Discovering Nutrition
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Nutrition books come in two basic types; those written for consumers that cover the latest issues and hot topics, and university-level textbooks designed for in-depth, multi-year exploration of nutrition concepts. What seems to be missing is a book that offers a concise look at nutrition from the scientific point of view that is relevant to today’s issues. This book was written to fill that void by serving as a resource for students, teachers, health care professionals, and consumers wishing to understand the full scope of nutrition in a concise and easy-to-read format. By eliminating much of the peripheral detail of a full textbook, the central topics of nutrition can be better emphasized. This book is well suited to students studying nutrition for the first time, as well as for health care professionals who wish to brush up on current nutrition issues and concepts. Consumers with a basic knowledge of biology will also find this book to be a valuable resource when making decisions about diet and health.

The general theme of the book focuses on the chemistry and metabolism of nutrients, and their impact on human health and well being. The chapters follow a logical sequence of the “life and times” of nutrients, from their presence in the environment (Part I) and the body (Part II), to their role in health and disease (Part III). The final section (Part IV) addresses many of the practical issues related to nutrition, such as choosing food wisely, interpreting nutrition information, and planning for a healthy future. Each chapter begins with a brief overview and ends with a “Chapter Test” that reviews some of the key points. You can “Check Your Performance” on the Chapter Tests to identify the topics that require further study. Additional review questions corresponding to each topic can be found in Appendix C. Each chapter also includes an “Application” of the chapter topic to real-life situations.

Few books are written in isolation, and several people have contributed greatly to this effort. I wish to thank Beverly Benes, PhD, RD, at the University of Nebraska for helping me realize the need for a fundamental nutrition review of this scope and for the many hours she invested during the planning stages. I also wish to thank Craig Hassel, PhD, at the University of Minnesota for his insights regarding “optimal health” and for helping me expand my view of nutrition beyond the scientific perspective. Many thanks also go to Ruth Rauscher, MA, RD, LMNT, for her knowledge of patient care and for encouraging me to emphasize the practical application of nutrition principles in everyday life. Her suggestions have helped make this book a useful resource for health care professionals.
Part I

Nutrients in the Environment
Nutrition. The word can conjure up a host of images that mean different things to different people. Some people think of nutrition as a medical science in which biology, chemistry, and physics all play a role. Other people think of nutrition as a social or behavioral science that focuses on eating habits and factors that influence our food choices. Still others view nutrition from a global perspective, taking into account factors that affect food production and distribution worldwide. The full scope of nutrition, in fact, encompasses all of these perspectives, making it a truly multi-disciplinary field of study. And yet there is one common theme that ties each of these disciplines together: the desire to better understand the interactions between food and living organisms.

**Essential Background**

❖ Basic biology
❖ Basic knowledge about food and its availability

**Topic 1.1**

The Many Faces of Nutrition

**Key Points**

What is nutrition?
What scientific disciplines contribute to the field of nutrition?

From the smallest bacteria to the mighty blue whale, all living things must receive a constant supply of food to sustain life. Despite this obvious fact, we seldom stop to think about all the different forms of food needed to sustain the many types of life found on earth. Every organism has evolved consuming the type of food to which it has best adapted. What may be a gourmet meal to a dung beetle may not be food to a honeybee. Even human populations have evolved consuming foods most readily available to them. Raw squid is commonly eaten in Japan; grubs are tasty treats for many Brazilian tribes; and Greenland Eskimos eat mostly seal and seabirds. It is quite remarkable how all forms of life, including humans, have adapted to their dietary surroundings in order to ensure the survival of their species.

The fact that living beings need food to survive is nothing new, but the notion that food contains specific “life-giving” substances—nutrients—is a fairly recent concept. The British physician James Lind (1716–1794) is generally credited with providing the first scientific evidence that certain foods—and, hence, specific nutrients—are needed to prevent ill health. In his now famous “A
Treatise of the Scurvy," Lind reported on his attempts to find a dietary cure for scurvy, a fatal disease common among sailors. We now know that scurvy is caused by vitamin C deficiency and its symptoms include bleeding gums, disorientation, and painful joints. Below is an excerpt from Lind’s medical report:

I shall conclude the precepts relating to the preservation of seamen with showing the best means of obviating many inconveniences which attend long voyages and of removing the several causes productive of this mischief.

