Dietary Reference Intakes (DRI)

The Dietary Reference Intakes (DRI) include two sets of values that serve as goals for nutrient intake—Recommended Dietary Allowances (RDA) and Adequate Intakes (AI). The RDA reflect the average daily amount of a nutrient considered adequate to meet the needs of most healthy people. If there is insufficient evidence to determine an RDA, an AI is set. AI are more tentative than RDA, but both may be used as goals for nutrient intakes. (Chapter 1 provides more details.)

In addition to the values that serve as goals for nutrient intakes (presented in the tables on these two pages), the DRI include a set of values called Tolerable Upper Intake Levels (UL). The UL represent the maximum amount of a nutrient that appears safe for most healthy people to consume on a regular basis. Turn the page for a listing of the UL for selected vitamins and minerals.

Estimated Energy Requirements (EER), Recommended Dietary Allowances (RDA), and Adequate Intakes (AI) for Water, Energy, and the Energy Nutrients

Age(yr)	Reference BMI (kg/m^2)	Reference height, cm (in)	Reference weight, kg (lb)	Water[a] AI (L/day)	Energy EER[b] (kcal/day)	Carbohydrate RDA (g/day)	Total fiber AI (g/day)	Total fat AI (g/day)	Linoleic acid AI (g/day)	Linolenic acid[c] AI (g/day)	Protein RDA (g/day)[d]	Protein RDA (g/kg/day)
Males												
0–0.5	—	62 (24)	6 (13)	0.7[e]	570	60	—	31	4.4	0.5	9.1	1.52
0.5–1	—	71 (28)	9 (20)	0.8[f]	743	95	—	30	4.6	0.5	11	1.2
1–3[g]	—	86 (34)	12 (27)	1.3	1046	130	19	—	7	0.7	13	1.05
4–8[g]	15.3	115 (45)	20 (44)	1.7	1742	130	25	—	10	0.9	19	0.95
9–13	17.2	144 (57)	36 (79)	2.4	2279	130	31	—	12	1.2	34	0.95
14–18	20.5	174 (68)	61 (134)	3.3	3152[h]	130	38	—	16	1.6	52	0.85
19–30	22.5	177 (70)	70 (154)	3.7	3067[h]	130	38	—	17	1.6	56	0.8
31–50				3.7	3067[h]	130	38	—	17	1.6	56	0.8
>50				3.7	3067[h]	130	30	—	14	1.6	56	0.8
Females												
0–0.5	—	62 (24)	6 (13)	0.7[e]	520	60	—	31	4.4	0.5	9.1	1.52
0.5–1	—	71 (28)	9 (20)	0.8[f]	676	95	—	30	4.6	0.5	11	1.2
1–3[g]	—	86 (34)	12 (27)	1.3	992	130	19	—	7	0.7	13	1.05
4–8[g]	15.3	115 (45)	20 (44)	1.7	1642	130	25	—	10	0.9	19	0.95
9–13	17.4	144 (57)	37 (81)	2.1	2071	130	26	—	10	1.0	34	0.95
14–18	20.4	163 (64)	54 (119)	2.3	2368	130	26	—	11	1.1	46	0.85
19–30	21.5	163 (64)	57 (126)	2.7	2403[i]	130	25	—	12	1.1	46	0.8
31–50				2.7	2403[i]	130	25	—	12	1.1	46	0.8
>50				2.7	2403[i]	130	21	—	11	1.1	46	0.8
Pregnancy												
1st trimester				3.0	+0	175	28	—	13	1.4	+25	1.1
2nd trimester				3.0	+340	175	28	—	13	1.4	+25	1.1
3rd trimester				3.0	+452	175	28	—	13	1.4	+25	1.1
Lactation												
1st 6 months				3.8	+330	210	29	—	13	1.3	+25	1.3
2nd 6 months				3.8	+400	210	29	—	13	1.3	+25	1.3

NOTE: For all nutrients, values for infants are AI. Dashes indicate that values have not been determined.

[a]The water AI includes drinking water, water in beverages, and water in foods; in general, drinking water and other beverages contribute about 70 to 80 percent, and foods, the remainder. Conversion factors: 1 L = 33.8 fluid oz; 1 L = 1.06 qt; 1 cup = 8 fluid oz.

[b]The Estimated Energy Requirement (EER) represents the average dietary energy intake that will maintain energy balance in a healthy person of a given gender, age, weight, height, and physical activity level. The values listed are based on an "active" person at the reference height and weight and at the midpoint ages for each group until age 19. Chapter 8 and Appendix F provide equations and tables to determine estimated energy requirements.

[c]The linolenic acid referred to in this table and text is the omega-3 fatty acid known as alpha-linolenic acid.

[d]The values listed are based on reference body weights.

[e]Assumed to be from human milk.

[f]Assumed to be from human milk and complementary foods and beverages. This includes approximately 0.6 L (~3 cups) as total fluid including formula, juices, and drinking water.

[g]For energy, the age groups for young children are 1–2 years and 3–8 years.

[h]For males, subtract 10 kcalories per day for each year of age above 19.

[i]For females, subtract 7 kcalories per day for each year of age above 19.

SOURCE: Adapted from the *Dietary Reference Intakes* series, National Academies Press. Copyright 1997, 1998, 2000, 2001, 2002, 2004, 2005 by the National Academies of Sciences.

Recommended Dietary Allowances (RDA) and Adequate Intakes (AI) for Vitamins

Age (yr)	Thiamin RDA (mg/day)	Riboflavin RDA (mg/day)	Niacin RDA (mg/day)[a]	Biotin AI (µg/day)	Pantothenic acid AI (mg/day)	Vitamin B_6 RDA (mg/day)	Folate RDA (µg/day)[b]	Vitamin B_{12} RDA (µg/day)	Choline AI (mg/day)	Vitamin C RDA (mg/day)	Vitamin A RDA (µg/day)[c]	Vitamin D AI (µg/day)[d]	Vitamin E RDA (mg/day)[e]	Vitamin K AI (µg/day)
Infants														
0–0.5	0.2	0.3	2	5	1.7	0.1	65	0.4	125	40	400	5	4	2.0
0.5–1	0.3	0.4	4	6	1.8	0.3	80	0.5	150	50	500	5	5	2.5
Children														
1–3	0.5	0.5	6	8	2	0.5	150	0.9	200	15	300	5	6	30
4–8	0.6	0.6	8	12	3	0.6	200	1.2	250	25	400	5	7	55
Males														
9–13	0.9	0.9	12	20	4	1.0	300	1.8	375	45	600	5	11	60
14–18	1.2	1.3	16	25	5	1.3	400	2.4	550	75	900	5	15	75
19–30	1.2	1.3	16	30	5	1.3	400	2.4	550	90	900	5	15	120
31–50	1.2	1.3	16	30	5	1.3	400	2.4	550	90	900	5	15	120
51–70	1.2	1.3	16	30	5	1.7	400	2.4	550	90	900	10	15	120
>70	1.2	1.3	16	30	5	1.7	400	2.4	550	90	900	15	15	120
Females														
9–13	0.9	0.9	12	20	4	1.0	300	1.8	375	45	600	5	11	60
14–18	1.0	1.0	14	25	5	1.2	400	2.4	400	65	700	5	15	75
19–30	1.1	1.1	14	30	5	1.3	400	2.4	425	75	700	5	15	90
31–50	1.1	1.1	14	30	5	1.3	400	2.4	425	75	700	5	15	90
51–70	1.1	1.1	14	30	5	1.5	400	2.4	425	75	700	10	15	90
>70	1.1	1.1	14	30	5	1.5	400	2.4	425	75	700	15	15	90
Pregnancy														
≤18	1.4	1.4	18	30	6	1.9	600	2.6	450	80	750	5	15	75
19–30	1.4	1.4	18	30	6	1.9	600	2.6	450	85	770	5	15	90
31–50	1.4	1.4	18	30	6	1.9	600	2.6	450	85	770	5	15	90
Lactation														
≤18	1.4	1.6	17	35	7	2.0	500	2.8	550	115	1200	5	19	75
19–30	1.4	1.6	17	35	7	2.0	500	2.8	550	120	1300	5	19	90
31–50	1.4	1.6	17	35	7	2.0	500	2.8	550	120	1300	5	19	90

