Chapter 2
Nutritional Needs

Research Dietitian
Conducts nutrition research to expand knowledge in dietetics.

Teaching Dietitian
Plans and conducts classes in nutrition and foodservice systems for dietetic interns and medical personnel.

Dietetic Technician
Provides services in assigned areas of foodservice management, teaches principles of food and nutrition, and provides dietary consultation under direction of a clinical dietitian.

Objectives
After studying this chapter, you will be able to
- name the key nutrients, describe their functions, and list important sources of each.
- analyze the effects of various nutrient deficiencies and excesses.
- explain the processes of digestion, absorption, and metabolism.

Terms to Know
- nutrient
- nutrition
- malnutrition
- deficiency disease
- dietary supplement
- fortified food
- carbohydrate
- glucose
- fiber
- fat
- fatty acid
- hydrogenation
- trans fatty acid
- cholesterol
- protein
- amino acid
- protein-energy malnutrition (PEM)
- vitamin
- fat-soluble vitamin
- water-soluble vitamin
- night blindness
- rickets
- scurvy
- beriberi
- pellagra
- anemia
- mineral
- macromineral
- trace element
- osteoporosis
- hypertension
- goiter
- digestion
- absorption
- peristalsis
- saliva
- metabolism
The foods you eat can affect your state of health. Food provides nutrients. Nutrients are chemical substances that help maintain the body.

Nutrition is the study of how your body uses the nutrients in the foods you eat. If you do not eat the foods your body needs, you may suffer from malnutrition. Malnutrition, in its simplest form, is a lack of the right proportions of nutrients over an extended period. Besides an inadequate diet, malnutrition can be caused by the body's inability to use nutrients from foods. In either case, the body does not receive all the nutrients it needs. Energy, growth, repair, and the regulation of various body processes can all be impaired.

Eating enough food does not necessarily mean you are eating all the foods you need. The amount of food eaten is not as important as the right variety of foods. A person who is malnourished may be overweight or underweight. Some of the effects of malnutrition may be long lasting. The foods a teenage girl eats today may affect her pregnancy in later years. The foods a pregnant woman eats may affect her unborn child's development. The foods a child eats may affect his or her growth and resistance to disease. Each person's health and life span may be affected by his or her food choices.

### The Nutrients

You need over 50 nutrients for good health. Some of the nutrients supply energy for the body. All the nutrients help build and maintain cells and tissues. They also regulate bodily processes such as breathing. No single food supplies all the nutrients the body needs to function.

You can divide all nutrients into the following six groups: carbohydrates, fats, proteins, vitamins, minerals, and water. A diet that meets the body's needs contains nutrients from all six groups in the right proportions.

Failure to meet your nutrient needs may result in a deficiency disease. This is an illness caused by the lack of a sufficient amount of a nutrient. Different deficiency diseases are caused by the lack of different nutrients.

#### Dietary Supplements

In an effort to meet their nutrient needs, some people choose to take dietary supplements, 2-1. These are purified nutrients that are manufactured or extracted from natural sources. Supplements usually come in tablet, capsule, liquid, or powder form. Some, such as vitamin C tablets, contain single nutrients. Others, like multivitamin capsules, contain a number of nutrients.

You should know supplements are considered to be neither food nor drugs. Therefore, they are not regulated by the Food and Drug Administration (FDA). No laws require manufacturers to prove their supplement products are safe. Manufacturers do not have to prove the claims they make about products are true, either. This does not mean all supplements are harmful. In fact, many products have been safely used for years. However, some products have been taken off the market because they were shown to have harmful effects.

Most health experts agree the best way to get the nutrients you need is to eat a varied diet. However, some people have trouble meeting all their nutrient needs from food alone. Doctors may suggest these people take a dietary supplement to help make up for any shortages in their diets. Seek the advice of a dietician or a physician before taking any supplements. Avoid supplements that provide large doses of single nutrients.

#### Functions of Carbohydrates

The main function of carbohydrates is to furnish the body with energy. You will learn that fats and proteins can also provide the body with energy. However, carbohydrates are the only source of energy the brain can use. Also, the body can use carbohydrates as an energy source more readily than fats or proteins. Fats serve as long-lasting energy reserves. Proteins are mainly needed to build and repair body tissues—functions they cannot perform if they are being used for energy.

#### Carbohydrates

Carbohydrates are the body's chief source of energy. Most carbohydrates come from plant foods. Three main types of carbohydrates are important in the diet—sugars, starches, and fiber.

Because of their molecular structure, sugars are sometimes called simple carbohydrates. The diet includes six types of sugars. At the molecular level, glucose, fructose, and galactose are made up of single sugar units. Glucose is the form of sugar carried in the bloodstream for energy use throughout the body. Therefore, it is sometimes called blood sugar. Fructose, which is also known as fruit sugar, is the sweetest of all sugars. See 2-2. A third sugar is galactose. It is found attached to glucose to form the sugar in milk.

Sucrose, lactose, and maltose are made up of pairs of sugar units. Sucrose is ordinary table sugar. The milk of mammals contains lactose, or milk sugar. Grain products contain maltose, or malt sugar.

2-1 Many people take dietary supplements to help meet the need for nutrients that may be lacking in their diets.

2-2 Fruits are good sources of fructose, the sweetest of all sugars.
Functions performed by fiber are linked to the prevention of heart disease and some types of cancer. Fiber binds to a compound made from cholesterol and carries it out of the body. This helps lower blood cholesterol levels, which reduces the risk of heart disease. Fiber stimulates the action of the muscles in the digestive tract, helping speed food through the body. The bulk created by fiber may also help dilute carcinogens (cancer-causing agents) in food. Experts believe these functions may help reduce the risks of cancer. Therefore, experts advise men through age 50 to consume 38 grams of fiber each day. They advise women to consume 25 grams daily. Recommended intakes drop a bit for older adults.