The following are the experiments.

On the 20th May, 1747, I took twelve patients in the scurvy on board the Salisbury at sea. Their cases were as similar as I could have them. They all in general had putrid gums, the spots and lassitude, with weakness of their knees. They lay together in one place, being a proper apartment for the sick in the fore-hold; and had one diet in common to all, viz., water gruel sweetened with sugar in the morning; fresh mutton broth often times for dinner; at other times puddings, boiled biscuit with sugar etc.; and for supper barley, raisins, rice and currants, sago and wine, or the like. Two of these were ordered each a quart of cyder a day. Two others took twenty five gutts of elixir vitriol three times a day upon an empty stomach, using a gargle strongly acidulated with it for their mouths. Two others took two spoonfuls of vinegar three times a day upon an empty stomach, having their gruels and their other food well acidulated with it, as also the gargle for the mouth. Two of the worst patients, with the tendons in the ham rigid (a symptom none the rest had) were put under a course of sea water. Of this they drank half a pint every day and sometimes more or less as it operated by way of gentle physic. Two others had each two oranges and one lemon given them every day. These they eat with greediness at different times upon an empty stomach. They continued but six days under this course, having consumed the quantity that could be spared. The two remaining patients took the bigness of a nutmeg three times a day of an electuray recommended by an hospital surgeon made of garlic, mustard seed, rad. raphan., balsam of Peru and gum myrrh, using for common drink barley water well acidulated with tamarinds, by a decoction of which, with the addition of cremor tartar, they were gently purged three or four times during the course.

The consequence was that the most sudden and visible good effects were perceived from the use of the oranges and lemons; one of those who had taken them being at the end of six days fit for duty. The spots were not indeed at that time quite off his body, nor his gums sound; but without any other medicine than a gargarism or elixir of vitriol he became quite healthy before we came into Plymouth, which was on the 16th June. The other was the best recovered of any in his condition, and being now deemed pretty well was appointed nurse to the rest of the sick...

As I shall have occasion elsewhere to take notice of the effects of other medicines in this disease, I shall here only observe that the result of all my experiments was that oranges and lemons were the most effectual remedies for this distemper at sea. I am apt to think oranges preferable to lemons, though it was principally oranges which so speedily and surprisingly recovered Lord Anson’s people at the Island of Tinian, of which that noble, brave and experienced commander was so sensible that before he left the island one man was ordered on shore from each mess to lay in a stock of them for their future security... Perhaps one history more may suffice to put this out of doubt. (James Lind, London, 1753)

The work of Lind and other investigators helped lay the groundwork for the branch of science we now call nutrition. But the present-day study of human nutrition is much more complex because it involves more than finding foods (and nutrients) that prevent deficiency diseases. The full scope of nutrition encompasses the social, psychological, economic, and even spiritual influences that affect what we eat. It involves an understanding of chronic diseases and the implications of long-term dietary habits. The field of nutrition involves food scientists, geneticists, anthropologists, plant scientists, dietitians, psychologists, animal scientists, biologists, epidemiologists, clinical and laboratory researchers, pharmacists, and physicians. And in some cultures, nutrition is viewed
from nonscientific perspectives, in which food contributes to the “balance” between the body, mind, and spirit. Thus, a thorough understanding of nutrition requires an awareness of many disciplines and perspectives, as well as the ability to interpret nutrition information in a technology driven world where the reliability of information is often highly questionable.

This book addresses the subject of nutrition largely from the scientific point of view. The primary goal is to provide an overview of nutrition that allows the reader to make well-informed lifestyle choices that promote good health and well being. The text emphasizes nutrient chemistry and metabolism, the role of nutrients in human health, and the many factors (internal and external) that challenge the healthful balance of nutrients.