NOTE: For all nutrients, values for infants are AI. The glossary on the inside back cover defines units of nutrient measure.

[a]Niacin recommendations are expressed as niacin equivalents (NE), except for recommendations for infants younger than 6 months, which are expressed as preformed niacin.

[b]Folate recommendations are expressed as dietary folate equivalents (DFE).

[c]Vitamin A recommendations are expressed as retinol activity equivalents (RAE).

[d]Vitamin D recommendations are expressed as cholecalciferol and assume an absence of adequate exposure to sunlight.

[e]Vitamin E recommendations are expressed as α-tocopherol.

Recommended Dietary Allowances (RDA) and Adequate Intakes (AI) for Minerals

Age (yr)	Sodium AI (mg/day)	Chloride AI (mg/day)	Potassium AI (mg/day)	Calcium AI (mg/day)	Phosphorus RDA (mg/day)	Magnesium RDA (mg/day)	Iron RDA (mg/day)	Zinc RDA (mg/day)	Iodine RDA (µg/day)	Selenium RDA (µg/day)	Copper RDA (µg/day)	Manganese AI (mg/day)	Fluoride AI (mg/day)	Chromium AI (µg/day)	Molybdenum RDA (µg/day)
Infants															
0–0.5	120	180	400	210	100	30	0.27	2	110	15	200	0.003	0.01	0.2	2
0.5–1	370	570	700	270	275	75	11	3	130	20	220	0.6	0.5	5.5	3
Children															
1–3	1000	1500	3000	500	460	80	7	3	90	20	340	1.2	0.7	11	17
4–8	1200	1900	3800	800	500	130	10	5	90	30	440	1.5	1.0	15	22
Males															
9–13	1500	2300	4500	1300	1250	240	8	8	120	40	700	1.9	2	25	34
14–18	1500	2300	4700	1300	1250	410	11	11	150	55	890	2.2	3	35	43
19–30	1500	2300	4700	1000	700	400	8	11	150	55	900	2.3	4	35	45
31–50	1500	2300	4700	1000	700	420	8	11	150	55	900	2.3	4	35	45
51–70	1300	2000	4700	1200	700	420	8	11	150	55	900	2.3	4	30	45
>70	1200	1800	4700	1200	700	420	8	11	150	55	900	2.3	4	30	45
Females															
9–13	1500	2300	4500	1300	1250	240	8	8	120	40	700	1.6	2	21	34
14–18	1500	2300	4700	1300	1250	360	15	9	150	55	890	1.6	3	24	43
19–30	1500	2300	4700	1000	700	310	18	8	150	55	900	1.8	3	25	45
31–50	1500	2300	4700	1000	700	320	18	8	150	55	900	1.8	3	25	45
51–70	1300	2000	4700	1200	700	320	8	8	150	55	900	1.8	3	20	45
>70	1200	1800	4700	1200	700	320	8	8	150	55	900	1.8	3	20	45
Pregnancy															
≤18	1500	2300	4700	1300	1250	400	27	12	220	60	1000	2.0	3	29	50
19–30	1500	2300	4700	1000	700	350	27	11	220	60	1000	2.0	3	30	50
31–50	1500	2300	4700	1000	700	360	27	11	220	60	1000	2.0	3	30	50
Lactation															
≤18	1500	2300	5100	1300	1250	360	10	13	290	70	1300	2.6	3	44	50
19–30	1500	2300	5100	1000	700	310	9	12	290	70	1300	2.6	3	45	50
31–50	1500	2300	5100	1000	700	320	9	12	290	70	1300	2.6	3	45	50

Tolerable Upper Intake Levels (UL) for Vitamins

Age (yr)	Niacin (mg/day)[a]	Vitamin B_6 (mg/day)	Folate (μg/day)[a]	Choline (mg/day)	Vitamin C (mg/day)	Vitamin A (μg/day)[b]	Vitamin D (μg/day)	Vitamin E (mg/day)[c]
Infants								
0–0.5	—	—	—	—	—	600	25	—
0.5–1	—	—	—	—	—	600	25	—
Children								
1–3	10	30	300	1000	400	600	50	200
4–8	15	40	400	1000	650	900	50	300
9–13	20	60	600	2000	1200	1700	50	600
Adolescents								
14–18	30	80	800	3000	1800	2800	50	800
Adults								
19–70	35	100	1000	3500	2000	3000	50	1000
>70	35	100	1000	3500	2000	3000	50	1000
Pregnancy								
≤18	30	80	800	3000	1800	2800	50	800
19–50	35	100	1000	3500	2000	3000	50	1000
Lactation								
≤18	30	80	800	3000	1800	2800	50	800
19–50	35	100	1000	3500	2000	3000	50	1000

[a]The UL for niacin and folate apply to synthetic forms obtained from supplements, fortified foods, or a combination of the two.

[b]The UL for vitamin A applies to the preformed vitamin only.

[c]The UL for vitamin E applies to any form of supplemental α-tocopherol, fortified foods, or a combination of the two.

Tolerable Upper Intake Levels (UL) for Minerals

Age (yr)	Sodium (mg/day)	Chloride (mg/day)	Calcium (mg/day)	Phosphorus (mg/day)	Magnesium (mg/day)[d]	Iron (mg/day)	Zinc (mg/day)	Iodine (μg/day)	Selenium (μg/day)	Copper (μg/day)	Manganese (mg/day)	Fluoride (mg/day)	Molybdenum (μg/day)	Boron (mg/day)	Nickel (mg/day)	Vanadium (mg/day)
Infants																
0–0.5	—[e]	—[e]	—	—	—	40	4	—	45	—	—	0.7	—	—	—	—
0.5–1	—[e]	—[e]	—	—	—	40	5	—	60	—	—	0.9	—	—	—	—
Children																
1–3	1500	2300	2500	3000	65	40	7	200	90	1000	2	1.3	300	3	0.2	—
4–8	1900	2900	2500	3000	110	40	12	300	150	3000	3	2.2	600	6	0.3	—
9–13	2200	3400	2500	4000	350	40	23	600	280	5000	6	10	1100	11	0.6	—
Adolescents																
14–18	2300	3600	2500	4000	350	45	34	900	400	8000	9	10	1700	17	1.0	—
Adults																
19–70	2300	3600	2500	4000	350	45	40	1100	400	10,000	11	10	2000	20	1.0	1.8
>70	2300	3600	2500	3000	350	45	40	1100	400	10,000	11	10	2000	20	1.0	1.8
Pregnancy																
≤18	2300	3600	2500	3500	350	45	34	900	400	8000	9	10	1700	17	1.0	—
19–50	2300	3600	2500	3500	350	45	40	1100	400	10,000	11	10	2000	20	1.0	—
Lactation																
≤18	2300	3600	2500	4000	350	45	34	900	400	8000	9	10	1700	17	1.0	—
19–50	2300	3600	2500	4000	350	45	40	1100	400	10,000	11	10	2000	20	1.0	—

[d]The UL for magnesium applies to synthetic forms obtained from supplements or drugs only.

