THE SCIENCE OF NUTRITION (Sci.70) COURSE LEARNING OBJECTIVES

CHAPTER 1
WHAT YOU EAT AND WHY

OVERVIEW

This introductory chapter provides an overview of the study of nutrition. Nutrients and their roles in the body are discussed. Results of large-scale dietary surveys of the American diet are presented concluding in establishing an American nutrition profile. Health objectives for the U.S. for the year 2010 are discussed. Hunger, appetite, and satiety are defined and put into perspective. Lastly, factors that influence food preferences and the development of food habits are explored.

The Nutrition Issue, "Using Scientific Research to Determine Nutrient Needs," describes the scientific method, and discusses how to spot nutrition fallacies and find reliable nutrition information. The Nutrition Insight covers math tools for nutrition.

CHAPTER OBJECTIVES

Upon completion of this chapter, the student will be able to:

1. define the terms nutrition, carbohydrate, protein, lipid (fat), alcohol, vitamin, mineral, water, kilocalorie (kcal), and dietary fiber.
2. use the caloric values of energy-yielding nutrients to determine the total calories (kcal) in a food or diet.
3. outline the basic units of the metric system used in nutrition and calculate a percentage value, such as percent of calories from fat in a diet.
4. list the major characteristics of the North American diet and the food habits that often need improvement.
5. describe how various factors affect our food habits: body physiological processes, meal size and composition, early experiences, ethnic customs, health concerns, advertising, social class, and economics.
6. list various attributes of a healthful lifestyle that also are consistent with *Healthy People 2010* goals.
7. identify diet and lifestyle factors that contribute to the 10 leading causes of death in North America.
8. understand the basics of the scientific method as it is used in developing hypotheses and theories in the field of nutrition.
9. identify reliable sources of nutrition information.

KEY TERMS

Alcohol
Amino acid
Anemia
Carbohydrate
Cardiovascular disease
Cell
Control group
Cortisol
Diabetes

Animal model
Appetite
Atom
Body Mass Index (BMI)
Cancer
Epidemiology
Essential nutrient
Experiments
Fatty acid
Gastrointestinal (GI) tract
Genes
Glucose
Hormone
Hunger
Hypertension
Hypotheses
Incidence
Infectious disease
Chemical reaction
Cholecystokinin (CCK)
Cholesterol
Chronic
Cirrhosis
Inorganic
Ion
Kilocalorie (kcal)
Leptin
Lipid
Metabolism
Minerals
Neuropeptide Y
Nutrients
Obesity
Organic
Osteoporosis
Placebo
Dietary fiber
Double-blind study
Element
Endorphins
Enzyme
Protein
Risk factor
Salt
Satiety
Serotonin
Solvent
Stroke
Theory
Triglyceride
Ulcer
Vegetarian
Vitamins
Water

REAL LIFE SCENARIO

Brendon listens to talk radio as he commutes to school each morning. He hears numerous advertisements for nutrient supplements. Commentators also warn about the dangers of certain lifestyle practices. New briefs discuss the latest breakthroughs, touting new findings regarding both positive and negative health practices. Typical terms he hears are cardiovascular disease, diabetes, cancer, obesity, vitamin E, omega-3 fatty acids, cholesterol, and creatine. All of these topics generally are covered in an introductory nutrition class. One advantage of Brendon taking such a class is to be able to decipher the health news that he reads in newspapers, hears on the radio, and is exposed to via television.

Start your exploration of nutrition by looking up these terms in the glossary at the back of the textbook. You will likely find this an interesting task, one that will heighten your awareness of nutrition and help you in your study of nutrition. Also consider adding a few other words you are curious about and look those up as well in the glossary, or use the index if the glossary does not contain the word.

LECTURE OUTLINE

I. Nutrition and your health
   - A. What is nutrition?
     1. Nutrition defined
   - B. Nutrients come from food
     1. Differences between food, nutrients, and nutrition
     2. Definition of essential nutrient
   - C. Why study nutrition?
     1. Ten leading causes of death in the U.S.
     2. Diseases that are nutrition-related

II. Classes and sources of nutrients

A. Overview of the six classes of nutrients
    1. Carbohydrates, lipids, proteins, vitamins, and minerals
    2. Functional categories
        a. Provide energy (kcals)
        b. Promote growth and development
        c. Regulate body processes
B. Carbohydrates
    1. 4 kilocalories per gram
    2. Simple sugars
        a. Monosaccharides
        b. Disaccharides
    3. Complex carbohydrates (polysaccharides)
        a. Starches
        b. Dietary fiber
C. Lipids
    1. 9 kilocalories per gram
    2. Triglycerides: fats and oils
        a. Saturated
        b. Unsaturated
            1) essential fatty acids
D. Proteins-amino acids
    1. 4 kilocalories per gram
    2. Functions
E. Vitamins
    1. Do not provide energy; 0 kilocalories per gram
    2. Functions
E. Minerals
    1. Do not provide energy; 0 kilocalories per gram
    2. Functions
F. Water
    1. Does not provide energy; 0 kilocalories per gram
    2. Functions

III. Nutrient composition of diets and the human body differ

IV. Energy sources and uses
A. We need energy for body functions
    1. Carbohydrates, fats, proteins
    2. Alcohol
        a. 7 kilocalories per gram
        b. Not a nutrient; has no required function
    3. Energy is held in chemical bonds
    4. Kilocalories
        a. Definitions of kilocalorie and calorie
        b. Calculating total food energy
        c. Calculating percentage of total energy intake

V. Current state of the North American diet and overall health
A. A profile of the American diet
B. Assessing the current North American diet

VI. Health objectives for the U.S. for the year 2010
A. Nutrition-related objectives

B. Improving overall health

VII. Understanding what drives us to eat
- A. The hypothalamus contributes to satiety regulation
- B. Meal size and composition affect satiety
- C. Hormones affect satiety
- D. Appetite affects what we eat
- E. Hunger and appetite put into perspective

VIII. Improving our diets
- A. Evolving dietary trends

NUTRITION ISSUE: Using scientific research to determine nutrient needs

I. Scientific method
- A. Observation of natural phenomenon
- B. Generating hypotheses
- C. Controlled scientific experiments are conducted
  1. Animal experiments
  2. Human experiments
     a. Case control study
     b. Double-blind study
- D. Peer review of experimental results
- E. Follow-up studies

II. Scientific method knowledge is used to evaluate nutrition claims and advice

ACTIVITIES

1. Use the **Rate Your Plate** activity at the end of Chapter 1. Have the students follow the instructions, and use it as an object for class discussion regarding their eating habits.
   - A. Make sure they follow the assignment instructions closely because this one-day food record can be used for future activities. They should record all foods and beverages consumed and the serving sizes, in addition to the other data. To allow them to get a sense of serving sizes, bring in measuring cups and devices, and actually illustrate what 1 cup of cereal looks like in a bowl, as well as the serving sizes of other foods. Ask the class to try to eat simple foods during the day of record and to avoid complex mixtures. It can be difficult to break these complex mixtures into individual ingredients for analysis.
   - B. Even though this is an end-of-the-chapter activity, it would be best if the food record were completed during the first week of class, so it can be used for subsequent activities.
   - C. Instructors should require a three-day food record so it can be used for future activities. The data, at a later time, can be averaged for the three days to assess nutrient intake.
2. Have students list the various kinds of restaurants in the campus area and tally how often they have frequented them. Do they use college or university food service? How often do they use vending machines? Why do they make the choices they do? What changes would they like to see made in the food and food service choices available?
3. Have students discuss their parents' food habits, both good and bad. How are the students' food habits similar to their parents'? How have their parents' food habits and

attitudes affected their eating habits?

4. Assign students to make a written record of food commercials they see during a day or night of TV watching. Ask them to discuss in writing or verbally what they have learned about the messages food commercials give and the eating habits they promote.
5. Have students make a list of five questions they have about food and nutrition. Collect the questions. The last week of the course hand back the questions. Have them divide up into groups and discuss whether they can answer their own questions. If some are left unanswered let them discuss possible answers in their groups. This will be a good way to review course material.
6. Have the students complete the questionnaire titled "How's Your Diet?" that is published by Center for Science in the Public Interest (CSPI) in their *Nutrition Action Healthletter* [1875 Connecticut Ave., N.W., Suite 300, Washington D.C. 20009-5728; (202) 332-9110]. The questionnaire contains 40 questions that focus on key diet features. For example, one question is, "Do you trim visible fat when you cook or eat red meat?" What the quiz will do is give students a rough idea of their current eating habits and, implicitly, suggest what they can do to improve them. Students can discuss strengths and weakness of their eating habits. They can list a few eating habits they would like to improve over the semester. The questionnaires and goals for improving eating habits can be saved by each student or the instructor. Toward the end of the course, students can be asked to complete the questionnaire again and compare it to the first to see how their eating habits have changed, for better and/or for worse.

READINGS

1. Blumenthal SJ: A top woman doctor tells how to get past the hype to the truth, *American Health* p. 36, January/February 1998.
   The Assistant U.S. Surgeon General provides advice on how to interpret research findings that appear in the media, such as who paid for the study and whether the findings are supported by previous studies.
2. Check-up for the new millennium. *Consumer Reports on Health*, p. 1, December 1999.
   A checklist of both healthy habits and no-so-healthy habits is given, along with suggested changes in habits to maximize wellness. The focus is on a balanced diet, maintaining a healthy weight, and performing regular physical activity.
3. Glanz K and others: Why Americans eat what they do: Taste, nutrition, cost, convenience, and weight control concerns as influences on food consumption, *Journal of the American Dietetic Association* 98:1118, 1998.
   Nutrition concerns are, unfortunately, less relevant to most people than taste and cost when it comes to food choice. One implication is that nutrition education programs should promote nutritious diets that are tasty and inexpensive.
4. *Healthy People 2010* targets healthy diet and healthy weight as critical goals. *Journal of the American Dietetic Association* 100:300, 2000.
   Many of the nutrition goals included in Healthy People 2010 *are enumerated. Two key goals are to reduce obesity and inactivity in the American population.*
5. Liebman B, Schardt: Diet and health: Ten megatrends. Nutrition Action Healthletter, p. 1, January/February 2001.
   Both positive and negative trends in the American diet in the past 30 years are shown in graphic form, demonstrating that improvements have been made in deaths from cardiovascular disease, but obesity is increasingly becoming a problem. Large restaurant serving sizes are one contributor to this problem.

6. Lifestyle and aging. *Mayo Clinic Health Letter*, p. 4, July 1999.
Mayo Clinic physicians provide their advice for a healthy lifestyle, such as getting regular exercise, opting for many whole-grain choices, and drinking alcohol in moderation, if at all.
7. McBean LD: Nutrition research: What can studies tell us? *Dairy Council Digest* 72(6):31, 2001.
Different types of nutrition research studies vary in their strengths and weaknesses. Rarely can a single study provide evidence of cause and effect between diet and disease. This cause and effect relationship becomes more probable when data from several different types of studies are consistent.
8. Tippet KS and others: Food consumption surveys in the U.S. Dept. of Agriculture. *Nutrition Today*, 34:33, 1999.
The variety of food consumption surveys conducted over the past 80 years by the U.S. Department of Agriculture are described, including studies currently underway. These indicate few adults consume the recommended amounts of fruits and vegetables each day.
9. Wellness guide to preventive care. *UC Berkeley Wellness Letter*, p. 4, November 2001.
Important habits that contribute to wellness are: maintaining a healthy weight; performing regular exercise; choosing a diet low in animal fat and sodium and rich in fruits, vegetables, whole grains, and low-fat or non-fat dairy products; eating at least two servings of fish a week; and moderating alcohol consumption if used.
10. Wetter AC and others: How and why do individuals make food and physical activity choices? *Nutrition Reviews* 59(3):S11-S20, 2001.
Health habits are influenced by a number of factors: beliefs, values, life experiences, socioeconomic status, educational attainment, interpersonal relationships, life stage, and social roles. Each decision made regarding health practices depends on input from these and other factors.

CHAPTER 2
TOOLS FOR DESIGNING A HEALTHY DIET

OVERVIEW

This chapter explores components of healthy diet plans – those that will minimize risks of developing nutrition-related diseases. Four aspects of a healthful diet - balance, variety, moderation, and nutrient density - are discussed in detail. An overview of nutritional status and its assessment is provided. Tools for planning dietary intake are discussed including the Daily Food Guide Pyramid, Dietary Guidelines, and food labels.

The Nutrition Issue, "Ethnic Influences on the American Diet," examines how cuisines of various cultures have affected the American diet. The Nutrition Insight explores nutrient standards. Dietary Reference Intakes (DRI), which include Recommended Dietary Allowances (RDA) and related standards are described.

CHAPTER OBJECTIVES

Upon completion of this chapter, the student will be able to:

1. develop an eating plan based on the concepts of variety, balance, moderation, nutrient density, and energy density.
2. outline the ABCDEs of nutrition assessment: anthropometric, biochemical, clinical, dietary, and economic.
3. describe what the Recommended Dietary Allowances (RDA) represent and how these relate to the other standards included in the new Dietary Reference Intakes.
4. learn the food groupings used in the Food Guide Pyramid and list potentially inadequate nutrients in that diet plan.
5. list the Dietary Guidelines and the diseases these guidelines are designed to prevent or minimize.
6. describe what a nutrition label currently consists of, and when and which health claims are allowed on a food package.
7. describe various ethnic influences on the North American diet.

KEY TERMS

Adequate intake
Anthropometric
Cholesterol
Daily value
Dietary reference intake
Dietary guidelines
Energy density
Heart attack
Malnutrition
Minimum requirement for health
Nutrient density
Nutritional state
Overnutrition
Phytochemical
Recommended dietary allowance
Subclinical
Undernutrition
Upper level

REAL LIFE SCENARIO

Andy is like many other college students. He grew up on a quick bowl of cereal and milk for breakfast and a hamburger, french fries, and cola for lunch, either in the school cafeteria or at a local fast-food restaurant. At dinner, he generally avoided eating any of his salad or vegetables, and by 9 o'clock he was deep into bags of chips and cookies. Andy has taken most of these habits to college. He prefers coffee for breakfast and possibly a chocolate bar. Lunch still is mainly a hamburger, french fries, and cola, but pizza and tacos now alternate more frequently than when he was in high school. One thing Andy really likes about the restaurants surrounding campus is that, for just about half a dollar more, he can supersize his meal. This helps him stretch his food dollar; searching out value meals for lunch and dinner now has become part of a typical day.

Provide some dietary advice for Andy. Start with his positive habits and then provide some constructive criticism, based on what you know now.

LECTURE OUTLINE

I. A food philosophy that works
   - A. Variety contributes to diet adequacy
   - B. Balance means not overconsuming any one food
   - C. Moderation refers mostly to portion size
   - D. Nutrient density can help guide food choices
   - E. Energy (kcal) density influences energy intake

II. States of nutritional health
   - A. Desirable nutrition
   - B. Undernutrition
   - C. Overnutrition

III. How could your nutritional state be measured?
   - A. Evaluating the ABCDEs
   - B. Recognizing the limitations of nutritional assessment

IV. Recommendations for food choices
   - A. The Food Guide Pyramid - a menu-planning tool
     1. Components of the Food Guide Pyramid
     2. Menu planning with the food guide pyramid
     3. Evaluating the current American diet using the Food Guide Pyramid
     4. How does your current diet rate?
   - B. Dietary Guidelines – another tool for menu planning
     1. Aim for fitness
     2. Build a healthy base
     3. Choose sensibly
     4. Practical use of the Dietary Guidelines
     5. The Dietary Guidelines and you

V. What do food labels have to offer in diet planning?
   - A. Label information
     1. Product name and manufacturing information
     2. Listing of certain food constituents
     3. Percentage of the Daily Value

4. Standard serving size
B. Exceptions to food labeling
C. Health claims on food labels

NUTRITION ISSUE: Ethnic Influences on the American Diet

I. Introduction
II. Native Americans
  A. Types
    1. Hunter-gatherers
    2. Crop growers
  B. Low-sodium and low-fat diet
  C. High fiber diet
  D. Lower heart disease rates than general U.S. population
III. Hispanic North Americans
  A. Spanish techniques combined with locally available foods
    1. Corn, beans, chili peppers
    2. Avocados, papayas, pineapples
    3. Wheat, chickpeas, melons, sugar, rice, nuts
  B. Regional variety
  C. Traditionally low-fat, high complex-carbohydrate diet; predominately rice, beans, fruits, and vegetables
IV. Northern European Northern Americans
  A. "Meat-and-potatoes"
  B. Abundant protein and nutrients
  C. High-fat diet
  D. Insufficient amount of grains, vegetables, and fruits are eaten
V. African North Americans
  A. "Soul food"
    1. Barbecued meat, fried chicken, sweet potatoes, chitterlings
    2. Black-eyed peas
    3. Greens are popular: collards, mustard, turnip, kale
  B. Pork and corn are the basis
  C. Ample vitamins, minerals, and dietary fiber
  D. High in sodium and saturated fat
  E. Low consumption of dairy products
VI. Asian North Americans
  A. Asian diet: fresh vegetables, minimal amounts of meat, and moderate fat
  B. Over 200 different vegetables are used in Chinese cuisine
  C. Regional cuisines
    1. Southern: rice
    2. Northern: noodles, bread, dumplings
  D. Popular dishes: hot pots and stir-fry
  E. Use a variety of sauces and seasonings
  F. Chinese-American restaurants often prepare food with large amounts of fat
VII. Italian North Americans
  A. Regional cuisines
    1. Northern: rice dishes, meat, dairy products

2. Sea: fish, fresh vegetables prepared with herbs, garlic, and olive oil
3. Poor: grains, vegetables, dried beans, and fish; little meat or oil

B. Italians eat six times more pasta than do Americans
C. Italian-American cuisine is similar to northern Italy's
1. Veal, cream, cheese, pesto sauces, pasta
D. Typically a high-fat diet

VIII. Jewish North Americans
A. Two groups
1. Ashkenazic Jews
2. Sephardic Jews
B. Common foods
1. Ashkenazic Jews: dark rye bread, borscht, herring, high-fat meats, cream cheese, corned beef, sauerkraut, and pickles
a. High in fat and sodium
2. Sephardic Jews: egg plant, humus, tahini, and couscous

IX. Ethnic diets and present trends
A. Advantages and shortcomings of various ethnic diets
B. Newcomers: Russia and Asia
C. Simple foods prepared in simple ways are most healthy

ACTIVITIES

1. Complete either Part I or Part II of the **Rate Your Plate** activity, "Does Your Diet Meet Nutrient Needs and Food Guide Pyramid Recommendations?". Then complete Parts III, IV, and V. For assistance in following the instructions for this activity, refer to the sample assessment in Appendix E of the text. In this activity, students will use the dietary record they kept as suggested in Chapter 1 activities. Having students complete and analyze a three-day food record would provide a more accurate nutrition assessment. Students should hold on to this assessment for future use.
2. Ask students to select nutrition labels from four food products they consume regularly and to calculate the actual amount or percent of RDA of selected nutrients for their age and gender group provided by these products.
3. Provide students with a sample of a day's food intake. Make sure it is high in fat, sodium, simple sugars, and low in fruits and vegetables. Ask students to make changes in this menu to comply with the Dietary Guidelines. Use Tables 2-1, 2-2, 2-5, 2-6 and Figure 2-3 in the chapter as guides to structure the menu initially and ultimately to modify it.
4. People often have difficulty accurately estimating portion/serving sizes of foods they eat. To help students with this, have them estimate food portions in class. You can do this by bringing to class samples of commonly consumed foods, various-sized glasses, bowls, measuring cups, measuring spoons, and a food scale if one is available. Examples of food to bring: puffed rice, Grape Nuts, cooked pasta, bagel or English muffin, chips, peanut butter, shelled sunflower seeds, raisins, orange juice, grape juice, mayonnaise, and some type of salad dressing. Pick and choose students to estimate a portion size using only the bowls and glasses provided. Keep the measuring cups and spoons, as well as the food scale hidden during this phase of the activity. Once portion sizes have been estimated by the students, show them, using measuring cups, measuring spoons, and the food scale, how accurate portion sizes look. They will be amazed. At the same time, discuss how to record food portions, what could happen to one's health when portion sizes are either overestimated or underestimated, how the Food Guide Pyramid and Exchange System

differ in serving sizes, and how relatively easy nutrient needs can be met by consuming foods.

