

# The Science of Nutrition: Linking Food, Function, and Health

## Chapter Summary

---

Nutrition is the science of food and how food nourishes the body and impacts health. Although early nutrition research focused on identifying, preventing, and treating deficiency disease, research today attempts to reduce the risk of chronic disease and is moving into a new realm: nutrigenomics. Because of its importance to wellness, nutrition has been included in the national health promotion and disease prevention plan known as *Healthy People 2020*. The six essential nutrients found in the foods we eat are carbohydrates, fats, proteins, vitamins, minerals, and water. Although only carbohydrates, fats, and proteins provide energy, all of the nutrients have specific roles critical to human growth and function. The Dietary Reference Intakes (DRIs) are reference standards for nutrient intakes for healthy people in the United States and Canada and should be used for dietary planning. Malnutrition occurs when a person's nutritional status is out of balance. Nutrition assessment includes a physical examination, health history, dietary intake, and anthropometric measurements.

Following the basic steps of the scientific method, researchers attempt to support or refute a hypothesis in an effort to develop theories about nutrition. Various types of research studies can be used if carefully designed. To avoid quackery, individuals must evaluate media reports by questioning the validity of the information and the research. Good sources of reliable nutrition information include registered dietitians, licensed dietitians, and people who hold advanced degrees in nutrition. In addition, there are many government health agencies that offer reliable information related to nutrition, as well as private organizations that promote health and wellness through research and education.

Nutrition Myth or Fact asks the question: Nutrigenomics: Personalized nutrition or pie in the sky?

## Learning Objectives

---

*After studying this chapter, the student should be able to:*

1. Define the term *nutrition* and describe the history of nutrition science (pp. 4–6).
2. Discuss why nutrition is important to health (pp. 6–9).
3. Identify the six classes of nutrients essential for health and describe their functions (pp. 9–15).
4. Distinguish among the six types of Dietary Reference Intakes for nutrients (pp. 15–18).
5. Describe the tools nutritional professionals and other healthcare providers use for gathering data related to an individual's nutritional status and diet (pp. 18–21).

6. Explain how nutrition professionals classify malnutrition (pp. 21-22).
7. Discuss the four steps of the scientific method (pp. 22–26).
8. Compare and contrast the various types of research studies used in establishing nutrition guidelines (pp. 26-27).
9. Describe the various approaches you can use to evaluate the truth and reliability of media reports, websites, and other sources of nutrition information (pp. 28–30).
8. List at least four sources of reliable and accurate nutrition information and state why they are trustworthy (pp. 30–33).

## Key Terms

---

Acceptable Macronutrient	fat-soluble vitamins	overt symptom
Distribution Range	food	primary deficiency
Adequate Intake	hypothesis	quackery
Behavioral Risk Factor	incidence	Recommended Dietary
Surveillance System	inorganic	Allowance
case-control studies	macronutrients	registered dietitian
Centers for Disease	major minerals	secondary deficiency
Control	malnutrition	subclinical deficiency
chronic diseases	micronutrients	theory
clinical trials	National Health and Nutrition	Tolerable Upper Intake
covert symptom	Examination Survey	Level
Dietary Reference	National Institutes	trace minerals
Intakes	of Health	undernutrition
epidemiological studies	nutrients	water-soluble vitamins
Estimated Average	nutrition	wellness
Requirement	observational studies	
Estimated Energy	organic	
Requirement	overnutrition	

## Chapter Outline

---

### I. What Is the Science of Nutrition and How Did It Evolve?

- A. Nutrition is the science that studies food and how food nourishes our bodies and influences our health.
  1. Food is the plants and animals that we consume.
- B. Nutrition is a relatively new scientific discipline compared to other sciences.
  1. Initial studies in the mid-1700s focused on the link between diet and disease.
  2. By the mid-1800s the energy-producing nutrients had been identified.
  3. Through the mid-1900s nutrition research focused on identifying and preventing deficiency disease.
  4. After World War II supporting wellness and treating chronic disease became the new pursuit of nutrition researchers.
  5. More recently, nutrition studies have shifted to nutrigenomics, which seeks to generate nutrition information tailored to our genetic makeup.