[e]Source of intake should be from human milk (or formula) and food only.

NOTE: An Upper Limit was not established for vitamins and minerals not listed and for those age groups listed with a dash (—) because of a lack of data, not because these nutrients are safe to consume at any level of intake. All nutrients can have adverse effects when intakes are excessive.

UNDERSTANDING NORMAL AND CLINICAL

Nutrition

Eighth Edition

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CHAPTER 1

An Overview of Nutrition

CHAPTER OUTLINE

Welcome to the world of **nutrition.** Although you may not always have been aware of it, nutrition has played a significant role in your life. And it will continue to affect you in major ways, depending on the **foods** you select.

Every day, several times a day, you make food choices that influence your body's health for better or worse. Each day's choices may benefit or harm your health only a little, but when these choices are repeated over years and decades, the rewards or consequences become major. That being the case, paying close attention to good eating habits now can bring you health benefits later. Conversely, carelessness about food choices can contribute to many chronic diseases ◆ prevalent in later life, including heart disease and cancer. Of course, some people will become ill or die young no matter what choices they make, and others will live long lives despite making poor choices. For the majority of us, however, the food choices we make each and every day will benefit or impair our health in proportion to the wisdom of those choices.

Although most people realize that their food habits affect their health, they often choose foods for other reasons. After all, foods bring to the table a variety of pleasures, traditions, and associations as well as nourishment. The challenge, then, is to combine favorite foods and fun times with a nutritionally balanced **diet.**

◆ In general, a **chronic** disease progresses slowly or with little change and lasts a long time. By comparison, an **acute** disease develops quickly, produces sharp symptoms, and runs a short course.
- **chronos** = time
- **acute** = sharp

nutrition: the science of foods and the nutrients and other substances they contain, and of their actions within the body (including ingestion, digestion, absorption, transport, metabolism, and excretion). A broader definition includes the social, economic, cultural, and psychological implications of food and eating.

foods: products derived from plants or animals that can be taken into the body to yield energy and nutrients for the maintenance of life and the growth and repair of tissues.

diet: the foods and beverages a person eats and drinks.

Food Choices

People decide what to eat, when to eat, and even whether to eat in highly personal ways, often based on behavioral or social motives rather than on an awareness of nutrition's importance to health. Many different food choices can support good health, and an understanding of nutrition helps you make sensible selections more often.

Personal Preference As you might expect, the number one reason people choose foods is taste—they like certain flavors. Two widely shared preferences are for the sweetness of sugar and the savoriness of salt. Liking high-fat foods also appears to be a universally common preference. Other preferences might be for the hot peppers

An enjoyable way to learn about other cultures is to taste their ethnic foods.

common in Mexican cooking or the curry spices of Indian cuisine. Some research suggests that genetics may influence people's food preferences.[1]

Habit People sometimes select foods out of habit. They eat cereal every morning, for example, simply because they have always eaten cereal for breakfast. Eating a familiar food and not having to make any decisions can be comforting.

Ethnic Heritage or Tradition
Among the strongest influences on food choices are ethnic heritage and tradition. People eat the foods they grew up eating. Every country, and in fact every region of a country, has its own typical foods and ways of combining them into meals. The "American diet" includes many ethnic foods from various countries, all adding variety to the diet. This is most evident when eating out: 60 percent of U.S. restaurants (excluding fast-food places) have an ethnic emphasis, most commonly Chinese, Italian, or Mexican.

Social Interactions Most people enjoy companionship while eating. It's fun to go out with friends for pizza or ice cream. Meals are social events, and sharing food is part of hospitality. Social customs invite people to accept food or drink offered by a host or shared by a group.

Availability, Convenience, and Economy People eat foods that are accessible, quick and easy to prepare, and within their financial means. Today's consumers value convenience and are willing to spend more than half of their food budget on meals that require little, if any, further preparation.[2] They frequently eat out, bring home ready-to-eat meals, or have food delivered. Even when they venture into the kitchen, they want to prepare a meal in 15 to 20 minutes, using less than a half dozen ingredients—and those "ingredients" are often semiprepared foods, such as canned soups. This emphasis on convenience limits food choices to the selections offered on menus and products designed for quick preparation. Whether decisions based on convenience meet a person's nutrition needs depends on the choices made. Eating a banana or a candy bar may be equally convenient, but the fruit offers more vitamins and minerals and less sugar and fat.

Positive and Negative Associations People tend to like particular foods associated with happy occasions—such as hot dogs at ball games or cake and ice cream at birthday parties. By the same token, people can develop aversions and dislike foods that they ate when they felt sick or that were forced on them.[3] By using foods as rewards or punishments, parents may inadvertently teach their children to like and dislike certain foods.

Emotional Comfort Some people cannot eat when they are emotionally upset. Others may eat in response to a variety of emotional stimuli—for example, to relieve boredom or depression or to calm anxiety.[4] A depressed person may choose to eat rather than to call a friend. A person who has returned home from an exciting evening out may unwind with a late-night snack. These people may find emotional comfort, in part, because foods can influence the brain's chemistry and the mind's response. Carbohydrates and alcohol, for example, tend to calm, whereas proteins and caffeine are more likely to activate. Eating in response to emotions can easily lead to overeating and obesity, but it may be appropriate at times. For example, sharing food at times of bereavement serves both the giver's need to provide comfort and the receiver's need to be cared for and to interact with others, as well as to take nourishment.

Values Food choices may reflect people's religious beliefs, political views, or environmental concerns. For example, many Christians forgo meat during Lent (the period prior to Easter), Jewish law includes an extensive set of dietary rules that govern the use of foods derived from animals, and Muslims fast between sunrise and sunset during Ramadan (the ninth month of the Islamic calendar). A con-

cerned consumer may boycott fruit picked by migrant workers who have been exploited. People may buy vegetables from local farmers to save the fuel and environmental costs of foods shipped in from far away. They may also select foods packaged in containers that can be reused or recycled. Some consumers accept or reject foods that have been irradiated or genetically modified, depending on their approval of these processes.

Body Weight and Image Sometimes people select certain foods and supplements that they believe will improve their physical appearance and avoid those they believe might be detrimental. Such decisions can be beneficial when based on sound nutrition and fitness knowledge, but decisions based on fads or carried to extremes undermine good health, as pointed out in later discussions of eating disorders (Highlight 8).

