effects or alter the health benefits conferred by another nutrient. Therefore, benchmark recommendations regarding nutrient intakes have been developed to guide clinical practice. These quantitative estimates of nutrient intakes are collectively referred to as the *dietary reference intakes* (DRIs). The DRIs have supplanted the RDAs—the single reference values used in the United States until the early 1990s. DRIs include the *estimated average requirement* (EAR) for nutrients as well as other reference values used for dietary planning for individuals: the RDA, the *adequate intake* (AI), and the tolerable *upper*