**Key Terms:** food, nutrition, chronic diseases

## II. How Does Nutrition Contribute to Health?

- A. Wellness is a multidimensional lifelong process that includes physical, emotional, and spiritual health.
  - 1. Nutrition and physical fitness are integral parts of wellness.
  - 2. Neglect of either nutrition or fitness can lead to serious health problems.
  - 3. Healthy diet and physical activity feel good.
- B. A healthful diet can prevent some diseases and reduce your risk for others.
  - 1. Nutrient deficiencies can cause serious illnesses.
  - 2. A poor diet can contribute to chronic diseases.
  - 3. Nutrition is strongly associated with heart disease, stroke, and diabetes.
  - 4. Obesity is the primary link between poor nutrition and mortality.
    - a. The prevalence of obesity increased dramatically from the 1970s through 2010.
- C. *Healthy People 2020* identifies nutrition-related goals for the United States.
  - 1. The overarching goals are to increase quality and years of healthy life and to eliminate health disparities.
  - 2. The broad goals are supported by hundreds of specific goals and objectives that outline a health promotion and disease prevention plan for the nation.

**Key Terms:** wellness, prevalence

### Figures and Table:

**Figure 1.1:** Many factors contribute to an individual's wellness.

**Figure 1.2:** The relationship between nutrition and human disease

**Figure 1.3:** Of the ten leading causes of death in the United States in 2012, three—heart disease, stroke, and diabetes—are strongly associated with poor nutrition.

**Figure 1.4:** Increase in obesity prevalence across the United States from 1994-2010

**Table 1.1:** Nutrition and Physical Activity Objectives from *Healthy People 2020*

## III. What Are Nutrients?

- A. Nutrients are chemicals found in foods that are critical to human growth and function.
  - 1. Organic nutrients contain carbon and hydrogen and include carbohydrates, proteins, lipids, and vitamins.
  - 2. Inorganic nutrients do not contain carbon and hydrogen and include minerals and water.
- B. Carbohydrates, lipids, and proteins are nutrients that provide energy.
  - 1. Energy nutrients are referred to as macronutrients.
    - a. The only nutrients that provide energy are the macronutrients, which are needed in large amounts to support normal function and health.
    - b. Alcohol is also a source of energy, but it is not a nutrient.
  - 2. Energy is expressed in units of kilocalories (kcal).
    - a. Carbohydrates and proteins provide 4 kcal per gram.
    - b. Alcohol provides 7 kcal per gram.
    - c. Lipids provide 9 kcal per gram.

3. Carbohydrates are a primary fuel source, especially for neurological function and physical activity.
    - a. Sources of carbohydrate include grains, vegetables, fruits, legumes, dairy products, seeds, and nuts.
    - b. Fiber is also classified as carbohydrate.
  4. Lipids provide energy and come in several forms.
    - a. Lipids contain proportionally less oxygen and water than do carbohydrates, which results in a higher energy yield per gram.
    - b. Triglycerides are the most common lipid in food.
    - c. The types of fatty acids in triglycerides determine their effects on health.
    - d. Triglycerides are an important energy source for our bodies at rest and during low-to moderate-intensity exercise.
    - e. Foods that contain lipids are important for the absorption of fat-soluble vitamins.
    - f. Phospholipids are synthesized in the body but found in few foods.
    - g. Cholesterol is a form of lipid that is synthesized in our body but can also be consumed in the diet.
    - h. Plant sterols are present in some plant-based foods such as vegetable oils.
  5. Proteins support tissue growth, repair, and maintenance.
    - a. Building blocks of protein are amino acids, all of which contain nitrogen.
    - b. Proteins can provide energy but are not a primary source.
    - c. Proteins play a major role in growth, structural repair, and maintenance by assisting in regulating metabolism and fluid balance.
    - d. Sources of protein include meat, dairy, seeds, nuts, and legumes, and to a lesser extent, vegetables and whole grains.
- C. Vitamins assist in the regulation of physiologic processes.**
1. Vitamins are organic compounds needed in relatively small amounts and are classified as micronutrients.
    - a. Vitamins play a role in the release and use of energy from energy nutrients.
    - b. Vitamins are essential to healthy bone, blood, muscle, and immune support; and in ensuring healthy vision.
  2. Vitamins are classified as water-soluble or fat-soluble.
    - a. Both are essential for health and found in many foods.
- D. Minerals assist in the regulation of many body functions.**
1. Minerals are inorganic substances that maintain their structure no matter what environment they are found in.
  2. Minerals assist in fluid regulation and energy production, are essential to healthy bones and blood, and help rid the body of harmful by-products of metabolism.
  3. Minerals are categorized as major minerals or trace minerals.
- E. Water supports all body functions.**
1. Sources of water include fluids and solid foods like fruits and vegetables.
  2. Water is essential to nerve impulses, body temperature, muscle contractions, nutrient transport, and excretion of waste.