5. Find a particular nutritional supplement that exceeds the USRDA for a variety of nutrients. Duplicate the label for each student. Point out in class how many nutrients significantly exceed the USRDA. Given the class's understanding of the USRDA, ask them to discuss the implications of those nutrients exceeding it.

READINGS

1. ADA Reports: Position of the American Dietetic Association: Functional foods. *Journal of the American Dietetic Association*, 99:1278, 1999.
   The philosophy that food can be health-promoting beyond its traditional nutritional value (i.e., phytochemical content) is gaining acceptance among scientists and health professionals. Never before have the health benefits of food had so much support.
2. American Heart Association Conference Proceedings: Unified dietary recommendations. *Circulation*, 100:450, 1999.
   A variety of health-related organizations, such as the American Heart Association and American Cancer Society, provide support for the dietary pattern recommended by the Dietary Guidelines.
3. Campbell TC, Chen J: Diet and health in rural China: Lessons learned and unlearned. *Nutrition Today*, 34:116, 1999.
   Studies of rural Asian subjects show that their traditional, primarily plant-based diet contributes to their low risk for chronic degenerative diseases. These findings are consistent with the observations of Asian migrants; they experience more of these diseases when they switch to a more westernized approach.
4. Clairmont MA: Nutraceuticals, phytochemicals and functional foods: A field of dreams for dietitians. *Today's Dietitian*, p. 36, April 2000.
   Growing evidence supports the role of phytochemicals in disease prevention. Phytochemical-rich foods discussed include broccoli, cabbage, tomatoes, tea, soy, whole grains, oranges, grapes, and onions.
5. deLorgeril and others: Mediterranean diet, traditional risk factors, and the rate of cardiovascular complications after myocardial infarction: Final report of the Lyon Diet Heart Study. *Circulation*, 99:779, 1999.
   People following a Mediterranean diet plan – in this case, based on canola oil products rather than the traditional source of fat, olive oil – showed a substantial reduction in heart attack risk. This study provides further evidence of the benefits of the Mediterranean diet.
6. Hasler C and others: How to evaluate the safety, efficacy, and quality of functional foods and their ingredients. *Journal of the American Dietetic Association*, 101:733, 2001.
   The term "functional food" is not yet legally defined. It is usually understood to mean any food or food ingredient that may provide a health benefit beyond the traditional nutrients it contains. The article goes on to review current health claims for foods.
7. Lauden R: Birth of the modern diet. *Scientific American*, p. 76, August 2000.
   Advances in knowledge concerning diet and nutrition have had a great effect on our diets over the last 300 years. Recognizing the importance of fruits and vegetables scores high marks for our current diet, while the central rule of fat in our diets because of the importance given to meat and fat-based sauces is blamed for the high amounts of obesity in most developed nations.
8. Rolls BJ: The role of energy density in the over consumption of fat. *Journal of Nutrition*, 130:2685, 2000.

Eating foods that have a low energy density is one way to feel full without consuming a lot of calories. If the food is high in fat, even small portions may have a high-energy content; energy-dense foods generally are consumed in larger quantities in order to feel full at the end of a meal.

9. Stampfer JM and others: Primary prevention of coronary heart disease in women through diet and lifestyle. *New England Journal of Medicine*, 343: 16, 2000.
Women who consume a varied diet (one rich in fiber, includes some fish, and is low in fried foods and animal fat), avoid overweight, drink small amounts of alcohol, exercise on a daily basis for about 30 minutes, and avoid smoking reduce their risk of heart attack by over 80%, compared with women without these habits.

10. Willett WC: *Eat, drink and be healthy*, New York: Simon & Schuster, 2001.
The diet plan in the book emphasizes whole grains, plant oils, vegetables eaten daily; fruits at least 2-3 times per day, nuts and legumes 1-3 times per day; fish, poultry, and eggs eaten 0-2 times per day; dairy products or calcium supplements one to two times per day; and little use of red meat, butter, white rice, white bread, potatoes, pasta, and sweets. Regular physical activity and weight control also is recommended, as is alcohol intake in moderation and a multi-vitamin and mineral supplement for most people.

CHAPTER 3
THE HUMAN BODY: A NUTRITION PERSPECTIVE

OVERVIEW

This chapter examines digestion and absorption as part of the study of human physiology that supports nutritional health. Particular attention is given to the basic anatomy (structure) and physiology (function) that contribute to the circulatory system nervous system, endocrine system, immune system, digestive system, urinary system, and storage capabilities of the human body. Digestion and absorption are discussed, highlighting the flow of food materials through the gastrointestinal tract and sphincters. The small intestine is addressed as the major site of nutrient absorption. Descriptions of the major types of absorption and portal and lymphatic circulation are included. Absorption of macronutrients in the small intestine is outlined as is the limited absorption that takes place in the large intestine.

The Nutrition Insight addresses genetics and nutrition. The Nutrition Issue, "When Digestive Processes Go Awry," examines the causes, symptoms, and treatments of common gastrointestinal problems.

CHAPTER OBJECTIVES

Upon completion of this chapter the student will be able to:

1. identify the function of the following cellular components: cell membrane, nucleus, mitochondria, cytoplasm, endoplasmic reticulum, Golgi complex, lysosomes, and peroxisomes.
2. define tissue, organ, and organ system.
3. list some characteristics of the 12 organ systems and outline a role for each related to nutrition, especially the cardiovascular system, endocrine system, nervous system, immune system, and urinary system.
4. understand the role of genetic background in the development of nutrition-related diseases.
5. outline the overall processes of digestion and absorption, including the roles played by the organs of the gastrointestinal tract and the related accessory organs: liver, gallbladder, and pancreas.
6. become familiar with some specific enzymes and hormones that act in digestion of the various nutrient groups.
7. identify the major nutrition-related gastrointestinal health problems and typical approaches to treatment.

KEY TERMS

Absorptive cells
Absorption
Adipose (fat) cells
Aerobic
Anaerobic
Antibody
Antigen
Artery
Bile
Capillary
Cardiovascular system
Cell-mediated immunity
Cell nucleus
Central nervous system (CNS)

Chromosome
Chyme
Complement
Connective tissue
Constipation
Creatinine
Cytoplasm
Digestion
Deoxyribonucleic acid (DNA)
Endocrine system
Endoplasmic reticulum (ER)
Enterohepatic circulation
Enzyme
Epiglottis
Epithelial tissue
Erythoropoietin
Esophagus
Gallbladder
Gastroesophageal reflux disease (GERD)
Gene
Golgi complex
H_2 blockers
Hydrogen peroxide
Ileocecal sphincter
Immune system
Immunoglobulins
Interferons Laxative
Lower esophageal sphincter
Lymphatic system
Lysosome
Mitochondria
Motility
Muscle tissue
Myelin sheath
Nervous system
Nervous tissue
Neuron
Neurotransmitter
Organ
Organelles
Organ system
Peripheral nervous system (PNS)
Peroxisome
pH
Phagocytosis
Pharynx
Phospholipid
Plasma
Portal circulation
Pulmonary circuit
Pyloric sphincter
Ribonucleic acid (RNA)
Salivary amylase
Secretory vesicles
Synapse
Systemic circuit
Tissues
Umami
Urea
Urinary system
Vein
Villi

REAL LIFE SCENARIO

Chad is a 20-year-old college sophomore. Over the last few months, he has been experiencing regular bouts of heartburn. This usually happens after a large lunch or dinner. Occasionally he has even bent down after dinner to pick up something and had some stomach contents travel back up his esophagus and into his oral cavity. This especially frightened Chad, so he visited the University Health Center

The nurse practitioner at the Center told Chad it was good he came in for a checkup. She suspects he has a disease called gastroesophageal reflux disease (GERD). She tells Chad that this can lead to serious problems if not controlled, such as a rare form of cancer. She provides Chad with a pamphlet describing GERD and schedules an appointment with a physician for further evaluation.

What type of dietary habits likely contribute to Chad's symptoms of GERD? What types of medications have been especially useful for treating this problem? Overall, how will Chad cope with this health problem, and will it ever go away?

LECTURE OUTLINE

I. Human physiology
   A. From cells to organ systems
II. The cell: Structure and function
   A. Cell (plasma) membrane
      1. Phospholipids
      2. Cholesterol

3. Proteins
4. Organelles

B. Cytoplasm
C. Mitochondria
D. Cell nucleus
E. Endoplasmic reticulum (ER)
F. Golgi complex
G. Lysosomes
H. Peroxisomes

III. Organization of the body
A. Circulatory system
1. Cardiovascular system
a. Portal circulation in the gastrointestinal tract
2. Lymphatic system
a. Lymphatic circulation in the gastrointestinal tract
B. Nervous system
1. Central nervous system
2. Peripheral system
C. Endocrine (hormonal) system
D. Immune system
1. Skin
2. Intestinal cells
3. White blood cells
E. Digestive system
1. The flow of digestion
a. Mouth
1) Chewing: break up, increase surface area
2) Tongue aids chewing
3) Taste receptors
4) Saliva – salivary amylase
5) Mucus: lubricate
6) Enzymes: carbohydrases
b. Esophagus
1) Epiglottis
2) Trachea
3) Lower esophageal sphincter
c. Stomach
1) Four-cup holding tank
2) Secretes acid
3) Secretes enzymes
4) Churns and mixes food
5) Holds food for two to four hours
6) Produces chime
7) Leaves stomach through the pyloric sphincter
d. Small intestine (about 10 feet)
1) Absorbs 95% of energy received from carbohydrate, protein, fat, and alcohol
2) Large surface area promotes nutrient absorption
3) Villi trap foodstuffs to enhance absorption
4) Constant renewal of intestinal lining
5) Various hormones and other substances participate in the

digestive process
6) Undigested food leaves through the Ileocecal sphincter

e. Large intestine: Colon
1) 5% of carbohydrate, protein, and fat escapes absorption
2) Small amounts of undigested starches are absorbed
3) Little other digestion
4) Storage of nondigestible remains; feces formed

f. Rectum
1) Elimination of waste as feces

g. Accessory organs
1) Liver produces bile
2) Gallbladder stores bile
3) Pancreas provides enzymes and other products

F. Urinary system
1. Kidneys remove wastes from the body
2. Excess water-soluble nutrients and other substances are filtered and excreted
3. Kidneys play additional roles in the body
4. Storage capabilities

NUTRITION ISSUE: When the digestive processes go awry

I. Ulcers
A. Causes
B. Occurrence
C. Symptoms
D. Risk - massive blood loss
E. Therapy
1. Antacids
2. Over-the-counter medications
3. Smoking cessation
4. Minimize the use of aspirin and similar compounds

II. Heartburn (gastroesophageal reflux disease)
A. Description
B. Treatment
1. Small meals
2. Low-fat diet
3. Smoking cessation
4. Do not lie down after meals
5. Avoid certain foods
C. Certain physical conditions can lead to heartburn
D. Recurrent heartburn should have medical evaluation

III. Constipation
A. Definition
B. Causes
C. The solution: eating dietary fiber
D. Risks of laxative use

IV. Hemorrhoids
A. Definition
B. Recognition
C. Self-care measures

D. Preventative steps

V. Irritable bowl syndrome
   A. Definition
   B. Symptoms
   C. Causes
   D. Therapy
      1. High fiber diet
      2. Avoid dairy products and gas-forming foods
      3. Moderate caffeine intake
      4. Low-fat and more frequent, small meals
      5. Stress reduction

VI. Diarrhea
   A. Definition
   B. Causes
   C. Treatment
      1. Drink lots of fluid
      2. Prompt treatment – within 24 to 48 hours for infants and older people

ACTIVITIES

1. Have students trace the digestion of major nutrients (carbohydrates, fats, and proteins) in a meal or a food such as whole milk, pizza, tacos, chocolate pie, or a Quarter Pounder. This should include nutrients involved, site of action, mechanical action, enzymes and bile, hormones, and products.
2. Use the **Rate Your Plate** activity to make students aware of their digestive tract and to take a closer look at heartburn.
3. Have the class discuss implications of having a condition in which one could not release the appropriate gastrointestinal hormones. Ask how the processes of digestion and absorption might be altered.
4. Divide students into groups of three or four individuals. Have each group devise a one-day menu plan for the following digestive complications: ulcers, heartburn, constipation, hemorrhoids, irritable bowel syndrome, and diarrhea. Have each group share their menu with the class; critique for accuracy.

READINGS

1. Answering your questions about immunity. *UC Berkeley Wellness Letter*, p. 4, May 2001.
   An adequate diet helps maintain the immune system. Nutrients such as protein, essential fatty acids, and certain vitamins and minerals play key roles. Moderate exercise and adequate sleep also improve immune function. Severely malnourished people are particularly vulnerable to immune dysfunction. Since many older people may not consume much food, there is evidence that they stay healthier if they take a multivitamin and mineral supplement. Still, megadoses of certain nutrients, such as zinc, can significantly harm some immune responses.
2. Collins FS, McKusick VA: Implications of the human genome project for medical science. *Journal of the American Medical Association*, 285:540, 2001.
   In the coming years, genetic tests will be available for many common conditions. This will allow individuals who wish to know this information to learn more about their individual susceptibilities, and to take steps to reduce those risks for which interventions are available. These could include diet and lifestyle modifications and drug therapy. One concern is the potential for discrimination in the workplace once a person's genetic

information is known. Ideally, federal legislation will outlaw that practice.

3. Constipation becomes more common with age, *Tufts University Health & Nutrition Letter* p. 7, February 1999.
   Normal frequency of bowel movements ranges from three times a day to three times a week. Constipation is an aging problem that can be treated with regular exercise, decreased dosage of medications that cause constipation, increased dietary fiber, more water consumption, and avoidance of laxatives unless absolutely necessary.
4. Heartburn, don't ignore it. *Mayo Clinic Health Letter*, 18:8, 2000.
   The causes of heartburn are explained. The new FDA-approved treatments for heartburn are introduced. One treatment is sewing up the lower esophageal sphincter (LES) and the other is burning a scar into the LES that tightens the sphincter.
5. Horwitz BJ, Fisher RS: Irritable bowel syndrome. *The New England Journal of Medicine*, 344:1846, 2001.
   People with irritable bowel syndrome often benefit from a diet adequate in fiber (20-30 grams per day) and low in caffeine, alcohol, fatty foods, gas-forming vegetables, and products containing sorbitol, such as sugarless gum and dietetic candy. Certain medications also are helpful in treating such individuals.
6. Kaynard A, Flora K: Gastroesophageal reflux disease (GERD). *Postgraduate Medicine*, 110(3):42, 2001.
   Large surveys show that half of the general adult population experiences monthly heartburn. A trial of high doses of proton pump inhibitors is becoming accepted therapy for GERD. Complications of long-standing GERD include damage to the esophagus and a form of esophageal cancer.
7. Tso P, Crissinger K: Overview of digestion and absorption. In Stepanuk MH (ed.): *Biochemical and physiological aspects of human nutrition* W.B. Saunders, 2000.
   One chapter in this human nutrition textbook identifies major structures and functions of the digestive tract. Control of absorption and metabolism is explained.
8. van De Graaff KM, Fox SI: *Concepts of human anatomy & physiology*. 5th ed. Boston: WCB McGraw-Hill, 1999.
   The basis for understanding human nutrition is to comprehend the role of anatomy and physiology as they relate to the foundation for personal health. This text provides the framework for integrating modern biology into the study of scientific nutrition.
9. Wond PWK, Kadakia S: How to deal with chronic constipation. *Postgraduate Medicine,* 106:199, 1999.
   The authors list the diagnostic criteria used to establish chronic constipation. Treatment includes patient education, bowel habit training, increased fluid and fiber intake and laxative use.

CHAPTER 4
CARBOHYDRATES

OVERVIEW

This chapter discusses the first of the nutrients that provide energy, carbohydrates. Simple and complex carbohydrates are defined and identified as monosaccharides, disaccharides, oligosaccharides, and polysaccharides. The digestion and absorption of carbohydrates are examined using the background information provided in Chapter 3. Sugars and their destiny in the body are discussed including hormonal regulation of glucose in the bloodstream and energy production. Food sources and sweetness of sugars are included. The importance of consuming carbohydrates is detailed. Recommendations for carbohydrate intake are summarized. The importance of complex carbohydrates and their roles in maintenance of health are explored. The potential health effects of excess sugar consumption and lactose intolerance are evaluated.

The Nutrition Insight addresses the issue of dietary fiber, an often underappreciated class of carbohydrates. The Nutrition Issue focuses on conditions related to impaired blood glucose regulation, such as diabetes mellitus and hypoglycemia.