Sources of Carbohydrates

Many foods are rich sources of carbohydrates. Foods high in simple carbohydrates include sugars, syrups, soft drinks, jams, jellies, candies, and other sweets. Sources of starch are breads, cereals, pasta products, and rice. Some vegetables, such as corn, potatoes, and dry beans and peas, are also high in starch. Whole grain cereal products and fresh fruits and vegetables are good sources of fiber.

Carbohydrate Deficiencies and Excesses

Foods high in carbohydrates are abundant and inexpensive. Therefore, deficiencies in the United States are usually the result of self-prescribed limitations. A diet low in carbohydrates may cause the body to use protein as an energy source. This can interfere with the normal growth and repair of body tissues. It can also create a chemical imbalance in the body that could be dangerous if it is allowed to continue. If fiber is lacking in the diet, constipation may occur.

Food energy is measured in calories. Nutrition experts recommend that most of the calories in your diet come from complex carbohydrates, especially those high in fiber, 2-3. They also recommend limiting the number of calories consumed from fat. Eating a diet high in whole grain breads and cereals will accomplish both goals. These foods are fiber-rich sources of complex carbohydrates. By consuming more calories from these foods, you may consume fewer calories from foods high in fat.

Too many simple carbohydrates in the diet can be a health concern. Foods high in sugars, such as candy and soft drinks, tend to be low in other nutrients. Eating simple carbohydrates in place of other foods may deprive the body of needed nutrients. Eating too many simple carbohydrates in addition to other foods increases the risk of unhealthful weight gain.

Bacteria in the mouth act on sugar and starch to produce acid. This acid can erode teeth, causing tooth decay and gum disease. To help avoid these problems, dentists recommend limiting snacks between meals, especially sticky sweets. They also suggest brushing teeth after eating, flossing daily, and getting regular dental checkups.

Q: Does eating too much sugar cause diabetes?

A: Diabetics have to watch their carbohydrate intake, but eating too much sugar does not cause diabetes. However, it can cause weight gain, and being overweight is a risk factor for diabetes.
Doctors urge people to take steps to keep their blood cholesterol levels within a safe range. However, cholesterol in the diet has only a small effect on cholesterol in the blood. A later section describes other factors that have a greater impact on blood cholesterol.

You should note that your body makes the cholesterol it needs. Therefore, you do not need to include cholesterol in your diet.

**Functions of Fats**

Fats in the diet serve a number of important roles. They provide a source of energy. They carry certain vitamins. Fats also carry flavor substances that make food taste good. They make foods such as meats and baked goods tender, which makes these foods more appealing. Fats help you feel full after eating, too.

Your body needs various fatty acids to make other important compounds, such as hormones. The body can produce some of the fatty acids it needs. However, there are a few fatty acids the body cannot produce. These are called essential fatty acids. You must obtain these fatty acids from the foods you eat.

Fats have many other important functions in the body. The body stores energy in fatty tissues. Besides serving as energy reserves, these tissues form cushions that help protect internal organs from injury. Fat under your skin forms a layer of insulation that helps maintain your body temperature. Fats are also part of the membrane that surrounds every cell in the body.

**Sources of Fats**

Saturated fats raise blood cholesterol levels. Eggs and many dairy products and meats are significant sources of these fats. That is why health experts advise limiting eggs and choosing lowfat or fat free dairy products and lean meats most often. Mono- and polyunsaturated fats do not raise blood cholesterol levels. Therefore, most of the fats in your diet should be mono- and polyunsaturated. Fish, nuts, and vegetable oils are rich in these types of fats. Olives and avocados are high in these fats, too. See 2-5.

**Fat Deficiencies**

Fat deficiencies are rare in the United States. However, a diet too low in fat may result in a loss of weight and energy. Also, too little fat may cause deficiencies of the fatty acids and fat-soluble vitamins carried by fats.

**Limiting Excess Fats and Cholesterol**

The typical diet in the United States is high in fat. A high-fat diet can contribute to weight problems. This is because fat is a concentrated source of food energy. Fat provides more than twice as many calories per gram as carbohydrates and proteins. Therefore, a diet that is high in fat may also be high in calories. Your body burns calories for the energy needed for movement and the maintenance of body processes. However, if your diet provides more fat or calories than your body needs, your body will store the excess as fat tissue.

Experts recommend no more than 35 percent of the calories in your daily diet should come from fat. No more than 10 percent of total calories should come from saturated fat. You should limit your daily cholesterol intake to 300 mg. These recommendations are based on more than possible weight problems. Saturated fats and, to a lesser extent, dietary cholesterol can increase the blood cholesterol level. Another type of fat that raises blood cholesterol is the trans fat found in hydrogenated vegetable oils. High blood cholesterol is one of several risk factors for heart disease. High-fat diets have also been linked to increased risk of several types of cancer.

Choosing a diet moderate in total fat means eating a variety of fruits, vegetables, legumes, and grain products. You should opt for lean meats, skinless poultry, and fish as well as lowfat and fat free dairy products. For a diet low in saturated fats, limit high-fat meat and full-fat dairy products. Choose fats and oils that have less than 2 grams of saturated fat per serving. Liquid and tub margarine and olive and canola oils meet this guideline. To reduce trans fat in your diet, limit foods that list hydrogenated oils on their ingredient lists. Such foods include many stick margarines and some cookies, chips, and crackers. Commercially fried foods, such as French fries and doughnuts, are also usually fried in these types of oils. To keep dietary cholesterol in check, limit egg yolks and cook with vegetable oil instead of animal fat.

**Proteins**

Proteins are chemical compounds that are found in every body cell. They are made up of small units called amino acids. Scientists have found 20 amino acids that are important to the human body. Nine of these amino acids are called essential amino acids. The body cannot make any essential amino acids. It can make others, but not at a rate fast enough to meet nutritional needs. Therefore, you must get the essential amino acids from the foods you eat. The other 11 amino acids are called nonessential amino acids. You do not have to get these amino acids from foods because your body can make them fast enough to meet its needs.

