

1.2: Overview of Nutrients and Calories

Learning Objectives

- Define the word “nutrient”.
- Identify the six classes of nutrients essential for health.
- List the three main energy (calorie) yielding nutrients and how many calories each of these nutrients provide.

What is in Food?

Your "diet" is defined as the foods you choose to eat. The diet of most people contains a variety of foods: grains, nuts, fruits, vegetables and more! The foods we eat contain nutrients. Nutrients are substances required by the body to perform its basic functions. Nutrients must be obtained from diet, since the human body does not synthesize them, or does not synthesize them in large enough amounts for human health. Nutrients are used for many body functions such as growing, moving your muscles, repairing tissues and much more! There are six classes of essential nutrients required for the body to function and maintain overall health. These six classes of essential nutrients are: carbohydrates, lipids (fats), proteins, water, vitamins, and minerals. These nutrients can also be categorized as organic or inorganic. When discussing the chemical structure of nutrients, "organic" indicates that the nutrient contains carbon; "inorganic" indicates that the nutrient does not contain carbon.

Foods also contain non-nutrients. Some non-nutrients appear to be very important for human health, like fiber and antioxidants; other non-nutrients may be harmful to human health such as alcohol, preservatives, colorings, flavorings and pesticide residues.

Table 1.2.1: Six Classes of Nutrients and Their Functions

<u>Nutrient</u>	<u>Organic vs. Inorganic</u>	<u>Functions</u>
Carbohydrates	Organic	<ul style="list-style-type: none"> • Provide a ready source of energy for the body (sometimes referred to as the preferred source of energy for the body). • Provide structural constituents for the formation of cells.
Lipids (Fats)	Organic	<ul style="list-style-type: none"> • Provide stored energy for the body. • Function as structural components of cells. • Function as signaling molecules for proper cellular communication. • Provide insulation to vital organs. • Helps maintain body temperature.
Proteins	Organic	<ul style="list-style-type: none"> • Necessary for: <ul style="list-style-type: none"> ◦ tissue formation ◦ cell repair ◦ regulating fluid balance ◦ hormone production ◦ enzyme production • Essential for building strong muscles. • Essential for a healthy immune system.
Water	Inorganic	<ul style="list-style-type: none"> • Transports essential nutrients to all body parts. • Involved in many body processes, including: <ul style="list-style-type: none"> ◦ fluid balance ◦ nerve impulses ◦ muscle contraction • Transports waste products for disposal. • Aids with body temperature regulation.

<u>Nutrient</u>	<u>Organic vs. Inorganic</u>	<u>Functions</u>
Vitamins	Organic	<ul style="list-style-type: none"> • Regulate body functions/processes. • Promote normal body-system functions.
Minerals	Inorganic	<ul style="list-style-type: none"> • Regulate body processes. • Necessary for proper cellular function. • Comprise body tissue.

Macronutrients

Nutrients that are needed in large amounts are called macronutrients. Macronutrients include carbohydrates, lipids (fats), proteins, and water. Carbohydrates, lipids, and proteins provide energy (calories) which can be used ("burned") by your body to perform basic functions. The energy from these macronutrients comes from their chemical bonds. This chemical energy is converted into cellular energy that is then utilized to perform work, allowing our bodies to conduct their basic functions. Water is needed in large quantities but does not contain energy (calories).

The following video provides a nice overview of macronutrients (and you can also read more about macronutrients below the video):



"Macros: Explained! Mind Over Munch Kickstart 2016" by Mind Over Munch

Carbohydrates

The major food sources of carbohydrates are grains, dairy products, fruits, and starchy vegetables like potatoes. Non-starchy vegetables also contain carbohydrates, but in lesser quantities. When you eat a food that contains carbohydrates, like bread for example, you receive approximately 4 calories of energy for every gram of carbohydrate you eat. Chemically speaking, carbohydrates are molecules composed of carbon, hydrogen, and oxygen. Carbohydrates are the preferred source of energy (calories) for your body; you'll learn more about carbohydrates in Chapter 4.