CHAPTER OBJECTIVES

Upon completion of this chapter, the student will be able to:

1. identify the basic structures and food sources of the major carbohydrates-monosaccharides, disaccharides, polysaccharides (starches), and dietary fiber.
2. describe food sources of carbohydrate and list some alternate sweeteners.
3. list the functions of carbohydrate in the body and the problems that result from not eating enough carbohydrate.
4. describe the regulation of blood glucose and the nutrients that can become blood glucose.
5. outline the effects of dietary fiber on the body.
6. list guidelines for carbohydrate intake.
7. identify the consequences of lactose maldigestion and diabetes, and explain appropriate dietary measures to take to reduce these health problems.

KEY TERMS

Acesulfame-K
Aspartame
Cariogenic
Dental caries
Epinephrine
Fasting hypoglycemia
Fermentation
Glucagon
Glycemic index (GI)
Glycogen
High-density lipoprotein (HDL)
Insulin
Ketone bodies
Lactose maldigestion
Low-density lipoprotein (LDL)
Phenylketonuria (PKU)
Photosynthesis
Phytobezoars
Reactive hypoglycemia
Saccharin
Sorbitol
Sucralose
Sugar
Syndrome X
Type 1 diabetes
Type 2 diabetes
Xylitol

REAL LIFE SCENARIO

Myeshia is a 19-year-old African-American female who recently read about the health benefits of calcium and decided to increase her intake of diary products. To start, she drank 2 cups of 1% milk at lunch. Not long afterward, she experienced bloating, cramping, and increased gas production. She suspected that the culprit of this source of pain was the milk she consumed, especially since her parents and her sister complain of being lactose intolerant (lactose is the chief milk carbohydrate). As well, the problem first appeared when she added the 2 servings of milk. She wanted to determine if milk products were in fact, the cause of her gastrointestinal discomfort, so the next day she again consumed 2 servings of milk products, but this time a cup of yogurt and a glass of milk, for lunch. Subsequently, she did not have any pain. What has Myeshia discovered?

LECTURE OUTLINE

I. Carbohydrates
   - A. An introduction
     1. Primary fuel source for some cells
     2. 4 kcal per gram
     3. Forms of carbohydrate
        - a. Blood glucose
        - b. Glycogen

II. Forms of simple carbohydrate
   - A. Photosynthesis defined
   - B. Monosaccharides
     1. Glucose
     2. Fructose
     3. Galactose
   - C. Disaccharides
     1. Sucrose
     2. Lactose
     3. Maltose

III. Forms of the more complex carbohydrates
   - A. Polysaccharides defined
     1. Amylose and amylopectin: storage form in plants
     2. Glycogen: storage form in humans
        - a. Liver
        - b. Muscle

IV. Carbohydrates in foods
   - A. Percent of kcalories as carbohydrates in foods
   - B. Diet high in starch rather than simple sugars
   - C. A closer look at sweeteners in foods
     1. Nutritive sweeteners
        - a. Sugars
        - b. Sugar alcohols
     2. Alternative sweeteners
        - a. Saccharin
        - b. Aspartame
        - c. Acesulfame-K

- d. Sucralose

V. Making carbohydrates available for body use
  - A. Digestion of starches and disaccharides
    1. Mouth
       - a. Starch digestion begins
       - b. Salivary amylase
    2. Stomach
       - a. Salivary amylase activity is halted
    3. Small intestine
       - a. Pancreatic amylase
       - b. Enzymes attached to intestinal cells
         1) Maltase
         2) Lactase
         3) Sucrase
       - c. Intestinal diseases may interfere with efficient digestion
         1) Abdominal discomfort
         2) Diarrhea
         3) Bacterial infections
  - B. Absorption of Monosaccharides
    1. Monosaccharides absorbed
    2. Transported to the liver via the portal vein
    3. Liver transforms galactose and fructose into glucose
    4. Liver exercises its metabolic options
       - a. Glucose is released into the bloodstream
       - b. Produce glycogen
       - c. Produce fat
    5. Five percent of starch escapes absorption, traveling to the large intestine

VI. Putting simple carbohydrates to work in the body
  - A. Yielding energy
    1. Blood glucose regulation
  - B. Protein sparing effect and preventing ketosis
    1. Importance of carbohydrate fuel for the body
    2. Minimum amount of carbohydrate needed
  - C. Regulating this energy source
    1. Insulin
    2. Glucagon
    3. Epinephrine (adrenaline)
  - D. Flavoring and sweetening foods

VII. Recommended carbohydrate intakes
  - A. No RDA established
  - B. Amounts of sugars consumed by Americans
  - C. Amount of dietary fiber needed
    1. Adults
       - a. 20-30 grams per day (10-13 grams per 1000 kcals)
       - b. 3 servings of whole grains per day
    2. Children (over age 2)
       - a. fiber intake equals age plus 5 grams per day
    3. Read food labels carefully – “whole grain”
  - D. Problems with high-fiber diets

1. Makes the stool hard - requires greater fluid intake
2. Intestinal gas
3. Fiber balls (phytobezoars) in the stomach – can block intestinal flow

E. Moderate intake of simple sugars
   1. Limit sugar intake to 10% of total energy intake daily

F. Problems with high sugar diets
   1. Diet quality
   2. Dental caries
   3. High glycemic index

G. Moderation in lactose intake is important for some people
   1. Lactose maldigestion defined
   2. Secondary lactose maldigestion defined
   3. Asian Americans, African-Americans, and Hispanic Americans most susceptible
      a. Most individuals can tolerate ½ to 1 cup of milk with meals
      b. Hard cheese and yogurt are more easily tolerated than milk
      c. Low-lactose milk and lactase pills are available

NUTRITION ISSUE: When blood glucose regulation fails

I. Diabetes
   A. Type 1
      1. Disease characteristics
      2. Pathology
         a. Immunological disorder?
         b. Lack of insulin
      3. Treatment
         a. Insulin therapy: injections or pump
         b. Dietary measures
         c. Possible aspirin and vitamin E supplementation
         d. Physical activity
      4. Risks associated with untreated diabetes
   B. Type 2
      1. Disease characteristics
      2. Pathology
         a. Inactivity and obesity
         b. Insulin receptors; limited binding
      3. Treatment
         a. Oral insulin therapy or injections (possibly)
         b. Weight reduction
            1) Dietary measures
            2) Physical activity
   C. Hypoglycemia
      1. Definition
      2. Diagnosis
      3. Nutrition therapy

ACTIVITIES

1. Assign students the **Rate Your Plate** activity, "How Does Your Diet Rate for Carbohydrate and Fiber?". If they calculated their nutrition analysis as specified in Chapter 2, they will have a value for their total carbohydrate and dietary fiber intake and will be able to complete the activity.
2. Have students go to the supermarket and check breakfast cereal food labels. Ask them to find three cereals with a high dietary fiber content (greater than 10% of the Daily Value). Use this as a springboard to discuss how to boost one's dietary fiber intake.
3. Make hot and cold tea, sweetening one batch with saccharin (Sweet & Low), another with aspartame (Equal), another with acesulfame-K (Sweet-One), and a last batch with table sugar. Prepare beforehand to determine amounts of each non-nutritive sweetener and sugar needed to achieve approximately equal sweetness. Have students drink and compare the products noting differences in sweetness/taste among cold products, and between cold and hot products (does temperature affect taste?). Have them share their opinions on taste and safety of each sweetener. Instead of purchasing tea and sweeteners, you may wish to purchase products already containing the sweeteners. Just make sure you purchase products with the same flavor so that students are comparing sweetness, not flavor.
4. Invite a person with diabetes, a nurse who works with diabetes, or a dietitian to discuss diabetes mellitus. Also have them address specific aspects of diet and treatment.
5. Bring foods with different sugar contents and place them on a table in front of the class. Have all students try to rank them according to sugar content per serving; place them in order from least sugar to most. Have an index card in front of each item with the approximate number of teaspoons of sugar per serving (5 grams of sugar is approximately 1 teaspoon). Ask a student to come forward to turn over the cards in front of each item to see if they were ranked correctly. Compare food labels or ingredients in the foods and discuss what made one food higher in sugar content than another.
6. Bring a can of regular soda pop, packet of Kool-Aid, jar of iced tea, teaspoon, sugar, a coffee cup, and six glasses to class. Ask students how much sugar they put in coffee, tea, and Kool-Aid. Ask them how much sugar they think is in a can of regular soda pop. Start putting sugar in the coffee cup and have students tell you when they would stop adding sugar to their coffee. Next, start putting sugar in one of the glasses and ask students when they would stop adding sugar to their tea. Do the same for Kool-Aid and soda pop. Now, show the students how much sugar is found in commercial products. Measure out the amount of sugar found in a serving of commercial sweetened ice tea, prepared Kool-Aid, and soda pop (5 grams of sugar is approximately 1 teaspoon). For example, most regular soda pop contains 8 to 10 teaspoons of sugar. Place 10 teaspoons of sugar in a glass and ask them if they would consume that much sugar if you gave it to them. Inform them that is what they are consuming each time they drink a can of regular soda pop. Compare the actual measures of sugar with those the class estimated. Discuss.
7. Have each student in the class bring an empty box of the cereal they eat most often. In groups of six to eight have each student defend his or her choice based on sugar and fiber content per serving. If a cereal is high in sugar and low in fiber, have the student identify alternative cereals he or she could eat that would be more healthful.
8. Purchase milk containing predigested lactose and regular milk. Have students drink and compare the taste of the products. Have students identify dairy alternatives for someone who is lactose intolerant.

READINGS

1. American Dietetic Association Reports: Position of the American Dietetic Association: Use of nutritive and nonnutritive sweeteners, *Journal of the American Dietetic Association* 98:580, 1998.
   Consumers can safely enjoy a range of nutritive and nonnutritive sweeteners when consumed in moderation and within the context of a diet consistent with the Dietary Guidelines for Americans. Nonnutritive sweeteners are safe for use by most persons within recommended intakes.
2. Anderson JW and others: Whole grain foods and heart disease risk. *Journal of the American College of Nutrition*, 19:291S, 2000.
   Foods that are rich in dietary fiber, including fruits, vegetables, legumes (beans), and whole-grain cereals, tend to be rich in vitamins, minerals, phytochemicals, antioxidants, and other micronutrients. Each of these components contributes to a reduction in cardiovascular disease risk.
3. Byers T: diet, colorectal adenomas, and colorectal cancer. *The New England Journal of Medicine*, 342:1206, 2000.
   Nutrients such as folate, selenium, and calcium are associated with a lower risk of colon cancer. Medications such as aspirin and related agents also may reduce the risk of this disease. Some studies from around the world also have shown a lower risk of colon cancer among populations with high intakes of fruits and vegetables.
4. Do you know your blood sugar level? *Consumer Reports on Health*, p. 1, July 2000.
   Even just slightly elevated blood glucose can put a person at health risk. People who should especially be tested for elevated blood glucose include those who are overweight, those with relatives with diabetes, non-Caucasians, women who had a baby weighing more than 9 pounds, and those who have hypertension, low HDL-cholesterol, or high blood triglycerides.
5. Guthrie JF, Morton JF: Food sources of added sweeteners in the diets of Americans. *Journal of the American Dietetic Association*, 100:43, 2000.
   Americans older than 2 years consume the equivalent of 82 grams of carbohydrate per day from added sweeteners. This accounts for 16% of total energy intake. Adolescent males consume the most added sweeteners, averaging 20% of total energy intake. The biggest source of added sweeteners is regular soft drinks, which account for one-third of intake. Other sources are table sugars, syrups, cakes, and other sweets.
6. Henkel J: Sugar substitutes: Americans opt for sweetness and lite. *FDA Consumer*, p. 12, November/December 1999.
   FDA has approved four sugar substitutes – saccharin, aspartame, acesulfame-K, and sucralose. At least three other sweeteners are under FDA review but have not been approved at this time. FDA stands behind its approval of current sugar substitutes.
7. Morris KL, Zemel MB: Glycemic index, cardiovascular disease, and obesity. *Nutrition Reviews*, 57:273, 1999.
   The glycemic index of food is influenced by starch structure, fiber content, food processing, physical structure of the food, and other macronutrients in a meal. Low-glycemic-index diets have been reported to lower blood glucose after a meal and insulin release, to improve blood lipids, and to increase insulin sensitivity.
8. Roberts K and others: Syndrome X: Medical nutrition therapy. *Nutrition Reviews*, 58:154, 2000.
   Lifestyle factors such as overeating and physical inactivity play a pivotal role in Syndrome X. The typical Western diet, which is high in refined carbohydrates, low in fiber, and high

in saturated fat, is associated with an increased risk of obesity, leading to insulin resistance and Syndrome X.

9. Vesa TH and others: Lactose intolerance. *Journal of the American College of Nutrition*, 19:165S, 2000.
   Many lactose maldigestors tolerate small to moderate amounts of lactose without remarkable discomfort. Lactose-hydrolysed milk products and fermented milk products also can help people exhibiting lactose intolerance.
10. Tuomilehto J and others: Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. *New England Journal of Medicine*, 344:1343, 2001.
    The onset of type 2 diabetes can be delayed or prevented when high-risk people make lifestyle changes that include weight reduction, increased exercise, adequate dietary fiber intake, and moderation in total fat and saturated fat intake.

CHAPTER 5
LIPIDS

OVERVIEW

This chapter on lipids highlights fatty acids, triglycerides, phospholipids, and sterols. The basic structure of fatty acids is described and essential fatty acids are discussed, including dietary recommendations and food sources. Current research related to omega-3 fatty acids is emphasized. Structure, dietary functions, and roles in the body are part of the triglyceride presentation. The roles of phospholipids and sterols, particularly cholesterol, are mentioned. A general explanation of fat digestion and absorption is provided. Lipid transport is discussed. Throughout the chapter, reference is made to the roles fat, cholesterol, and lipoproteins play in the development or prevention of cardiovascular disease. Recommendations for fat intake are outlined including those from the American Heart Association and the National Cholesterol Education Program. Dietary sources of total fat and various fatty acids are discussed.

Nutrition Insights discuss fat replacement strategies for foods. The Nutrition Issue addresses cardiovascular disease, a topic relevant to those living in the U.S.

CHAPTER OBJECTIVES

Upon completion of this chapter, the student will be able to:

1. list four classes of lipids (fats) and the role of each in nutritional health.
2. differentiate between fatty acids and triglycerides.
3. differentiate among saturated, monounsaturated, and polyunsaturated fatty acids in terms of structure and food sources.
4. name the two essential fatty acids and explain why they are called “essential.”
5. name the classes of lipoproteins and classify them according to their functions.
6. discuss the implications of various fats, including omega-3 fatty acids, with respect to cardiovascular disease.
7. identify available fat replacements.
8. characterize the symptoms of cardiovascular disease and highlight some known risk factors.

KEY TERMS

Alpha-linolenic acid
Anorexia nervosa
Antioxidant
BHA and BHT
Bile acids
Carotenoids
Cerebrovascular accident (CVA)
Chylomicron
Docosahexaenoic acid (DHA)
Eicosapentaenoic acid (EPA)
Emulsifier
Essential fatty acid
Glycerol
Hemorrhagic stroke
Homocysteine
Hydrogenation
Lanugo
Lecithins
Linoleic acid
Lipase
Lipoprotein
Lipoprotein lipase
Long-chain fatty acids
Menopause

Monoglyceride
Monounsaturated fatty Acid
Myocardial infarction
Oleic acid
Omega-3 fatty acid
Omega-6 fatty acid
Oxidize
Phospholipid
Plaque
Polyunsaturated fatty acid
Rancid
Sterol
Total parenteral nutrition
Trans fatty acid
Vegan
Very low-density lipoprotein (VLDL)

REAL LIFE SCENARIO

Jackie is a 21-year-old health-conscious individual, in her third year of nursing school. She recently learned that a diet high in saturated fat can contribute to high blood cholesterol and that exercise is beneficial for the heart. Jackie now takes a brisk 30-minute walk each morning before going to class, and she has started to cut as much fat out of her diet as she can, replacing it mostly with carbohydrates. A typical daily intake for Jackie now might begin with a breakfast of a bowl of Fruity Pebbles with 1 cup of skim milk and ½ cup of apple juice. For lunch, she might pack a turkey sandwich on white bread with lettuce, tomato, and mustard; a small package of fat-free pretzels; and a handful a fat-reduced vanilla wafers. Dinner could be a large portion of pasta with some olive oil and garlic mixed in, and a small iceberg lettuce salad with lemon juice squeezed over it. Her snacks usually are baked chips, low-fat cookies, fat-free frozen yogurt, or the fat-free pretzels. She drinks diet soft drinks throughout the day as her main beverage.

Do you think this is a healthy way for Jackie to reduce fat in her diet? Point out some positive practices. What would you suggest changing in her diet to make it more heart healthy?