**Key Terms:** nutrients, organic, inorganic, macronutrients, micronutrients, fat-soluble vitamins, water-soluble vitamins, major minerals, trace minerals

**Figures and Tables:**

**Figure 1.5:** The six groups of nutrients found in the foods we consume.

**Figure 1.6:** Carbohydrates are a primary source of energy for our body.

**Figure 1.7:** Lipids are an important energy source during rest and low-intensity exercise.

**Figure 1.8:** Proteins contain nitrogen in addition to carbon, hydrogen, and oxygen.

**Table 1.2:** Overview of Vitamins

**Table 1.3:** Overview of Minerals

#### **IV. What Are the Current Dietary Recommendations and How Are They Used?**

**A.** The Dietary Reference Intakes identify a healthy person's nutrient needs.

1. DRIs are used in both Canada and the United States and are for healthy people only.
2. DRIs for most nutrients consist of six values:
  - a. Estimated Average Requirement (EAR) represents the average daily nutrient intake level estimated to meet the requirement of half the individuals in any life stage or gender group.
  - b. Recommended Dietary Allowance (RDA) is the average daily nutrient intake level that meets the nutrient requirements of 97–98% of the healthy individuals in a particular life stage or gender group.
  - c. Adequate Intake (AI) is a recommended average daily nutrient intake based on observed or experimentally determined estimates and is used when an EAR cannot be established.
  - d. Tolerable Upper Intake Level (UL) is the highest average daily nutrient intake likely to pose no risk of adverse health effects to most individuals in a particular life stage or gender group.
  - e. Estimated Energy Requirement (EER) is the average dietary energy intake that is predicted to maintain energy balance in a healthy individual.
  - f. Acceptable Macronutrient Distribution Range (AMDR) identifies a range of intakes for the three energy nutrients that is both adequate and associated with a reduced risk of chronic disease.

**B.** Diets based on the DRIs promote wellness.

**Key Terms:** Dietary Reference Intakes (DRIs), Estimated Average Requirement (EAR), Recommended Dietary Allowance (RDA), Adequate Intake (AI), Tolerable Upper Intake Level (UL), Estimated Energy Requirement (EER), Acceptable Macronutrient Distribution Range (AMDR)

**Figure:**

**Figure 1.9:** Dietary Reference Intakes (DRIs)

#### **V. How Do Nutrition Professionals Assess the Nutritional Status of Clients?**

**A.** Nutrition professionals must have a thorough understanding of their clients' nutritional status, which may fall anywhere along a continuum.

