Chapter 8

Nutrition: Non-Energy Yielding Nutrients

IN THIS CHAPTER
- Vitamins
- Dietary Reference Intakes
- Minerals
- Electrolytes
- Water
- Exercise & Fluid Loss
- Acclimation
- Food Guide Pyramid
- Food Labels
- Food Descriptors
**Vitamins**

Unlike carbohydrates, fats, and proteins, vitamins do not provide energy to the body. They function primarily as metabolic catalysts that release energy from food consumed and help maintain homeostasis within the body. There are currently thirteen different vitamins classified as either water-soluble or fat-soluble. **Water-soluble vitamins** regulate metabolic reactions, control the process of tissue synthesis, aid in the protection of the cell’s plasma membrane and facilitate proper tissue function. **Fat-soluble vitamins** function to enhance tissue formation and integrity, prevent cell damage, and serve as constituents of certain compounds.

Vitamin requirements are generally met by the consumption of a well balanced diet. Unlike carbohydrates and protein structures, the body cannot reassemble vitamins from other chemical compounds, with the exception of vitamin D, and therefore must be consumed in the diet. Some vitamins, such as A, D, niacin, and folic acid require activation from an inactive precursor known as a pro-vitamin. A common example of a pro-vitamin is beta-carotene, the precursor for vitamin A.

**Water-Soluble**

Water-soluble vitamins largely act as **coenzymes**, which participate directly in chemical reactions. Because they are water-soluble, these vitamins disperse in the body’s fluid without being stored in any appreciable quantity. They generally exist in the body at usable potency between 8 to 14 hours, which suggests that they should be consumed periodically throughout the day (13; 35; 88). Excess consumption is usually excreted in the urine but toxicity is possible in rare situations. When daily consumption of water-soluble vitamins falls to approximately 50% of the recommended value, deficiencies can develop in as little as four weeks time (12; 100).

**Fat-Soluble**

Fat-soluble vitamins are dissolved and stored in the liver and adipose tissue. Metabolic demands cause the vitamins to mobilize in lipids, allowing them to be transported to the body’s tissues from the liver. Without the lipids, the vitamins do not have a transport mechanism. Excess consumption of fat-soluble vitamins can cause toxicity, particularly with vitamins A and D (63; 99). Diets that are very low in fat can accelerate deficiencies but are relatively uncommon. Although fat-soluble vitamins do not need to be consumed everyday, regular intake is useful in maintaining homeostasis.

<table>
<thead>
<tr>
<th>Fat Soluble Vitamins</th>
<th>Water Soluble Vitamins</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>C</td>
</tr>
<tr>
<td>K</td>
<td>B Complex</td>
</tr>
<tr>
<td>E</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
</tr>
</tbody>
</table>

A well-balanced diet will usually meet most individuals’ requirements, regardless of age and physical activity level. For those who are highly active, a multi-vitamin may be warranted to provide any additional nutrient needs from vitamins (14; 89). This may be particularly important for individuals who do not consume enough vitamin C and folic acid. Additionally, folic acid and B6 may provide added protection against heart disease (7; 20). They reduce high blood **homocysteine** levels that have been linked to coronary heart disease (18; 30). Other beneficial actions of certain vitamins include their role as **antioxidants**. During both aerobic and anaerobic metabolism, **free radical** formation can occur, caused by electron leakage along the electron transport chain. Under normal metabolic conditions, as much as 2-5% of oxygen used by the body forms oxygen-containing free radicals (28; 42; 79). These highly chemically reactive molecules increase the potential for cellular damage and can increase the oxidation of LDL cholesterol, accelerating the process of atherosclerosis (25; 69; 81).

Free radical production is associated with cigarette smoke inhalation, environmental pollutants, and even exercise. They have been linked with oxidative stress leading to advanced aging, cancer, diabetes, heart disease and a decline in the immune system. Vitamins A, C, E, and the vitamin precursor beta-carotene can serve protective function against free radical activity, notably lowering risks of cancer and heart disease (24; 60; 80).

**~Key Terms~**

**Water-soluble Vitamins**- Consist of the B-vitamins and vitamin C and are stored in the body for a brief period of time before being excreted.

**Fat-soluble Vitamins**- Consist of the vitamins A, D, E and K. These vitamins are stored in fat cells.

**Coenzymes**- A non-protein, organic substance that usually contains a vitamin or mineral and combines with a specific protein, the apoenzyme, to form an active enzyme system.

**Homocysteine**- An amino acid normally used by the body in cellular metabolism and in the manufacturing of proteins. Elevated concentrations in the blood are thought to increase the risks for heart disease.
<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Adult RDA a</th>
<th>Functions</th>
<th>Sources</th>
<th>UL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiamin(B1)</td>
<td>1.2 mg</td>
<td>Part of a coenzyme used in energy metabolism, supports normal appetite and nervous system functions</td>
<td>Occurs in all nutritious foods in moderate amounts; pork, bacon, ham, whole grains, nuts, legumes</td>
<td>ND</td>
</tr>
<tr>
<td>Riboflavin(B2)</td>
<td>1.7 mg</td>
<td>Part of a coenzyme used in energy metabolism, supports normal vision and skin health</td>
<td>Milk, yogurt, cottage cheese, meat, green leafy vegetables, and whole grains</td>
<td>ND</td>
</tr>
<tr>
<td>Niacin</td>
<td>16 mg</td>
<td>Part of a coenzyme used in energy metabolism, supports health of skin, nervous system, and digestive system</td>
<td>Milk, eggs, meat, poultry, fish, whole-grain and enriched breads &amp; cereals, nuts</td>
<td>35 mg</td>
</tr>
<tr>
<td>B6</td>
<td>2.0 mg</td>
<td>Part of a coenzyme used in amino acid and fatty acid metabolism, helps convert tryptophan to niacin, helps make red blood cells</td>
<td>Green and leafy vegetables, meats, fish, poultry, shellfish, legumes, fruits, whole grains</td>
<td>100 mg</td>
</tr>
<tr>
<td>Pantothenic acid</td>
<td>5 mg*</td>
<td>Part of a coenzyme used in energy metabolism</td>
<td>Whole-grain cereals, bread, dark green vegetables</td>
<td>ND</td>
</tr>
<tr>
<td>Folic Acid</td>
<td>400 μg</td>
<td>Functions as coenzyme in synthesis of nucleic acids and protein</td>
<td>Green vegetables, beans, whole-wheat products</td>
<td>1000 μg</td>
</tr>
<tr>
<td>B12</td>
<td>2.4 μg</td>
<td>Part of a coenzyme used in new cell synthesis, red blood cell formation, helps maintain nerve cells</td>
<td>Animal products such as meat, fish, poultry, milk, cheese, eggs</td>
<td>ND</td>
</tr>
<tr>
<td>Biotin</td>
<td>30 μg</td>
<td>Part of a coenzyme used in the synthesis of fatty acids and glycogen</td>
<td>Egg yolk, dark green vegetables</td>
<td>ND</td>
</tr>
<tr>
<td>C</td>
<td>90 mg</td>
<td>Intracellular maintenance of bone, capillaries, and teeth</td>
<td>Citrus fruits, green peppers, tomatoes</td>
<td>2000 mg</td>
</tr>
<tr>
<td>A</td>
<td>900 μg</td>
<td>Vision, skin health, bone and tooth growth, reproduction, hormone synthesis and regulation, immunity</td>
<td>Retinol: Fortified milk, cheese, carrots, butter, fortified margarine, eggs, liver</td>
<td>3000 μg</td>
</tr>
<tr>
<td>D</td>
<td>5 μg*</td>
<td>Mineralization of bones, calcium absorption</td>
<td>Fortified milk, margarine, butter, cereals, eggs</td>
<td>50 μg</td>
</tr>
<tr>
<td>E</td>
<td>15 mg</td>
<td>Antioxidant, stabilization of cell membranes, regulation of oxidation reactions</td>
<td>Polyunsaturated plant oils, green and leafy vegetables, wheat germ, whole grain products, nuts, seeds</td>
<td>1000 mg</td>
</tr>
<tr>
<td>K</td>
<td>120 μg*</td>
<td>Synthesis in blood clotting proteins and a protein that binds calcium in the bones</td>
<td>Bacterial synthesis in the digestive tract, green leafy vegetables, cabbage-type vegetables, potatoes</td>
<td>ND</td>
</tr>
</tbody>
</table>