LECTURE OUTLINE

I. Lipids: Common properties and main types
   - A. Definition:
     1. Do not dissolve in water
     2. Use of the words "fats" and “oils”
   - B. Fatty acids: the simplest form of lipids
     1. General structure
     2. Saturated
        - a. Physical and chemical characteristics
     3. Monounsaturated
        - a. Physical and chemical characteristics
     4. Polyunsaturated
        - a. Physical and chemical characteristics
     5. Chain length affects fatty acid characteristics
   - C. Triglycerides
   - D. Phospholipids
   - E. Sterols

II. Fats and oils in food
   - A. Fat percentages of various foods
     1. Foods containing approximately 100% of energy as fat
        - a. Salad oils
        - b. Butter
        - c. Margarine
        - d. Mayonnaise
     2. Foods containing approximately 80% fat
        - a. Walnuts
        - b. Bologna
        - c. Avocados
        - d. Bacon
     3. Foods containing approximately 75% fat
        - a. Peanut butter
        - b. Cheddar cheese

4. Foods containing approximately 40% to 60% fat
    a. Meats
    b. Dairy
    c. Doughnuts
5. Major lipids and food examples
    a. Saturated fatty acids: Animal fats
    b. Unsaturated fatty acids: Plant fats
    c. Phospholipids: Egg yolks, wheat germ, peanuts, organ meats
    d. Cholesterol: Animal Foods

B. Hidden fat
1. Where to look – Nutrition Facts labels on food
    a. Ingredients listed by order of weight in the product
    b. Low-fat, fat-free, and reduced-fat defined

C. Wise use of reduced-fat foods
1. Caution: many still are very energy dense
2. “Reduced-fat” is not a license to overeat

III. Making lipids available for body use
A. Fat digestion
1. Stomach
    a. Enzymes (lipases) act on triglycerides with fatty acids of short-chain and medium-chain lengths
2. Small intestine
    a. Triglycerides break into monoglycerides and fatty acids
    b. Role of bile in digestion

B. Fat absorption
1. End products: fatty acids and monoglycerides
2. Short- and medium-chain fatty acids travel through the portal vein to the liver
3. Long-chain fatty acids reform triglycerides and enter circulation via the lymphatic system

IV. Carrying lipids in the bloodstream
A. Carrying dietary fats
1. Lipoproteins
2. Chylomicrons
    a. Carry dietary fats to cells

B. Transporting various fats mostly made by the body
1. Very-low-density lipoproteins (VLDL)
    a. Carries lipids made by liver to cells
2. Low-density lipoproteins (LDL)
    a. Carries cholesterol made by liver and other sources to cells
    b. Plaque formation
    c. "Bad" cholesterol
3. High-density lipoproteins (HDL)
    a. Contributes to cholesterol removal from cells
    b. "Good" cholesterol

V. Lipid functions
A. Essential fatty acids
1. Omega-3
    a. Alpha-linolenic
    b. Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are related forms
    c. Tend to decrease blood clotting

d. Tend to decrease inflammatory processes
2. Omega-6
a. Linoleic
3. In general
a. Participate in immune processes
b. Participate in vision
c. Help form cell membranes
d. Aid in the production of hormone like compounds
B. Effects of an essential fatty acid deficiency
C. Broader roles for fatty acids and triglycerides
1. Providing energy for the body
a. Fatty acids are the main fuel for muscles at rest and during light activity
2. Storing energy
a. Stored mainly as triglycerides
b. Storage is limitless
c. Energy dense: 9 kcals per gram
d. Adipose cells are 80% lipid and 20% water and protein
3. Insulating and protecting the body
4. Transporting fat-soluble vitamins

VI. Phospholipids in the body
A. Functions
1. Lecithin: emulsifiers
2. Practical uses

VII. Cholesterol in the body
A. Functions
1. Hormones
2. Bile acids
3. Vitamin D
4. Cell membranes
B. The liver makes what the body needs

VIII. Exploring another dimension of fat – Properties in food
A. Provides satiety, flavor, and texture
B. Hydrogenation and food production
1. Process defined
2. Potential health effects of trans fatty acids
3. Suggestions for avoiding too much hydrogenated fat
C. Fat rancidity limits shelf life of foods
D. Emulsifiers improve many food products

IX. Recommendations for fat intake
A. No RDA established
B. Lipid amounts consumed by Americans
C. American Heart Association recommendation
1. Fat intake should not exceed 30% of total daily energy intake
a. 10% saturated fatty acids
b. 10% monounsaturated fatty acids
c. 10% polyunsaturated fatty acids
2. Maximum of 20% of total energy from fat for people who have elevated LDL
D. National Cholesterol Education Program Recommendations
1. Reduce saturated fatty acids to 7% of total energy intake if elevated LDL does not respond to 10% of energy intake

2. Limit cholesterol intake to 300 milligrams per day; 200 milligrams if LDL remains elevated

NUTRITION ISSUE: Cardiovascular disease

I. Warning signs and statistics about coronary heart disease in the U.S.
II. Cardiovascular disease development
    A. Occurs slowly
    B. Associated with inadequate blood circulation
        1. Myocardial infarction (heart)
            a. Blood clots
            b. Plaque formation
        2. Cerebrovascular accident (CVA, brain)
            a. Blood clots
            b. Irregular beating heart
        3. Atherosclerosis
            a. Plaque formation
III. Risk factors for heart disease
    A. Total cholesterol over 200 milligrams per 100 milliliters of blood
    B. High LDL
    C. Low HDL
    D. Age
        1. Men: older than 45 years
        2. Women: older than 55 years
    E. Family history
    F. Smoking
    G. High blood pressure (hypertension)
    H. Diabetes
    I. Obesity
    J. Inactivity
IV. Lowering LDL by dietary changes
    A. Reduce dietary saturated fat and cholesterol
    B. Increase monounsaturated and polyunsaturated fats
    C. Increase dietary fiber
V. Lowering blood triglycerides
    A. Do not overeat
    B. Limit alcohol and simple sugar intake
    C. Spread meals throughout the day
    D. Consume fish
VI. Raising HDL level
    A. Exercise
    B. Eat regularly
    C. Match the amount of energy consumed with that expended
    D. Eat less total fat
    E. Moderate alcohol consumption
VII. Medical intervention
    A. Last resort
    B. The necessity of medications plus diet
VIII. Other possible medical therapies for cardiovascular disease
    A. Cholestin
        1. Not regulated by FDA

2. Use with medical supervision

B. FDA-approved margarines
   1. Benecol
   2. Take Control

IX. General strategy for reducing cardiovascular disease risk
   A. Consume less saturated fat and trans fatty acids
   B. Eat fish rich in omega-3 fatty acids twice a week; include plant sources
   C. Eat plenty of fruits, vegetables, nuts, and soy
   D. Eat more whole grains and less refined carbohydrates
   E. Eat regularly spaced meals
   F. Consume moderate amounts of alcohol
   G. Moderate coffee intake; replace some use with tea
   H. Moderate salt intake
   I. Meet calcium needs
   J. Avoid excess iron intake

ACTIVITIES

1. Ask students to complete the **Rate Your Plate** activity for this chapter. This activity will use the assessment they completed for Chapter 2. Students will be able to compare their intakes to the American Heart Association and National Cholesterol Education guidelines for lipid intake.
2. Have students go to a supermarket and compare the P/S ratio of butter and different margarines, including stick, tub, and squeezable. They can calculate the P/S ratio simply by dividing the grams of saturated fat into those of polyunsaturated fat. Have them report the brands of margarine with the highest P/S ratio. Also, have them collect information on the type of oil used in each of the brands. Use this activity as a springboard to discuss types of margarines and oils to use to lower the risk of coronary heart disease, as well as hydrogenation.
3. In class, compare different fats used in oil products sold in the supermarket and describe the differences in saturation.
4. Have students go to a supermarket and compare various meats for fat grams per serving. They should compare ground turkey, turkey hot dogs, chicken breasts, breaded chicken breasts, ground beef, and various brands of lunch meats by looking at the food labels. Have students share with classmates what they found. For example, were the poultry products lower in fat grams per serving than red meats? Did breaded products contain the most fat grams per serving? What percentage of luncheon meats were fat?
5. Bring coffee whiteners, whipped toppings, peanut butter, and mayonnaise labeled "no cholesterol" to class. Describe the amount of fat and type of fat in each, illustrating differences in the concepts of cholesterol and fat.
6. Have students purchase a *T-Factor Diet Fat Gram Counter* from an area bookstore or require it as a course book in your campus bookstore. Have them tally fat grams they eat for a day using this tool. Have them, on a prescribed day, report their total verbally. Use this as a springboard to discuss ways of reducing fat intake.
7. Have each student write for *The Lowfat Lifeline Catalog* from Lowfat Lifeline, 626 Benton, P.O. Box 1889, Port Townsend, WA 98368. This will give them a book of resources if they are interested in exploring lowfat cooking and consuming a lowfat diet.

READINGS

1. de Lorgeril M and others: Mediterranean Diet: Traditional risk factors and the rate of

cardiovascular complications after myocardial infarction. *Circulation*, 99:779, 1999.
People who had already suffered a heart attack and followed a Mediterranean Diet enjoyed a significantly reduced risk from suffering another heart attack. The majority of subjects instructed on the Mediterranean Diet were compliant, suggesting that implementing this dietary style with instructions from trained individuals is not as difficult as one might think.

2. Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults: Executive summary of the third report of the National Cholesterol Education Program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III). *Journal of the American Medical Association*, 285:2486, 2001.
All adults ages 20 years or older should have a fasting lipoprotein profile once every 5 years. Diabetes no longer is considered just a risk factor for cardiovascular disease, but virtually guarantees the disease will develop. Other new recommendations are raising the desirable HDL-cholesterol level of 40 mg/dL or more, and using a combination of age, total cholesterol, HDL-cholesterol, blood pressure, and smoking history in a formula to determine which persons need cholesterol-lowering medications.
3. Healing broken hearts. *Nutrition Action Health Letter*, p. 1, June 1999.
Dr. Dean Ornish reviews his diet solution to reversing atherosclerosis in people with obvious disease. The vegan diet used includes about 10% of calories from fat. Yoga, exercise, and stress-management sessions are additional lifestyle changes.
4. HU FB and others: Dietary saturated fats and their food sources in relation to the risk of coronary heart disease in women. *American Journal of Clinical Nutrition*, 70:1001, 1999.
Along with other saturated fatty acids, stearic acid was found in this study to be associated with increased cardiovascular disease risk. Since saturated fats usually are found together in foods, there is no need to differentiate between them in the diet (e.g., mystric acid vs. stearic acid).
5. HU FB and others: Types of dietary fat and risk of coronary heart disease: A critical review. *Journal of the American College of Nutrition*, 20:5, 2001.
Replacing saturated fat with unsaturated fat is more effective for lowering the risk of cardiovascular disease than simply reducing total fat consumption. There is strong evidence that a higher intake of omega-3 fatty acids from fish or plant sources lowers cardiovascular disease risk. The belief that fat is bad is widespread but is incorrect; saturated fat and trans fat should get the attention when recommending lower fat intakes.
6. Jacobs DR and others: Whole-grain intake may reduce the risk of ischemic heart disease death in postmenopausal women: The Iowa women's health study. *American Journal of Clinical Nutrition*, 68:248, 1998.
There is a clear association between a generous whole-grain intake and reduced risk of cardiovascular disease in women. The constituents of whole grains that may be responsible for this reduced risk include phytochemicals, fiber, and antioxidants.
7. Krauss RM and others: AHA Dietary Guidelines: Revision 2000: A Statement for Healthcare Professionals From the Nutrition Committee of the American Heart Association. *Circulation,* 102:2284, 2000.
This report contains the latest advice for the public regarding diet and cardiovascular disease from the American Heart Association. The revised guidelines place an increased emphasis on the need for weight control and heart-healthy diet.
8. Lichtenstein AH and others: Effects of different forms of dietary hydrogenated fats on serum lipid and cholesterol levels. *The New England Journal of Medicine*, 340:1933, 1999.
Oil that has not been hydrogenated was found to have the most favorable results on

total blood cholesterol and LDL-cholesterol, whereas margarine that was high in trans fatty acids produced more negative blood cholesterol profiles.

9. Stampfer M and others: Primary prevention of coronary heart disease in women through diet and lifestyle. *The New England Journal of Medicine*, 343:16, 2000.
   Following a set of specific lifestyle factors, including a balanced diet with a small amount of wine each day, exercise, and abstinence from smoking, can help protect women from coronary heart disease.
10. Truan TL: Antioxidant supplements to prevent heart disease: Real hope or empty hype? *Postgraduate Medicine*, 109(1):109, 2001.
    The notion that antioxidant supplements can prevent cardiovascular disease is not supported by current clinical evidence. Until conclusive evidence is available regarding the efficacy, safety, and appropriate dosage of antioxidants, the more prudent recommendation for the general public is to consume more fruits, vegetables, and whole grains.

CHAPTER 6
PROTEINS

OVERVIEW

This chapter introduces amino acids and the basic structure and organization of proteins. Essential and nonessential amino acids are differentiated. The digestion and absorption of proteins are explored. The biological functions of protein in producing body constituents; hormones and enzymes; maintaining fluid and acid-base balance; immune function; forming glucose; and its uses as an energy source are detailed. The Recommended Dietary Allowance for protein is discussed. Dietary recommendations for protein intake include comments regarding risks associated with high protein intakes and the importance of dietary plant proteins. Protein content in foods is listed. Protein-energy malnutrition is described along with appropriate prevention and treatment.

The Nutrition Insight addresses the interest in soy protein. Vegetarianism is the topic addressed in the Nutrition Issue section.

CHAPTER OBJECTIVES

Upon completion of this chapter, the student will be able to:

1. describe how amino acids make up protein.
2. distinguish between essential (indispensable) and nonessential (dispensable) amino acids.
3. explain why adequate amounts of each of the essential amino acids are required for protein synthesis.
4. list the primary functions of protein in the body.
5. calculate the RDA for protein for an adult when a healthy weight is given.
6. describe what is represented by positive protein balance, negative protein balance, and protein equilibrium.
7. distinguish between high-quality and low-quality protein and the sources of each, and describe how two lower-quality proteins can be complimentary for each other and in turn provide enough of all the essential amino acids for a diet.
8. describe how protein-energy malnutrition can eventually lead to disease in the body.
9. develop vegetarian diet plans that meet the body's nutritional needs.

KEY TERMS

Buffers
Capillary bed
Carbon skeleton
Complementary proteins
Denature
Edema
Essential amino acids
Extracellular space
Fruitarian
Gastrin
High-quality (complete) proteins
Kwashiorkor
Lactoovovegetarian
Lactovegetarian
Limiting amino acid
Lower-quality (incomplete) proteins
Marasmus
Nonessential amino acids
Pepsin
Peptide bond
Polypeptide
Protein-energy malnutrition (PEM)
Sloughed
Trypsin
Urea
Vegan

REAL LIFE SCENARIO

Shannon is a college freshman. She lives in a campus dorm and is an aerobics instructor in the afternoon. She eats two or three meals a day at the dorm cafeteria and snacks between meals. Shannon and her roommate both decided to become vegetarians because they recently read a magazine article describing the health benefits of a vegetarian diet. Yesterday her vegetarian diet consisted of a pop tart for breakfast and a tomato-pasta dish (no meat) with pretzels and a diet soft drink for lunch. In the afternoon, after her aerobic class, she had a few cookies. At dinnertime, she had a vegetarian sub sandwich with two glasses of fruit punch. In the evening, she had a bowl of popcorn.

What type of vegetarian is she? How could she improve her new diet to meet her nutritional needs?

LECTURE OUTLINE

I. Protein – An introduction
  A. Introduction
    1. Contain nitrogen which carbohydrates and fats do not
    2. Regulate and maintain our bodies
    3. Provide 4 kcals per gram
  B. Amino acids
    1. Building blocks of protein
    2. Basic structure
    3. Determination of specific amino acids
      a. Nonessential amino acids
      b. Essential amino acids
        1) Health implications if essential needs are not met
  C. Putting essential and nonessential amino acids into perspective
    1. Physiological aspects
    2. Dietary considerations
      a. Animal proteins provide all essential amino acids
        1) Support body growth and maintenance
        2) High quality; complete
      b. Plant proteins lack one or more amino acids
        1) Lower quality; incomplete
      c. Partially complete proteins support maintenance only; have a limiting amino acid
        1) Limiting amino acids in plant foods
      d. Combining proteins to make them complete
        1) Complementary proteins

II. Proteins - amino acids joined together
  A. Protein synthesis
    1. Steps in protein synthesis
      a. gene defects
  B. Protein turnover
    1. Process described
    2. Amino acids are recycled
  C. Protein organization
    1. Sequential order
      a. Sickle cell disease

D. Protein denaturation
    1. Alters structure and function
    2. Can be caused by acid, base, heat, agitation
    3. Often destroys normal physiological functions

III. Protein in foods
A. Plant proteins
    1. Nutrient density
    2. Food sources
        a. Soy
        b. Legumes
        c. Beans
    3. Side effects
B. Protein digestion and absorption
    1. Digestion
        a. Begins in the stomach
            1) Roles of pepsin and gastrin
            2) Importance of stomach acid in pepsin activation
        b. Small intestine
            1) Enzymes released in response to partially digested proteins
            2) Proteins divided into shorter amino acid chains
    2. Absorption
        a. Short amino acid chains are absorbed
        b. Final digestion of amino acid chains into amino acids occurs in absorptive cells of the small intestine
        c. Amino acids travel to the liver via the portal vein
            1) Combined into protein
            2) Converted to glucose
            3) Converted to fat
            4) Released into blood stream
    3. Complications if whole proteins are absorbed

IV. Putting proteins to work in the body
A. Producing vital body constituents
    1. Constituents listed
    2. Constant state of protein breakdown, rebuilding, and repair
        a. Bone marrow
        b. Intestine
B. Maintaining fluid balance
    1. Blood proteins attract fluids
    2. Exert pressure - attracts fluids into the blood
    3. Levels decrease in protein deficiency
    4. Fluid shifts into tissues - edema
C. Contributing to acid-base balance
    1. Assists in keeping blood slightly alkaline
    2. Act as buffers
D. Forming hormones and enzymes
    1. Hormones: internal body messengers
        a. Contain one, to many, amino acids
        b. Important regulatory functions
    2. Enzymes: speed chemical reactions
        a. Crucial role in cell function
E. Contributing to the immune function

1. Production of antibodies
F. Forming glucose
G. Providing energy

V. Protein needs
A. Sufficient amount needed to balance output with intake
1. Requirements determined by nitrogen balance
a. Positive protein balance
b. Negative protein balance
c. Protein equilibrium
2. Estimated requirements
a. Adults: 0.8 grams per kilogram body weight
b. Doubles during infancy
c. Pregnancy increases protein needs by about 10 to 15 grams per day
d. Endurance athletes and body builders: 1.2-1.4 grams per kilogram body weight
B. Does eating a mainly high-protein diet harm you?
1. No clear-cut danger – positives and negatives
2. Effect on calcium
3. Linked to cardiovascular disease and colon cancer
4. Kidney function

VI. Protein-energy malnutrition
A. Definition and overview
B. Kwashiorkor
1. Primarily protein deficiency
2. Associated with weaning from breast to starchy diet
3. Energy needs marginally met and protein intake inadequate
4. Symptoms
a. Apathy, listlessness
b. Failure to grow and gain weight
c. Increased susceptibility to infection
d. Reduced muscle mass, abdomen and leg edema
e. Changes in hair color, flaky skin
5. Disease process can reverse with adequate diet
C. Marasmus
1. Primarily from insufficient amount of protein, energy, and other nutrients
2. No breast feeding or weaning early
3. Seen in cities where fashionable to bottle-feed, poor sanitation
4. Symptoms
a. "Skin and bones" appearance
b. Little or no subcutaneous fat
5. Full recovery from the disease may never occur
a. Brain may not grow to its full adult size

NUTRITION ISSUE: Vegetarianism

I. Introduction
A. History
B. Nutrition implications

II. Why do people become vegetarians?
A. Belief that killing animals is unethical
B. Religious

C. Economical
D. Health

III. Food planning for vegetarians
  A. Variety of styles
    1. Vegans
    2. Fruitarian
    3. Lactovegetarian
    4. Lactoovovegetarian
    5. Lacto vegetarian Food Group Plan
  B. The vegan
    1. Diet requires creative planning
      a. Use complementary protein sources
      b. Using vegetarian cookbooks helps simplify menu planning
      c. Include good sources of riboflavin, vitamin D, vitamin B_{12}, calcium, iron, and zinc
    2. Cautions for vegan children
      a. Difficult to meet energy needs because of low caloric density and high fiber content of diet

ACTIVITIES

1. Have students complete the **Rate Your Plate** activity, "Is Your Protein Intake Sufficient to Meet Your Needs?". Students will use the nutritional assessment they completed in Chapter 2. All they will need to do is get the total protein value from their assessment, calculate their RDA for protein, and compare them. Have students complete the balance of the activity.
2. Have students plan a low cost, lactovegetarian menu that meets their particular RDA for protein. They could use the food-group plan for lacto-vegetarians and the exchange system as tools to do this.
3. From what students have learned about vegetarianism and plant protein sources, have them, as a class, plan two well-balanced vegetarian dinners that they would be willing to try. Make sure they vary the texture, temperature, color, and taste of each meal. This could be done during a class period, soliciting suggestions from the class and writing the suggestions on a transparency, board, poster paper, or similar medium.
4. Have students collect information on protein supplements that could be obtained from health food stores, sporting supply stores, or ordered from magazines for athletes and/or body builders. Have them work individually or in small groups to evaluate these products in relation to cost, protein quality and quantity, and presence of other nutrients. Develop a table comparing the quality of protein in supplements to dietary sources.
5. Have individual or small groups of students visit supermarkets, food co-ops, health food stores, or other food suppliers, and determine what plant sources of protein are available. Develop a table with food supplier, address, telephone number, sources of plant protein available, and approximate cost per unit. Have students develop and discuss ways in which these items could be incorporated in a meal; focus on complementation. This could include developing a recipe or combining various food items to make an appetizing, protein-complementary meal. You also could have students compare the price of one serving of animal protein and one serving of a plant protein.
6. Have students taste tofu, a quality plant protein. Tofu with different firmness can be cut into sampling pieces for the students to taste. Also present tofu in a tasty recipe such as a dip. Get their impressions of it. Ask the students to think of ways that tofu can be used in a vegetarian or omnivorous diet. To become aware of good tofu recipes, purchase a copy of

The New Laurel's Kitchen.