Animal foods and soybeans have complete proteins, 2-6. These proteins contain all nine essential amino acids. Complete proteins will support growth and normal maintenance of body tissues. Most plant foods have incomplete proteins. These proteins are missing one or more of the essential amino acids. Incomplete proteins will neither support growth nor provide for normal maintenance.
Protein needs are based mainly on age, body size, and physical state. Children need more protein per pound of body weight than adults because they are growing so rapidly. Likewise, adult men and women need the same amount of protein. Therefore, because men generally weigh more than women, they need more protein each day. Pregnant women need extra protein to support the growth of their developing babies. Nursing women need extra protein to produce milk.

Sources of Protein

Important sources of complete protein are lean meats, poultry, fish, milk, cheese, and eggs. Dried beans, peas, and nuts are sources of incomplete protein. Grain products and vegetables provide smaller amounts of incomplete protein.

Protein Deficiencies and Excesses

If the diet does not contain enough protein and calories, a condition called protein-energy malnutrition (PEM) may result. In adults, symptoms of this condition include fatigue and weight loss. In children, this condition can lead to diarrhea, infections, poor brain development, and stunted growth. PEM is common in many underdeveloped areas of the world. However, even wealthy nations have hungry people who are affected by PEM. People who fail to get enough food for reasons such as drug addictions or eating disorders may also suffer from PEM.

If the diet contains too much protein, the body converts the extra protein to fat and stores it in the fat tissue. The body cannot convert stored protein back into amino acids for use in building tissues. Eating nutritious foods at meals throughout the day will maintain your body’s supply of amino acids. See 2-7.

Vitamins

Vitamins are complex organic substances. You need them in small amounts for normal growth, maintenance, and reproduction. Your body cannot produce most vitamins, at least not in large enough amounts to meet your nutritional needs. The best way to get all the vitamins you need is to eat a nutritious diet.

Vitamins are either fat-soluble or water-soluble. Fat-soluble vitamins dissolve in fats. They are carried by the fats in foods and can be stored in the fatty tissues of the body. Over time, fat-soluble vitamins can build up in the body and may reach dangerous levels. Water-soluble vitamins dissolve in water. The body does not store them to any great extent. Instead, excess water-soluble vitamins are carried out of the body in the urine.

Although the body does not store large amounts of water-soluble vitamins, consuming large quantities may still be harmful. You are not likely to get harmful quantities of fat- or water-soluble vitamins from the foods you eat. However, taking large doses of vitamin supplements could put you at risk of developing symptoms of toxicity or poisoning.

Vitamins A, D, E, and K are the fat-soluble vitamins. Vitamin C and the B-complex vitamins are water-soluble.

Vitamin A

The body uses vitamin A to make a chemical compound the eyes need to adapt to darkness. Vitamin A promotes normal bone growth. The health of tissues such as skin and mucous membranes also depends on the presence of vitamin A.

Sources of Vitamin A

Your body obtains vitamin A in two forms. The first form is the vitamin itself. Vitamin A is in foods like liver, egg yolk, whole milk and fortified dairy products, butter, and fish oils.

The second form of vitamin A is beta-carotene. This is a provitamin, which is a substance the body can convert into a vitamin. Beta-carotene is in plant foods. Deeper color indicates the presence of more beta-carotene. Therefore, orange and dark green fruits and vegetables normally have a higher vitamin A value than lighter colored produce.

Vitamin A Deficiencies and Excesses

If the diet contains too little vitamin A, the eyes will become sensitive to light. They may develop night blindness, which is a reduced ability to see in dim light. The skin will become rough, and susceptibility to disease may increase. In severe cases, stunted growth may result.

People seldom get too much vitamin A from food. However, if they take too much vitamin A supplements, fatigue, headaches, nausea, vomiting, and liver damage may eventually occur.

Vitamin D

The major function of vitamin D is to promote the growth and proper mineralization of bones and teeth. Vitamin D performs this function by helping the body use the minerals calcium and phosphorus.

Sources of Vitamin D

Vitamin D occurs naturally in a few foods. These include eggs, liver, and fatty fish. In addition, vitamin D is added to most milk as well as some cereals and margarine, 2-8.

The body can also make vitamin D with sun exposure. Vitamin D is made when the skin is exposed to sunlight. Thus, people call vitamin D the “sunshine vitamin.” Sunlight helps convert a substance found in the skin to vitamin D. Advanced age, darker skin color, sunscreen, heavy clothing, and smog all decrease the production of vitamin D in the skin.

Sun exposure is linked to about 30 percent of all cancers. However, you do not have to be in the sun for long periods to manufacture vitamin D. Therefore, you should follow advice for using sunscreens, wearing protective clothes, and avoiding dangerous exposure times. Most people who drink milk and enjoy normal outdoor activities will get enough vitamin D to meet their needs.
Vitamin D Deficiencies and Excesses

If the diet does not contain enough vitamin D, the body will not be able to use calcium and phosphorus as it should. In severe cases, children with vitamin D deficiencies can develop a disease called rickets. Symptoms of rickets include crooked legs and misshapen breastbones. Adults may develop other bone abnormalities.

If the diet contains too much vitamin D, the body will store the excess. Over an extended period, excesses of vitamin D may result in nausea, diarrhea, and loss of weight. In severe cases, kidneys and lungs may be damaged, and bones may become deformed.

Vitamin E

In humans, vitamin E functions mainly as an antioxidant. This is a substance in foods that significantly reduces the harmful effects of oxygen on normal body functions. Some cells in the body, such as cells in the lungs, are constantly exposed to high levels of oxygen. Oxygen can destroy the membranes of these cells. When vitamin E is present, however, it combines with the oxygen before the oxygen can react with and harm the cells. Vitamin E also keeps oxygen from reacting with red and white blood cells, fatty acids, carotene, and vitamin A. Cell damage and substance breakdown due to oxygen exposure has been linked to several diseases, including heart disease and cancer.