1. Malnutrition is an imbalance in nutritional status whereby the individual is getting too much or too little of a particular nutrient or energy over a significant period of time.
  2. Nutritional assessments become the foundation of dietary and lifestyle recommendations.
- B.** Tests conducted during a physical exam elicit objective data that can be empirically verified.
1. The tests performed during a physical examination depend on the client's medical history, disease symptoms, and risk factors.
  2. Vital sign assessment and laboratory tests provide clues to nutritional status.
  3. Anthropometric assessments include measurements of height and weight.
    - a. Measurements taken by someone who is properly trained are compared with standards for age and gender.
    - b. These measurements determine whether body size and growth are normal.
    - c. Although not true anthropometric measures, body composition measurements distinguish the lean body tissue from fat tissue.
- C.** Health-history questionnaires elicit subjective information.
1. A health history includes questions on demographics, medication status, family history of disease, personal history, menstrual history, exercise history, and socioeconomic factors.
  2. Specific questionnaires can be used to assess a person's nutrient and energy intakes.
    - a. A diet history done by interview or questionnaire helps to identify nutrition or eating problems and unique nutritional needs.
    - b. A 24-hour dietary recall is a quick, simple way to assess a person's dietary intake, but it has serious limitations.
    - c. Food-frequency questionnaires assist in determining a person's typical dietary pattern over a predefined period of time.
    - d. A diet record over a specified period of time, although time consuming, can be analyzed to provide relatively accurate estimates of energy and nutrient intakes.
- D.** A finding of malnutrition requires further classification.
1. Overnutrition occurs when a person consumes too much energy or too much of a given nutrient over time.
    - a. It can be further classified as overweight or obesity.
  2. Undernutrition occurs when someone consumes too little energy or too few nutrients over time, causing significant weight lost, nutrient deficiency, or nutrient deficiency disease.
  3. Nutritional deficiencies are either primary or secondary.
    - a. Primary deficiency occurs when a person does not consume enough of a nutrient.
    - b. Secondary deficiency occurs when a person cannot absorb enough of the nutrient, excretes too much, or the body is not utilizing the nutrient efficiently.
  4. The symptoms of a subclinical deficiency are covert or hidden and require testing to uncover.
    - a. The signs and symptoms become overt when they become obvious to the client, such as pain, fatigue, or a bruise.

**Key Terms:** malnutrition, overnutrition, undernutrition, primary deficiency, secondary deficiency, subclinical deficiency, covert, overt

## **VI. How Can You Interpret Research Study Results?**

- A.** Research involves applying the scientific method.
  - 1. A scientist first observes and describes a phenomenon initiating the research process.
  - 2. A hypothesis attempts to explain the observation.
  - 3. An experiment is designed to test the hypothesis.
    - a. The sample size must be large enough to rule out chance results.
    - b. A control group is used for comparison to the treatment group.
    - c. To increase validity, as many variables as possible are eliminated.
  - 4. Data is collected and analyzed to determine support or rejection of the hypothesis.
  - 5. Most hypotheses need revision after initial testing.
  - 6. To be considered reliable, an experiment must be repeatable.
    - a. Initial research never proves or disproves.
    - b. Media often overdramatizes initial research.
  - 7. Following extensive research, a theory may be developed.
- B.** Various types of research studies tell us different stories.
  - 1. Animal studies are used as model studies for preliminary data to assist in human study design, and are used to conduct research that can't be done with humans.
    - a. Animal study results may not apply directly to humans and may also be considered unethical.
  - 2. Observational studies assess relationships between dietary habits and disease trends.
    - a. Epidemiological studies examine patterns, causes and effects of health and disease conditions in defined populations, and report the prevalence and incidence of disease.
    - b. Observational studies assess dietary habits, disease trends, and other health phenomena of large populations and determine the factors that may influence these phenomena.
  - 3. Case-control studies are more complex observational studies
    - a. Case control studies compare a group of people with a particular condition to a similar group of people without the condition.
  - 4. Clinical trials are tightly controlled experiments that examine cause and effect.
    - a. In a clinical trial, an intervention is given to determine its effect on a disease or health condition.
    - b. People in the experimental group are given the intervention, but people in the control group are not and the responses of the two groups are compared.
    - c. When evaluating the quality of a clinical trial it is important to know whether the subjects were randomly chosen (randomized clinical (controlled) trials) and whether the researchers and subjects were blinded.
    - d. Clinical trials that are double-blind and placebo-controlled are the most valid.
    - e. The "placebo effect" refers to a phenomenon whereby the control group experiences improved health despite the fact that they have only received a placebo.