7. Have students visit the campus bookstore, a library, or area bookstore and locate five vegetarian resources including cookbooks. Have them reference each resource, noting the number of pages, whether it is soft cover or hard cover, and the price (if known). Compile a list of vegetarian resources for the students.

READINGS

1. Greaves KA, Thomson K: Soy protein comes to the aid of women. *Today's Dietitian*, p. 23, April 2001.
   There are multiple benefits from consumption of soy protein: heart health, bone health, and relief of menopausal symptoms. The benefits of a diet containing soy protein extend to people across the life cycle.
2. Henkel J: Soy: Health claims for soy proteins, questions about other components. *FDA Consumer*, p. 13, June 2000.
   In October 1999, FDA gave food manufacturers permission to put labels on products indicating that soy proteins in these foods may help lower heart disease risk. There is less evidence to support the consumption of other components of soy especially when consumed as concentrated supplements.
3. How much protein is enough? *Consumer Reports on Health*, p. 8, February 2001.
   It is particularly important for pregnant women, breastfeeding women, young children, and older adults to meet protein needs. A daily intake of about 15% of total calorie intake is adequate to meet the protein needs of most people.
4. Is it time to stop eating meat? *Harvard Health Letter*, p. 6, September 2001.
   It is best to consume red meat on an occasional basis, rather then daily. Chicken, fish, legumes, and nuts are healthier, protein-rich alternatives.
5. Johnston TK: Nutritional implications of vegetarian diets. In shills ME and others (eds.): *Modern nutrition in health and disease*. 9th ed. Baltimore: Williams & Wilkins, 1999.
   Vegetarian diets have a long history. There are many positive aspects of a primarily plant-based diet, including ample consumption of fruits and vegetables. Many typical diseases, such as cardiovascular disease, and osteoporosis, are less common in vegetarians than in people consuming animal protein-rich diets. These findings are discussed in detail.
6. Kris-Etherton PM and others: The effects of nuts on coronary heart disease risk. *Nutrition Reviews*, 59:103, 2001.
   Nuts have many nutritional attributes. They are rich in unsaturated fatty acids, dietary fiber, antioxidant vitamins, minerals, and numerous bioactive substances (i.e., flavonoids and plant sterols) that have many health benefits. A growing body of *evidence demonstrates that nuts decrease cardiovascular disease risk*.
7. Liebman B, Hurley J: Beans: No longer a bore. *Nutrition Action Health Letter*, p. 13, May 1999.
   If one hasn't consumed beans on a regular basis, it is best to start with small portions and increase this gradually over a few weeks, so one's GI tract has a chance to adjust. Use of the product Beano can also help reduce intestinal gas-related discomfort.
8. Messina V, Mangels AR: Considerations in planning vegan diets: Children. *Journal of the American Dietetic Association*, 101:661, 2001.
   Vegans must find good sources of vitamin B-12, riboflavin, zinc, calcium, and, if sun exposure is not adequate, vitamin D. This should not be problematic, due to the growing number and availability of fortified vegan foods that can help meet all nutrient needs. With appropriate food choices, vegan diets can be adequate, even for children. The article

provides numerous examples of sources for the nutrients of concern in the vegan diet.

9. Norat T, Riboli E: Meat consumption and colorectal cancer: A review of epidemiologic evidence. *Nutrition Reviews*, 59(2):37, 2001.

   The risks of colorectal cancer are higher in people who consume diets rich in processed meat and red meat compared to individual who consume small amounts. Total meat intake is not as much of a concern if one chooses a diet low in red meat and processed meats.

10. Smit E and others: Estimates of animal and plant protein intake in US adults: Results from the third National Health and Nutrition Examination Survey, 1998-1991. *Journal of the American dietetic Association*, 99:813, 1999.

    The main source of protein in the American diet is animal protein (69%). Meat, fish, and poultry protein contributes most of the animal protein. Women tend to consume a lower percentage of red meat and a higher percentage of proteins from chicken, dairy, fruits, and vegetables.

CHAPTER 7
VITAMINS

OVERVIEW

Vitamins are organic substances that are present in foods we eat and which perform specific body functions. The introduction to this chapter compares water-soluble and fat-soluble vitamins and gives evidence that we have discovered all vitamins. Fat-soluble and water-soluble vitamins are presented individually including their properties, functions in the body, potential for deficiency or toxicity, food sources and recommended intakes. Emphasis is placed on the interaction of these nutrients with others and factors that control their metabolism in the body. Vitamin and mineral supplementation also are discussed.

The Nutrition Insight addresses nutrient supplements. People most likely to need supplements and what supplement should be chosen are discussed. "Nutrition and cancer" is the topic covered in the Nutrition Issue.

CHAPTER OBJECTIVES

Upon completion of this chapter, the student will be able to:

1. define the term vitamin.
2. classify the vitamins according to whether they are fat-soluble or water-soluble.
3. list the major functions and deficiency symptoms for each fat-soluble vitamin.
4. list the major functions and deficiency symptoms for each water-soluble vitamin.
5. list three important food sources for each fat-soluble vitamin.
6. describe symptoms of vitamin toxicities and factors that contribute to them.
7. describe toxicity symptoms from excess consumption of certain fat-soluble and water-soluble vitamins.
8. distinguish between vitamins and nonvitamins, such as inositol and taurine.
9. evaluate the use of vitamin supplements with respect to their potential benefits and hazards to the body.
10. describe some cancer-causing mechanisms, and describe how diet and nutrition are related to their minimization.

KEY TERMS

Analog
Benign
Beriberi
Cancer initiation
Cancer progression
Cancer promotion
Dementia
Dermatitis
Epithelial cells
Erythrocytes
Fat-soluble vitamins
Fetus
Hemolysis
International unit
Intrinsic factor
Isomers
Macrocytic anemia
Malignant
Megadose
Megaloblast
Metastisis
Mutation
Neural tube defect
Night blindness
Nitrosamine
Osteomalacia
Pernicious anemia
Prostate gland
Rickets
Retinoids
Tocopherols
Vitamins
Water-soluble vitamins
Xerophthalmia

REAL LIFE SCENARIO

Kristen works nights at a local package distribution center to make some extra money. The combination of taking a full course load at college and working nights has created a lot of stress for her. Kristen's many commitments also make it important that she not become ill. On a recent coffee break at her job, a co-worker suggested she take *Nutramega* supplements to help prevent colds, flu, and other illnesses. The product's label suggests that *Nutramega* helps prevent such problems, especially those associated with the changing of seasons. The label recommends taking two to three tablets every 3 hours at the first sign of a decline in well-being, and two to three tablets daily for health maintenance. Kristen looks at the Supplement Facts label on the bottle and finds that each tablet contains (as percent of Daily Value): 33% for vitamin A (three-quarters of which is preformed vitamin A), 700% for vitamin C, 50% for zinc, and 10% for selenium. A month's supply also costs about $50.

Should Kristen use this product? Are there health risks associated with this product, especially considering the dosage recommended on the label?

LECTURE OUTLINE

I. Vitamins: vital dietary components
   - A. Introduction
     1. Definition
     2. History of vitamins
   - B. Have scientists found all vitamins?
   - C. Storage of vitamins in the body
   - D. Vitamin toxicity
     1. Fat-soluble vitamins can accumulate in the body and have toxic effects
        - a. Toxicities of vitamins A and D are observed most frequently
        - b. Vitamin E can be toxic if taken in supplemental (pill) form
     2. Niacin, vitamin B-6, and vitamin C can be toxic if taken in supplemental (pill) form
   - E. Preservation of vitamins in foods
     1. Water soluble vitamins – thiamin, vitamin C, and folate – can be destroyed with improper storage and excessive cooking
     2. Heat, light, exposure to the air, cooking in water, and alkalinity all are factors that can destroy vitamins
     3. Suggestions for preserving nutrients in foods

II. The fat-soluble vitamins – A, D, E, and K
   - A. Absorption
     1. With dietary fat
     2. Special carriers in the bloodstream
     3. Storage in the liver and adipose tissue
     4. 40% to 90% are absorbed
   - B. Vitamin A
     1. Retinoids versus carotenoids
     2. Functions
        - a. Vision
        - b. Health of other cells
        - c. Growth, development, and reproduction
        - d. Cardiovascular disease prevention
        - e. Cancer prevention

f. Vitamin A analogs for acne
3. Vitamin A in foods and needs
a. Liver, fortified milk
b. Dark green and orange vegetables and fruits
c. Retinol equivalents versus international units
d. RDA
1) 700 to 900 micrograms of retinol activity equivalents (RAEs)
4. Toxicity of vitamin A
a. Upper level is 3000 micrograms preformed vitamin A
b. Can lead to fetal malformations, spontaneous abortions, and liver toxicity

C. Vitamin D
1. Also considered a hormone
2. Made in response to sunlight exposure
3. Functions
a. Regulates calcium and bone metabolism
1) Calcium and phosphorus absorption
2) Reduces kidney excretion of calcium
3) Regulates deposition of calcium and phosphorus in bone
A) Rickets
B) Osteomalacia
4. Dietary sources and needs
a. Mostly in fortified foods (e.g., milk)
b. Fish oils, tuna, salmon
c. RDA: 5 to 10 micrograms (200 to 400 IU) per day
5. Toxicity
a. Upper level is 50 micrograms per day (2000 IU)

D. Vitamin E
1. Functions
a. Antioxidant
b. Improves vitamin A absorption
2. Deficiency: Cell membrane breakdown, hemolysis
3. Food sources and needs
a. Plant oils
b. RDA: 15 milligram per day of alphatocopheral
c. Individuals at risk of a deficiency
d. Toxicity
1) Can antagonize vitamin K's role in blood clotting

E. Vitamin K
1. Bacterial synthesis
2. Functions
a. Blood clotting
b. Given to newborns to ensure blood clotting
3. Food sources and RDA
a. Liver
b. Green leafy vegetables
c. RDA: 90 to 120 micrograms per day
d. Toxicity
1) Increased bleeding tendency

III. Water-soluble vitamins and choline
A. The B vitamins

1. Function as coenzymes
2. Key roles in metabolism
3. 50% to 90% absorbed

B. B vitamin intakes of North Americans
1. Typical diets contain plentiful B vitamins
2. Many foods are fortified with B vitamins
3. Marginal deficiencies may occur

C. Thiamin - B_1
1. Functions
   a. Release energy from carbohydrates
2. Deficiency: Beriberi
   a. Weakness, poor arm and leg coordination
   b. Loss of appetite
   c. Enlarged heart and sometimes severe edema (wet beriberi)
3. Food sources and needs
   a. Pork
   b. Whole and enriched grains, legumes
   c. RDA: 1.1 to 1.2 milligrams per day

D. Riboflavin - B_2
1. Functions
   a. Energy metabolism
2. Deficiency
   a. Broad-based symptoms hard to distinguish from other deficiencies
3. Food sources and RDA
   a. Milk, milk products
   b. Enriched white bread, rolls, and crackers
   c. Meat and eggs
   d. RDA: 1.1 to 1.3 milligrams per day

E. Niacin - B_3
1. Functions
   a. Energy and fat metabolism
2. Deficiency: Pellagra
   a. Three Ds: Dementia, dermatitis, diarrhea
   b. Death can occur
   c. Early symptoms include poor appetite, weight loss, and weakness
3. Food sources and needs
   a. Mushrooms, asparagus, peanuts
   b. Wheat bran, enriched white bread and breakfast cereals
   c. Tuna and other fish
   d. Poultry, beef
   e. Peanuts
   f. 60 milligrams tryptophan = 1 gram niacin
   g. RDA: 14 to 16 milligrams per day
4. Toxicity
   a. Begins at intakes of 35 milligrams of the nicotinic acid form
   b. headache, itching, and increased blood flow to the skin (flushing)
5. Sometimes large amounts are used under a doctor's supervision to treat cardiovascular disease

F. Pantothenic acid
1. Functions
   a. Helps release energy from carbohydrates, fats, and protein

2. Food sources and needs
    a. Sunflower seeds, mushrooms, peanuts, and eggs
    b. Meat, milk, and many vegetables
    c. Adequate Intake: 5 milligrams per day

G. Biotin
1. Functions
    a. Acts in fat and carbohydrate metabolism
    b. Promotes synthesis of glucose, fatty acids, and DNA
    c. Breaks down certain amino acids
2. Deficiency
    a. Scaly inflammation of the skin
    b. Changes in tongue and lips
    c. Decreased appetite, nausea, vomiting
    d. Anemia, depression, muscle pain and weakness
    e. Poor growth
3. Food sources and needs
    a. Cauliflower
    b. Egg yolks
    c. Peanuts
    d. Cheese
    e. Intestinal bacteria supply some biotin
    f. Avid in raw egg whites binds biotin and inhibits its absorption
    g. Adequate Intake: 30 micrograms per day

H. Vitamin B_6
1. Functions
    a. Carbohydrate, protein, and fat metabolism
    b. Amino acid metabolism
    c. Converts homocysteine to methionine
    d. Neurotransmitter synthesis
        1) Not proven to be helpful in treating premenstrual syndrome
        2) May reduce pain in carpal tunnel syndrome
    e. Synthesis of hemoglobin
2. Food sources and needs
    a. Meat, fish, and poultry
    b. Ready-to-eat breakfast cereals, potatoes, and milk
    c. Fruits and vegetables; bananas, cantaloupe, broccoli, and spinach
    d. RDA: 1.3 to 1.7 milligrams per day
    e. Deficiency
        1) People with alcoholism are susceptible
3. Toxicity
    a. Upper Level is 100 milligrams per day
        1) Irreversible nerve damage
        2) Walking difficulties, and hand and foot numbness

I. Folate
1. Functions
    a. DNA, RNA, purine, pyrimidine synthesis
    b. Amino acid metabolism
2. Deficiency
    a. Affects red blood cells
    b. Precursor cells cannot divide
    c. Grow larger: megaloblasts

d. Macrocytes
e. Decreased oxygen-carrying capacity
f. Magaloblastic anemia
g. Linked to neural tube defects

3. Food sources and needs
   a. Enriched bread, rolls, buns, and pasta
   b. Green leafy vegetables, organ meats
   c. Orange juice
   d. Destroyed in food processing
   e. Susceptible to heat
   f. RDA: 400 micrograms per day
   g. Toxicity
      1) Upper Limit: 1 milligram per day (pill form)
      2) FDA limits nonprescription levels to 400 micrograms
      3) Could mask vitamin B_{12} deficiency

J. Vitamin B_{12}

1. Characteristics
   a. Family of compounds
   b. Contain cobalt
   c. Form coenzymes
   d. Synthesized by bacteria, fungus, and other lower organisms
2. Absorption
   a. Liberated from food by stomach acid
   b. Binds with substance from salivary glands and intrinsic factor from stomach
   c. Travels to small intestine
   d. Absorbed and transferred to blood protein
      1) 30% to 70% absorbed
   e. Disruption of vitamin B_{12} absorption leads to deficiency
3. Functions
   a. Folate metabolism
   b. Maintain myelin sheath that insulates nerve fibers
4. Deficiency: Pernicious anemia
   a. Macrocytic
   b. Decreased ability to absorb vitamin B_{12}
   c. Weakness, sore tongue, back pain, apathy, tingling in extremities
5. Food sources and needs
   a. Animal foods - meat, poultry, seafood, eggs, milk, and milk products
   b. Synthetic form found in ready-to-eat cereals and pills
      1) Not food bound; therefore, more readily absorbed
   c. Some from bacterial and soil contamination
   d. RDA: 2.4 micrograms per day
   e. Risk of deficiency
      1) Vegans
      2) Elderly
   f. Toxicity unknown