Sources of Vitamin E

Vitamin E is widely distributed throughout the food supply. Sources include fats and oils, whole grain breads and cereals, liver, eggs, whole milk dairy foods, and leafy green vegetables.

Vitamin E Deficiencies and Excesses

The average diet in the United States supplies sufficient amounts of vitamin E. Therefore, deficiencies are rare. However, premature infants may have deficiencies. Babies that do not reach full term fail to receive enough vitamin E from their mothers before birth. Toxicity from excess dietary vitamin E also seems to be rare. However, people who take large doses of vitamin E supplements are at increased risk of hemorrhage.

Vitamin K

Vitamin K is known as the blood-clotting vitamin. Vitamin K performs this function by helping the liver make a substance called prothrombin. Prothrombin is a protein blood needs to clot. If vitamin K is not available, the liver cannot form prothrombin and blood cannot clot properly.

Sources of Vitamin K

Bacteria in the human intestinal tract can make vitamin K. Leafy green vegetables and cauliflower are good dietary sources of vitamin K. Additional sources include other vegetables, organ meats, and egg yolk.

Vitamin K Deficiencies and Excesses

Most people receive enough vitamin K from the foods they eat. Deficiencies are more likely due to a body’s inability to absorb or make vitamin K. In cases where deficiency is severe, hemorrhaging can occur due to lack of blood clotting.

The amount of vitamin K consumed in a normal diet is not harmful. However, toxicity can develop through the use of vitamin K supplements. See 2-9.

Vitamin C

Vitamin C, which is also known as ascorbic acid, performs many important functions in the body. It helps in the formation and maintenance of collagen, a protein that is part of connective tissue. Collagen is the cementing material that holds body cells together. Vitamin C helps make the walls of blood vessels firm, and it helps wounds heal and broken bones mend. It aids in the formation of hemoglobin (a substance in red blood cells) and helps the body fight infections. It also functions as a dietary antioxidant.

Sources of Vitamin C

Fresh fruits and vegetables are the best sources of vitamin C in the diet. Citrus fruits, strawberries, and cantaloupe are good fruit sources of vitamin C. Leafy green vegetables, green peppers, broccoli, and cabbage are good vegetable sources.

Vitamin C Deficiencies and Excesses

Because vitamin C is a water-soluble vitamin, the body cannot readily store it. Therefore, you need a daily supply. People who smoke face increased oxygen damage in the body and thus need extra vitamin C for its antioxidant effects. Too little vitamin C in the diet can cause poor appetite, weakness, bruising, and soreness in the joints. A

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2-8 Fortified milk is a key source of vitamin D for many people.

2-9 The fat-soluble vitamins can be stored in the body.
prolonged deficiency may result in a disease called scurvy. Symptoms of this disease include weakness, bleeding gums, tooth loss, and internal bleeding.

Vitamin C does help the body fight infection. However, scientists do not agree it will prevent or cure the common cold. Avoid taking vitamin C supplements unless directed to do so by a physician. Excess vitamin C may cause nausea, cramps, and diarrhea.

**Thiamin**

Thiamin, or vitamin B₁, is part of a larger group of vitamins called the B-complex vitamins. All the B-complex vitamins are water-soluble. Each B vitamin has distinct properties. However, they work together in the body.

Thiamin helps the body release energy from food. It forms part of the coenzymes needed for the breakdown of carbohydrates. (Coenzymes are chemical substances that work with enzymes to promote enzyme activity.) Thiamin helps promote normal appetite and digestion. It also helps keep the nervous system healthy and prevent irritability.

**Sources of Thiamin**

Nearly all foods except fats, oils, and refined sugars contain some thiamin. However, no single food is particularly high in this vitamin. Wheat germ, pork products, legumes, and whole grain and enriched cereals are good sources of thiamin, 2-10.

**Thiamin Deficiencies**

Too little thiamin in the diet will first cause nausea, apathy, and loss of appetite. A severe thiamin deficiency can result in a disease of the nervous system called beriberi. It begins with numbness in the feet and ankles followed by cramping pains in the legs. The next stage is leg stiffness. If the deficiency is prolonged, paralysis and potentially fatal heart disturbances may result.

Cooking foods in water can cause a loss of water-soluble vitamins. To preserve the vitamin value of foods, use only a small amount of cooking water. Also, keep the cooking time as short as possible. You can preserve the vitamins lost in cooking liquid by using the cooking liquid in gravies, sauces, and soups.

**Riboflavin**

Riboflavin, or vitamin B₂, is the second member of the B-complex group. Riboflavin forms part of the coenzymes needed for the breakdown of carbohydrates. It helps cells use oxygen and helps keep skin, tongue, and lips normal. Helping to prevent scaly, greasy areas around the mouth and nose is also a function of riboflavin.

**Sources of Riboflavin**

Organ meats, milk and milk products, eggs, and oysters are good sources of riboflavin. Leafy green vegetables and whole grain and enriched cereal products are good sources, too.

**Riboflavin Deficiencies**

Too little riboflavin in the diet can cause swollen and cracked lips and skin lesions. Later symptoms include inflammation of the eyes and twilight blindness.

**Niacin**

Niacin forms part of two coenzymes involved in complex chemical reactions in the body. It helps keep the nervous system, mouth, skin, tongue, and digestive tract healthy. Niacin also helps the cells use other nutrients.

**Sources of Niacin**

The most common sources of niacin include muscle meats, poultry, peanuts, and peanut butter, 2-11. The body can convert tryptophan, one of the essential amino acids, into niacin. Milk contains large amounts of tryptophan.