### Topic 1.2

**Evolution of Nutrition Science**

**Key Points**

- How did the study of nutrition evolve into a science?
- What key historical events contributed to our understanding of nutrition?

Nutrition entered the realm of science with the experiments of Sanctorius (1561–1636). Sanctorius, an Italian physician, published a report in which he weighed the amount of food and drink he consumed every day, then compared that to the weight of his excreta (feces and urine). He noted that his excreta weight was much less than the weight of his food and drink, yet his overall body weight did not change. He concluded that the weight of food and drink retained by the body was slowly lost as water through a process he called “insensible perspiration.” Two centuries later, Lavoisier (1743–1794) conducted more refined experiments on the relationships between food intake and body heat loss, amount of oxygen inhaled, and amount of carbon dioxide exhaled. He concluded that heat produced by the body resulted from the combustion of food in a process that was similar to the process that takes place when substances are burned outside the body. From Lavoisier’s work, we now know that the undetectable loss of food weight originally observed by Sanctorius was due to the loss of carbon dioxide through respiration, not perspiration (see Chapter 3). Lavoisier is often called the father of nutrition because the principles he established regarding respiration and metabolism are still used today. The experiments of Sanctorius and Lavoisier represent early milestones in nutrition that caused major shifts in thinking about the interactions between food and the body.

Another important milestone in the study of nutrition was the recognition that foods are made of specific components—**carbohydrate**, **protein**, and **fat**—that the body uses for energy. The French physiologist Magendie (1783–1855) was the first to distinguish between these three major nutrient categories. Liebig (1803–1873), a German physiologist, later showed that carbohydrate, protein, and fat were indeed the food components “burned” for fuel inside the body. He was also the first to estimate the energy content of foods. Although Liebig misinterpreted how the body uses carbohydrate, protein, and fat, he was correct in proposing that all three components are essential in the diet to maintain health.

In the late nineteenth century, several researchers attempted to reproduce milk in the laboratory using carbohydrate, protein, and fat isolated from cows’ milk and other food sources. When the synthetic milk was fed to laboratory animals, they died. However, the animals survived if natural
milk or other natural foods were added to their diets. This led to the conclusion that other vital substances must be present in food besides carbohydrate, protein, and fat.

Building on the research of Lind and others, the concept that deficiency diseases were caused by the lack of specific chemicals in the diet—and that consuming the chemical would cure the disease—was solidified by Cashmir Funk (1884–1967) and Frederick Hopkins (1861–1947) in their classic papers written in 1912. While Hopkins referred to these food chemicals as accessory factors, it was Funk who proposed the name vitamine—later shortened to vitamin—for these essential nutrients. The discovery and isolation of the vitamins dominated nutrition research in the early part of the twentieth century. Many students are surprised to learn that discovery of the vitamins is fairly recent, beginning with vitamin A in 1909. Vitamin $B_{12}$ was not discovered until 1946. Even today experts are debating whether the chemical choline is an essential nutrient worthy of vitamin status.

The importance of dietary minerals also became apparent during the past century. The minerals needed in relatively large amounts (e.g., calcium and iron) were more easily studied and the first to be considered essential dietary components. Some trace minerals, however, are needed in very small amounts and were more difficult to study, especially when one considers the limitations of research methods in the early twentieth century. Although research methods used today are much more refined, the exact role of several trace minerals (e.g., boron and nickel) is still uncertain.

The past century was an exciting time for nutrition research, one in which nutrition was firmly establishing as an independent scientific discipline. The early studies have allowed us to view nutrition from a broad perspective in which every food substance we consume ultimately impacts our health and well being. Since the discovery of the vitamins and other essential nutrients, there has been a rapid decline in deficiency diseases among human populations. As we will see in later chapters, attention is now shifting from deficiency diseases to the role of nutrients in chronic diseases such as cancer, osteoporosis, and heart disease. The future of nutrition research will likely reach well beyond our traditional understanding of nutrients and, instead, focus on how substances in food can optimize health even in the absence of disease.