Nutrition and Health Benefits Finally, of course, many consumers make food choices that will benefit health. Food manufacturers and restaurant chefs have responded to scientific findings linking health with nutrition by offering an abundant selection of health-promoting foods and beverages. Foods that provide health benefits beyond their nutrient contributions are called **functional foods.**[5] Whole foods—as natural and familiar as oatmeal or tomatoes—are the simplest functional foods. In other cases, foods have been modified to provide health benefits, perhaps by lowering the fat contents. In still other cases, manufacturers have fortified foods by adding nutrients or **phytochemicals** that provide health benefits (see Highlight 13). ◆ Examples of these functional foods include orange juice fortified with calcium to help build strong bones and margarine made with a plant sterol that lowers blood cholesterol.

Consumers typically welcome new foods into their diets, provided that these foods are reasonably priced, clearly labeled, easy to find in the grocery store, and convenient to prepare. These foods must also taste good—as good as the traditional choices. Of course, a person need not eat any of these "special" foods to enjoy a healthy diet; many "regular" foods provide numerous health benefits as well. In fact, "regular" foods such as whole grains; vegetables and legumes; fruits; meats, fish, and poultry; and milk products are among the healthiest choices a person can make.

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To enhance your health, keep nutrition in mind when selecting foods.

◆ Functional foods may include whole foods, modified foods, or fortified foods.

IN SUMMARY

A person selects foods for a variety of reasons. Whatever those reasons may be, food choices influence health. Individual food selections neither make nor break a diet's healthfulness, but the balance of foods selected over time can make an important difference to health.[6] For this reason, people are wise to think "nutrition" when making their food choices.

The Nutrients

Biologically speaking, people eat to receive nourishment. Do you ever think of yourself as a biological being made of carefully arranged atoms, molecules, cells, tissues, and organs? Are you aware of the activity going on within your body even as you sit still? The atoms, molecules, and cells of your body continually move and change, even though the structures of your tissues and organs and your external appearance remain relatively constant. Your skin, which has covered you since your birth, is replaced entirely by new cells every seven years. The fat beneath your skin is not the

functional foods: foods that contain physiologically active compounds that provide health benefits beyond their nutrient contributions; sometimes called *designer foods* or *nutraceuticals*.

phytochemicals (FIE-toe-KEM-ih-cals): nonnutrient compounds found in plant-derived foods that have biological activity in the body.

• **phyto** = plant

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Foods bring pleasure—and nutrients.

same fat that was there a year ago. Your oldest red blood cell is only 120 days old, and the entire lining of your digestive tract is renewed every 3 to 5 days. To maintain your "self," you must continually replenish, from foods, the **energy** and the **nutrients** you deplete as your body maintains itself.

Nutrients in Foods and in the Body

Amazingly, our bodies can derive all the energy, structural materials, and regulating agents we need from the foods we eat. This section introduces the nutrients that foods deliver and shows how they participate in the dynamic processes that keep people alive and well.

Composition of Foods Chemical analysis of a food such as a tomato shows that it is composed primarily of water (95 percent). Most of the solid materials are carbohydrates, lipids, ◆ and proteins. If you could remove these materials, you would find a tiny residue of vitamins, minerals, and other compounds. Water, carbohydrates, lipids, proteins, vitamins, and some of the minerals found in foods are nutrients—substances the body uses for the growth, maintenance, and repair of its tissues.

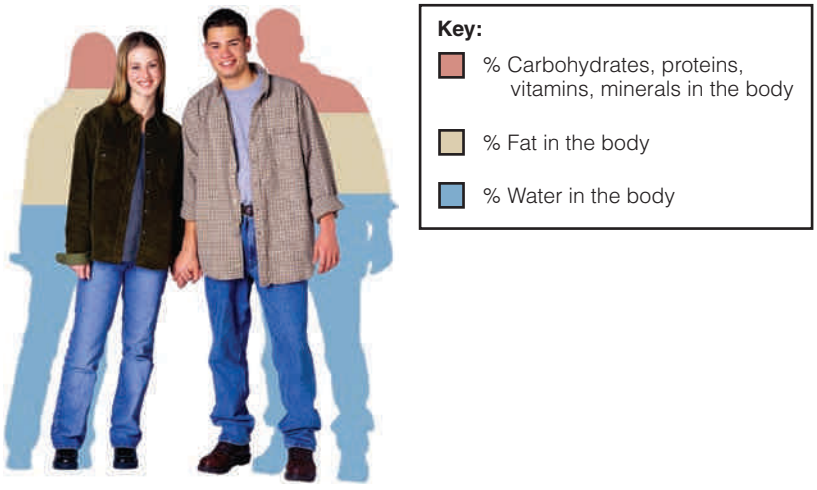
◆ As Chapter 5 explains, most lipids are fats.

This book focuses mostly on the nutrients, but foods contain other compounds as well—fibers, phytochemicals, pigments, additives, alcohols, and others. Some are beneficial, some are neutral, and a few are harmful. Later sections of the book touch on these compounds and their significance.

Composition of the Body A complete chemical analysis of your body would show that it is made of materials similar to those found in foods (see Figure 1-1). A healthy 150-pound body contains about 90 pounds of water and about 20 to 45 pounds of fat. The remaining pounds are mostly protein, carbohydrate, and the major minerals of the bones. Vitamins, other minerals, and incidental extras constitute a fraction of a pound.

FIGURE 1-1 Body Composition of Healthy-Weight Men and Women

The human body is made of compounds similar to those found in foods—mostly water (60 percent) and some fat (13 to 21 percent for young men, 23 to 31 percent for young women), with carbohydrate, protein, vitamins, minerals, and other minor constituents making up the remainder. (Chapter 8 describes the health hazards of too little or too much body fat.)



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energy: the capacity to do work. The energy in food is chemical energy. The body can convert this chemical energy to mechanical, electrical, or heat energy.

nutrients: chemical substances obtained from food and used in the body to provide energy, structural materials, and regulating agents to support growth, maintenance, and repair of the body's tissues. Nutrients may also reduce the risks of some diseases.

Chemical Composition of Nutrients The simplest of the nutrients are the minerals. Each mineral is a chemical element; its atoms are all alike. As a result, its identity never changes. For example, iron may have different electrical charges, but the individual iron atoms remain the same when they are in a food, when a person eats the food, when the iron becomes part of a red blood cell, when the cell is broken down, and when the iron is lost from the body by excretion. The next simplest nutrient is water, a compound made of two elements—hydrogen and oxygen. Minerals and water are **inorganic** nutrients—which means they do not contain carbon.

The other four classes of nutrients (carbohydrates, lipids, proteins, and vitamins) are more complex. In addition to hydrogen and oxygen, they all contain carbon, an element found in all living things. They are therefore called **organic** ◆ compounds (meaning, literally, "alive"). Protein and some vitamins also contain nitrogen and may contain other elements as well (see Table 1-1).

◆ In agriculture, *organic* farming refers to growing crops and raising livestock according to standards set by the U.S. Department of Agriculture (USDA).