**Niacin Deficiencies and Excesses**

Too little niacin in the diet can cause a disease called pellagra. Skin lesions and digestive problems are the first symptoms. Mental disorders and death may follow if the disease goes untreated. Pellagra normally occurs only when the diet is limited to just a few foods that are not good sources of niacin.

Excess niacin from food has not been reported to cause health problems. However, too much niacin from supplements can cause nausea; vomiting; and a red flushing of the face, chest, and arms.

**Vitamin B₆**

Vitamin B₆ helps nerve tissues function normally and plays a role in the regeneration of red blood cells. It takes part in the breakdown of proteins, carbohydrates, and fats. Vitamin B₆ also plays a role in the reaction that changes tryptophan into niacin.

**Sources of Vitamin B₆**

Vitamin B₆ is in many plant and animal foods. The best sources of this vitamin are muscle meats, liver, vegetables, and whole grain cereals.

**Vitamin B₆ Deficiencies**

Vitamin B₆ is in so many foods that a deficiency rarely occurs naturally. In cases of prolonged fasting, however, a B₆ deficiency can occur. Skin lesions, soreness of the mouth, and a smooth red tongue can develop. In advanced cases, nausea, vomiting, weight loss, irritability, and convulsive seizures may result.
Folate

Folate is another B-complex vitamin. It helps the body produce normal blood cells. It plays a role in biochemical reactions in cells that convert food into energy. Folate is especially important in the diets of pregnant women and is often given to them as a supplement. It has been shown to help prevent damage to the brain and spinal cord of unborn babies.

Sources of Folate

Food sources of folate include broccoli, asparagus, leafy green vegetables, and dry beans and peas. Liver, yogurt, strawberries, bananas, oranges, and whole grain cereals are good sources, too, 2-12. Most enriched bread and cereal products, including flour, pasta, and rice, are fortified with a form of folate.

Folate Deficiencies

A poor diet, impaired absorption, or an unusual need by body tissues may cause folate deficiencies. Symptoms include inflammation of the tongue and digestive disorders, such as diarrhea. Folate deficiency can also result in two types of anemia. This is a condition that reduces the number of red blood cells in the bloodstream. This decreases the amount of oxygen the blood can carry. Symptoms of anemia include weakness and fatigue. People often associate anemia with a deficiency of iron. However, deficiencies of several vitamins and minerals can lead to various types of anemia.

Vitamin $B_{12}$

Vitamin $B_{12}$ promotes normal growth. It also plays a role in the normal functioning of cells in the bone marrow, nervous system, and intestines.

Sources of Vitamin $B_{12}$

Vitamin $B_{12}$ is in animal protein foods and brewer’s yeast. Many cereals and breakfast foods are also fortified with this vitamin. A nutritious diet that includes animal foods should supply enough vitamin $B_{12}$. However, plant foods do not provide vitamin $B_{12}$. Therefore, strict vegetarians need to eat fortified foods or take a supplement to avoid a deficiency.

Vitamin $B_{12}$ Deficiencies

In simple cases of vitamin $B_{12}$ deficiency, a sore tongue, weakness, loss of weight, apathy, and nervous disorders may result. In extreme cases, pernicious anemia can develop. This is a chronic disease typified by abnormally large red blood cells. It also disturbs the nervous system, causing depression and drowsiness. Pernicious anemia can be fatal unless treated.

Pantothenic Acid

Pantothenic acid is part of the B-complex group of vitamins. Its main function is as a part of coenzyme A. The body needs coenzyme A to use the energy nutrients. Pantothenic acid also promotes growth and helps the body make cholesterol.

Sources of Pantothenic Acid

Pantothenic acid is in all plant and animal tissues. Organ meats, yeast, egg yolk, bran, wheat germ, and dry beans are among the best sources of pantothenic acid. Milk is also a good source.

Pantothenic Acid Deficiencies

Pantothenic acid is in so many foods that deficiencies are rare. In cases where a deficiency does exist, symptoms include vomiting, sleeplessness, and fatigue.

Biotin

Of all the B-complex vitamins, biotin is one of the least well known. However, it is as essential in the diet as the other B vitamins. The body needs biotin for the breakdown of fats, carbohydrates, and proteins. It is also an essential part of several enzymes.

Sources of Biotin

Biotin is in both plant and animal foods. Kidney and liver are the richest sources of biotin. Chicken, eggs, milk, most fresh vegetables, and some fruits are also good sources.

Biotin Deficiencies

Because biotin is in most foods, deficiencies are rare. Symptoms of a biotin deficiency are scaly skin, mild depression, fatigue, muscular pain, and nausea. See 2-13.

Minerals

Carbohydrates, fats, proteins, and water make up about 96 percent of your body weight. Minerals are inorganic substances that make up the other 4 percent. Minerals become part of the bones, soft tissues, and body fluids. Minerals also help regulate body processes. Scientists have found the body needs at least 21 minerals for good health. However, they do not yet completely understand the roles of some of these minerals.

The body contains larger amounts of some minerals than others. Macrominerals are minerals needed in the diet in amounts of 100 or more milligrams each day. Calcium, phosphorus, magnesium, sodium, potassium, and chlorine are macrominerals. Microminerals, or trace elements, are minerals needed in amounts less than 100 milligrams per day. Iron, zinc, iodine, and fluorine are among the trace elements. They are just as important for good health as macrominerals.

Calcium

The body contains more calcium than any other mineral. Most of the calcium is in the bones and teeth. The fluids and soft tissues contain the rest. The body stores a reserve of excess calcium inside long bones.

Calcium combines with phosphorus to build and strengthen bones and teeth. Calcium helps blood clot and keeps the heart and nerves working properly. It also helps regulate the use of other minerals in the body.