K. Vitamin C

1. Characteristics
   a. Found in all living tissues
   b. Most animals can synthesize
   c. Similar to monosaccharides

2. Absorption and metabolism
    a. 80% to 90% absorbed
    b. Decreases with increased dosage
    c. High intakes can cause diarrhea
3. Functions
    a. Collagen synthesis
        1) Highly concentrated in connective tissue, bones, teeth, tendons, and blood vessels
        2) Wound healing
        3) Interruption of tissue metabolism from a Vitamin C deficiency leads to **scurvy**: weakness, poor wound healing, bone pain, fractures, bleeding gums, diarrhea, and pinpoint hemorrhages.
    b. Antioxidant (water-soluble)
        1) Reduce formation of cancer-causing nitrosamines
        2) Keep folate enzymes intact
    c. Enhanced iron absorption
        1) Keeps iron in most absorbable form
    d. Immune system
        1) Vitamin C and the common cold
            A) Does not prevent colds in large quantities; however, may reduce symptoms
        2) No evidence that high doses will cure colon cancer
4. Food sources and needs
    a. Green pepper, cauliflower, broccoli, cabbage, strawberries, papayas, potatoes
    b. Almost exclusively in fruits and vegetables
    c. Lost in processing and cooking
    d. RDA: 75 to 90 milligrams per day
        1) Smokers need an extra 35 milligrams per day
    e. Risk of deficiency
        1) Alcoholism
        2) Elderly men
        3) Associated with poverty
    f. Toxicity
        1) Upper Limit: 2 grams per day
        2) Higher amounts
            A) Inflammation of the stomach
            B) diarrhea

IV. Choline
A. Functions
    1. Precursor to acetylcholine, a neurotransmitter associated with attention, learning, and memory; muscle control; and other functions
    2. Precursor of phospholipids
    3. Participates in aspects of homocysteine metabolism
B. Deficiency
    1. Linked to liver damage
C. Deemed an essential nutrient
D. Food sources and needs
    1. Widely distributed in foods
    2. Milk, liver, eggs, and peanuts
    3. Adequate Intake: 425 to 550 milligrams per day

4. Upper Level: 3.5 grams per day
    a. Fishy body odor
    b. Low blood pressure

V. Vitamin-like compounds
- A. Necessary for metabolism
- B. Synthesized by the body
- C. Examples
    1. Carnitine
    2. Inosital
    3. Taurine
    4. Lipoic acid

NUTRITION ISSUE: Nutrition and cancer

I. Introduction
- A. Second leading cause of death
- B. Disease described
- C. Lifestyle versus genetic factors

II. Mechanisms of Carcinogenesis

III. Cancer initiation
- A. Process
- B. Causes

IV. Cancer promotion
- A. Process
- B. Causes

V. Cancer progression
- A. Process
- B. Causes

VI. Diet and cancer
- A. Contribution of fat and energy intakes to cancer risk
- B. Cancer-inhibiting food constituents

VII. The bottom line
- A. Diet
    1. Diet should be moderate in energy and fat
    2. Cancer inhibiting foods
        a. Fruits
        b. Vegetables
        c. Whole grains
        d. Beans
        e. Fish
        f. Low-fat or nonfat milk products
- B. Other suggestions to reduce risk for cancer
    1. Remain physically active
    2. Avoid obesity
    3. Moderate alcohol intake
    4. Limit intake of salt-cured, smoked, and nitrate-cured foods
- C. Early detection is key – warning signs (acronym is CAUTION)
    1. A **c**hange in bowel or bladder habits
    2. **A** sore that does not heal
    3. **U**nusual bleeding or discharge

4. A **t**hickening or lump in the breast or elsewhere
5. **I**ndigestion or difficulty in swallowing
6. An **o**bvious change in a wart or mole
7. A **n**agging cough or hoarseness

D. Other detection methods
1. Unexplained weight loss is an additional warning sign
2. Colonoscopy examinations
3. Prostate-specific antigen (PSA)
4. Papanicolaou tests (Pap smears)
5. Breast examinations (mammograms starting at age 40)

ACTIVITIES

1. Assign students the **Rate Your Plate** activity, "Measuring Your Vitamin Intake Against the RDAs". They will need to use the nutrition analysis they did for Chapter 2. They will need to retrieve the values for the appropriate vitamins, their RDAs, and the percentage of the RDA. These values should be readily available from their assessment. They then should complete the balance of the assignment including the analysis.
2. Ask students to bring to class the vitamin supplements they use, or you provide a variety of brands (brand names and generic). Ask students to evaluate them using the guideline that no vitamin should be present in amounts greater than 150% of the USRDA. Divide the supplements into those that meet the guidelines and those that exceed them. Discuss the implications of consuming vitamins in too-high quantities. Next, compare the cost of name brands to generic ones. Have students determine how much money they would save by purchasing generic brands. Do this as a general class activity. Make a list of generic brands on the board and their prices and a similar list in a column next to it of the name brands. Do a price comparison. Lastly, discuss situations and conditions that would warrant the use of supplemental vitamins.
3. Most vitamins have an interesting history. Have each student prepare a background report on the discovery and isolation of one vitamin. These could be handed in and graded or presented as oral reports.
4. During class discussion, have students describe various food preparation and storage techniques that should be used to preserve the water-soluble vitamin content of fruits and vegetables.
5. Fortified foods have become increasingly common in the U.S. Ask students to survey cereal products found in the supermarket and compare the vitamin content in at least eight. Which cereal would they choose if they wanted to get the most vitamin nutriture?
6. Have students write the name of each vitamin on an index card. On the back, they will list one to three key functions of that vitamin; food sources; deficiency name, if appropriate; deficiency symptoms; and toxicity symptoms. Have students study these index cards in pairs until they can recall the information about each vitamin.
7. Before class, write the name of each vitamin on a piece of paper, index card, or "post-it." If you use paper or an index card, remember to take stick pins or tape to class to fasten the card/paper on students' backs. Secure one card/paper/post-it on the back of each student. Have students circulate throughout the room asking other students questions about the vitamin posted on their back. Only yes and no questions are permitted, for example, "Am I involved in blood clotting?" and "Are green vegetables good food sources of me?" Only two questions can be asked of any person. After asking two questions of a person, students must move to someone else. Continue the game until everyone correctly identifies the vitamin they are.

READINGS

1. ADA Reports: Position of The American Dietetic Association: Food fortification and dietary supplements. *Journal of The American Dietetic Association* 101:115, 2001.
   The best nutritional strategy for promoting optimal health and reducing the risk of chronic disease is to wisely choose a wide variety of foods. Additional vitamins and minerals from fortified foods and/or supplements can help some people meet their nutritional needs.
2. Food and Nutrition Board, Institute of Medicine: *Dietary Reference Intakes for thiamin, riboflavin, niacin, vitamin B-6, folate, vitamin B-12, pantothenic acid, biotin, and choline*. Washington, DC: National Academy Press, 1998.
   Explanation as to how nutrient recommendations were established for the B-vitamins and choline, with specific reference to establishing RDA and related standards. The functions of each of the B-vitamins and choline are explained.
3. Food and Nutrition Board, Institute of Medicine: *Dietary Reference Intakes for vitamin C, vitamin E, selenium, and carotenoids*. Washington, DC: National Academy Press, 2000.
   The functions of antioxidant nutrients; how RDA and related standards were determined; and deficiency and toxicity symptoms are explained. This is the definitive report by the panel of experts on nutrient needs for dietary antioxidants.
4. Food and Nutrition Board, Institute of Medicine: *Dietary reference intakes for vitamin A, vitamin K, arsenic, boron chromium., copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc*. Washington, DC: National Academy Press, 2001.
   New nutrient recommendations recently have been set for vitamin A and vitamin K. The rationale used to set the RDA or Adequate Intake and Upper Level for these nutrients is discussed in detail.
5. Holick MF: Meeting vitamin D needs of the elderly. *Nutrition & the M.D.*, p. 1, May 2001.
   Older adults are likely to be deficient in vitamin D if they do not receive regular sun exposure or consume enough vitamin D-fortified foods, such as milk. Needs for vitamin D usually can be met by exposure to sunlight two to three times per week. Exposure time should be about 25% of that required to cause a sunburn. This may not provide vitamin D for older people, however, as aging decreases the ability of the skin to produce vitamin D. This, a yearly determination of vitamin-D status should be a part of the health evaluation by a physician for all older adults, and low status corrected with vitamin-D supplements.
6. Holt PR: Dairy foods and prevention of colon cancer: Human studies. *Journal of the American College of Nutrition*, 18:379S, 1999.
   Combined data from several studies suggest that daily consumption of 850 milligrams of calcium per day is accompanied by a reduced incidence of colon tumors. Low-fat dairy foods or supplemental calcium may reduce colon cancer incidence.
7. Mason JB: Folate in the prevention of cancer. *Nutrition & the M.D.*, p. 1, August 2001.
   Most experts in nutrition and the cancer prevention field feel that increasing folate intake to achieve a cancer-preventive effect is best accomplished by increasing consumption of foods that contain the vitamin, because these are likely to contain other cancer-preventive factors. However, as long as total intake does not exceed approximately 1000 micrograms per day, there is little risk associated with folic acid supplementation.
8. Russell R: Vitamins and minerals: How much is too much? *Nutrition Action Healthletter*, p.8, June 2001.
   People older than age 50 need at least 2.4 micrograms of vitamin B-12 from a supplement or fortified food like a ready-to-eat breakfast cereal. This should suffice to meet vitamin B-12 needs, even if the person has reduced stomach absorption of vitamin B-12. Most older people do not drink enough milk to meet the current RDA for vitamin D. For people over

70 years, vitamin D as part of supplement use is typically necessary, especially for older people living in northern climates. The article goes on to list the Upper Levels for vitamins and minerals, comparing these amounts to the RDAs or Adequate Intakes, as well as the Daily Values set by the FDA.

9. Should you take a vitamin E supplement? *Harvard Health Letter,* 26(11):1, September 2001.
   Meeting the RDA for vitamin E is an important goal for maintaining health. Whether consuming more vitamin E than the RDA provides further health benefits is under debate. Currently, experts suggest that it is safe to consume 200-400 IU of vitamin E each day in the form of a supplement, but solid evidence for the effectiveness of this practice in regard to health is lacking.
10. Willett WC: Diet, nutrition, and the prevention of cancer. In Shils ME and others (eds.): *Modern nutrition in health and disease*. 9th ed. Baltimore, MD: Williams & Wilkins, 1999.
    Excessive energy intake increases risk of cancer. The author recommends consuming more fruits and vegetables, avoiding excess intake of red meat and animal fat, and limiting alcohol intake.

CHAPTER 8
WATER AND MINERALS

OVERVIEW

This chapter discusses water, major minerals, and trace minerals. The nature and general chemical properties of water, specific nutrient-related functions, and thirst are addressed. Mineral bioavailability and nutrient interactions are explored. Major minerals such as sodium, potassium, chloride, calcium, phosphorus, magnesium, and sulfur are discussed in context of their functions, food sources, requirements or recommendations, and health implications (i.e., deficiency and toxicity). Calcium's relationship to bone health is highlighted. Trace minerals including iron, zinc, selenium, iodide, copper, fluoride, chromium, manganese, and molybdenum are covered. A variety of other vital trace minerals are examined. Specific functions, food sources, deficiency and toxicity symptoms, and requirements or recommendations for intake are given for each of the eight trace minerals. Iron is highlighted.

The Nutrition Insight examines minerals and their relationship to hypertension. Topics that are discussed include blood pressure control, causes of hypertension, salt and blood pressure, other minerals and blood pressure, prevention of hypertension, and medications to treat hypertension. The Nutrition Issue presented is osteoporosis.

CHAPTER OBJECTIVES

Upon completion of the chapter, the student will be able to:

1. classify the minerals as major or trace minerals.
2. list conditions of the body, dietary factors, and other pertinent relationships that influence the absorption, retention, and availability of specific minerals.
3. list and briefly explain the functions of water in the body.
4. list key functions of the major and trace minerals.
5. identify possible deficiency and toxicity symptoms associated with the major and trace minerals.
6. list at least two food sources for each of the major and trace minerals.
7. describe the processes involving minerals that aid in maintaining bone health as well as those that aid in control of blood pressure.

KEY TERMS

Aldosterone
Amniotic fluid
Antidiuretic hormone (ADH)
Bioavailability
Bisphosphonates
Bone mass
Bone mineral density
Cryptosporidiosis
DEXA bone scan
Diuretic
Goiter
Hematocrit
Heme iron
Hemochromatosis
Hemoglobin
Myoglobin
Nonheme iron
Tetany

REAL LIFE SCENARIO

Jana, a sophomore in high school, recently became a vegan. Her mother is concerned about her diet, because she is not a vegan herself, and worries about Jana's health. One of her primary concerns is osteoporosis, particularly because she knows that 95% of bone growth occurs by ages 16-17. Jana needs an adequate source of calcium in her diet to aid with her rapid bone development. Jana also recently started smoking, and her only physical activity is choir practice.

Jana's diet on a recent day consisted of the following items. For breakfast, she had oatmeal made with water, a banana, and a cup of fruit juice. At midmorning, she bought a snack cake from the vending machine. At lunch, she had vegetable pasta, bread with olive oil, a side salad, 1 ounce of mixed nuts, and a soft drink. For dinner, she had a soy burger along with mixed vegetables and rice. As an evening snack, she had some cookies and another soft drink.

What factors place Jana at risk for osteoporosis in the future? Suggest any necessary changes to her current diet.

LECTURE OUTLINE

I. Water
- A. Introduction
  1. 50% to 70% of the body's weight
  2. Lean tissue: 73% water
  3. Fat tissue: 20% water
  4. Can survive only a few days without water
     a. Can not store or conserve water as well as other dietary components
- B. Water in the body – intracellular and extracellular fluid
  1. Intracellular versus extracellular fluid
     a. Intracellular: fluid within cells
     b. Extracellular: fluid outside cells
     c. Water shifts freely in and out of cells; attracted to ions
- C. Water contributes to temperature regulation
  1. Water changes temperature slowly because it has a great ability to hold heat
  2. Perspiration
     a. Evaporation cools the skin
     b. Doesn't work as well in humid climates
- D. Water helps remove waste products
  1. Major route of elimination: urine
  2. Major body waste product: urea
     a. Result of protein metabolism
  3. Amount of urine produced dictated by extra protein and sodium consumed
  4. Healthy urine output: 1 to 2 liters (1 to 2 quarts) per day
     a. Less than 600 milliliters (2 1/2 cups) not good; kidneys must excessively concentrate the urine
        1) Promotes kidney stones
- E. Other functions of water
  1. Helps form lubicants found in knees and other body joints
  2. Basis for saliva, bile, and amniotic fluid
- F. How much water do we need?
  1. Intake versus losses

a. 1 milliliter per kcalorie expended
b. Water intake; must balance losses
    1) Drinks: 1 liter (1 quart) per day
    2) Foods: 1 liter (1 quart) per day
    3) Metabolic water: 350 milliliters (1 ½ cup)
    4) Total: 2.4 liters (10 cups)
c. Water losses
    1) Urine production: 1.4 liters
    2) Lungs: 400 milliliters
    3) Colon: 150 milliliters
    4) Skin: 500 milliliters
    5) Total: 2.4 liters
d. Kidneys conserve water by reabsorbing 97% of water carrying waste products

G. Thirst
1. Thirst mechanism is not always reliable
2. Athletes
    a. Weigh before and after training sessions to determine their rate of water loss and thus water needs
    b. Drink 3 cups of water per pound lost
3. Others who have greater water needs
    a. Ailing children
    b. Older persons
    c. Infants
4. What if the thirst mechanism is ignored?
    a. Body conserves water
    b. Antidiuretic hormone released
        1) Reduces urine output
    c. Insensible loss continues
5. Thirsty when body water falls by 1% to 2%
6. 4% loss of body weight as water; muscular strength and endurance compromised
    a. 10% to 12% reduction of body weight: decreased heat tolerance and weakness
    b. 20% reduction: coma and death

H. Water safety: How safe is the water we consume?
1. Bottled vs. tap water
    a. 90% of public water is in compliance with current regulations
    b. 10 million people in the U.S. are at risk for consuming non-approved water
    c. Microbial contamination as a threat to water safety
    d. Minimal charge to have water tested by the municipal water department

II. Minerals
A. General functions
B. Mineral bioavailability
1. Our bodies vary in their capabilities to absorb and use available minerals; minerals are not bioavailable unless we can absorb them
2. Ability to absorb depends on many factors
    a. Spinach and calcium as an example
3. Minerals from animal products absorbed better than from plants

a. Less binders and dietary fibers to hinder absorption
4. Effect of refining
a. The more refined, the lower its mineral content
b. Enrichment process adds back some lost minerals
C. Fiber-mineral interactions
1. Phytic and oxalic acid
2. High-fiber diets can decrease the absorption of iron, zinc, magnesium, and probably other minerals
D. Mineral-mineral interactions
1. Minerals with similar size and charge compete with one another for absorption
2. Example, high doses of calcium supplements can interfere with iron absorption
E. Vitamin-mineral interactions
F. Mineral toxicities
1. Excess mineral intake can lead to toxic results
2. Trace minerals; iron and copper
3. Mineral supplements exceeding 100% of nutrient recommendations should be taken only under a physician's supervision

III. Major minerals
A. Sodium (Na)
1. Functions
a. Fluid balance
b. Nerve impulse conduction
c. Aid absorption of some nutrients (e.g., glucose)
2. Sodium in foods and needs
a. Salt in cooking and at the table
b. Processing
1) Canned products
2) White bread and rolls
3) Cheese
4) Luncheon meats and hot dogs
5) Salted snack foods
6) Potato chips and french fries
7) Sauces and gravies
c. Minimum requirement: 500 milligrams per day
d. 4000 to 7000 milligrams per day typically eaten by adults
e. Body adapts to sodium intake with excess output in urine
f. 10% to 15% of adults are sodium-sensitive
1) Sodium and hypertension
g. Adapting to a lower sodium intake
B. Potassium (K)
1. Functions
a. Fluid balance
b. Nerve impulse conduction
c. Absorption rate: 90%
2. Deficiency
a. Life-threatening
1) Loss of appetite
2) Muscle cramps
3) Confusion

4) Constipation
5) Cardiac arrhythmias

3. Potassium in foods and needs
    a. Fruits and vegetables
    b. Milk, whole grains, dried beans, and meats
4. Minimum requirement: 2,000 milligrams per day
5. People at risk of deficiency
    a. Alcoholics
    b. Taking diuretics
    c. Vomiting – anorexics and bulimics
    d. People on very-low-calorie diets
    e. Athletes who exercise excessively
6. Toxic effects of high amounts if kidneys don't function normally