Essential Nutrients The body can make some nutrients, but it cannot make all of them. Also, it makes some in insufficient quantities to meet its needs and, therefore, must obtain these nutrients from foods. The nutrients that foods must supply are **essential nutrients.** When used to refer to nutrients, the word *essential* means more than just "necessary"; it means "needed from outside the body"—normally, from foods.

◆ Carbohydrate, fat, and protein are sometimes called **macronutrients** because the body requires them in relatively large amounts (many grams daily). In contrast, vitamins and minerals are **micronutrients,** required only in small amounts (milligrams or micrograms daily).

The Energy-Yielding Nutrients: Carbohydrate, Fat, and Protein

In the body, three organic nutrients can be used to provide energy: carbohydrate, fat, and protein. ◆ In contrast to these **energy-yielding nutrients,** vitamins, minerals, and water do not yield energy in the human body.

◆ The international unit for measuring food energy is the **joule,** a measure of *work* energy. To convert kcalories to kilojoules, multiply by 4.2; to convert kilojoules to kcalories, multiply by 0.24.

Energy Measured in kCalories The energy released from carbohydrates, fats, and proteins can be measured in **calories**—tiny units of energy so small that a single apple provides tens of thousands of them. To ease calculations, energy is expressed in 1000-calorie metric units known as kilocalories (shortened to kcalories, but commonly called "calories"). When you read in popular books or magazines that an apple provides "100 calories," it actually means 100 kcalories. This book uses the term kcalorie and its abbreviation kcal throughout, as do other scientific books and journals. ◆ The "How to" on p. 8 provides a few tips on "thinking metric."

TABLE 1-1 Elements in the Six Classes of Nutrients

Notice that organic nutrients contain carbon.

	Carbon	Hydrogen	Oxygen	Nitrogen	Minerals
Inorganic nutrients					
Minerals					✓
Water		✓	✓		
Organic nutrients					
Carbohydrates	✓	✓	✓		
Lipids (fats)	✓	✓	✓		
Proteins[a]	✓	✓	✓	✓	
Vitamins[b]	✓	✓	✓		

[a]Some proteins also contain the mineral sulfur.
[b]Some vitamins contain nitrogen; some contain minerals.

inorganic: not containing carbon or pertaining to living things.
- **in** = not

organic: in chemistry, a substance or molecule containing carbon-carbon bonds or carbon-hydrogen bonds. This definition excludes coal, diamonds, and a few carbon-containing compounds that contain only a single carbon and no hydrogen, such as carbon dioxide (CO_2), calcium carbonate ($CaCO_3$), magnesium carbonate ($MgCO_3$), and sodium cyanide (NaCN).

essential nutrients: nutrients a person must obtain from food because the body cannot make them for itself in sufficient quantity to meet physiological needs; also called **indispensable nutrients.** About 40 nutrients are currently known to be essential for human beings.

energy-yielding nutrients: the nutrients that break down to yield energy the body can use:
- Carbohydrate
- Fat
- Protein

calories: units by which energy is measured. Food energy is measured in **kilocalories** (1000 calories equal 1 kilocalorie), abbreviated **kcalories** or **kcal.** One kcalorie is the amount of heat necessary to raise the temperature of 1 kilogram (kg) of water 1°C. The scientific use of the term *kcalorie* is the same as the popular use of the term *calorie.*

HOW TO Think Metric

Like other scientists, nutrition scientists use metric units of measure. They measure food energy in kilocalories, people's height in centimeters, people's weight in kilograms, and the weights of foods and nutrients in grams, milligrams, or micrograms. For ease in using these measures, it helps to remember that the prefixes on the grams imply 1000. For example, a *kilo*gram is 1000 grams, a *milli*gram is 1/1000 of a gram, and a *micro*gram is 1/1000 of a milligram.

Most food labels and many recipe books provide "dual measures," listing both household measures, such as cups, quarts, and teaspoons, and metric measures, such as milliliters, liters, and grams. This practice gives people an opportunity to gradually learn to "think metric."

A person might begin to "think metric" by simply observing the measure—by noticing the amount of soda in a 2-liter bottle, for example. Through such experiences, a person can become familiar with a measure without having to do any conversions.

To facilitate communication, many members of the international scientific community have adopted a common system of measurement—the International System of Units (SI). In addition to using metric measures, the SI establishes common units of measurement. For example, the SI unit for measuring food energy is the joule (not the kcalorie). A joule is the amount of energy expended when 1 kilogram is moved 1 meter by a force of 1 newton. The joule is thus a measure of *work* energy, whereas the kcalorie is a measure of *heat* energy. While many scientists and journals report their findings in kilojoules (kJ), many others, particularly those in the United States, use kcalories (kcal). To convert energy measures from kcalories to kilojoules, multiply by 4.2. For example, a 50-kcalorie cookie provides 210 kilojoules:

$$50 \text{ kcal} \times 4.2 = 210 \text{ kJ}$$

Exact conversion factors for these and other units of measure are in the Aids to Calculation section on the last two pages of the book.

Volume: Liters (L)

1 L = 1000 milliliters (mL)
0.95 L = 1 quart
1 mL = 0.03 fluid ounces
240 mL = 1 cup

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A liter of liquid is approximately one U.S. quart. (Four liters are only about 5 percent more than a gallon.)

© PhotoEdit/Felicia Martinez

One cup is about 240 milliliters; a half-cup of liquid is about 120 milliliters.

Weight: Grams (g)

1 g = 1000 milligrams (mg)
1 g = 0.04 ounce (oz)
1 oz = 28.35 g (or 30 g)
100 g = 3½ oz
1 kilogram (kg) = 1000 g
1 kg = 2.2 pounds (lb)
454 g = 1 lb

A kilogram is slightly more than 2 lb; conversely, a pound is about ½ kg.

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A half-cup of vegetables weighs about 100 grams; one pea weighs about ½ gram.

© Tony Freeman/Photo Edit

A 5-pound bag of potatoes weighs about 2 kilograms, and a 176-pound person weighs 80 kilograms.

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To practice thinking metrically, log on to **academic.cengage.com/login**, go to Chapter 1, then go to How To.

Energy from Foods The amount of energy a food provides depends on how much carbohydrate, fat, and protein it contains. When completely broken down in the body, a gram of carbohydrate yields about 4 kcalories of energy; a gram of protein also yields 4 kcalories; and a gram of fat yields 9 kcalories (see Table 1-2). Fat, therefore, has a greater **energy density** than either carbohydrate or protein. Figure 1-2 compares the energy density of two breakfast options, and later chapters describe how considering a food's energy density can help with weight management. ◆ The "How to" on p. 9 explains how to calculate the energy available from foods.

◆ Foods with a high energy density help with weight gain, whereas those with a low energy density help with weight loss.

energy density: a measure of the energy a food provides relative to the amount of food (kcalories per gram).

One other substance contributes energy—alcohol. Alcohol is not considered a nutrient because it interferes with the growth, maintenance, and repair of the body, but it does yield energy (7 kcalories per gram) when metabolized in the body. (Highlight 7 presents alcohol metabolism; Chapter 27 mentions the potential harmful role of alcohol in hypertension and the possible beneficial role in heart disease.)