Sources of Calcium

Milk and milk products like yogurt and cheese are the best food sources of calcium. Some cereals, fruit juices, and other foods are fortified with calcium. Foods that are labeled “good source of calcium” provide 10 to 19 percent of the recommended daily amount for most people. Foods that are labeled “excellent source of calcium” provide 20 percent or more. Whole fish, green vegetables, and broccoli also provide some calcium in the diet. Calcium supplements are available. However, most experts agree food sources supply the most beneficial balance of calcium with other nutrients (like phosphorus and vitamin D).

Osteoporosis

Children with severe calcium deficiencies may develop malformed bones. However, these bone disorders are most often the result of a vitamin D deficiency. This is because vitamin D affects the body’s ability to use calcium.

Many teens and adults in the United States, especially females, do not get the recommended daily intake of calcium. If the diet does not supply enough calcium, the body will take the calcium it needs from the bones. This becomes an increasing problem in old age, when bone mass naturally decreases. Bones weakened further by the draw on their calcium supply become porous and brittle. This is a condition known as osteoporosis.

Osteoporosis affects millions of people in the United States. It causes many fractures of hips and other bones. Resulting complications make osteoporosis a leading cause of crippling and death. Women are most often afflicted because they have less bone mass than men. Osteoporosis is also related to hormone changes that take place in older women. Therefore, women who have gone through menopause are at the greatest risk of developing this disease.

Doctors cannot correct osteoporosis. However, obtaining enough calcium (and phosphorus) can help prevent it. This is especially important during the growth years when bones are developing and the body more readily absorbs calcium. Research has shown that being physically active throughout life can also help reduce the risk of osteoporosis. This is because performing weight-bearing activities, such as walking, helps increase bone mass.
**Water-Soluble Vitamins**

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<td>Biotin</td>
<td>Helps the body break down the energy nutrients</td>
<td>Chicken, eggs, fresh vegetables, kidney, liver, milk, some fruits</td>
</tr>
<tr>
<td></td>
<td>Forms part of several enzymes</td>
<td></td>
</tr>
<tr>
<td>Folate</td>
<td>Helps produce normal blood cells</td>
<td>Asparagus, bananas, broccoli, fortified bread and cereal products, leafy green vegetables, legumes, liver, oranges, strawberries, whole grain cereals, yogurt</td>
</tr>
<tr>
<td></td>
<td>Helps convert food into energy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Helps prevent damage to the brain and spinal cord of unborn babies</td>
<td></td>
</tr>
<tr>
<td>Niacin</td>
<td>Helps keep nervous system healthy</td>
<td>Dried beans and peas, enriched and whole grain breads and cereals, fish, meat, milk, poultry, peanut butter, peanuts</td>
</tr>
<tr>
<td></td>
<td>Helps keep skin, mouth, tongue, and digestive tract healthy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Helps cells use other nutrients</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Forms part of two coenzymes involved in complex chemical reactions in the body</td>
<td></td>
</tr>
<tr>
<td>Pantothenic Acid</td>
<td>Forms part of a coenzyme needed to release energy from carbohydrates, fats, and proteins</td>
<td>Bran, dry beans, egg yolk, milk, organ meats, wheat germ, yeast</td>
</tr>
<tr>
<td></td>
<td>Promotes growth</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Helps the body make cholesterol</td>
<td></td>
</tr>
<tr>
<td>Riboflavin</td>
<td>Helps cells use oxygen</td>
<td>Cheese, dark green leafy vegetables, eggs, fish, ice cream, liver and other meats, milk, poultry</td>
</tr>
<tr>
<td></td>
<td>Helps keep skin, tongue, and lips normal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Helps prevent scaly, greasy areas around the mouth and nose</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Helps prevent irritability</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Forms part of the coenzymes needed for the breakdown of carbohydrates</td>
<td></td>
</tr>
<tr>
<td>Thiamin</td>
<td>Helps promote normal appetite and digestion</td>
<td>Dried beans, eggs, enriched or whole grain breads and cereals, fish, pork and other meats, poultry</td>
</tr>
<tr>
<td></td>
<td>Helps keep nervous system healthy and prevent irritability</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Helps body release energy from food</td>
<td></td>
</tr>
<tr>
<td>Vitamin B6</td>
<td>Helps nerve tissue function normally</td>
<td>Liver, muscle meats, vegetables, whole grain cereals</td>
</tr>
<tr>
<td></td>
<td>Plays a role in the breakdown of proteins, fats, and carbohydrates</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Plays a role in the reaction in which tryptophan is converted to niacin</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Plays a role in the regeneration of red blood cells</td>
<td></td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>Protects against pernicious anemia</td>
<td>Cheese, eggs, fish, liver and other meats, milk</td>
</tr>
<tr>
<td></td>
<td>Plays a role in the normal functioning of cells</td>
<td></td>
</tr>
<tr>
<td>Vitamin C</td>
<td>Promotes healthy gums and tissues</td>
<td>Broccoli, cantaloupe, citrus fruits, green peppers, leafy green vegetables, potatoes and sweet potatoes cooked in the skin, raw cabbage, strawberries, tomatoes</td>
</tr>
<tr>
<td></td>
<td>Helps wounds heal and broken bones mend</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Helps body fight infection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Helps make cementing materials that hold body cells together</td>
<td></td>
</tr>
</tbody>
</table>

Sources of Phosphorus

Meat, poultry, fish, eggs, and milk and other dairy products are good sources of phosphorus. Many soft drinks also supply a large amount of phosphorus. However, they lack the variety of nutrients provided by other food sources. If you eat enough foods that are high in protein and calcium, you should receive enough phosphorus.

Phosphorus Deficiencies and Excesses

Most people have no trouble getting enough phosphorus in their diets. There are no known symptoms for phosphorus deficiency. On the other hand, too much phosphorus in the diet can cause problems. The ratio of calcium to phosphorus in the diet should be no lower than 1:2. However, people who drink a lot of soft drinks and not much milk may have a lower calcium to phosphorus ratio. This can cause calcium to be pulled from the bones to correct the ratio. As mentioned earlier, depleting the bones’ calcium supply can lead to osteoporosis.