**Topic 1.3**

**Definition of a Nutrient**

**Key Points**

Why is there no single definition of a nutrient?
What do “essential” and “nonessential” mean?
Why is it sometimes difficult to distinguish between a nutrient and a drug?

Given the vital importance of food in sustaining life, nutrition researchers have for many years used the following definition of a nutrient: “Components of food that cannot be made in the body but are essential for normal growth and development.” At first glance, this definition seems adequate and rather straightforward, as we know that the absence of essential nutrients will cause acute deficiency diseases leading to death. In fact, the discovery of the vitamins early in the twentieth century greatly reduced the incidence of several debilitating diseases such as scurvy,
beriberi, and pellagra. However, the classic definition has become inadequate as we learn more about nutrients. Many issues regarding the nature of nutrients make it much more difficult to define them, and our simple definition is probably too narrow to cover the broad spectrum of what nutrients are and what they do. Most nutrition experts now recognize the limitations of the classic definition of a nutrient and are reluctant to create a simple one-size-fits-all definition.

Notice that the word essential is used in the classic definition, suggesting that a nutrient is something the body cannot make and is therefore required in the diet. Part of the difficulty in defining nutrients is that they may be viewed as substances in food that the body incorporates into its countless functions, whether or not those nutrients are made in the body. Cholesterol is an example of a food substance that the body uses for some very important functions, but humans do not need cholesterol in the diet because the body makes all that it needs. So while cholesterol is clearly not an essential nutrient, it can still be considered a nutrient because it is consumed in the diet and used by the body. Even more confusing are a handful of essential nutrients—including vitamin D—that the body makes, but the amount is usually too small to meet the body’s needs. These nutrients are generally regarded as essential, even though they are occasionally made in amounts that satisfy the body’s requirements. There are also examples of nutrients that can become essential if the body can no longer make them because of certain metabolic conditions. Cirrhosis of the liver and kidney dysfunction are examples in which the organs cannot make vital body chemicals, so dietary sources become important for survival. Premature infants also have difficulty making enough “nonessential” nutrients to meet the body’s requirements. Therefore, while the concept of essentiality is important, we must recognize that not all nutrients are essential and that some nutrients can become essential under certain metabolic conditions.

Nutrition experts currently recognize over 30 essential nutrients that humans require for normal growth, development, and the maintenance of health. There are probably dozens or perhaps hundreds more nonessential nutrients that the body uses even though there may be no absolute dietary requirement. A complete understanding of nutrients must therefore include their impact on long-term chronic diseases such as cancer, osteoporosis, and heart disease. Even some of the traditional nutrients known to be essential for the prevention of deficiency diseases are now thought to have biological effects on metabolic processes involving chronic diseases. Vitamin E, for example, has long been known to be essential for normal reproduction, although more recent evidence suggests it may also reduce the risk of coronary heart disease. This expanded role of the nutrients beyond the classic definition means that while some food substances are not essential for growth and development, their presence in the diet may help influence overall health and increase the quality of life. Nutrients that fall into this category include the many different chemicals naturally found in plants (phytochemicals). Nutrition researchers are just beginning to understand how these nonessential nutrients can help prevent chronic diseases and improve overall health and well being.

Given these considerations, no single definition of a nutrient can accurately summarize its full impact on human health and disease. It should be no surprise that most professional organizations such as the American Dietetic Association, the American Society for Nutritional Sciences, and the American Medical Association have avoided publishing nutrient definitions and, instead, strive to provide the general public with updated and accurate information that reflects our growing knowledge. It is also apparent that as we learn more, the line between “nutrient” and “drug” has become blurred. The legal definition of a drug is a substance that can treat, cure, and prevent disease—but so can nutrients naturally present in the food supply. Food companies are busy developing products enriched in some of these nutrients in a way of promoting health and preventing chronic diseases. The many roles of nutrients will be discussed throughout this book, including how essential and nonessential nutrients influence disease, as well as their impact on health in the absence of disease. The following section will provide a brief overview of the major essential nutrient classes
and their functions. Other chapters will cover some nonessential nutrients and their role in promoting good health.