FIGURE 1-2 Energy Density of Two Breakfast Options Compared

Gram for gram, ounce for ounce, and bite for bite, foods with a high energy density deliver more kcalories than foods with a low energy density. Both of these breakfast options provide 500 kcalories, but the cereal with milk, fruit salad, scrambled egg, turkey sausage, and toast with jam offers three times as much food as the doughnuts (based on weight); it has a lower energy density than the doughnuts. Selecting a variety of foods also helps to ensure nutrient adequacy.

LOWER ENERGY DENSITY

This 450-gram breakfast delivers 500 kcalories, for an energy density of 1.1 (500 kcal ÷ 450 g = 1.1 kcal/g).

HIGHER ENERGY DENSITY

This 144-gram breakfast delivers 500 kcalories, for an energy density of 3.5 (500 kcal ÷ 144 g = 3.5 kcal/g).

Most foods contain all three energy-yielding nutrients, as well as water, vitamins, minerals, and other substances. For example, meat contains water, fat, vitamins, and minerals as well as protein. Bread contains water, a trace of fat, a little protein, and some vitamins and minerals in addition to its carbohydrate. Only a few foods are exceptions to this rule, the common ones being sugar (pure carbohydrate) and oil (essentially pure fat).

Energy in the Body The body uses the energy-yielding nutrients to fuel all its activities. When the body uses carbohydrate, fat, or protein for energy, the bonds between

HOW TO Calculate the Energy Available from Foods

To calculate the energy available from a food, multiply the number of grams of carbohydrate, protein, and fat by 4, 4, and 9, respectively. Then add the results together. For example, 1 slice of bread with 1 tablespoon of peanut butter on it contains 16 grams carbohydrate, 7 grams protein, and 9 grams fat:

16 g carbohydrate × 4 kcal/g = 64 kcal
7 g protein × 4 kcal/g = 28 kcal
9 g fat × 9 kcal/g = 81 kcal
Total = 173 kcal

From this information, you can calculate the percentage of kcalories each of the energy nutrients contributes to the total. To determine the percentage of kcalories from fat, for example, divide the 81 fat kcalories by the total 173 kcalories:

81 fat kcal ÷ 173 total kcal = 0.468 (rounded to 0.47)

Then multiply by 100 to get the percentage:

0.47 × 100 = 47%

Dietary recommendations that urge people to limit fat intake to 20 to 35 percent of kcalories refer to the day's total energy intake, not to individual foods. Still, if the proportion of fat in each food choice throughout a day exceeds 35 percent of kcalories, then the day's total surely will, too. Knowing that this snack provides 47 percent of its kcalories from fat alerts a person to the need to make lower-fat selections at other times that day.

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To practice calculating the energy available from foods, log on to **academic.cengage.com/login**, go to Chapter 1, then go to How To.

TABLE 1-2 kCalorie Values of Energy Nutrients[a]

Nutrients	Energy (kcal/g)
Carbohydrate	4
Fat	9
Protein	4

NOTE: Alcohol contributes 7 kcalories per gram that can be used for energy, but it is not considered a nutrient because it interferes with the body's growth, maintenance, and repair.

[a]For those using kilojoules: 1 g carbohydrate = 17 kJ; 1 g protein = 17 kJ; 1 g fat = 37 kJ; and 1 g alcohol = 29 kJ.

◆ The processes by which nutrients are broken down to yield energy or used to make body structures are known as **metabolism** (defined and described further in Chapter 7).

the nutrient's atoms break. As the bonds break, they release energy. ◆ Some of this energy is released as heat, but some is used to send electrical impulses through the brain and nerves, to synthesize body compounds, and to move muscles. Thus the energy from food supports every activity from quiet thought to vigorous sports.

If the body does not use these nutrients to fuel its current activities, it rearranges them into storage compounds (such as body fat), to be used between meals and overnight when fresh energy supplies run low. If more energy is consumed than expended, the result is an increase in energy stores and weight gain. Similarly, if less energy is consumed than expended, the result is a decrease in energy stores and weight loss.

When consumed in excess of energy needs, alcohol, too, can be converted to body fat and stored. When alcohol contributes a substantial portion of the energy in a person's diet, the harm it does far exceeds the problems of excess body fat. (Highlight 7 describes the effects of alcohol on health and nutrition.)

Other Roles of Energy-Yielding Nutrients In addition to providing energy, carbohydrates, fats, and proteins provide the raw materials for building the body's tissues and regulating its many activities. In fact, protein's role as a fuel source is relatively minor compared with both the other two nutrients and its other roles. Proteins are found in structures such as the muscles and skin and help to regulate activities such as digestion and energy metabolism.

The Vitamins

The **vitamins** are also organic, but they do not provide energy. Instead, they facilitate the release of energy from carbohydrate, fat, and protein and participate in numerous other activities throughout the body.

Each of the 13 different vitamins has its own special roles to play.* One vitamin enables the eyes to see in dim light, another helps protect the lungs from air pollution, and still another helps make the sex hormones—among other things. When you cut yourself, one vitamin helps stop the bleeding and another helps repair the skin. Vitamins busily help replace old red blood cells and the lining of the digestive tract. Almost every action in the body requires the assistance of vitamins.

Vitamins can function only if they are intact, but because they are complex organic molecules, they are vulnerable to destruction by heat, light, and chemical agents. This is why the body handles them carefully, and why nutrition-wise cooks do, too. The strategies of cooking vegetables at moderate temperatures for short times and using small amounts of water help to preserve the vitamins.

The Minerals

In the body, some **minerals** are put together in orderly arrays in such structures as bones and teeth. Minerals are also found in the fluids of the body, which influences fluid properties. Whatever their roles, minerals do not yield energy.

Only 16 minerals are known to be essential in human nutrition.† Others are being studied to determine whether they play significant roles in the human body. Still other minerals are environmental contaminants that displace the nutrient minerals from their workplaces in the body, disrupting body functions. The problems caused by contaminant minerals are described in Chapter 13.

Because minerals are inorganic, they are indestructible and need not be handled with the special care that vitamins require. Minerals can, however, be bound by substances that interfere with the body's ability to absorb them. They can also be lost during food-refining processes or during cooking when they leach into water that is discarded.

vitamins: organic, essential nutrients required in small amounts by the body for health.

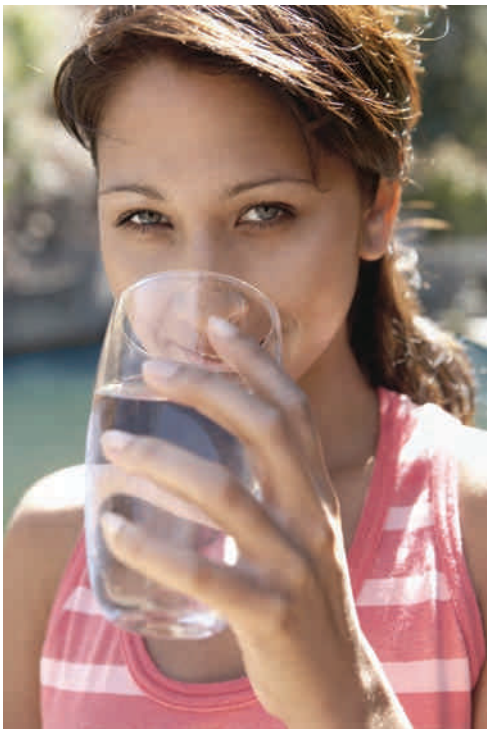
minerals: inorganic elements. Some minerals are essential nutrients required in small amounts by the body for health.