Magnesium

About half of the body’s magnesium is in the skeleton. The other half is in the soft tissues and body fluids. Magnesium helps cells use proteins, fats, and carbohydrates to produce energy. It helps regulate the body’s temperature and keeps the nervous system working properly. Magnesium also helps muscles contract and improves the balance between alkalis and acids.

Sources of Magnesium

Whole grains and grain products are good sources of magnesium. Nuts, beans, meat, and dark green leafy vegetables also supply magnesium.

Magnesium Deficiencies

Healthy people who eat a nutritious diet receive enough magnesium. A deficiency, however, can occur in alcoholics. People suffering from malfunctioning kidneys, severe diarrhea, or malnutrition may also form deficiencies. Symptoms include twitching, muscle tremors, an irregular pulse, insomnia, and muscle weakness.
Sodium, Chloride, and Potassium

Like calcium and phosphorus, sodium, chloride, and potassium work as a nutrient team. Blood plasma and other fluids outside the cells contain most of the body’s sodium and chloride. In addition, some sodium is in bones, and some chloride is in gastric juices. Most of the body’s potassium is within the cells.

Sodium and chloride are found naturally in many foods. Table salt provides added amounts of these minerals. However, processed foods are, by far, the largest source of sodium and chloride in the U.S. diet.

Potassium is widely found in the food supply. It is in some meats, milk products, and many types of seafood. Many vegetables, including sweet and white potatoes, tomato products, beet greens, and legumes, are good sources of potassium. Fruit sources include prune juice, bananas, peaches, and apricots.

Sodium, Chloride, and Potassium Deficiencies and Excesses

Deficiencies of sodium and chloride are rare. People who sweat a lot during heavy work or exercise may lose some sodium. Cases of severe diarrhea, vomiting, and burns can cause losses, too. However, normal eating usually replaces these losses.

Unlike sodium and chloride, potassium intake is low in the diets of many people. People who do not get enough potassium may not have deficiency symptoms. However, they are not getting all the benefits of a diet rich in potassium. Potassium may help people have healthy blood pressure.

Most people consume much more sodium than they need. Normally, you excrete excess sodium through urine. In some cases, however, the body cannot get rid of the sodium, and fluids build up. The resulting swelling is called edema.

Research has shown there is a link between sodium and hypertension, or high blood pressure. The more salt people consume, the higher their blood pressure will be. Thus, people who have hypertension have a lower limit for sodium.

The best way to reduce sodium in the diet is to limit your use of processed foods. Many cured meats, canned foods, frozen entrees, snack items, and condiments like soy sauce are high in sodium. When you do use processed foods, be sure to read nutrition labels. The amount of sodium can vary widely in similar products. Compare labels and choose those products that are lowest in sodium. Limiting your use of salt in cooking and at the table can also help you reduce sodium intake. See 2-16.

Trace Elements

The body contains very small amounts of trace elements. Experts have determined some of these minerals are vital for good health. Recommended daily intakes have been set for copper, selenium, manganese, and a number of other trace elements besides those discussed here. However, these minerals have not been shown to pose a great concern in the diets of most people in the United States.

Iron

The human body contains about 4 g of iron. Over half of this iron is in the blood, where it combines with a protein to form hemoglobin. Hemoglobin is a protein pigment found in red blood cells. It takes oxygen from the lungs and carries it to cells throughout the body.

Q: Should I take a potassium supplement to increase my intake?

A: General advice is to increase intake of potassium from food sources. You should only take potassium supplements if a doctor directs you to do so.
The body does not excrete iron in any quantity. The body stores iron and reuses it. When iron reserves are low, anemia can result. Loss of appetite, pale skin, and tiredness are common symptoms of anemia.

Women and infants suffer from anemia more often than other groups of people. Women lose varying amounts of iron each month during menstruation. Women who do not consume enough iron may become anemic. Infants have some iron reserves when they are born. When these reserves are depleted, however, the infant must receive iron from foods, such as iron-fortified cereal. Milk is not a good source of iron. Infants kept on a milk-only diet may develop anemia. See 2-17.

Liver, beef, and egg yolks are animal sources of iron. Iron is also found in such plant sources as leafy green vegetables, legumes, and enriched grains. The body absorbs iron from animal sources more easily than iron from plant sources. Eating foods rich in vitamin C with plant sources will enhance iron absorption.

Zinc helps a number of enzymes perform their functions. It helps wounds heal and aids the functioning of the immune system. It promotes normal growth and development in children, too. Lack of zinc can stunt the growth and sexual development of children. Zinc deficiency may also result in poor wound healing and impaired taste and night vision. Large doses of zinc supplements can cause fever, nausea, and vomiting. Over time, heart disease and kidney failure can develop. Meat, poultry, seafood, legumes, and whole grains are good sources of zinc.

Iodine

The thyroid gland stores a third of the body's iodine. This small gland is located at the base of the neck. Iodine is an essential part of thyroxine, a hormone produced by the thyroid gland. Thyroxine regulates the rate at which the body uses energy. If the diet does not contain enough iodine, the cells of the thyroid gland become enlarged. As the gland swells, it forms a lump at the front of the neck. This visible enlargement of the thyroid gland is called a goiter.

Insufficient iodine during the prenatal period and early childhood may cause severe mental retardation. Combined with a slowed growth rate, this deficiency can cause swollen facial features and enlarged lips and tongue. Early treatment can reverse some of these characteristics. Seafood, seaweed, and iodized salt are good sources of iodine.

Fluoride

The greatest quantities of fluoride are in the teeth and bones. The teeth need fluoride for maximum resistance to decay. Fluoride is most helpful during the development of teeth, but it serves a protective function for the life of the tooth. Studies have also shown fluoride may be effective in maintaining the health of bones.