aValues are Recommended Daily Allowance (RDA) for adults 19 to 50 years of age, unless marked with an asterisk. The requirements may vary for children, older adults, and pregnant or lactating women. bValues are Adequate Intakes (AI), indicating that sufficient data to set the RDA are unavailable.

UL = not yet determined.

Adapted from Franks and Howley, 1999, and Institute of Medicine
To ensure adequate consumption of the micronutrients, the American government funds an expert committee of the Food and Nutrition Board of the National Academy of Sciences’ Institute of Medicine to establish recommendations and guidelines for nutrient intake. In 1995, a Standing Committee on the Scientific Evaluation of Dietary Reference Intakes was established to review scientific research on nutrients and recommend levels that would prevent deficiency and chronic diseases, as well as estimate intake levels that may be hazardous to health. Collectively the values are called the Dietary Reference Intakes (DRI).

**Dietary Reference Intakes (DRI)**

The DRIs encompass four categorical sets of reference values including the Estimated Average Requirements (EAR), Recommended Daily Allowance (RDA), Adequate Intakes (AI), and the Tolerable Upper Intake Level (UL). Although not enough research exists to cover every nutrient in each category, significant information exists to provide values for the large majority of nutrients. The DRIs are based on the bioavailability of the nutrient, which takes into account the actual quantity absorbed by the intestines, not just the amount ingested. Essentially, the nutrient recommendations establish a range that consumers can follow to meet their individual nutritional needs. Individuals who exercise or are ill often have additional nutrient requirements above the needs of the sedentary population. Therefore, nutritional experts may assign a consumption value near the tolerable upper intake level of particular nutrients for these individuals. On the contrary, individuals who do not engage in physical activity may only need to consume the nutrient quantities reflected by the RDA. The RDAs are evidence-based estimates of what intakes are necessary to support good health and lower risk for disease.

**Estimated Average Requirements (EAR)** – The amount of each nutrient that meets the requirements of half of healthy people in a particular life-stage and gender group.

**Recommended Daily Allowance (RDA)** – The amount of each nutrient that meets the needs of 97% of healthy people in a particular life-stage and gender group. The RDAs are determined using the EARs. Therefore, if an estimated average has not been determined for a nutrient, it will not be assigned a value in the RDAs.

**Adequate Intakes (AI)** – The average intake of each nutrient needed to sustain health, based on studies of people in a particular life-stage and gender group. AI’s are used when an RDA does not exist.

**Tolerable Upper Intake Level (UL)** – The upper limit of safe, daily intake for a nutrient. Exceeding the UL may lead to adverse health effects.

The concept of “more is better” often does not apply in nutrition. Due to the fact that physiological homeostasis depends upon biochemical reactions, adding more of a particular element or compound will not necessarily increase the level of the reaction. High intakes of vitamins cause increased chemical concentrations once the enzyme systems are saturated. The additional circulating compounds impact system function. In fact, adding excessive amounts of most nutrients causes adverse effects. Megadosing vitamins can cause irreversible damage even if the vitamin is water soluble (63; 101).

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**Quick Insight**

Food manufacturers are conscious of the nutrients in the foods they sell. When nutrients are lost during the manufacturing process, a practice of replacing the lost nutrients to improve the food’s nutritional quality called “enrichment” is utilized. In some cases, the manufacturer will add nutrients that exist in small quantities or are not present in the food at all. Fortified foods have nutrients added into the product to improve the overall nutritional value. Common examples are Vitamin D fortified milk or orange juice fortified with calcium.
~Key Terms~

**Free Radicals** - An unstable molecule that causes oxidative damage by stealing electrons from surrounding molecules, thereby disrupting activity in the body’s cells.

**Dietary Reference Intakes (DRI)** - A comprehensive set of nutrient reference values for healthy populations that can be used for assessing and planning diets.

Although a daily vitamin is often recommended to ensure adequate nutritional status, when combined with other supplements and normal dietary consumption, the intake values may rise above the upper limit for safe consumption.

**Minerals**

Roughly 4% of total body mass is composed of minerals. These inorganic compounds are mainly metallic elements that serve as constituents of enzymes, hormones, and vitamins. Minerals are often incorporated into structures and chemicals in the body. Their functions include:

1. Providing components for bone and teeth.
2. Regulation of cellular metabolism, actions of the heart, muscle, and nervous system.
3. The maintenance of acid base balance.
4. Regulation of cellular fluid balance.

Minerals play an extensive role in the catabolic and anabolic processes of the cell, activating the numerous reactions necessary to release energy from the breakdown of energy-yielding nutrients. Minerals also help assist with the synthesis of the metabolic compounds, which enables the biological nutrient formation of glycogen, triglycerides, and protein from glucose, fatty acids, and amino acids. Minerals are fundamental in most activities of the body, and although they are consumed in small amounts, play a significant role in physiological homeostasis.