**Topic 1.4**

Overview of the Nutrient Classes

**Key Points**

- What are the major nutrient classes and what do they do?
- What are the major differences between macronutrients and micronutrients?
- Why is water considered a major nutrient class?

The six essential nutrient classes are carbohydrates, proteins, fats, vitamins, minerals, and water. Each group may contain a variety of different substances, but all substances within each class share a basic chemistry or function that determines their classification. Carbohydrates, proteins, and fats are often referred to as the **macronutrients** because they are required in relatively large amounts in the diet. Another common feature of the macronutrients is their ability to provide the body with energy (see Chapter 3). Vitamins and minerals are considered to be the **micronutrients** because they are needed in only small amounts. Contrary to popular belief, the micronutrients do not contain energy and provide no energy to the body. However, some micronutrients participate in the chemical reactions that release energy from the macronutrients and are therefore essential for proper energy metabolism. Water is also an essential nutrient and, unlike the other nutrient classes, must be consumed daily to prevent water deficiency (dehydration).

**Carbohydrates** provide the bulk of most human diets and are the major sources of energy worldwide. Carbohydrates are a diverse family of substances that include **sugars**, **starch**, and **fiber**. Sugars and starch provide energy, whereas most dietary fiber provides no energy because it passes through the digestive tract and is not absorbed by the body. (A small proportion of fiber is metabolized by bacteria in the large intestine and, therefore, some energy can be captured for use in our bodies.) When we use the term “sugar,” most people think of the refined white crystals commonly called “table” sugar. However, there are many types of sugars found in nature such as fruit sugar and milk sugar. Foods naturally rich in sugars include fruits, vegetables, honey, milk, and other dairy products. Sugar beets and sugar cane are particularly rich in sugar and are the major sources of commercially refined table sugar. Processed foods containing added sugars—such as candy and soft drinks—account for most of the sugar consumed in economically developed countries. Starch is found naturally in grains and vegetables, and is the primary carbohydrate consumed throughout the world. It is the main ingredient in foods such as beans, rice, potatoes, pasta, and breads. Refined starch is also used extensively in the food industry as a thickening agent in processed foods. Many people believe that eating foods containing starch and sugar are “fattening” and that sugar is more fattening than starch. In truth, starch and sugar provide exactly the same amount of energy, so sugar is no more fattening than starch. Furthermore, excess body fat is the result of consuming too much food, not just carbohydrates. Balancing the amount of food a person eats in relation to how much energy the body uses is discussed in Chapter 8. The term “fiber” refers to any plant material that is resistant to digestion and passes through the digestive tract unaltered. In this way, dietary fiber helps to prevent constipation and may lower the risk of colon cancer by speeding up the passage of fecal matter and substances in food that may cause cancer. One caution is that fiber in
the intestinal tract may interfere with the absorption of other essential nutrients, although a well-balanced diet including plenty of fluids helps to ensure that all essential nutrients are consumed in adequate amounts.