**Key Terms:** hypothesis, theory, epidemiological studies, incidence, observational studies, case-control studies, clinical trials

**Figure:**

**Figure 1.10:** The Scientific Method

## VII. How Can You Use Your Knowledge of Research to Help You Evaluate Nutrition Claims?

- A. Use your knowledge of research to help you evaluate media reports.
1. Watch for conflict of interest and bias.
    - a. Investigate who conducted the research and who paid for it.
    - b. A conflict of interest occurs when a person is in a position to derive personal benefit and unfair advantage from actions or decisions made in their official capacity.
    - c. A bias is any factor that might influence the researcher to favor certain results.
  2. Investigate the author of the report, the references cited in it, and the content of its claims.
    - a. Quackery is the promotion of an unproven remedy, usually by someone unlicensed and untrained, for financial gain.
  3. Determine if the information published on a website is credible.
    - a. Examine credentials of website sponsors; check the date of the website; look at the web address; check the bottom line.

**Key Terms:** conflict of interest, quackery

## VIII. Nutrition Advice: Who Can You Trust to Help You Choose Foods Wisely?

- A. Trustworthy experts are educated and credentialed.
1. A Registered Dietitian (RD) possesses appropriate education, experience, and registration to qualify to provide nutrition counselling.
    - a. A RD/Nutritionist is a RD who is also a qualified nutritionist.
  2. A Licensed dietitian meets the credentialing requirements of a given state to engage in the practice of dietetics.
  3. Many individuals are educated and experienced in nutrition and hold an advanced degree (master's or PhD) in nutrition.
  4. A physician is licensed to practice medicine but typically has limited experience and training in nutrition.
  5. "Nutritionist" is a job title that generally has no definition or laws regulating it.
- B. Government sources of information are usually trustworthy.
1. Centers for Disease Control and Prevention (CDC) protects the health and safety of Americans
    - a. National Health and Nutrition Examination Survey (NHANES) tracks the food and nutrient consumption of Americans.
    - b. Behavioral Risk Factor Surveillance System (BRFSS) tracks lifestyle behaviors that increase risk for chronic disease.
  2. National Institutes of Health (NIH) is the world's leading medical research center and the focal point for medical research in the United States.
- C. Professional organizations provide reliable nutrition information.

1. The Academy of Nutrition and Dietetics is the largest organization of food and nutrition professionals in the world.
2. American Society of Nutrition (ASN) is the premier research society for improving quality of life through the science of nutrition.
3. Society for Nutrition Education (SNE) promotes healthy, sustainable food choices through nutrition research and education.
4. American College of Sports Medicine (ACSM) leads the world in sports medicine and exercise science research.
5. The Obesity Society (TOS) is dedicated to the study of obesity.

**Key Terms:** Registered dietician (RD), Centers for Disease Control and Prevention (CDC), National Health and Nutrition Examination Survey (NHANES), Behavioral Risk Factor Surveillance System (BRFSS), National Institutes of Health (NIH)

## Activities

---

1. Have students write down everything they have had to eat or drink during the past 24 hours. Place them in groups to discuss this technique as a diet assessment tool.  
Ask them to consider the following questions:
  - a. What are the limitations of using the tool?
  - b. What are the advantages to using the tool?
  - c. What questions could you ask to improve the tool?
  - d. Why would this be the tool used for the NHANES?
2. Have students develop a food-frequency questionnaire that could be used to assess the eating habits of college students living on campus. You may want to show them examples of other food-frequency questionnaires to help them develop the tool.
3. To prepare students to complete the diet analysis, have them measure servings of the foods they eat at home. Tell them to ask questions when dining away from home (or in the dining service) to determine portion sizes. Have them make notes about their investigation of portions on their food record. (This assignment can then be used when discussing the Nutrition Facts Panel in Chapter 2.)
4. Using a search engine (such as Google), ask students to find a current article on nutrition research from a popular media source. You may choose to bring some current articles to class instead. Either in small groups or in individual papers, have students explain the degree of validity of the article by responding to the questions from the section of the chapter entitled *Use Your Knowledge of Research to Help You Evaluate Nutrition Claims* (found on page 28 in the text). Students can then discuss the characteristics that increase the believability of the report.
5. Assign groups of students each website listed at the end of the chapter. Students should explore the website and prepare a brief explanation of what the organization does and what types of information can be found on the website. Students should identify ways that they might use the information throughout the course, while they are in college, and throughout their career.