**Calcium**

The average American diet usually meets the nutritional requirements for every mineral except iron and calcium (48; 62). Calcium is the most abundant mineral in the body, carrying out numerous roles to support normal biological processes. It is involved in muscle contractions, the transmission of nerve impulses, serves as an activator for several enzymes, and helps transport fluids across cell membranes. Calcium combines with phosphorus in the body to form bone and teeth, which represents about 75% of the total mineral content found in humans. Due to its role in bone formation, calcium deficiencies significantly impact bone health.

A common misconception is that bones are static, when in fact they are actually very dynamic, going through constant changes. Earlier, we learned bones are continuously being broken down and rebuilt in a process known as bone remodeling. Bone remodeling is controlled by two types of bone cells, osteoclasts and osteoblasts. This catabolic/anabolic relationship allows the bone to remain healthy and facilitates repair of damage. When the main construction material, calcium, is unavailable, the process of remodeling becomes impaired. Bones represent the largest storage pool of calcium in the body. When inadequate amounts of calcium are taken in through the diet, the body pulls calcium from the bone and transfers it to the bloodstream in order to maintain other biological processes. When calcium is used for other purposes, the restorative balance becomes disproportionate, leading to osteopenia and eventually, osteoporosis. The average adult female consumes approximately half of the recommended 1000-1500 mg per day (86; 90), which supports the trend of osteoporosis reaching near-epidemic numbers.

### Recommended Calcium Intakes by Age & Gender

<table>
<thead>
<tr>
<th>Life Stage</th>
<th>Age</th>
<th>Males (mg/day)</th>
<th>Females (mg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infants</td>
<td>0-6 months</td>
<td>210</td>
<td>210</td>
</tr>
<tr>
<td>Infants</td>
<td>7-12 months</td>
<td>270</td>
<td>270</td>
</tr>
<tr>
<td>Children</td>
<td>1-3 years</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>Children</td>
<td>4-8 years</td>
<td>800</td>
<td>800</td>
</tr>
<tr>
<td>Children</td>
<td>9-13 years</td>
<td>1300</td>
<td>1300</td>
</tr>
<tr>
<td>Adolescents</td>
<td>14-16 years</td>
<td>1300</td>
<td>1300</td>
</tr>
<tr>
<td>Adults</td>
<td>19-50 years</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>Adults</td>
<td>51 years and older</td>
<td>1200</td>
<td>1200</td>
</tr>
<tr>
<td>Pregnancy</td>
<td>18 years and younger</td>
<td>1300</td>
<td>1300</td>
</tr>
<tr>
<td>Pregnancy</td>
<td>19 years and older</td>
<td>1200</td>
<td>1200</td>
</tr>
<tr>
<td>Breastfeeding</td>
<td>16 years and younger</td>
<td>1300</td>
<td>1300</td>
</tr>
<tr>
<td>Breastfeeding</td>
<td>19 years and older</td>
<td>1200</td>
<td>1200</td>
</tr>
</tbody>
</table>
## Nutrition: Non-Energy Yielding Nutrients

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Adult RDA ( \text{Men} )</th>
<th>Adult RDA ( \text{Women} )</th>
<th>Functions</th>
<th>Sources</th>
<th>UL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>1000 mg*</td>
<td>1000 mg*</td>
<td>The principal mineral of bones and teeth. Normal muscle contraction and relaxation, nerve function, blood clotting, blood pressure, immune defenses</td>
<td>Milk and milk products, oysters, sardines, tofu (bean curd), greens, legumes</td>
<td>2500 mg</td>
</tr>
<tr>
<td>Chloride</td>
<td>750 mg</td>
<td>750 mg$</td>
<td>Nerve and muscle function water balance (with sodium)</td>
<td>Table salt</td>
<td>ND</td>
</tr>
<tr>
<td>Magnesium</td>
<td>420 mg</td>
<td>320 mg$</td>
<td>Bone mineralization, building of protein, enzyme action, normal muscular contraction, transmission of nerve impulses, and maintenance of teeth</td>
<td>Nuts, legumes, whole grains, dark green vegetables, seafood, chocolate, cocoa</td>
<td>350 mg^</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>700 mg</td>
<td>700 mg$</td>
<td>Important in cells’ genetic material, in cell membranes as phospholipids, bones and teeth</td>
<td>All animal tissues</td>
<td>4000 mg</td>
</tr>
<tr>
<td>Potassium</td>
<td>2000 mg</td>
<td>2000 mg$</td>
<td>Nerve and muscle function</td>
<td>All whole foods: meats, milk, fruits, vegetables, grains, legumes.</td>
<td>ND</td>
</tr>
<tr>
<td>Sodium</td>
<td>500 mg*</td>
<td>500 mg$</td>
<td>Maintains cells’ normal fluid balance and acid-base balance in the body; nerve impulse transmission</td>
<td>Salt, soy sauce, processed foods</td>
<td>ND</td>
</tr>
<tr>
<td>Chromium</td>
<td>35 µg*</td>
<td>25 µg$</td>
<td>Associated with insulin and required for the release of energy from glucose</td>
<td>Meat, unrefined foods, fats, vegetable oils</td>
<td>ND</td>
</tr>
<tr>
<td>Copper</td>
<td>900 µg</td>
<td>900 µg$</td>
<td>Necessary for the absorption and use of iron in the formation of hemoglobin; part of several enzymes</td>
<td>Meat, nuts, seafood</td>
<td>10,000 µg</td>
</tr>
<tr>
<td>Fluoride</td>
<td>4 mg</td>
<td>3 mg$</td>
<td>An element involved in the formation of bones and teeth; helps to make the teeth resistant to decay</td>
<td>Drinking water, tea, seafood</td>
<td>10 mg</td>
</tr>
<tr>
<td>Iodine</td>
<td>150 µg</td>
<td>150 µg$</td>
<td>Thyroid hormone function</td>
<td>Iodized salt, seafood</td>
<td>1100 µg</td>
</tr>
<tr>
<td>Iron</td>
<td>8 mg</td>
<td>18 mg$</td>
<td>Part of the proteins hemoglobin and myoglobin, necessary for the utilization of energy</td>
<td>Red meats, fish, poultry, shellfish, eggs, legumes, dried fruits</td>
<td>45 mg</td>
</tr>
<tr>
<td>Manganese</td>
<td>2.3 mg*</td>
<td>1.8 mg*</td>
<td>Enzyme function</td>
<td>Whole grains, nuts, fruits, vegetables</td>
<td>11 mg</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>45 µg</td>
<td>45 µg$</td>
<td>Energy metabolism in cells</td>
<td>Whole grains, organ meats, peas, beans</td>
<td>2000 µg</td>
</tr>
<tr>
<td>Selenium</td>
<td>35 µg</td>
<td>35 µg$</td>
<td>Works with vitamin C</td>
<td>Meat, fish, whole grains, eggs</td>
<td>400 µg</td>
</tr>
<tr>
<td>Zinc</td>
<td>11 mg</td>
<td>8 mg$</td>
<td>Part of the hormone insulin and many enzymes; involved in making genetic materials and proteins, immune reactions</td>
<td>Meats, fish, shellfish, poultry, grains, vegetables</td>
<td>40 mg</td>
</tr>
</tbody>
</table>