Protein seems to have a more positive image than the other macronutrients. Unlike carbohydrates and fats, protein is usually associated with promoting good health and increasing one's strength and vitality. Athletes often choose high-protein foods or take protein supplements with the promise of increasing muscle mass, strength, and endurance. But does dietary protein deserve such a positive reputation? Does it really increase a person's strength and vitality? Should we be concerned about eating too much protein? A more complete understanding of what proteins are and what they do in the body is needed to accurately answer these questions. First, as an essential nutrient, protein is required in the diet to replace body proteins that are degraded as part of normal metabolism. Most people in developed countries consume about twice as much protein as the body needs. Second, the body uses only what it needs, so excess dietary protein is mostly “burned” for energy. Consuming excess protein does not automatically make muscles larger or become stronger—only exercise will do that! Finally, consuming high-protein diets does have some risks. The processing of protein in the body requires lots of water (about seven times more water than required for processing carbohydrates). Consequently, dehydration is a common problem, particularly for people who exercise and lose even more water through sweat and evaporation. Also, the kidneys are the only organs that can process the waste products of protein metabolism for elimination in the urine. An excess of dietary protein over time can overwhelm the kidneys and cause permanent damage. Like all nutrients, protein should be consumed as part of an overall balanced diet that contains adequate—but not excessive—amounts of protein. Overconsumption of protein can easily occur in economically developed countries where both animal and plant foods containing protein are readily available.

In contrast to protein, dietary fats have a negative reputation because of their link to heart disease and cancer. In some cases their negative reputation is justified, although the role of dietary fat in health and disease is very complicated and not fully understood by scientists. On the one hand, we know that certain types of fat are required for proper growth and maintenance of health, and their absence in the diet causes specific deficiency diseases. On the other hand, too much of certain kinds of fat can increase the risk of chronic disease. Part of the confusion is that several types of fat exist in nature and are present in the food we eat. Another point of confusion is that many different names are used to describe the substances in food we commonly call “fat.” To a chemist, any molecule in food that does not dissolve in water belongs to a family of chemicals called lipids. The most important lipids in the food supply are triglycerides and cholesterol, which are chemically unrelated substances except for the fact that they do not dissolve in water. Triglycerides are the lipids commonly known as fat, oil, grease, shortening, lard, tallow, suet, ghee, and a variety of other names around the world. A bottle of soybean oil, for example, is pure triglyceride. We generally use the term “fat” to describe triglycerides that are solid at room temperature, and “oil” if they are liquid at room temperature. Fats and oils are actually mixtures of many different types of triglycerides with different chemical properties, which explains why some mixtures are solid and some are liquid. Triglycerides provide energy to the body and are found throughout the food supply in both animal and plant products. Cholesterol is another dietary lipid, but it is found only in animal products—cholesterol does not exist in the plant kingdom. You should be aware of clever marketing schemes that advertise plant foods as “cholesterol free” and then charge you a higher price! Cholesterol is made in the body in adequate amounts and is therefore not considered an essential nutrient. Unlike triglycerides, cholesterol provides no energy but it is a critical structural component of every cell in the body.

Mention the word vitamin, and an almost magical image comes to mind. Vitamins have been purported to do everything from boosting one’s energy level to increasing sexual prowess to curing disease. While it is true that vitamins are required for a variety of metabolic functions, the
restorative abilities attributed to them may be somewhat overstated. From the scientific viewpoint, vitamins are essential dietary substances needed in small amounts to regulate chemical reactions in the body. In this sense, vitamins are important for proper growth and maintenance of good health, but they appear to possess no greater properties beyond their basic chemical function. Vitamins do indeed participate in the chemical reactions that release energy from carbohydrates, proteins, and fats, but contain no inherent energy themselves. Vitamins are required for normal reproductive metabolism, but they are not aphrodisiacs. And inclusion of vitamins in the diet will cure disease, but only the specific deficiency diseases that develop in their absence. Vitamins are generally found throughout the food supply in developed countries and are consumed in adequate amounts, so despite popular belief, a vitamin supplement is usually not needed.

Minerals are among the basic elements of the earth that cannot be created or broken down by natural forces. Of the more than 100 earthly elements, the body requires at least 16 of them for a variety of functions such as conducting electricity, regulating chemical reactions, and providing structural components to the body. The minerals have traditionally been grouped according to the amount found in the human body or by how much is needed in the diet. The major minerals are those that comprise greater than 0.05% of total body weight, whereas the trace minerals are found in quantities less—usually much less—than 0.05% body weight. It is very likely that the body requires many more trace minerals than we currently believe, but they may be needed in such small amounts that current research methods are not sensitive enough to study their metabolic function. Minerals are generally found throughout the food supply. Plants obtain minerals from the soil in which they are grown, and animals accumulate minerals by eating the plants. Not surprisingly, the mineral content of foods is dependent on which minerals are present in the geographic region where the foods are produced. For example, there is a large region in China where the soil is deficient in selenium, and symptoms of selenium deficiency are common among the people that live in that region. Mineral deficiencies are rare in populations living in developed countries where the found supply is abundant.