Drinking water is the most common source of fluoride, as commonly eaten foods contain very little. Many communities add fluoride to public drinking water if it is not present naturally. However, it may not be added to bottled water. Most toothpastes also contain fluoride. See 2-18.

Water

The body must have water to function. People can live more than a month without food. However, they can live only a few days without water.

Functions of Water

Between 50 and 75 percent of your body weight is water. Water is found both inside and outside all your cells. Water aids proper digestion and cell growth and maintenance. All chemical reactions within the body rely on water.

2-16 You need 100 milligrams or more of each of the macrominerals in your daily diet.

2-17 Infants are born with enough iron reserves to support them through the first four to six months of life. Iron-fortified cereal is a good source of iron for older infants.

2-18 Trace elements are needed by the body in very small amounts. However, they are no less important than any other nutrients in your diet.
Diggestion and Absorption

Suppose you eat a hamburger for lunch. Before your body can use the nutrients in the hamburger, the hamburger must go through digestion. Then the nutrients must go through absorption. Digestion is the bodily process of breaking food down into simpler compounds the body can use. Absorption is the process of taking in nutrients and making them part of the body.

The Digestive Tract

The digestive or gastrointestinal tract is a tube about 30 feet (9 m) long. It extends from the mouth to the anus. It contains the esophagus, the stomach, the small intestine, and the large intestine. These parts of the digestive tract work together both mechanically and chemically to help the body use food.

Water Intake and Excretion

Your body takes the water it needs from the liquids you drink and the foods you eat. About 80 percent of your water intake comes from liquids. These liquids include water, milk, broth, coffee, tea, fruit juices, and other beverages. About 20 percent of your water intake comes from the food you eat. Different foods contain different amounts of water. For instance, lettuce contains more water than a slice of bread.

The body excretes most of the water it uses through the kidneys as urine. It excretes the remaining water through the skin and lungs in the feces.

Water Requirements

Some nutrition experts suggest an easy way to figure your daily water needs. Divide your body weight in pounds by two. The result equals how many ounces of fluids you should drink each day. This means a 150-pound person should drink about 75 ounces of water and other fluids per day (150 ÷ 2 = 75). See 2-19.

Some people need more water. Someone who is in a coma or suffering from fever or diarrhea has increased water needs. People on high-protein diets and those living in hot climates must also increase their water intake.

Excess water is not a problem for most healthy people. However, the kidneys cannot keep up with rapid intake of extreme amounts of fluids. This level of intake can lead to water intoxication.

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a reservoir, or storage area. Eventually the body will excrete these materials in the feces.

The Absorption Process

The body can absorb water, ethyl alcohol, and simple sugars directly from the stomach. They pass through the stomach walls into the bloodstream. Most absorption, however, takes place in the small intestine.

Millions of hairlike fingers called villi line the small intestine. The villi increase the absorptive surface of the small intestine by more than 600 percent. Each villus contains a lymph vessel surrounded by a network of capillaries. Nutrients absorbed by the capillaries pass into the portal vein and travel directly to the liver.

The body absorbs nearly all carbohydrates as monosaccharides or single sugar units. The body absorbs fats and other lipids in two forms: as fatty acids and glycerol and as mono- and diglycerides. (Glycerol is an alcohol obtained from the breakdown of fat. Diglycerides are compounds formed by the combination of glycerol and fatty acids.) The body absorbs nearly all proteins as amino acids.

Metabolism

Metabolism is the chemical processes that take place in the cells after the body absorbs nutrients. Enzymes cause nearly all metabolic reactions. The body uses some nutrients to replace substances used for growth. It uses some nutrients to carry out bodily processes. The body breaks down some nutrients into simpler substances to release energy. The body uses part of this energy to carry out metabolic reactions. It converts the rest into heat.

Each nutrient follows a distinct metabolic path. The body converts all carbohydrates into glucose for use as an energy source, 2-21. If carbohydrates are not needed for immediate energy, they can be converted to glycogen. This is the storage form of carbohydrates in the body. Excess carbohydrates can also be stored in the body as fat tissue.

During fat metabolism, fatty acid chains are shortened. The body uses most fat for fuel. The body can use amino acids from protein metabolism for cell maintenance or cell growth. It can also use amino acids to make enzymes, antibodies, and nonessential amino acids. The body can use amino acids as an energy source, too.

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2. **Writing.** Choose one of the nutrients discussed in this chapter. Write a short story from the point of view of the nutrient. Creatively describe where you live (food sources) and your job (functions in the human body). Share your story in class.

3. **Science.** Make a poster illustrating the digestion process.

**Build Your Thinking Skills**

1. **Evaluate.** Read the label of a multivitamin supplement. Note the percent Daily Value provided for each of the vitamins in the supplement. Evaluate what this indicates, based on what you learned from the chapter about the effects of excess fat-soluble and water-soluble vitamins in the body. Discuss your findings and conclusions in class.

2. **Plan.** Plan a basic nutrition lesson for a primary school child. Use visual aids that appeal to children, such as magazine pictures, colorful posters, or puppets.

**Apply Technology**

1. Visit a grocery store and make a list of 10 foods that are enriched or fortified with nutrients. Discuss in class how the technology used to fortify and enrich foods has affected the quality of the U.S. diet.

2. Measure your blood pressure using a blood pressure cuff that gives a digital readout.

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**Using Workplace Skills**

Lupe is a dietetic technician at St. Andrew’s Hospital. She consults with patients about how to modify their diets in response to specific health conditions. She has to keep detailed records on each patient for her supervisor to review and for use in follow-up visits.

To be an effective worker, Lupe needs skill in organizing and maintaining files. Put yourself in Lupe’s place and answer the following questions about your need for and use of these skills:

A. How would maintaining well-organized files help you when your patients come in for follow-up visits?

B. How would maintaining well-organized files help your supervisor?

C. How might your failure to organize and maintain files affect your patients?

D. What is another skill you would need in this job? Briefly explain why this skill would be important.

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