*Values are Recommended Daily Allowances (RDA) for adults 19 to 50 years of age, unless marked with an asterisk. The requirements may vary for children, older adults, and pregnant or lactating women.

*Minimum estimated daily intake requirement

*Tolerable Upper Intake Levels (UL) for adults 19 to 50 years of age. Intakes above the UL may lead to negative health consequences.

*This refers to pharmacological agents only, and not amounts contained in food and water. No evidence of ill effects from ingestion of naturally occurring amounts in food and water.

ND= not yet determined

Adapted from Frankis and Howley, 1989, and Institute of Medicine.
It is estimated that more than 50% of all women eventually develop the disease (43).

Studies have shown that bone mass decreases through the third decade of life without proper nutrition and exercise (39; 84), but this action can be significantly reduced with adequate consumption of calcium and load-bearing exercise, such as resistance training. Females may lose as much as 1% of bone mineral density a year after the age of 35 (38; 85). This loss is aggravated by menopause, a time during which estrogen production is dramatically reduced, and calcium absorption is decreased, thereby causing as much as a 3-6% loss of bone mass annually for the five years following menopause (41). Estrogen is a vital hormone in calcium regulation. It facilitates intestinal absorption of calcium, reduces calcium excretion, and enhances calcium retention by the bone in both men and women. Adequate calcium, vitamin D, and exercise can reverse the developmental process of osteoporosis (29).

Iron deficiency is the most common nutrient deficiency in the world (52). Iron serves as the key mineral in the formation of oxygen carrying materials, including hemoglobin and myoglobin. In these molecules, iron is responsible for the binding of oxygen. It is also an important component of many enzyme systems and physiological processes. The intestinal absorption of iron is consistent with the type of iron source consumed.

Recommended Dietary Allowances For Iron

<table>
<thead>
<tr>
<th>Population</th>
<th>Age, years</th>
<th>Iron, mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children</td>
<td>1-3</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>4-8</td>
<td>10</td>
</tr>
<tr>
<td>Males</td>
<td>9-13</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>14-18</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>19-30</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>31-50</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>50-70</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>&gt;70</td>
<td>8</td>
</tr>
<tr>
<td>Females</td>
<td>9-13</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>14-18</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>19-30</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>31-50</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>50-70</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>&gt;70</td>
<td>8</td>
</tr>
<tr>
<td>Pregnancy</td>
<td>≥16</td>
<td>27</td>
</tr>
<tr>
<td>Lactation</td>
<td>≤18</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>&gt;18</td>
<td>9</td>
</tr>
</tbody>
</table>

~Key Terms~

**Minerals** - Any of a group of inorganic elements that are essential to humans and animals for normal body function.

**Calcium** - A mineral essential in building and maintaining bone, blood clotting, and muscle contractions.

**Osteoclasts** - A type of bone cell that removes bone tissue by removing the bone’s mineralized matrix.

**Osteoblasts** - A cell from which bone develops.

**Iron** - A key mineral in the formation of oxygen binding material, including hemoglobin and myoglobin.

**Electrolytes** - Salts and minerals that produce electrically charged particles (ions) in body fluids and are an important component in maintaining proper hydration status.

Iron-rich foods, particularly animal source iron, to enhance absorption capabilities. As mentioned earlier, eating meat increases iron status more effectively than iron supplements, even when consumed with vitamin C (triples iron absorption rate) (87). Exercise can also augment iron absorption when supported by proper nutrition (54; 77; 94).

**Electrolytes**

Some additional minerals are of particular interest for the fitness professional due to their role in fluid balance. **Electrolytes** are electrically charged ions that come from the minerals sodium, potassium, and chlorine. Sodium and chloride represent the main minerals contained in blood plasma and extracellular fluid, while potassium regulates actions from inside the cell. The electrolytes play a very important role by modulating fluid exchange between the cell and the extracellular environment. The balance is maintained by a well-regulated electrical gradient that enables all the cellular activities required for biological homeostasis to occur. Nervous transmissions, muscle contractions, glandular function, and the regulation of pH balance all depend on the electrical balance control of the electrolytes. Imbalances associated with poor intake of electrolytes in the diet can lead to serious physiological problems. Of major concern is the thermoregulatory system, which depends upon the regulation of water balance to function properly. When the system becomes impaired, heat illness can result, and the possibility of death becomes a relevant issue. Excessive fluid loss from exercise will contain electrolytes. Proper diet and water consumption should be maintained to ensure adequate intake of electrolytes and proper hydration. Beverages containing electrolytes can be a viable re-hydration option.

**Water**

Water constitutes nearly 75% of muscle weight and approximately 50% of fat weight (70). It is the most abundant and important nutrient in the body. Without any water, life can only be sustained for three to five days. It plays a role in almost all the functions of the body as a constituent of compounds, transporter, reactant, and as a principal of gaseous diffusion. As a functional component, water lubricates joints, protects moving organs, provides body volume and form, thermoregulates, and is used in chemical balance and as an ingredient in cellular metabolism. It serves more roles than any other single nutrient in the body. If water consumption does not meet requirements and dehydration occurs, the body fails to function properly.