C. Chloride (Cl)
1. Functions
    a. Extracellular fluid
    b. Component of stomach hydrochloric acid (HCl)
    c. Nerve function
2. Deficiency unlikely
3. Chloride in foods and needs
    a. Fruits and some vegetables
    b. Chlorinated water
    c. Salt (i.e., sodium chloride)
        1) 60% chloride
4. Minimum requirement: 700 milligrams per day

D. Calcium (Ca)
1. Absorption
    a. Depends on acidic environment in GI tract and vitamin D
    b. Absorbed in upper small intestine
    c. 25% absorbed; as high as 60% during infancy and pregnancy
    d. Factors that enhance absorption
        1) Infancy and pregnancy
        2) Acidic environment
        3) Presence of vitamin D
        4) Parathyroid hormone
        5) Dietary glucose
        6) Lactose
    e. Factors that inhibit absorption
        1) Phytic acid
        2) Phosphorus excess
        3) Tannins in tea
        4) Vitamin D deficiency
        5) Menopause
        6) Diarrhea
        7) Old age
2. Functions
    a. Forming and maintaining bones and teeth
    b. Blood clotting
    c. Muscle contraction
        1) Low calcium; muscles cannot relax
    d. Normal nerve transmission

e. Regulates cellular metabolism
f. Other health benefits of calcium
1) Decrease risk of colon cancer
2) Decrease risk of kidney stones
3) May reduce blood pressure
4) May reduce LDL levels

3. Calcium in foods and needs
a. Food sources
1) Dairy products; except cottage cheese
2) Fortified foods
3) Leafy greens, broccoli, sardines, and canned salmon
b. Adequate Intake: 1,000 to 1,200 milligrams per day
1) Current intakes
A) Adult women 600 to 800 milligrams per day
B) Men 800 to 1,000 milligrams per day

4. Calcium supplements
a. For people who can't get enough from their diet
b. Good choices
1) Calcium carbonate
2) Calcium citrate

5. Toxicity
a. lead toxicity possible
b. Above 2,000 milligrams per day
c. Upper Level: 2,500 milligrams per day
d. Kidney stones
e. Constipation, intestinal gas
f. Decreased absorption of other minerals

E. Phosphorus (P)
1. Functions
a. Component of enzymes, DNA, all cell membranes, and bone
1) 85% in bone
2) 15% circulates freely in bloodstream and in cells

2. Phosphorus in foods and needs
a. Food sources
1) Milk, cheese, bread, meat
2) Breakfast cereals, bran, eggs, nuts, and fish
3) 20% to 30% from food additives
A) Baked goods, cheeses, processed meats, and soft drinks
b. RDA: Adults older than 18 - 700 milligrams per day
1) Upper Level: 3 to 4 grams per day

3. High risk groups for deficiency
a. Premature infants
b. Vegans
c. Alcoholics
d. Elderly
e. Diarrhea

4. Doesn't appear to be toxic

F. Magnesium (Mg)
1. Functions
a. Nerve and heart functions
b. Maintenance of bone; 60% of body's magnesium

c. Cofactor for over 200 enzymes
d. Absorb 40% to 60%

2. Deficiency symptoms
   a. Irregular heartbeat
   b. Weakness
   c. Muscle pain
   d. Disorientation
   e. Seizures
3. Benefits
   a. Decreases blood pressure
   b. Prevents heart rhythm abnormalities
   c. Inhibits blood clotting
4. Magnesium in foods and needs
   a. Food sources
      1) Whole grains, broccoli, squash, beans, nuts, and seeds
      2) Milk and meats
   b. RDA
      1) Males: 420 milligrams per day
      2) Females: 320 milligrams per day
      3) Current intake
         A) Males: 325 milligrams per day
         B) Females: 225 milligrams per day
      4) UL is 350 milligrams per day
5. Those at high risk of deficiency
   a. Diuretic users
   b. Heavy perspirers (i.e., for weeks)
   c. Diarrhea and vomiting victims
   d. Alcoholics
6. Not toxic for most people

G. Sulfur (S)
1. Functions
   a. Structure of some amino acids
   b. Acid-base balance
   c. Part of drug detoxifying pathways
   d. Food preservation
2. Food sources
   a. Foods containing protein

IV. Trace minerals
A. Iron (Fe)
1. Absorption and distribution
   a. Absorption varies
      1) 15% in healthy people
      2) Up to 20% in iron-deficient people
   b. Form influences how much is absorbed
      1) Heme iron; absorbed more than twice as efficiently as nonheme iron
         A) Animal flesh
         B) Best source of iron
      2) Nonheme iron; elemental iron
         A) Animal flesh, eggs, milk, vegetables, grains, and other plant foods

c. Factors that increase and decrease absorption
    1) Increase
        A) Protein factor
        B) Consuming heme and nonheme sources together
        C) Vitamin C increases absorption of nonheme iron
        D) Presence of copper
        E) Deficiency
    2) Decrease
        A) Phytic and oxalic acid
        B) Tannins in tea
        C) Zinc
        D) High doses of calcium
d. Greatest influence on absorption; need for it
e. Mucosal block against iron absorption
f. Most of the iron present in hemoglobin molecules of the red blood cells

2. Functions of iron
    a. Component of hemoglobin and myoglobin
    b. Oxygen transport
    c. Component of enzymes and some proteins
    d. Immune function
    e. Drug detoxification
3. Iron-deficiency anemia
    a. Decreased oxygen-carrying capacity
    b. High risk categories
        1) Infants
        2) Preschoolers
        3) Puberty, both men and women
        4) Childbearing years
        5) Pregnancy
        6) Blood loss from ulcers, colon cancer, or hemorrhoids
    c. Clinical symptoms
        1) Pale skin
        2) Fatigue
        3) Poor temperature regulation
        4) Loss of appetite
        5) Apathy
4. Iron in foods and needs
    a. Food sources
        1) Animal products; best sources
        2) Iron supplements
        3) Grain products
        4) Iron-fortified formulas and cereals for children
        5) Milk as a poor source
    b. RDA
        1) Males and females over 50 years old: 8 milligrams per day
        2) Females 19 to 50 years old: 18 milligrams per day
        3) Content of the American diet
            A) Males: 17 milligrams per day
            B) Females: 12 milligrams per day
5. Toxicity of iron
    a. Upper Level: 45 milligrams per day

b. Those susceptible
1) Infants
2) Genetic disease; hereditary hemochromatosis

B. Zinc (Zn)
1. History
2. Deficiency symptoms
a. Acne like rash
b. Diarrhea
c. Lack of appetite
d. Reduced sense of taste and smell
e. Hair loss
f. Growth, sexual development, and learning ability may also be hampered
3. 40% absorbed
4. Functions
a. Cofactor for over 100 enzymes
b. DNA and protein metabolism
c. Immune function
d. Proper bone and sexual organ development
e. Storage and release of insulin
f. Cell membrane structure and function
g. Aids in the prevention of oxidative cell damage
5. Zinc in foods and needs
a. Food sources
1) Protein-rich foods
A) Beef, fortified breakfast cereals, milk, poultry, and bread
2) Plant sources – secondary source
A) Whole grains, peanuts, beans
b. RDA
1) Males: 11 milligrams per day
2) Females: 8 milligrams per day
6. Toxicity; greater than 3 to 4 times the RDA
a. Upper Level: 40 milligrams per day
b. Inhibits copper absorption
c. Reduces HDL-cholesterol by 15%
d. Diarrhea, cramps
e. Nausea, vomiting
f. Depressed immune system function

C. Selenium (Se)
1. Function
a. Antioxidant
b. Contributes to thyroid hormone metabolism
2. Deficiency
a. Muscle pain and wasting
b. Form of heart disease
3. Selenium in foods and needs
a. Food sources
1) Fish, meats, eggs, organ meats, shellfish
2) Grain products
3) Soil levels affect amounts in plants
b. RDA: 55 micrograms per day

4. Toxicity
    a. Upper Level 400 micrograms per day
    b. Hair loss

D. Iodine (I)
1. Introduction
2. Function
    a. Synthesis of thyroid hormones
        1) Regulate metabolic rate
        2) Promote growth and development
3. Deficiency
    a. Goiter
        1) Thyroid gland enlarges as it attempts to take up more iodide from the blood stream
        2) Once formed, it doesn't shrink
    b. Cretinism
4. Food sources of Iodide and needs
    a. Food sources
        1) Iodized salt
        2) Saltwater fish, seafood, dairy, and grain products
    b. RDA: 150 micrograms per day
5. Upper Level: 1.1 milligrams per day

E. Copper (Cu)
1. Functions
    a. Metabolizes iron
    b. Cross-connections in connective tissue proteins
    c. Cofactor for antioxidant enzymes
    d. Immune system functions
    e. Blood clotting
    f. Blood lipoprotein metabolism
2. Symptoms of deficiency
    a. Anemia
    b. Low white blood cell count
    c. Bone loss
    d. Poor growth
    e. Some forms of cardiovascular disease
3. Copper in foods and needs
    a. Food sources
        1) Liver, seafood, cocoa, legumes, nuts, dried fruits, whole grains
    b. RDA: 900 micrograms per day
4. Groups at risk of deficiency
    a. Premature infants
    b. Infants recovering from semistarvation
    c. People recovering from intestinal surgery
    d. Those who consume too much zinc
5. Toxicity
    a. Upper Limit: 10 milligrams per day
    b. Vomiting
    c. Wilson's disease; mental degeneration

F. Fluoride (F)
1. Introduction

2. Functions
    a. Strengthens the structure of bones and teeth
        1) Decreases the rate of dental caries
    b. Possible treatment for severe osteoporosis
3. Fluoride in foods and needs
    a. Sources
        1) Tea, seaweed, seafood
        2) Water-fortification
        3) Toothpaste, fluoride treatments by dentists
    b. Adequate Intake: 3.1 to 3.8 milligrams per day
4. Toxicity
    a. > 6 milligrams: mottling of the teeth in children (not adults)
    b. > 20 milligrams:
        1) Stomach upset
        2) Bone pain

G. Chromium (Cr)
1. Functions
    a. Glucose entry into cells
    b. Deficiency leads to high serum cholesterol and triglyceride levels, as well as poor glucose tolerance
2. Food sources of Chromium and needs
    a. Food sources
        1) Egg yolks, whole grains, meats, mushrooms, nuts, and beer
    b. Adequate Intake: 25 to 35 micrograms
        1) Higher end intake may improve blood glucose regulation in Type 2 diabetes
        2) Higher end intake may raise HDL
3. Toxicity
    a. > 100 micrograms per day: should be supervised by a physician
    b. Liver damage
    c. Lung cancer

H. Manganese (Mn)
1. Functions
    a. Cofactor of enzymes used in carbohydrate metabolism
    b. Bone formation
2. No known deficiency
3. Food sources
    a. Nuts, rice, oats, whole grains, beans, leafy vegetables
4. Adequate Intake: 1.8 to 2.3 milligrams
5. Upper Level: 11 milligrams per day
    a. Neurotoxic symptoms

I. Molybdenum (Mo)
1. Functions
    a. Interacts with iron and copper
    b. Cofactor of enzymes
2. No noted deficiencies
3. Food sources
    a. Milk products, beans, whole grains, nuts
4. RDA: 45 micrograms per day
5. Toxicity
    a. Upper Level: 2 milligrams per day

b. Weight loss
c. Decreased growth

V. Other trace minerals
A. Importance of other trace minerals unknown
B. Watch for risk of toxicity with high doses
C. Examples: boron, nickel, vanadium, arsenic, and silicon

NUTRITION ISSUE: Osteoporosis

I. Introduction to osteoporosis
II. Bone structure and strength
A. Bone structural types
1. Cortical bone
2. Trabecular bone
B. Bone mass
C. Bone mineral density
III. Bone mass is related to age and gender
A. Peak bone mass by age 20
B. Bone mass varies among adults
IV. Osteoporosis
A. Decreased bone density
B. Type I; postmenopausal
C. Type II; senile
V. Preventing osteoporosis
A. Meet calcium, vitamin D, and other nutrient needs
B. Regular menstruation
C. Weight-bearing and resistance activities
D. Avoid smoking and excess alcohol
E. Estrogen replacement for menopausal women
F. Increased calcium intake

ACTIVITIES

1. Assign students the **Rate Your Plate** activity, "How Does Your Mineral Intake Measure Up?". Have them use the nutrition analysis they prepared for Chapter 2. They should retrieve their intake values for the appropriate minerals, RDA, and percentage of RDA. For sodium and potassium, students must use standards given in the table provided for the **Rate Your Plate** activity to determine percentages of those standards consumed. Have students complete the table and analysis section of the activity.
2. Have students visit a local pharmacy to investigate the mineral content of supplements. The following could be assigned:
A. Select 10 multiple vitamin/mineral supplements. Be sure to include at least two generic brands. List the brand name, contents, measure, and percentage of USRDA. For example, *One A Day*: Vitamin C, 60 mg, 100% of USRDA. Have students compile the information and make into a handout for the class. Discuss which brands would be wise choices if one were looking for a vitamin/mineral supplement. Are any products available in which all minerals provide less than 150% of the USRDA?
B. Compare available calcium supplements for source of calcium, absorbability, and cost. Include various antacids in the comparison. Once again, the information

could be complied and offered as a handout. Rank the calcium supplements from best choice to worst choice. Do these products contain any other nutrients?

3. Sodium is a mineral that can be highly variable in dietary intakes. It is important to help students identify high sodium food sources. This can be done several ways:
   A. Form small teams and have each investigate the sodium content of a specific group of food products. Have each team report to the class average sodium content and range of sodium contained in the group.
   B. Visit a local supermarket and identify the availability of products labeled as "low sodium," "reduced sodium," and "no added salt." How much difference is there between sodium content and cost of these products compared to the "regular" product?
   C. To help students understand the effect of food processing on sodium content, have them use their food composition table in the text to compare sodium content of yogurt: plain, whole milk, no solids; yogurt: plain, lowfat, milk solids added; yogurt: plain, nonfat, milk solids added. Discuss why sodium content rises as fat decreases. A similar exercise can be done comparing sodium content of raw peaches, canned peaches in heavy syrup, and peach pie.
4. Bring a variety of calcium supplements to class, including antacids. Or, have students bring to class calcium supplements they consume. Test their digestibility/ absorbability by dropping each supplement in 6 ounces of cider vinegar. Explain that vinegar has approximately the same pH as the stomach. Stir every 5 minutes and observe which ones dissolve in 30 minutes...in 60 minutes. Use this as a springboard for discussing calcium supplements.
5. Have students visit a local pharmacy and select 10 products sold as iron supplements: five for use with infants or children, four for adults, and one prenatal vitamin. The pharmacist will have to assist the student with prenatal vitamin information. Determine the source and amount of iron in these products, as well as cost per daily dosage.
6. Have students visit a supermarket to look at the breakfast cereals to find the one highest in iron and fiber and lowest in sugar. Compare their findings. Rank cereals from most nutrient dense to least. Use this as a springboard to discuss iron sources.
7. Have students write the name of each mineral on an index card. On the back, they will list one to three key functions of that mineral; food sources; deficiency name, if appropriate; deficiency symptoms; and toxicity symptoms. Have students study these index cards in pairs until they can recall the information about each mineral.
8. Before class, write the name of each mineral on a piece of paper, index card, or "post-it." If you use paper or an index card, remember to take stick pins or tape to class to fasten the card/paper on students' backs. Secure one card/paper/post-it on the back of each student. Have students circulate throughout the room asking other students questions about the mineral posted on their back. Only yes and no questions are permitted, for example, "Am I involved in red blood cell formation?" and, "Are spinach, oysters, and liver good sources of me?". Only two questions can be asked of any person. After asking two questions of a person, students must move to someone else. Continue the game until everyone correctly identifies the mineral they are.

READINGS

1. Altkom D, Vokes T: Treatment of postmenopausal osteoporosis. *Journal of the American Medical Association*, 285:1415, 2001.
   Disphosphonates are currently the best choice for preventing bone loss with regard to medical therapy. People on such therapy should also consume 1200 to 1500 milligrams

of calcium, as well as 400 to 800 IU of vitamin D daily if sun exposure is limited.

2. Anderson JJB: The important role of physical activity in skeletal development: How exercise may counter low calcium intake. *American Journal of Clinical Nutrition*, 71:1384, 2000.
A greater bone mass gained early in life is now considered a critical factor in protecting against osteoporotic fractures later in life. The critical years for skeletal growth and accumulation of bone mass are in the prepubertal and pubertal decades. These years are a particularly good time for regular physical activity, as it, along with adequate diet, increases bone mass.

3. Andrews NC: Disorders of iron metabolism. *The New England Journal of Medicine*, 341:1986, 1999.
Iron is able to accept and donate electrons, so it is capable of binding oxygen and participating in many enzyme systems. However, iron can damage tissues by causing the conversion of hydrogen peroxide to free radicals. Iron can't be readily excreted from the body; the cells that line the gastrointestinal tract act as a barrier to overabsorption.

4. Food and Nutrition Board, Institute of Medicine: *Dietary Reference Intakes for calcium, phosphorus, magnesium, vitamin D, and fluoride*. Washington, DC: Standing committee on the Scientific Evaluation of Dietary Reference Intakes National Academy Press, 1997.
Dietary standards recently have been set for many major minerals. The rationale used to set RDA or Adequate Intakes and Upper Levels for these nutrients is discussed in detail.

5. Food and Nutrition Board, Institute of Medicine: *Dietary Reference Intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc*. Washington, DC: Standing Committee on the Scientific Evaluation of Dietary Reference Intakes National Academy Press, 2001.
Dietary standards have recently been set for many trace minerals. The rationale used to set RDA or Adequate Intakes and Upper Levels for these nutrients is discussed in detail.

6. Jackson JL and others: Zinc and the common cold: A meta-analysis revisited. *Journal of Nutrition*, 130:1512S, 2000.
An analysis of current studies using zinc supplements to treat the common cold failed to find evidence of a significant reduction in cold duration. Studies reporting a benefit from zinc therapy have been criticized for poor blinding of the study subjects.

7. Kleiner SM: Water: An essential but overlooked nutrient. *Journal of the American Dietetic Association*, 99:200, 1999.
Dehydration of as little as a 2% loss of body weight results in decreased physiological responses. New research indicates that fluid consumption in general and water consumption in particular can reduce the risk of kidney stones, certain cancers, obesity, and mitral valve prolapse. Adequate fluid intake is especially important for the overall health of older adults.