## Diet Analysis Activity

6. Have your students keep a diet record for 3 to 7 days (7 will give them a better assessment). If you are only requesting 3 days, have them choose 3 days during which their eating habits are typical. A good guideline is to include 2 weekdays and 1 weekend day. Have them record all foods and drinks they consume for each of the 3 days. Be sure they estimate the quantities of each item to the best of their abilities. Ask them to enter this information into their diet analysis software and to compare their intakes to the DRIs appropriate for their age and gender. It is not necessary to meet 100% of each DRI every day. A general guideline is meeting between 80% and 120% of the requirements over a 1-week period. Have them answer the following questions:
  - a. For how many nutrients analyzed did you meet requirements?
  - b. How many nutrients were less than 80% of requirements?
  - c. How many nutrients were greater than 120% of requirements?

Keep this assessment for use in future activities.

## Nutrition Debate Activity

7. Prepare 12 to 15 statements that people typically believe about various nutrition topics (see list below). Some of the statements should be true and others false. Each statement should be printed in a large readable font on its own sheet of paper. Tape the pages to the walls around the classroom. Give each student about eight stickers. Tell them to go around the room and read each statement. If they believe the statement is true, they should mark it with a sticker. Emphasize the fact that each student should use personal judgment (not their neighbor's) and that they will remain anonymous, because everyone has the same kind of stickers. Once everyone has read all of the statements, remove them from the walls, read them, show the class the number of stickers on the page, and reveal whether the statement is myth or currently accepted fact. Ask students to discuss why they believe what they do about these statements. From what sources have you acquired health and nutrition information? Why did you consider the source reliable? Should people consider the top sources of the class reliable? Why or why not? Note: You may want to save the statements with the stickers to revisit when you return to the topic.

Possible Statements:

- Artificial sweeteners have been shown to cause cancer and contribute to other medical conditions.
- A diet low in cholesterol is the best method to treat high blood cholesterol.
- Fish oil may aid the treatment of depression and anxiety.
- A low-sodium diet has been proven effective in preventing hypertension.
- Smokers who eat a variety of fruits and vegetables daily have a lower risk of lung cancer than smokers who eat few fruits and vegetables.
- *E. coli* is found on produce as often as it is found on animal products.
- The only nutrient that is found to be lower in athletes than the general population is iron.
- High-protein, low-carb diets are best for weight loss and body building.

- Today's baby formulas are almost identical to human breast milk but not as cost effective.
- Alcoholism is higher in the elderly population than in teens and young adults.
- Vegetarians cannot get enough protein, vitamins, and minerals from diet alone.

## **Web Resources**

---

### **Healthy People 2020**

[www.healthypeople.gov](http://www.healthypeople.gov)

### **Academy of Nutrition and Dietetics**

[www.eatright.org](http://www.eatright.org)

### **Centers for Disease Control and Prevention (CDC)**

[www.cdc.gov](http://www.cdc.gov)

### **National Center for Health Statistics**

[www.cdc.gov/nchs](http://www.cdc.gov/nchs)

### **National Institutes of Health**

[www.nih.gov](http://www.nih.gov)

### **American Society for Nutrition**

[www.nutrition.org](http://www.nutrition.org)

### **American College of Sports Medicine**

[www.acsm.org](http://www.acsm.org)

### **The Obesity Society**

[www.obesity.org](http://www.obesity.org)

### **Institute of Medicine of the National Academies**

[www.iom.edu/Global/Topics/Food-Nutrition](http://www.iom.edu/Global/Topics/Food-Nutrition)

### **PubMed**

[www.ncbi.nlm.nih.gov/pubmed](http://www.ncbi.nlm.nih.gov/pubmed)

---