An important relationship exists between water and minerals within the body, which makes their daily consumption vital for health. Minerals need water to form electrolytes in the body. In turn, water needs minerals to maintain fluid balance inside and outside of the cell membrane. Body water is generally categorized into two compartments: intracellular and extracellular fluids. Most water is found inside of the cells as intracellular fluid, while approximately one-third of body water exists outside of the cell as extracellular fluid. Extracellular fluid includes blood plasma, the water found between the cells (interstitial fluid), lymph, saliva, fluid secreted by glands and organs, as well as the fluids that hydrate the spinal cord. Cells of the body are permeable, so
The **Female Triad** is a combination of disordered eating, amenorrhea, and osteoporosis. It is estimated that 25% or more of female athletes are at risk of suffering the consequences of estrogen imbalance due to insufficient caloric intake and excessive exercise stress. Body fat levels below essential requirements disrupt menstrual activity, causing a reduction in circulating estrogen concentrations (31). The reduced level of estrogen causes calcium regulation to become dysfunctional. When combined with restricted diets that are low in calcium, the risk for osteoporosis is dramatically elevated (64). Common characteristics, signs, and symptoms of the female triad include (11):

- Young adult females
- Lean or low body mass
- Recurrent stress fractures
- Exercise fanatic
- Low self-esteem
- Self critical
- Hard-driving personality
- Highly competitive
- Signs of depression
- Emotional highs and lows

~Quick Insight~

Water moves relatively easily through the cellular membrane as needed by the current physiological environment. This mobility allows the body to maintain a system that prevents cells from losing too much fluid or becoming over saturated. Minerals play an important role in facilitating this regulatory mechanism.

When minerals dissolve in water, they become ions or electrolytes. As stated earlier, the term electrolyte is given to these ions because they have an electrical charge and conduct electricity. When these electrical conductors are maintained in correct concentration within the cell and outside of the cell, water balance is maintained. The electrolyte responsible for maintenance of intracellular fluid volume is potassium, while extracellular fluid is regulated by sodium and chlorine. Magnesium also contributes to the action both inside and outside of the cell but is rarely identified with the other electrolytes (104).

When the cellular environment is disturbed through excess fluid loss, fluid and electrolyte imbalances occur. Individuals experiencing excessive fluid loss through exercise, heat, vomiting, or diarrhea can reach a hazardous state of dehydration (22; 103). When extracellular fluid is lost due to any of these physiological agitators, the reduction of extracellular fluid draws intracellular fluid from the cell in an attempt to restore balance. Exacerbating the problem, electrolytes are also lost during this process. This creates a hazardous situation because the fluid regulatory mechanism is compromised, which in extreme cases, increases potential risk for kidney and heart failure (10; 97; 102). Immediate fluid replenishment is imperative to restore fluid balance once it is lost. In severe cases of dehydration, intravenous therapy is used to increase fluid volumes. In less severe cases, water and electrolyte solutions should be consumed orally. The following charts illustrate normal fluid intake and fluid output pathways.
The sodium-potassium relationship is very important in the maintenance of homeostasis (59). Together, the electrolyte ions regulate the fluid balance in tissues by establishing the proper electrical gradient across cell membranes. When excess salt is consumed in the diet, it increases the excretory function of the kidneys by decreasing aldosterone, the hormone that increases sodium re-absorption. In some cases the excess sodium cannot be adequately regulated, causing too much sodium to remain in the body. The excess sodium pulls water into the blood, causing the blood to become hyperhydrated, thereby increasing the blood pressure. Sodium-induced hypertension occurs in approximately 33% of the individuals who are diagnosed with hypertension (26; 106).

The average American consumes twice the recommended intake of salt in the diet. The high intake is not often met by appropriate balance with potassium. Individuals who have an elevated risk for high blood pressure should reduce salt in their diet and consume adequate quantities of potassium. Tomatoes, potatoes, oranges, bananas, and meat are good sources of potassium.

Daily Fluid Intake
Daily fluid intake is important to prevent dehydration and heat illness. Most people do not consume enough water to meet their daily requirements, particularly when they are physically active. Fluid is gained and lost through a variety of mechanisms. For the average, sedentary person living in normal environmental conditions, 2.5 L of water should be adequate daily consumption (96). When the environment becomes heated and activity is increased in duration and intensity, the physiological demand for water increases dramatically. Fluid intake volumes may increase to 5 L or as much as 10 L under more extreme physiological stress (49; 95).

Three primary sources can serve to satisfy daily fluid intake requirements: liquids consumed, foods consumed, and metabolic processes (see graph). Fluid consumption should attempt to focus on pure water or electrolyte drinks. Some of the hydration effects of soda, coffee, and tea are negated due to the diuretic effects of the caffeine contained in these beverages. Additionally, supplement drinks with creatine, ma huang, or ephedrine can also negatively affect water balance. Healthy food sources, particularly fruits and vegetables, contain considerable amounts of water, whereas fats and sweets have relatively low water content. Metabolic water is created when food molecules are catabolized for energy-forming carbon dioxide and water. This metabolic water provides about 25% of daily water requirements for a sedentary person. During physical activity, carbohydrate breakdown supplies additional water when glycogen liberates the water that bonds with glucose. Each gram of glycogen contains 2.7 grams of water, accounting for more than 1,000 grams of water maintained inside the body when glycogen stores are at full capacity.

Fluid Loss
Water output from the body is a relatively efficient process. The four primary mechanisms for fluid loss include urine, water loss through the skin, water loss as water vapor during respiration, and water lost in feces. Fluid loss through urine is determined by the re-absorption rate of the kidneys, as well as the amount of solute that passes through the kidneys each day. The average re-absorption rate of water is about 99%, leaving roughly 1000-1500 ml of fluid to be excreted as urine each day (9; 32; 78). This fluid loss is increased when protein is used as energy, which accelerates the dehydration rate of the body. The excretory function of removing fecal matter also requires water. To ensure the matter moves easily through the large intestine, water constitutes approximately 70% of the total volume of human excrement (100-200 ml of water). This becomes increasingly relevant when an individual suffers from diarrhea, which can cause a fluid loss between 1500-5000 ml (19).

Water lost from the skin and through respiration accounts for the rest of the fluid lost each day. Water vapor leaves the body with each breath, and accounts for about 250-300 ml of water lost each day through normal respiration. When under the stress of exercise, fluid loss increases due to increased ventilatory requirements and can equal approximately 2 to 5 ml per minute of vigorous exercise, depending on the environment (33; 98). Interestingly, this rate is highest in colder climates and higher altitudes because the body must release water to moisten inspired air to help it move through the pulmonary airways (6; 27; 57).

The skin also experiences increased fluid loss during exercise. Under normal conditions, the skin will lose about 350 ml of fluid per day to “insensible perspiration.” This perspiration occurs as water seeps from deeper tissues out to the skin. Water can also be

<table>
<thead>
<tr>
<th>Energy Nutrient (100g)</th>
<th>Metabolic Water (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrates</td>
<td>55 g</td>
</tr>
<tr>
<td>Protein</td>
<td>100 g</td>
</tr>
<tr>
<td>Fats</td>
<td>107 g</td>
</tr>
</tbody>
</table>
excreted from sweat glands that lie beneath the skin’s surface. Generally, the body will lose between 500-750 ml of water to normal daily sweating. Sweating serves as a refrigeration mechanism to help cool the body. As the body produces sweat, it is evaporated from the skin, causing a cooling effect. This is the body’s best defense against overheating. A heat acclimated body can produce as much as 12 L of sweat in one day at a rate of 1 L per hour during prolonged intense exercise (67).