8. Liebman B: High blood pressure: The end of an epidemic? *Nutrition Action Health Letter*, p. 1, December 2000.
The DASH-Sodium trial included intakes of 3300 milligrams per day, 2400 milligrams per day, or 1500 milligrams per day of sodium in addition to the standard DASH diet plan. Each reduction in sodium intake resulted in a further fall in both systolic and diastolic blood pressure. Thus, people with hypertension should consider following the basic DASH diet and lowering sodium intake as much as possible.

9. NIH Consensus Development Panel on Osteoporosis Prevention, Diagnosis, and Treatment; Osteoporosis prevention, diagnosis, and treatment. *Journal of the American Medical Association*, 285:785, 2001.
Osteoporosis is a major health threat. In the United States alone, 10 million persons already have osteoporosis, and 18 million more have low bone mass, placing them at

increased risk for this disorder. Assessment of bone mass, identification of fracture risk, and determination of who should be treated are optimal goals when evaluating patients for osteoporosis.

10. Schardt D: Water, water, everywhere. *Nutrition Action Health Letter*, 41, June 2000.
On the whole, people in the United States can feel confident about the quality of their drinking water. Almost 90% of public water systems in the United States report no violations of EPA limits for drinking water contaminants. The main individuals at risk from contaminated drinking water are those with compromised immune systems and possibly people in rural communities. The former persons should take the extra precaution to boil tap water for at least 1 minute, whereas the latter may consider having their tap water tested to see if it meets current EPA standards.

CHAPTER 9
ENERGY BALANCE AND WEIGHT CONTROL

OVERVIEW

This chapter first addresses energy balance including energy intake and expenditure. Factors that contribute to energy expenditure and ways to determine it are described. Energy imbalances are discussed with considerable time devoted to diagnosing obesity. An emphasis is placed on the fact that obesity is multicausal, with both heredity and environment playing roles. The discussion of obesity treatment emphasizes controlling energy intake, increasing energy expenditure, and modifying behavior. Principles for a sound weight-loss plan are discussed. Suggestions for obtaining professional help and managing morbid obesity are provided. Lastly, treating underweight is discussed.

Nutrition Insights focus on the set point theory of weight maintenance and medications to aid weight loss. "Fad diets" is the Nutrition Issue topic.

CHAPTER OBJECTIVES

Upon completion of this chapter, the student will be able to:

1. describe the uses of energy by the body and what constitutes energy balance.
2. describe various ways to diagnose overweight and obesity.
3. outline the risks to health posed by overweight and obesity.
4. list and discuss factors affecting energy balance in overweight and obesity with respect to nature and nurture, and describe the concept of set point with regard to body weight.
5. describe why and how reduced energy intake, behavior modification, and increased physical activity fit into a weight-loss plan.
6. outline the benefits and hazards of various weight-loss methods for severe obesity.
7. describe possible reasons and treatments for underweight status.
8. evaluate fad weight-reduction diets and determine which are unsafe, doomed to fail, or both.

KEY TERMS

Amphetamine
Basal metabolism
Bioelectrical impedance
Body mass index (BMI)
Chain-breaking
Cognitive restructuring
Contingency management
Direct calorimetry
Energy balance
Fraternal twins
Gastroplasty
Identical twins
Indirect calorimetry
Lean body mass
Lower body obesity
Negative energy balance
Nonexercise activity thermogenesis (NEAT)
Positive energy balance
Relapse prevention
Self-monitoring
Stimulus control
Thermic effect of food
Thrifty metabolism
Underwater weighing
Underweight
Upper body obesity
Very-low-calorie diet (VLCD)

REAL LIFE SCENARIO

Crystal has a hectic schedule. She works during the day for a "temp" agency, primarily performing secretarial duties. Three times a week she attends night classes at the local community college in pursuit of computer certification. She has little time to think about what she eats – convenience rules. Unfortunately, over the past few years Crystal's weight has been climbing. Watching television a few nights ago, she saw an infomercial for a product that promises she can eat large portions of tasty foods but not gain weight. Famous celebrities support the claim that this product allows one to eat at will and not gain weight. She doesn't have a lot of spare money, but the claim that by taking this product you can eat whatever you want and never gain weight is tempting. What do you think she should do?

LECTURE OUTLINE

I. Energy balance
  A. Introduction
    1. kcalorie intake versus kcalorie output
      a. Positive energy balance
      b. Negative energy balance
  B. Energy intake
    1. Determining the energy content of foods
      a. Bomb calorimeter
      b. Bomb calorimeter values tell only part of the story
  C. Energy output
    1. Basal metabolism: minimum energy expended in a fasting state
      a. 60% to 70% of total kcalorie expenditure
      b. Factors that influence basal metabolism
        1) Lean body mass
        2) Amount of body surface
        3) Gender
        4) Body temperature
        5) Thyroid hormone
        6) Nervous system activity
        7) Age
        8) Nutritional state
        9) Pregnancy
        10) Caffeine and tobacco use
      c. Basal metabolism lowered 10% to 20% during low-kcalorie intake (150 to 300 kcals per day)
      d. Basal metabolic rate declines about 2% each decade past age 30
    2. Energy for physical activity
      a. 25% to 40% of total energy output
      b. Emphases on increasing general activity
      c. Obesity linked to inactivity
    3. Thermic effect of food
      a. 5% to 10% of total kcalories eaten
    4. Nonexercise activity thermogenesis (NEAT)
      a. Increase in nonvoluntary physical activity triggered by overeating

D. Determination of energy use by the body
    1. Direct and indirect calorimetry
    2. Estimates of energy needs
E. Estimation of a healthy weight
    1. Introduction
        a. Weight-for-height standards
        b. Family history should be considered
            1) Hypertension
            2) Elevated LDL-cholesterol
            3) Family history of obesity, cardiovascular disease, or cancer
            4) Pattern of fat distribution in the body
            5) Elevated blood glucose
        c. Other factors
            1) Lowest weight held for one year
            2) Desirable clothing size
            3) Weight maintained during previous diets
        d. Overall advice for establishing a healthy weight
            1) Do this under a physician's care
            2) Base on weight history
            3) Consider fat distribution pattern
            4) Consider family history of obesity-related disease
            5) Consider current health status
    2. Using body mass index (BMI) to set healthy weight
        a. Weight (in kg) divided by Height^2 (in meters)
        b. BMI > 25: Health risks begin
        c. BMI of 18.5 to 24.9 is healthy
    3. Putting healthy weight into perspective
        a. Consider weight in terms of health, not simply fashion
F. Energy Imbalance
    1. Estimating body fat content and diagnosing obesity
        a. Desirable amount of body fat
            1) Women: 21% to 35%
            2) Men: 8% to 24%
        b. Body fat estimation methods
            1) Underwater weighing
            2) Skinfold thickness
            3) Bioelectrical impedance
            4) Infrared light
            5) X-ray photon absorptiometry
        c. Using BMI to establish obesity
            1) BMI = 18.5: underweight; at nutritional risk
            2) BMI 18.5-24.9: healthy; acceptable range
            3) BMI 25 to 29.9: overweight; obesity-related health risks
            4) BMI 30 to 39.9: obese; increases health risk
            5) BMI > 40: severely obese; major health risk
    2. Using body fat distribution to establish obesity
        a. Upper body (android) obesity
            1) Related to heart disease, high blood pressure, and type 2 diabetes
            2) Encouraged by alcohol intake and testosterone

3) Apple shape
b. Lower body (gynoid) obesity
1) Fat resists being shed
2) Encouraged by estrogen and progesterone
3) Pear shape
3. Using age of onset as an obesity measure
a. Juvenile versus adult onset
4. Putting obesity in perspective
a. Measured in numerous ways
b. Treatment needs to be individualized
c. About a 10% weight loss is needed for people to experience improvement in health and self esteem

G. Why some people are obese – nature versus nurture
1. How does nature contribute to obesity
a. Genetic background accounts for 40% to 70% of weight differences between people
b. Endomorphs, mesomorphs, and ectomorphs
c. Metabolism's role
2. Does nurture have a role
a. Environmental factors can impact weight
1) High-fat diets and inactivity promote weight gain
2) Poverty can contribute to obesity
3) Stress, boredom, and large pregnancy weight gain are associated with obesity
3. Nurture and nature together

II. Treatment of obesity: Basic premises
A. Some basic premises
1. Much of the current mania surrounding dieting is misdirected
2. The body defends itself against weight change
3. Weight cycling is a common phenomenon
4. Weight gain in adulthood is all too common
5. Changes in body composition deserve a primary focus in weight loss
6. Weight loss in perspective
B. Quick weight loss can't be mostly fat
C. What to look for in a sound weight-loss diet
1. Control of energy intake
2. Increased physical activity
3. Life long change in habits
D. Controlling energy intake – the first key to weight loss
1. kcalorie control
a. 1200 kcals per day for women
b. 1500 kcals per day for men
2. Lower fat intake
3. What should be eaten
E. Regular physical activity
1. Duration and regular performance are the keys to success
F. Behavior modification
1. Strategies
a. Chain-breaking

b. Stimulus control
c. Cognitive restructuring
d. Contingency management
e. Self-monitoring

2. Relapse prevention is important
3. Social support aids behavior change
4. A recap
    a. Success versus failure

G. Professional help for weight loss
1. Professional triad
    a. Physician
    b. Registered dietitian
    c. Exercise physiologist
2. Weight loss organizations
    a. TOPS
    b. Weight Watchers
3. Medications for weight loss
    a. People who are candidates
    b. Medications alone have not been found to be successful
    c. Medications
        1) Phenteramine (Fastin or Ionanmin)
        2) Sibutramine (Meridia)
        3) Orlistat (Xenical)
4. Treatment of severe obesity
    a. Very-low-calorie diets
    b. Gastroplasty

III. Treatment of underweight
A. Potential causes
1. Anorexia nervosa
2. Cancer
3. Infectious disease
4. Digestive tract disorders
5. Excessive physical activity
6. Smoking
7. Genetics

B. Risks associated with being underweight
1. Loss of menstrual cycle
2. Complications with pregnancy and surgery
3. Slow recovery after illness

C. Rule out medical conditions
D. Increase consumption of energy-dense foods
E. Encourage a regular meal and snack schedule
F. Reduce physical activity
G. Resistance training (weightlifting) program

NUTRITION ISSUE: Fad diets: why all the commotion?

I. Introduction
A. FDA concerns itself only when products are suspected of doing serious harm

- B. Let the buyer beware

II. How to recognize a fad diet
- A. Characteristics of a fad diet
  1. Promote quick weight loss
  2. Limit food selections, prescribe rituals
  3. Use testimonials
  4. Cure-alls
  5. Recommend expensive supplements
  6. No permanent change in eating habits
  7. Criticize the scientific community

III. Types of fad diets
- A. Low- or restricted-carbohydrate approaches
  1. Protein tissue loss
  2. Urinary loss of essential ions
  3. Water loss when protein is metabolized
  4. Examples
     a. Dr. Atkins' Diet Revolution
     b. Dr. Stillmen's Calories Don't Count diet
     c. The Scarsdale diet
     d. Four Day Wonder diet
     e. Zone diet
     f. Sugar Busters diet
- B. Low-fat approaches
  1. 5% to 10% of energy intake as fat
  2. Eat grains, fruits, and vegetables
  3. Boring diet
  4. Examples
     a. Pritikin diet
     b. Dr. Dean Ornish diet
- C. Novelty diets
  1. Emphasize one food or food group
     a. Rice diet
     b. Egg diet
     c. Beverly Hills diet
     d. Food gets stuck in your body
        1) Fit for Life
        2) Beverly Hills diet
        3) Eat Great
        4) Lose Weight
     e. Commercial schemes
        1) Sun Sign Diet
        2) Champagne Diet
        3) Cabbage Soup Diet
        4) Body Type Diet
        5) Lifetime Nutrition Diet

IV. Quackery is characteristic of fad diets
- A. People taking advantage of others
- B. Current examples
  1. Herbal laxative teas

2. Chromium picolinate

ACTIVITIES

1. Assign students the **Rate Your Plate** activity, "A Close Look at Your Weight Status". They should complete the calculations and the interpretation and application sections. They should turn this assignment in to be graded.
2. Have students read a popular diet book or current magazine article describing a weight-loss plan. They can use Table 10-8 as a guide for making their choice. Have them read the book and do the following:
   A. Write a report evaluating the book/article, using the principles of a sound weight-loss program and characteristics of fad diets listed in the chapter as guides. Have them address weaknesses and strengths of the diet approach, faddist tendencies, and violations of sound weight-loss principles.
   B. Evaluate the diet described by the book, using the Daily Food Guide for comparison.
   C. These reports could be used as a basis for making oral reports on various diets.
3. Have students revise their own dietary record that they kept to do their nutritional assessment for Chapter 2 to make it nutritionally adequate and to provide 1,200 kilocalories. Some will need to add and others eliminate or decrease foods to reach 1,200 kilocalories. Have them use the Daily Food Guide to determine nutritional adequacy of the diet they have created.
4. Have students select three food products for which claims are made like "low calories," "light," "reduced calories," or "dietetic," and compare that product to a similar one for which no claim is made for energy and nutrient content. For example, comparing reduced calorie mayonnaise to regular.
5. Have students bring an advertisement for a weight-reduction aid to class. Select from these and have the class evaluate, in writing or as a class discussion, the rationale, effectiveness, cost, and potential hazards.
6. Have students get menus from area restaurants and fast-food establishments. Put these menus on an overhead transparency. Use the overheads for class discussion. Ask students to choose foods and meals from these menus that would be appropriate for weight control.
7. Use a class period to allow students to go to a campus facility to have their body fat assessed using skinfold thicknesses. If there are no campus resources, ask someone from a local fitness center to do it, or do it yourself with the help of another faculty member of the opposite gender (so the female and male could assess same-gender students). Most exercise physiology books have formulas and instructions for doing skinfold measurements.
8. Ask a resource from the community to lecture in your class about various weight control issues:
   A. Ask a physician to discuss treatment for morbid obesity.
   B. Ask leaders from TOPS or Weight Watchers to discuss their approaches and programs.
9. Divide students into groups. Have each group compile three lists. The first list should contain healthful eating tips, for example, trim fat from meat before cooking. The second list should contain helpful dieting tips, for example, cut vegetables, dried fruit, and pretzels are good snack choices when traveling in a car. The third list should contain dieting traps and ways to prevent being "trapped." An example would be the restaurant ordering trap. The prevention tip would be to think of what would be healthful food choices before

entering the restaurant. And, once in the restaurant, be the first to order if you are with others so their choices will not influence yours. Use the lists as a springboard for discussing behavior modification. Collect the lists, consolidate information, have someone type resulting lists, and either photocopy for students or make a copy available for interested students to photocopy.

READINGS

1. Allara L: The return of the high-protein, low-carbohydrate diet: Weighing the risks. *Nutrition in Clinical Practice*, 15:26, 2000.
   The weight problem in this country is not seen as being due to one particular nutrient ingested – for example, too much carbohydrate or too little protein – but, instead, to an increase in total calorie intake without some compensation, such as increased physical activity.
2. Atkinson RL: A 33-year-old woman with morbid obesity. *Journal of the American Medical Association*, 283:3236, 2000.
   The history of an African-American woman who has struggled with weight control since her teenage years is presented. Dr. Atkinson reviews much of what is known about obesity treatment as he presents the options suggested to the patient, such as the use of diet control, exercise, behavior modification, pharmacotherapy, and possible gastric bypass surgery.
3. Dickerson LM, Carek PH: Drug therapy for obesity. *American Family Physician*, 61:2131, 2000.
   If drug therapy is recommended in the management of obesity, it should be used in combination with a structured diet and exercise program to achieve the greatest and longest-lasting results. The use of phenteramine (Ionamin), sibutramine (Meridia), and orlistat (Xenical) is reviewed.
4. Expert panel on the identification, evaluation, and treatment of overweight in adults: Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: Executive summary. *American Journal of Clinical Nutrition*, 68:899, 1998.
   Step-by-step plans are provided for the evaluation and treatment of weight and obesity. After successful weight loss, the likelihood of weight-loss maintenance is enhanced by a program consisting of dietary therapy, physical activity, and behavior therapy – this should be continued indefinitely.
5. Kennedy ET and others: Popular diets: correlation of health, nutrition, and obesity. *Journal of the American Dietetic Association*, 101:411, 2001.
   For the most part, individuals successful at weight loss and later weight control restrict intake of certain types or classes of foods, eat all types of foods but in limited quantity, count calories, limit percentage of daily energy intake from fat, and participate in regular physical activity.
6. Lyznicki JM and others: Obesity: Assessment and management in primary care. *American Family Physician*, 63:2185, 2001.
   Basic treatment of overweight and obese patients requires a comprehensive approach involving diet and nutrition, regular physical activity, and behavioral change, with an emphasis on long-term weight management rather than short-term extreme weight reduction. The article discusses these interventions in detail.
7. Kushner R: Medical management of the bariatric surgery patient. *Nutrition and the M.D.*, p.1, July 2001.
   Gastric surgery now is considered a well-established treatment for patients with severe

obesity. Patients can expect to lose approximately one-third of their initial body weight with resolution of existing medical conditions and improvement in quality of life. Ongoing nutritional and medical management is required to prevent nutritional deficiencies and optimize post-operative care.

8. Marcus J: Dietitians come in all sizes. *Today's Dietitian*, p. 26, October 1999.
People who weigh more than current healthy BMI standards undergo unfair social hardship that erodes self-esteem. Some health professionals are calling for size acceptance – less emphasis on body size and more emphasis on healthy eating and personal fitness.

9. Mokdad AH and others: The continuing epidemics of obesity and diabetes in the United States. *Journal of the American Medical Association*, 286:1195, 2001.
The percentage of the U.S. population that has obesity and/or type 2 diabetes has increased in recent years. This is likely to be even a bigger problem in the future if more attention to preventive measures, such as healthy eating and regular physical activity, are not implemented on a widespread basis. Restoring physical activity to daily routines is especially important.

10. Peter JC and others: Control of energy balance in Stipanuk MH, *Physiological Aspects of Human Nutrition*, Philadelphia, PA: W.B. Saunders, 2000.
Set point with respect to body weight is more effective in preventing weight loss than weight gain. Throughout adult life a person may settle at a variety of "set-point" weights, rather a single weight. For a person who is sedentary and consumes a large amount of dietary fat, it is thought that any increase in body weight actually represents an adaptation to this high-fat diet. This is because it is thought that only by reaching a certain point of body fatness will this sedentary person be able to balance the amount of fat consumed with that burned by the body.