* The water-soluble vitamins are vitamin C and the eight B vitamins: thiamin, riboflavin, niacin, vitamins B_6 and B_{12}, folate, biotin, and pantothenic acid. The fat-soluble vitamins are vitamins A, D, E, and K. The water-soluble vitamins are the subject of Chapter 10 and the fat-soluble vitamins, of Chapter 11.

† The major minerals are calcium, phosphorus, potassium, sodium, chloride, magnesium, and sulfate. The trace minerals are iron, iodine, zinc, chromium, selenium, fluoride, molybdenum, copper, and manganese. Chapters 12 and 13 are devoted to the major and trace minerals, respectively.

Water

Water, indispensable and abundant, provides the environment in which nearly all the body's activities are conducted. It participates in many metabolic reactions and supplies the medium for transporting vital materials to cells and carrying waste products away from them. Water is discussed fully in Chapter 12, but it is mentioned in every chapter. If you watch for it, you cannot help but be impressed by water's participation in all life processes.



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Water itself is an essential nutrient and naturally carries many minerals.

IN SUMMARY

Foods provide nutrients—substances that support the growth, maintenance, and repair of the body's tissues. The six classes of nutrients include:

- Carbohydrates
- Lipids (fats)
- Proteins
- Vitamins
- Minerals
- Water

Foods rich in the energy-yielding nutrients (carbohydrates, fats, and proteins) provide the major materials for building the body's tissues and yield energy for the body's use or storage. Energy is measured in kcalories. Vitamins, minerals, and water facilitate a variety of activities in the body.

Without exaggeration, nutrients provide the physical and metabolic basis for nearly all that we are and all that we do. The next section introduces the science of nutrition with emphasis on the research methods scientists have used in uncovering the wonders of nutrition.

The Science of Nutrition

The science of nutrition is the study of the nutrients and other substances in foods and the body's handling of them. Its foundation depends on several other sciences, including biology, biochemistry, and physiology. As sciences go, nutrition is young, but as you can see from the size of this book, much has happened in nutrition's short life. And it is currently entering a tremendous growth spurt as scientists apply knowledge gained from sequencing the human **genome.** The integration of nutrition, genomics, and molecular biology has opened a whole new world of study called **nutritional genomics**—the science of how nutrients affect the activities of genes and how genes affect the interactions between diet and disease.[7] Highlight 6 describes how nutritional genomics is shaping the science of nutrition, and examples of nutrient–gene interactions appear throughout later sections of the book.

Conducting Research

Consumers may depend on personal experience or reports from friends ◆ to gather information on nutrition, but researchers use the scientific method to guide their work (see Figure 1-3 on p. 12). As the figure shows, research always begins with a problem or a question. For example, "What foods or nutrients might protect against the common cold?" In search of an answer, scientists make an educated guess **(hypothesis),** such as "foods rich in vitamin C reduce the number of common colds." Then they systematically conduct research studies to collect data that will test the hypothesis (see the glossary on p. 14 for definitions of research terms). Some examples of various types of research designs are presented in Figure 1-4 (p. 13). Each type of study has strengths and weaknesses (see Table 1-3 on p. 14). Consequently, some provide stronger evidence than others.

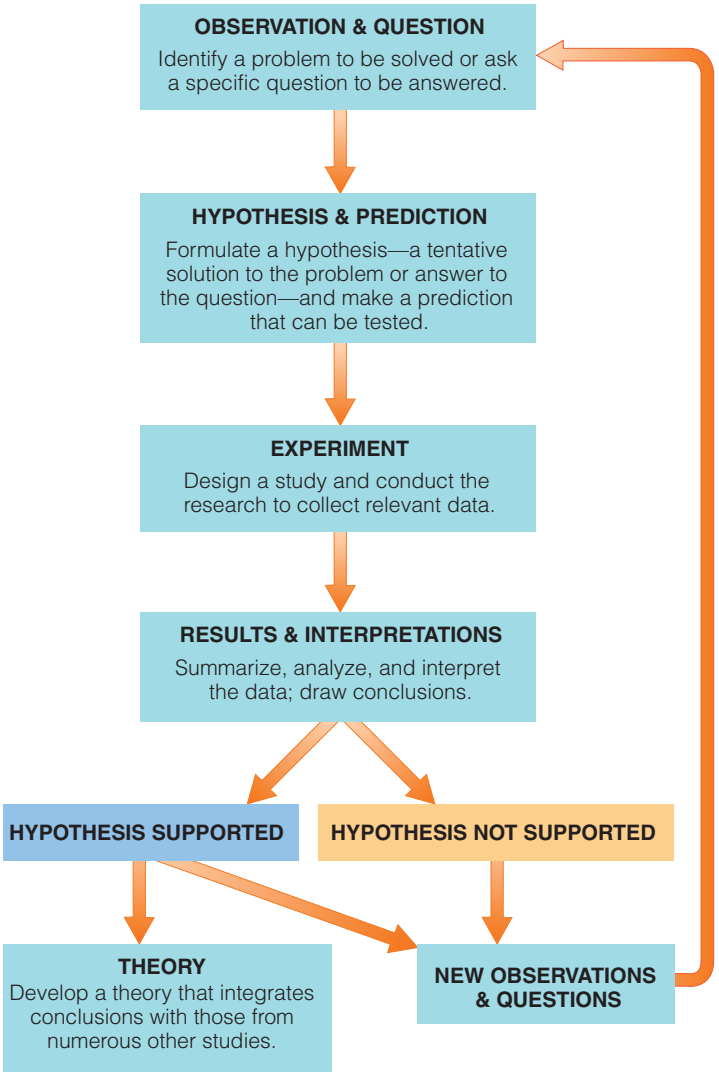
◆ A personal account of an experience or event is an **anecdote** and is not accepted as reliable scientific information.
- **anekdotos** = unpublished

genome (GEE-nome): the full complement of genetic material (DNA) in the chromosomes of a cell. In human beings, the genome consists of 46 chromosomes. The study of genomes is called **genomics.**

nutritional genomics: the science of how nutrients affect the activities of genes **(nutrigenomics)** and how genes affect the interactions between diet and disease **(nutrigenetics)**.

FIGURE 1-3 The Scientific Method

Research scientists follow the scientific method. Note that most research generates new questions, not final answers. Thus the sequence begins anew, and research continues in a somewhat cyclical way.



In attempting to discover whether a nutrient relieves symptoms or cures a disease, researchers deliberately manipulate one variable (for example, the amount of vitamin C in the diet) and measure any observed changes (perhaps the number of colds). As much as possible, all other conditions are held constant. The following paragraphs illustrate how this is accomplished.

Controls In studies examining the effectiveness of vitamin C, researchers typically divide the **subjects** into two groups. One group (the **experimental group**) receives a vitamin C supplement, and the other (the **control group**) does not. Researchers observe both groups to determine whether one group has fewer or shorter colds than the other. The following discussion describes some of the pitfalls inherent in an experiment of this kind and ways to avoid them.