Water is often the forgotten nutrient, yet it is the major component of our diet and our bodies. In fact, water is perhaps the most critical of all essential nutrients in the sense that humans survive only a few days without water, but can survive several weeks or months without other essential nutrients. The average adult consumes about 10 cups of water each day in the form of water-containing foods and beverages. While most water in the body comes from the diet, some water is generated from chemical reactions that occur during normal metabolism. Water is distributed throughout the body, both inside and outside cells. It provides several major functions in the body, such as lubricating joints, transporting nutrients in the blood, transporting waste products in the urine, regulating body temperature, and providing the medium for virtually every chemical reaction in the body. Physically active people require more water each day than inactive people because of increased water losses through sweat and evaporation.

Humans depend on a constant supply of food for health and survival. Eating enough of the right foods in order to get all of the essential nutrients the body needs is not always easy to figure out, especially with the multitude of food choices available to consumers. To make matters even more confusing, health “experts” are continually warning us about foods we should avoid and which ones promote health. A few years ago consumers were told to stop eating butter because it caused heart disease and to switch to margarine. Then margarine became the bad guy because the type of
fat used to make margarine was supposed to be worse than butter. This “good food/bad food” mentality has unfortunately created many misleading concepts and unfounded beliefs about food and its impact on health and disease. The nature of nutrition research is not black and white, and the apparently contrasting messages are merely a reflection of evolving knowledge and understanding of how nutrients function in the body. The first step in making healthy food choices is to realize there is no such thing as good foods or bad foods—all foods can fit into a healthy diet. In fact, no single food is perfectly balanced in all the essential nutrients required by the body. A healthy diet therefore depends on eating a variety of foods from several different sources, such as fruits, vegetables, meats, grains, milk and dairy products. This approach will help insure that all of the body’s needs are met while helping to reduce the risk of chronic diseases.
5. Certain nutrients are “burned” for energy in a manner similar to when substances are burned outside the body.

Multiple Choice
6. Which nutrient class is most often associated with acute deficiency diseases?
   a. Lipids  
   b. Vitamins  
   c. Proteins  
   d. Carbohydrates

7. Carbohydrate, proteins, and fats are considered macronutrients because
   a. They are more important than vitamins and minerals  
   b. They are required in the diet in greater amounts than micronutrients  
   c. They can be stored in the body  
   d. They provide energy

8. Which of the following is not considered a source of dietary carbohydrate?
   a. Soybean oil  
   b. Pasta  
   c. Celery  
   d. Table sugar

9. Some of the earliest studies in nutrition focused on
   a. Dietary fat and reducing the risk of heart disease  
   b. Calcium deficiency and osteoporosis  
   c. Curing scurvy with certain foods  
   d. Reducing blood pressure by drinking milk

10. Which of the following statements regarding protein intake in economically developed countries is true?
   a. Protein is the most abundant nutrient class in the diet  
   b. Protein supplements are usually needed to meet the body’s requirement  
   c. Animal foods provide the only source of dietary protein  
   d. Protein consumption is twice the required amount needed by the body

Short Answer
11. Cholesterol is a vitally important component of every cell in the body. It is also consumed in the diet. So why is cholesterol not considered an essential nutrient?
12. Why are experts unsure about which trace minerals (and how many) are essential to humans?
13. What do vitamins do in the body?
14. Why is cancer considered a “chronic” disease?

Essay
15. Explain why a substance in food that is not absolutely essential for normal growth and development can still be considered a nutrient
Further Reading