In addition to the aforementioned conditions and physiological functions of the body, fluid output can be affected by several other factors as well. High protein intake, low-calorie diets, pregnancy and lactation, high sodium consumption, higher fiber diets, and the consumption of moderates, such as alcohol and caffeine all increase the need for additional water intake (21; 93). Each particular factor requires a specific amount of water to compensate for the added fluid lost through one of the four fluid loss mechanisms. Determining how much additional water is necessary requires understanding what facilitated the loss in the first place. Examining each mechanism and its relative mean fluid-loss value will help to determine how much more water must be ingested in order to meet daily need.

Exercise and Fluid Loss

Exercise exacerbates the effects of water loss mechanisms due to cardiovascular adjustments and evaporation. The dissipation of metabolically-generated heat can cause excessive sweating, which may lead to an accompanying reduction of plasma volume, which, in turn, causes fluid shifts out of the intercellular and interstitial compartments. When the environmental climate includes high heat and humidity, the cardiovascular system is taxed by the physiological demands of heat dissipation. During these conditions, the blood must transfer metabolic heat to the periphery for cooling. This requirement reduces the amount of available blood for the delivery of oxygen and is one reason why relative intensity is affected by heated conditions. In addition, exercising in the heat lowers absolute VO₂ because the reduced amount of available blood directly lowers stroke volume. The heart rate increases in an attempt to compensate for the decrease in stroke volume and thereby produces higher heart rates at all submaximal exercise levels. At maximal aerobic capacity, the heart rate cannot make up for the reduced stroke volume and VO₂max is reduced.

During exercise, the body experiences rapid internal temperature changes. Heat generated by the active muscles will lead to an elevated core temperature. A modest rise in core temperature creates the optimal thermal environment for physiologic and metabolic function. Although this response is normal, the thermodynamics of the body still requires a well-regulated heat dissipation response. The hypothalamus in the brain contains the central coordinating center for the regulation of temperature within the body. It is responsible for the thermoregulatory adjustments made in response to deviations in temperature. Heat regulating mechanisms become activated by signals from thermal receptors in the skin and by the temperature of blood, both of which directly stimulate the thermoregulatory center. In response to this information, the body mobilizes fluid for a cooling effect. Evaporation provides the major physiological defense against overheating during rest and activity. When environmental heat and internal heat activated by physical activity are experienced simultaneously, the response is handled primarily by increased perspiration. This results in a decrease of body fluid and leads to rapid dehydration.

Dehydration

The primary controller of hydration status is thirst. Unfortunately, the threshold for the initiation of thirst occurs at a point where a person may already be mildly dehydrated (8; 66; 83). For most people, basing water consumption on thirst will likely lead to inadequate water consumption. This is a particular concern for the elderly as the thirst mechanism becomes impaired due to attenuation of central volume receptors (65; 82). Dehydration occurs at a loss of 1.0% or greater of body weight due to fluid loss and occurs when fluid output is greater than fluid intake. As indicated earlier, water is lost from multiple body functions, and all metabolic activity requires water in some capacity. On average, we replace all of the water in our bodies about once every 10-12 days. Athletes in heavy training generally replace all of their water about once every six days. Whenever fluid dynamics become output dominated, body functions become impaired (≥2% loss of body weight) (46). Moderate exercise can cause a fluid loss of 0.5 to 1.5 L • hour⁻¹. This number significantly increases up to 3 L • hr⁻¹ when conditions become more strenuous, either through increased physical exertion or environmental factors (16; 73; 76). Fluid loss can reach life-threatening levels in a very short period of time, and accumulative fluid loss can be just as dangerous. Consistently losing water over an extended period of time without adequate replenishment can cause a normal bout of exercise to become a significant hazard due to poor hydration status.

The risk of heat related illness, such as a stroke, is greatly increased when the body is dehydrated. This same problem occurs with prolonged exercise.
Hypovolemia and sweat gland fatigue can occur once hydration status reaches a fluid loss greater than 5% of body mass (61). Since most of the fluid lost from sweat is supplied by blood plasma, cardiovascular function is impaired due to a reduced availability of oxygen and a lower cardiac output. This reduction in cardiac output can cause kidney dysfunction, heart dysfunction and possibly death from stroke. Additionally, the reduced blood plasma volume further compromises the body’s thermoregulatory capacity(61) These thermoregulatory and physiologic functions experience decreased efficiency with almost any level of dehydration. The fact that dehydration can occur when swimming, exercising in colder environments, and in higher altitudes is often overlooked (36; 60). Diuretic use also contributes to dehydration status by decreasing the amount of water recycled by the kidneys and thus, increasing urine output. The fluid excreted through urine from diuretic consumption also comes from blood plasma. As mentioned earlier, individuals who consistently consume soda, coffee, or other diuretic-containing beverages instead of water may be impairing their hydration status. The same is true for alcohol consumption.

**Maintaining Proper Hydration**

Fluid replacement is the key to maintaining healthy body dynamics. When proper hydration combines with adequate acclimation to the training and environment, the synergistic effect greatly reduces the risk for dehydration and heat-related illnesses.

**Acclimation**

For individuals with proper acclimation to training stress and environment, plasma volumes are higher; there is an earlier onset of sweating; the body experiences greater sweat distribution; there is an increased release of antidiuretic hormone (ADH) and aldosterone to conserve electrolytes and increase...
recycling of water in the kidneys; and there is improved cutaneous blood flow. The effects of acclimation must be complemented with regularly scheduled fluid consumption throughout the day and during activity. Ingesting fluids during exercise increases blood flow to the skin, causing a more effective cooling process. Strictly following an adequate water replacement schedule prevents dehydration and its consequences, particularly hyperthermia. Fitness professionals must remain diligent about keeping scheduled fluid intakes throughout their client’s training regimens. Most exercisers and athletes underconsume their recommended fluid intake when left to monitor their own intake (23). A fully hydrated individual will experience improvements in performance compared to their efforts during a state of compromised hydration status.

