

# Vitamins and Minerals: Micronutrients with Macro Powers

## Chapter Summary

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The micronutrients, vitamins and minerals, are needed in much smaller amounts than macronutrients. Vitamins are classified as fat-soluble or water-soluble and have both an alphabetical and chemical name. Fat-soluble vitamins are found in fatty foods, are absorbed with fat, are stored in the body, and can reach toxic levels. Water-soluble vitamins are found in a variety of foods, are easily absorbed, and are more likely to be deficient than toxic, although toxicity is possible. Minerals are classified as major minerals, trace minerals, and ultra-trace minerals depending on the amount required. The chemical form and various factors in food determine the amount of the vitamin or mineral that is absorbed. Some vitamins are converted to an active form for use by cells, and minerals change atomic structure as needed.

Controversies in micronutrient metabolism have arisen as a result of marketing and limitations of research. Usually, consuming micronutrients from a daily variety of healthy foods is better than supplementation or eating refined, enriched foods. Research indicates that micronutrients may play a role in reducing the risk of chronic disease, that some supplements pose additional health problems for some individuals, and that megadoses of many vitamins and minerals can result in serious toxicity symptoms. Future research may uncover more essential nutrients, and genetics research may determine increased individuality in nutrient needs.

## Learning Objectives

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

1. Describe some incidents that led to the discovery of micronutrients (p. 293).
2. Distinguish between fat-soluble and water-soluble vitamins (pp. 293–296).
3. Describe the differences between major, trace, and ultra-trace minerals (pp. 296–299).
4. Explain why the amount of a micronutrient we consume may differ significantly from the amount our bodies absorb and use (pp. 299–301).
5. Discuss the role of micronutrient supplements in supporting or threatening our health (pp. 301–303).

## Key Terms

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fat-soluble vitamins  
major minerals  
megadosing

micronutrients  
minerals  
trace minerals

ultra-trace minerals  
vitamins  
water-soluble vitamins

## Chapter Outline

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### I. How Were the Micronutrients Discovered?

- A. Micronutrients, vitamins, and minerals are needed in much smaller amounts than macronutrients.
- B. Initial knowledge of vitamins comes from observation of animals and humans.
- C. Years of laboratory research confirmed the critical role of small amounts of accessory factors, now known as vitamins and minerals.

**Key Term:** micronutrients

### II. How Are Vitamins Classified?

- A. Vitamins are organic compounds that regulate many body processes.
  - 1. Thirteen vitamins are recognized as essential to consume.
  - 2. A healthful diet can meet most of an individual's vitamin needs.
- B. Vitamins A, D, E, and K are fat-soluble vitamins.
  - 1. Fat-soluble vitamins are found in fatty portions of food and absorbed with fat.
  - 2. The body stores these vitamins in adipose tissue.
  - 3. Excessive intake, mainly in supplemental form, can lead to toxicity.
  - 4. Toxicity includes damage to hair, skin, bones, eyes, and nervous system.
  - 5. Megadoses of ten times the RDA for vitamins A and D can result in irreversible organ damage and death.
  - 6. Deficiencies may occur in those with disorders that reduce dietary absorption and in those who consume minimal amounts of fat.
- C. Vitamin C and the B-vitamins are water-soluble vitamins.
  - 1. Water-soluble vitamins are found in a wide variety of foods and are readily absorbed directly into the bloodstream.
  - 2. Other than vitamin B<sub>12</sub>, water-soluble vitamins are not stored and must be consumed daily.
  - 3. Toxicity, although rare, occurs mostly from excessive supplementation and may result in nerve damage and skin lesions.
  - 4. Deficiency symptoms arise quickly, especially during fetal development, infancy, and childhood, causing diseases and syndromes.
- D. The same vitamin may have more than one name and may designate a small cluster of chemically related compounds.
  - 1. Most of the fat-soluble vitamins are “umbrella” clusters for similar compounds.
    - a. Vitamin A refers to retinol, retinal, and retinoic acid.
    - b. The set of chemical compounds known as tocopherols are classified as vitamin E.

- c. Cholecalciferol and ergocalciferol are known as vitamin D.
  - d. Vitamin K includes phyloquinone and menaquinone.
2. Water-soluble vitamins have alphabetic and chemical designations.
    - a. Most alphabetic designations refer to a single chemical compound.
    - b. Niacin and vitamin B<sub>6</sub> refer to an umbrella cluster.

**Key Terms:** vitamins, fat-soluble vitamins, water-soluble vitamins, megadosing

**Tables:**

**Table 1:** Fat-Soluble Vitamins

**Table 2:** Water-Soluble Vitamins

### III. How Are Minerals Classified?

- A. Minerals are inorganic elements in their simplest form and cannot be synthesized.
- B. Major minerals are required in amounts above 100 mg daily, and amounts above 5 g are found in the human body.
  1. The seven major minerals are: sodium, potassium, phosphorus, chloride, calcium, magnesium, and sulfur.
- C. Trace minerals are required in amounts less than 100 mg daily and found in the body at amounts less than 5 g.
  1. Four trace minerals have an established RDA or AI: fluoride, iron, manganese, zinc
- D. Ultra-trace minerals are required by the body at less than 1 mg per day.
  1. Five ultra-trace minerals have an established RDA or AI guideline: chromium, copper, iodine, molybdenum, and selenium.
- E. Minerals are identified by only one name but exist within different chemical compounds and vary in absorption.