Lipids (Fats)

Lipids (fats) are found predominately in butter, margarine, lard, oils, meats, animal fat, dairy products, nuts, seeds, and many processed foods. Lipids provide more energy per gram than carbohydrates (9 calories per gram of lipids versus 4 calories per gram of carbohydrates). Lipids are also a family of molecules composed of carbon, hydrogen, and oxygen, but unlike carbohydrates, they are insoluble in water. The main job of lipids is to store energy (calories) for later use. Lipids are an important energy source during rest and low-intensity exercise. In addition, lipids surround and protect organs, aid in temperature regulation, and regulate many other functions in the body. You'll learn more about lipids in Chapter 5.

Proteins

Major food sources of proteins include meats, dairy products, seafood, and a variety of different plant-based foods (e.g., soy, seeds, nuts, and legumes/beans). Proteins are macromolecules composed of chains of subunits called amino acids. Amino acids are composed of carbon, hydrogen, oxygen, and nitrogen. Proteins provide 4 calories of energy per gram; however providing energy is not protein's most important function. Proteins provide structure to bones, muscles, and skin; support tissue growth, repair, and maintenance; and play a role in conducting most of the chemical reactions that take place in the body. Chapter 6 will dive deeper into the multiple functions of proteins.

Water

There is one other nutrient that we must have in large quantities: water. Water does not contain carbon, but is composed of two hydrogen atoms and one oxygen atom per molecule of water. Unlike the energy-yielding macronutrients (carbohydrates, lipids, and protein), water does not provide any energy (calories). More than 60 percent of your total body weight is water. Without it, nothing could be transported in or out of the body, chemical reactions would not occur, organs would not be cushioned, and body temperature would fluctuate widely. You'll explore water in more detail in Chapter 7.

Micronutrients

Micronutrients are nutrients required by the body in lesser amounts, but are still essential for carrying out bodily functions. Micronutrients include all the essential vitamins and minerals. There are 13 essential vitamins and 16 essential minerals (see Tables 1.2.2 and 1.2.3 for a complete list and their major functions). In contrast to carbohydrates, lipids, and proteins, micronutrients do not contain calories. This is often confusing because most people have heard how tired a person will feel if they are low in a micronutrient such as iron. The tiredness can be explained by the fact that micronutrients assist in the process of making energy by being part of enzymes (i.e., coenzymes). Enzymes catalyze (cause or speed up) chemical reactions in the body and are involved in many aspects of body functions from producing energy, to digesting nutrients, to building macromolecules. Micronutrients play many roles in the body which will be further investigated in Chapters 7-10.

Vitamins

The thirteen essential vitamins are categorized as either water-soluble or fat-soluble. Water-soluble vitamins dissolve easily in water; fat-soluble vitamins dissolve easily in fats and oils. Excess water-soluble vitamins are excreted in urine and are not typically stored in large amounts in the body; however, excess fat-soluble vitamins are stored in the body. The water-soluble vitamins are vitamin C and all the B vitamins, which include thiamin, riboflavin, niacin, pantothenic acid, pyroxidine, biotin, folate and cobalamin. The fat-soluble vitamins are A, D, E, and K. Vitamins are required to perform many functions in the body such as making red blood cells, synthesizing bone tissue, and playing a role in normal vision, nervous system function, and immune system function. In addition, vitamins are essential to energy metabolism (process by which macronutrients are broken down into smaller molecules that our body can absorb and use).

Table 1.2.2: Vitamins and Their Major Functions

Vitamins	Major Functions
Water-soluble	
B ₁ (thiamin)	Coenzyme, energy metabolism assistance
B ₂ (riboflavin)	Coenzyme, energy metabolism assistance
B ₃ (niacin)	Coenzyme, energy metabolism assistance
B ₅ (pantothenic acid)	Coenzyme, energy metabolism assistance
B ₆ (pyroxidine)	Coenzyme, amino acid synthesis assistance
Biotin	Coenzyme
Folate	Coenzyme, essential for growth
B ₁₂ (cobalamin)	Coenzyme, red blood cell synthesis
C	Collagen synthesis, antioxidant
Fat-soluble	
A	Vision, reproduction, immune system function

Vitamins	Major Functions
D	Bone and teeth health maintenance, immune system function
E	Antioxidant, cell membrane protection
K	Bone and teeth health maintenance, blood clotting

The following video provides a nice overview of vitamins:



"How Do Vitamins Work?" by Ginnie Trinh Nguyen

Minerals

Minerals are solid inorganic substances that form crystals and do not break down; they maintain their structure no matter what environment they're in. Minerals are classified depending on how much of them we need. Trace minerals, such as molybdenum, selenium, zinc, iron, and iodine, are required in amounts less than 100 milligrams per day; macrominerals, such as calcium, magnesium, potassium, sodium, and phosphorus, are required in amounts more than 100 milligrams per day. Many minerals are critical for enzyme function, others are used to maintain fluid balance, build bone tissue, synthesize hormones, transmit nerve impulses, contract and relax muscles, and protect against harmful free radicals. In addition, minerals are essential to energy metabolism (process by which macronutrients are broken down into smaller molecules that our body can absorb and use).