Pre-Exercise Hydration
Pre-exercise hydration can help provide added protection against heat stress due to delayed dehydration and a decrease in core temperature changes (72; 75). This consumption can start 24 hours before the exercise bout or competition and should continue up to 20 minutes before the training begins. Pre-exercise fluid consumption should be approximately 400-600 ml of water, which serves to increase stomach volume and optimizes gastric emptying (51; 61; 71; 74). This pre-exercise hydration can be very important for endurance activities and training in hot climates where it is difficult to balance intake with output.

Hydration During & Post-Exercise
To maintain proper hydration, fluid should be consumed throughout the exercise regimen. Fitness professionals can ensure that hydration status is optimized by tracking urine composition and bodyweight changes. In a well hydrated individual, urine should typically be produced in large volumes, have a limited odor, and exhibit a light coloration. Urine that is dark and gives off noticeable odor suggests the body is dehydrated. Likewise, changes in pre- and post-exercise bodyweight indicate fluid lost during the training bout. Charting training weight differences enables the fitness professional to gauge the normal fluid loss for each client. This provides clear data for fluid replacement quantities. On average, one pound of weight loss equates to 450 ml (15 oz) of water loss.

Time intervals for replenishment are also important factors in maintaining proper hydration status. For fluid loss of 1000 ml per hour, 250 ml of water should be consumed every 15 minutes (50; 61). For fluid loss in excess of 1000 ml per hour the same quantity should be consumed every 10 minutes (67). Identifying the actual amount of fluid lost is the first step to adequately replacing the lost contents.

Rehydration fluid intake does not have to be limited to water. Palatable carbohydrate-electrolyte solutions (4-8% CHO solution) can serve to facilitate more complete hydration than plain water alone (17; 91). This facilitated hydration can be used both during and following exercise and competition. Beverages containing 20-60 mmol/L have shown to increase recovery hydration and electrolyte balance post-exercise (40; 92). Additionally, small amounts of potassium 2-5 mmol/L may enhance the retention of water in intracellular space and may diminish any extra potassium loss from sodium retention by the kidneys (67).

Immediately post-exercise, pure water is quickly absorbed and dilutes the plasma sodium concentration to the point that it decreases plasma osmolarity. This, in turn, increases urine production and inhibits the sodium-dependent stimulation process that initiates the thirst mechanism in the brain. When the fluids have the correct concentration of sodium, plasma sodium concentrations remain elevated, which sustains the thirst sensation, promotes the retention of ingested fluid, and speeds up plasma volume restoration during rehydration (3; 47; 56). Carbohydrate-electrolyte drinks contribute to
the ideal solution for activity and recovery hydration. The glucose solutions stimulate both sodium and water absorption in the intestines. Carbohydrate-electrolyte drinks have proven to be effective in aiding fluid replenishment (15; 58). However, when carbohydrate concentrations are too high, gastric emptying and the rate of intestinal fluid absorption is negatively effected. The total gastric volume plays an important role in the rate of gastric emptying. Higher gastric volumes increase the rate of gastric emptying. Due to the fact that many people experience discomfort when exercising with greater gastric volumes, the carbohydrate concentration is very important if a sports drink is used for hydration.

Sport drinks are intended for individuals who exercise at levels that compromise water balance. Many individuals do not reach the exercise intensities or durations that warrant carbohydrate-electrolyte solutions. The glucose solutions do contain calories in the form of sugar. Over-consuming replenishment drinks can contribute to a positive caloric balance. Water alone does not have any calories and, for low to moderate exercise is probably adequate for the majority of participants.

Selecting Dietary Sources

Knowing what to eat and how much of any given nutrient to consume on a daily basis confuses many people. Trends toward increased rates of obesity and related disease in America warrant the serious concerns held by health organizations. Despite constant advancements in knowledge and medicine, a steady decline in the overall health of the nation continues; evidenced by the increased rate of obesity and related disease. The problems seem to come from a combination of sources, which include:

1. Sound nutritional practices are not reaching the general public in a way that is effective in reducing the rate of weight gain. Many people do not know what nutrients are in what foods, even with clear labels to help them understand food products.

2. Americans are impacted by time and pressure demands, citing them as excuses for poor nutritional choices.

3. The amount of physical activity engaged in does not match the energy being consumed.

4. Manufacturers have developed numerous pitfalls and obstacles to sound nutrition practices by promoting and endorsing quick-fix solutions and by taking advantage of a natural tendency for convenience.

5. The media presents incomplete or incorrect information and no regulatory body sanctions what is being communicated to consumers through print or digital sources.

The government does provide outlets for quality information, but in many cases, it is still very confusing for consumers to use appropriately. The USDA developed the food guide pyramid as an easy tool to provide Americans with a practical approach to good nutrition. The food guide pyramid provides simple guidelines as to where nutrient sources should be derived, as well as the recommended servings from each category. If followed correctly, the pyramid will meet the nutritional needs of approximately 90% of the population.

Food Guide Pyramid

The food guide pyramid should be an easy answer for many of the dietary questions that face Americans. However, it has come under harsh criticism for its effectiveness and practicality, particularly for individuals engaging in weight loss programs. The reasons that some estimates for obesity in the U.S. have broached the 35% mark are a lack of physical activity and the failure of most individuals to eat well-rounded, calorie-controlled diets as suggested by the food guide pyramid. Due to the fact that many Americans maintain low activity levels, consume a diet relatively high in fat and sugar, and commonly ingest more calories than they expend, it is obvious the food guide...
system is not, by itself, adequate to manage America’s nutritional needs. If individual diets consisted of mainly fruits, vegetables, lean meats, and whole grains in the appropriate serving sizes, as defined by the pyramid, obesity would not be such a pressing health issue in the United States.

A drawback to the pyramid system of eating is that most people do not differentiate between smart food choices and poor food selections from each section of the pyramid. For instance, choosing processed carbohydrate sources over whole grain products is very common because few people recognize the difference. Additionally, for many people there is a tendency to select foods that are higher in calories from each group due to taste.

Attempting to follow the food guide pyramid is also challenging because of the time and convenience factor. The reason for this phenomenon is three-fold: 1) it is difficult to monitor food when eating out, 2) convenience foods selected by many people are often high in fat and sugar, and 3) very few people recognize correct serving sizes. Quite often foods at restaurants are served in portions 2 to 4 times that of the recommended amount. In addition, the serving sizes defined by the USDA are much smaller than what is normally consumed in the average household. So, even though someone may believe they are following the pyramid, they are actually over-consuming foods from every category, except the fruit and vegetable groups.

Food Labels
Learning how to read a food label and developing an understanding of serving size portions is the first step to being able to effectively use the pyramid. Actually presenting clients with appropriate serving sizes and portion examples can help them realize dietary intake quantities that fulfill their relative need. The chart describes what a typical serving size should look like from each category.