**Key Terms:** minerals, major minerals, trace minerals, ultra-trace minerals

**Tables:**

**Table 3:** Major Minerals

**Table 4:** Trace and Ultra-Trace Minerals

### IV. How Do Our Bodies Use Micronutrients?

- A. What one eats differs from what one absorbs.
  1. The chemical form of many vitamins and minerals determines the amount absorbed.
  2. Other factors in the same food may increase or decrease absorption of certain vitamins and minerals.
  3. Absorption of vitamins and minerals can be influenced by other foods within the meal.
  4. Eating a variety of healthful foods improves the absorption of micronutrients.
- B. The chemical form of micronutrients in foods differs from what the cells use.
  1. Many vitamins must be activated through chemical transformation.
  2. Minerals can change in atomic structure for optimal use by the cells.

**Figure 1:** Maximizing Micronutrients

## V. Controversies in Micronutrient Metabolism

- A.** Are supplements healthful sources of micronutrients?
1. Although vitamin/mineral toxicity seldom occurs with diet, it is easy to develop toxic overload from supplements.
  2. Supplements of some vitamins/minerals have ill effects on specific groups of people.
  3. Minerals are better absorbed from animal food sources than from supplements.
  4. Enrichment of low-nutrient foods does not provide the variety of nutrients and other dietary factors in a variety of healthful choices.
  5. In addition to the fact that there may be more essential nutrients than have been identified, whole foods provide benefits beyond the purified individual nutrients and refined, enriched foods.
  6. Healthful food offers social, emotional, and other benefits that cannot be replaced.
  7. Some populations and individuals require supplements to maintain health.
- B.** Can micronutrients prevent or treat chronic disease?
1. Research studies have suggested links between certain vitamins and minerals and reduced risk of chronic disease.
  2. Nutrigenomics suggests that some individuals require higher or lower intakes of micronutrients to achieve health and prevent disease.
  3. Critical evaluation of such claims and avoidance of megadoses of micronutrients protect the consumer against harm.
- C.** Do more essential nutrients exist?
1. Scientists continually explore the possibility that substances that appear to benefit human health may be essential.

## Activities

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1. Assign each student or small groups of students either a vitamin or a mineral. Students should learn the history of the discovery of the vitamin/mineral, factors that improve the absorption of the specific vitamin or mineral, and the deficiency or toxicity disease and/or conditions that are related to it. Short presentations using some form of audiovisual can be done as each vitamin/mineral is studied in class or as preparation for an exam over the various vitamins and minerals.
2. Gather advertisements for a variety of single vitamin or mineral supplements. Have students evaluate the information for truth in advertising using the tables in this chapter. Discuss the following questions:
  - a. How do advertisers use such factual information to make the product sound like a miracle cure?
  - b. Which claims seem too outlandish to acknowledge? Why are these claims not considered fraudulent?
  - c. What claims would they consider investigating further to determine research backing?

3. Ask students to interview at least five of their friends and/or family members to find out how many of them are taking supplements and what type of supplements they are taking. In class, compile a table that includes:

- a. age of the person interviewed
- b. whether or not that person takes supplement(s)
- c. what type of supplement(s) taken
- d. reason given for taking the supplement(s)

Discuss the perceptions these people have about supplementation and how accurate those perceptions are.

### **Diet Analysis Activity**

4. Have students review their micronutrient intake from their nutrition analysis and determine which ones are low in their diets compared to the recommendations. Using the tables accompanying this chapter, have them answer the following questions:
  - a. What food would you willingly eat to improve your intake of the specific micronutrient?
  - b. Why would you or would you not consider supplementing with this particular nutrient?

### **Nutrition Debate Activity**

5. Using a debate format, have students discuss the appropriateness of health professionals recommending nutrient supplementation to prevent and treat infectious and chronic disease. Include in this debate:
  - a. Who should be responsible for disseminating information on supplementation?
  - b. Should supplements be prescribed or regulated in any way?
  - c. Should supplement manufacturers be held liable for ill effects of supplementation?

### **Web Resources**

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#### **US Food and Drug Administration**

[www.fda.gov/food/dietarysupplements/default.htm](http://www.fda.gov/food/dietarysupplements/default.htm)

#### **Food and Nutrition Information Center**

[fnic.nal.usda.gov/dietary-supplements](http://fnic.nal.usda.gov/dietary-supplements)

#### **Office of Dietary Supplements**

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

#### **Linus Pauling Institute of Oregon State University**

[lpi.oregonstate.edu](http://lpi.oregonstate.edu)

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