Table 1.2.3: : Minerals and Their Major Functions

Minerals	Major Functions
Macrominerals	
Sodium	Fluid balance, nerve transmission, muscle contraction
Chloride	Fluid balance, stomach acid production
Potassium	Fluid balance, nerve transmission, muscle contraction
Calcium	Bone and teeth health maintenance, nerve transmission, muscle contraction, blood clotting
Phosphorus	Bone and teeth health maintenance, acid-base balance
Magnesium	Protein production, nerve transmission, muscle contraction
Sulfur	Protein production
Trace Minerals	
Iron	Carries oxygen, assists in energy production

Minerals	Major Functions
Zinc	Protein and DNA production, wound healing, growth, immune system function
Iodine	Thyroid hormone production, growth, metabolism
Selenium	Antioxidant
Copper	Coenzyme, iron metabolism
Manganese	Coenzyme
Fluoride	Bone and teeth health maintenance, tooth decay prevention
Chromium	Assists insulin in glucose metabolism
Molybdenum	Coenzyme

Vitamin and mineral deficiencies can cause severe health problems. For example, a deficiency in vitamin A can lead to night blindness. Anemia, a condition where there aren't enough healthy red blood cells to carry adequate oxygen throughout the body, can result from an iron deficiency.

Food Energy

Though this is only Chapter 1, you have already seen the words "calories" and "energy" used several times. In everyday life you have probably heard people talk about how many calories they burned on the treadmill or how many calories are listed on a bag of chips. Calories are a measure of food energy. Energy is the capacity to do work. Our bodies break down the energy-providing nutrients (carbohydrates, fats and oils, protein) and reassemble them into a fuel that supports physical activity and basic functioning.

As you read above, carbohydrates provide 4 calories for every gram we consume; proteins provide 4 calories for every gram we consume; and fats provide 9 calories for every gram we consume. Another source of calories is alcohol. Alcohol is not considered to be a nutrient (because it's not required by the body to perform its basic functions), but it does provide 7 calories of energy for every gram we consume. Vitamins, minerals and water do not provide any calories, but they are still essential nutrients.

Technically, food energy is measured in kilocalories. A kilocalorie is the amount of heat generated by a particular macronutrient that raises the temperature of 1 kilogram of water 1 degree Celsius. To measure the number of kilocalories in a particular food substance, a certain amount of food is burned in a device called a calorimeter. As the food burns, heat is created. The heat dissipates to the surrounding water while a thermometer detects the change in temperature of the water. A kilocalorie of energy performs 1,000 times more work than a calorie. In science, a kilocalorie is often written as "kcal" or "Calorie" (with a capital "C"). So, 1 kilocalorie = 1 kcal = 1 Calorie = 1,000 calories. Although kilocalories, kcals, or Calories (with a capital "C") are technically the appropriate terms, most people refer to the amount of energy in food as a calorie (with a lower case "c"), so this text will use calories (with a lower case "c") for the sake of simplicity. On food labels, "calorie" is used when referring to kilocalories. For more on calories, watch the video below.



"What is a Calorie?" by Emma Bryce

Key Takeaways

- Foods contain nutrients that are essential for our bodies to function.
- Four of the classes of nutrients required for bodily function are needed in large amounts. They are carbohydrates, lipids, proteins, and water, and are referred to as macronutrients.
- Two of the classes of nutrients are needed in lesser amounts, but are still essential for bodily function. They are vitamins and minerals.
- The "energy yielding" nutrients are carbohydrates, lipids (fats), and proteins. Carbohydrates provide 4 calories for every gram we consume; fats provide 9 calories for every gram we consume; and proteins provide 4 calories for every gram we consume.

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