When foods are purchased in a prepared form rather than individually measurable, reading the labels on the container provides insight into the contents, nutrients, and caloric breakdown of the product; however, knowing the information in a single serving is only useful if the number of servings can be determined from the portion consumed. Individuals often inappropriately
apply the single serving content information to the total amount eaten, even though the portion may be multiple servings. Part of this problem lies in the serving containers used for eating. Plates, bowls, and dishes are often large enough to hold numerous portions. It is a natural tendency to cover a plate or fill a bowl with food. People wind up consuming the entire quantity of food served even if their caloric requirements would be met by a smaller portion.

The food label provides specific information required by the Nutrition Education Labeling Act of 1990. The ingredients are required to be on the label for packaged foods and are listed in descending order by weight. The Nutritional Facts Panel is also required. It identifies the number of servings per container and reflects the amount of food by weight or volume that constitutes a single serving. The serving size is the portion that contains the nutrient amounts listed on the label. The following nutrient information is required of each label:

### Sample Food Label

#### Nutritional Facts

**Serving Size:** 1 cup  
**Servings Per Container:** 4

<table>
<thead>
<tr>
<th>Amount Per Serving</th>
<th>Calories</th>
<th>From Fat</th>
<th>% Daily Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Fat</td>
<td>10g</td>
<td></td>
<td>15%</td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>5g</td>
<td></td>
<td>22.5%</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>24mg</td>
<td></td>
<td>8%</td>
</tr>
<tr>
<td>Sodium</td>
<td>730mg</td>
<td></td>
<td>36.5%</td>
</tr>
<tr>
<td>Total Carbohydrates</td>
<td>26g</td>
<td></td>
<td>9%</td>
</tr>
<tr>
<td>Dietary Fiber</td>
<td>1g</td>
<td></td>
<td>5%</td>
</tr>
<tr>
<td>Sugars</td>
<td>9g</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein</td>
<td>9g</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Vitamin A 5%**  
**Vitamin C 0%**

**Calcium 25%**  
**Iron 6%**

Percent Values are based on a 2,000 calorie diet. Your Daily values may be higher or lower depending on your calorie needs.

<table>
<thead>
<tr>
<th>Calories</th>
<th>2,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total fat</td>
<td>Less than 65g</td>
</tr>
<tr>
<td>Sat fat</td>
<td>Less than 20g</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>Less than 300mg</td>
</tr>
<tr>
<td>Sodium</td>
<td>Less than 2,400mg</td>
</tr>
<tr>
<td>Total Carbohydrates</td>
<td>Less than 300g</td>
</tr>
<tr>
<td>Fiber</td>
<td>Less than 25g</td>
</tr>
</tbody>
</table>

**Calories per gram:**  
**Fat 9**  
**Carbohydrate 4**  
**Protein 4**
Percentage of calories from carbohydrates, fats, and proteins seem like a reasonable way to track energy nutrients, but the actual implementation methodology required to correctly track energy intake this way is very difficult. Essentially, a person would have to know their total caloric intake, the specific number of calories from each energy source, and know how to convert the energy value into a percentage. Obviously exact serving sizes and knowledge of every food consumed would be required for true accuracy. This is not a reasonable method for tracking dietary intake because it is much too difficult to employ, requires specific competencies in math conversions, and would require knowledge of all food contents ingested. Below is the conversion method used to convert energy nutrient weight into the percentage of dietary calories.

**Converting Grams to Percentages**

125 grams of fat consumed through a 2700 kcal diet.

\[
\frac{125 \text{ grams} \times 9 \text{ kcal/gram}}{2700 \text{ kcal diet}} = 41\% \text{ fat}
\]

**Food Description** terminology can also become confusing. For most consumers looking to avoid adding extra pounds, boxes labeled light, low-fat, non-fat, and reduced-calorie all look very appealing, but very few people recognize what the terms actually mean.

**Nutrient Content** descriptors are used to market foods based on improved consumer health awareness. The FDA and Food Safety and Inspection Service of the USDA regulate the specific descriptive information found on food labels. The following terms are commonly found on many food product labels.

Consumers can rely on the descriptors because they are properly regulated, but some confusion still exists as to when they are appropriate. For instance, a jelly bean package advertises itself as fat-free, but the food is basically pure sugar. True, the product does not contain fat, but jelly beans never have contained fat, so labeling the package fat-free is obviously done to confuse consumers into thinking it is a healthier food. Personal trainers need to educate their clients to appropriate food selection and make them aware of how to use the food labels and recognize the meaning of the labeling descriptors.

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**~Key Terms~**

**Food Guide Pyramid** - A diagram used in nutrition education which shows the suggested quantity of food from each food group that an individual should consume each day.

**Nutritional Facts Panel** - A label on consumer products that identifies servings per container, amount of food by weight or volume that constitutes a single serving, and relevant nutritional information.

**Daily Values** - Indicates the amount of a nutrient that is provided by a single serving of a food item.

**Food Description** - Terminology in describing food as light, low-fat, non-fat, and reduced calorie.

**Nutrient Content** - Descriptions used to market foods based on improved consumer standards.
**Food Descriptors**

**Free** - often associated with fat-free or sugar-free, means the product contains no amount of, or only trivial quantities of, the referred components. Less than 0.5 g per serving or less than 5 kcal per serving.

**Low** - can be used if the foods can be consumed regularly without causing excessive intakes of its referred components.

**Low-Calorie** - less than 40 kcal per serving.

**Low-Fat** - less than 3g per serving.

**Low-Cholesterol** - less than 20 mg per serving.

**Low-sodium** - less than 140 mg per serving.

**Light** - has three possible meanings: 1) 1/3rd fewer calories or half the fat, 2) the sodium content of a low calorie, low fat food has been reduced by 50%, 3) the term describes the color, texture or other property as long as it explains intent e.g. "light brown sugar."

**Reduced** - the contents contain at least 25% less of the component than the referenced product.

**Lean** - less than 10g fat, 4.5g or less saturated fat, and less than 95 mg of cholesterol per serving and per 100 g.

**Extra Lean** - less than 5 g of fat, less than 2 g of saturated fat, less than 95 mg of cholesterol per serving.

**Good Source** - 10-19% of the Daily Value.

**High In** - 20% or more of the Daily Value.

**Extra** - at least 10% more than the Daily Value in the reference food.

**Very Low Sodium** - 35 mg or less sodium.

**Sodium Free** - less than 5 mg per serving.

**High Fiber** - 5g or more per serving.

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**Chapter Eight References**