In sorting subjects into two groups, researchers must ensure that each person has an equal chance of being assigned to either the experimental group or the control group. This is accomplished by **randomization;** that is, the subjects are chosen randomly from the same population by flipping a coin or some other method involving chance. Randomization helps to ensure that results reflect the treatment and not factors that might influence the grouping of subjects.

Importantly, the two groups of people must be similar and must have the same track record with respect to colds to rule out the possibility that observed differences in the rate, severity, or duration of colds might have occurred anyway. If, for example, the control group would normally catch twice as many colds as the experimental group, then the findings prove nothing.

In experiments involving a nutrient, the diets of both groups must also be similar, especially with respect to the nutrient being studied. If those in the experimental group were receiving less vitamin C from their usual diet, then any effects of the supplement may not be apparent.

Sample Size To ensure that chance variation between the two groups does not influence the results, the groups must be large. For example, if one member of a group of five people catches a bad cold by chance, he will pull the whole group's average toward bad colds; but if one member of a group of 500 catches a bad cold, she will not unduly affect the group average. Statistical methods are used to determine whether differences between groups of various sizes support a hypothesis.

Placebos If people who take vitamin C for colds *believe* it will cure them, their chances of recovery may improve. Taking anything believed to be beneficial may hasten recovery. This phenomenon, the result of expectations, is known as the **placebo effect.** In experiments designed to determine vitamin C's effect on colds, this mind-body effect must be rigorously controlled. Severity of symptoms is often a subjective measure, and people who believe they are receiving treatment may report less severe symptoms.

One way experimenters control for the placebo effect is to give pills to all participants. Those in the experimental group, for example, receive pills containing vitamin C, and those in the control group receive a **placebo**—pills of similar appearance and taste containing an inactive ingredient. This way, the expectations of both groups will be equal. It is not necessary to convince all subjects that they are receiving vitamin C, but the extent of belief or unbelief must be the same in both groups. A study conducted under these conditions is called a **blind exper-**

FIGURE 1-4 Examples of Research Designs

EPIDEMIOLOGICAL STUDIES

CROSS-SECTIONAL

Researchers observe how much and what kinds of foods a group of people eat and how healthy those people are. Their findings identify factors that might influence the incidence of a disease in various populations.

Example. The people of the Mediterranean region drink lots of wine, eat plenty of fat from olive oil, and have a lower incidence of heart disease than northern Europeans and North Americans.

CASE-CONTROL

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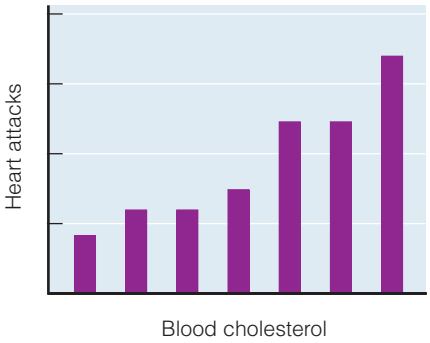
Researchers compare people who do and do not have a given condition such as a disease, closely matching them in age, gender, and other key variables so that differences in other factors will stand out. These differences may account for the condition in the group that has it.

Example. People with goiter lack iodine in their diets.

COHORT



Researchers analyze data collected from a selected group of people (a cohort) at intervals over a certain period of time.

Example. Data collected periodically over the past several decades from over 5000 people randomly selected from the town of Framingham, Massachusetts, in 1948 have revealed that the risk of heart attack increases as blood cholesterol increases.

EXPERIMENTAL STUDIES

LABORATORY-BASED ANIMAL STUDIES

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Researchers feed animals special diets that provide or omit specific nutrients and then observe any changes in health. Such studies test possible disease causes and treatments in a laboratory where all conditions can be controlled.

Example. Mice fed a high-fat diet eat less food than mice given a lower-fat diet, so they receive the same number of kcalories—but the mice eating the fat-rich diet become severely obese.

LABORATORY-BASED IN VITRO STUDIES

USDA Agricultural Research Service

Researchers examine the effects of a specific variable on a tissue, cell, or molecule isolated from a living organism.

Example. Laboratory studies find that fish oils inhibit the growth and activity of the bacteria implicated in ulcer formation.

HUMAN INTERVENTION (OR CLINICAL) TRIALS

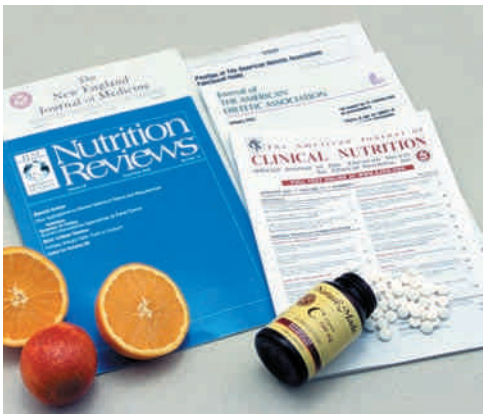
© PhotoDisc/Getty Images

Researchers ask people to adopt a new behavior (for example, eat a citrus fruit, take a vitamin C supplement, or exercise daily). These trials help determine the effectiveness of such interventions on the development or prevention of disease.

Example. Heart disease risk factors improve when men receive fresh-squeezed orange juice daily for two months compared with those on a diet low in vitamin C—even when both groups follow a diet high in saturated fat.

iment—that is, the subjects do not know (are blind to) whether they are members of the experimental group (receiving treatment) or the control group (receiving the placebo).

Double Blind When both the subjects and the researchers do not know which subjects are in which group, the study is called a **double-blind experiment.** Being fallible human beings and having an emotional and sometimes financial investment



Knowledge about the nutrients and their effects on health comes from scientific study.

TABLE 1-3 Strengths and Weaknesses of Research Designs

Type of Research	Strengths	Weaknesses
Epidemiological studies determine the incidence and distribution of diseases in a population. Epidemiological studies include cross-sectional, case-control, and cohort (see Figure 1-4).	• Can narrow down the list of possible causes • Can raise questions to pursue through other types of studies	• Cannot control variables that may influence the development or the prevention of a disease • Cannot prove cause and effect
Laboratory-based studies explore the effects of a specific variable on a tissue, cell, or molecule. Laboratory-based studies are often conducted in test tubes (in vitro) or on animals.	• Can control conditions • Can determine effects of a variable	• Cannot apply results from test tubes or animals to human beings
Human intervention or **clinical trials** involve human beings who follow a specified regimen.	• Can control conditions (for the most part) • Can apply findings to some groups of human beings	• Cannot generalize findings to all human beings • Cannot use certain treatments for clinical or ethical reasons

in a successful outcome, researchers might record and interpret results with a bias in the expected direction. To prevent such bias, the pills would be coded by a third party, who does not reveal to the experimenters which subjects were in which group until all results have been recorded.

Analyzing Research Findings

Research findings must be analyzed and interpreted with an awareness of each study's limitations. Scientists must be cautious about drawing any conclusions until they have accumulated a body of evidence from multiple studies that have used various types of research designs. As evidence accumulates, scientists begin to develop a **theory** that integrates the various findings and explains the complex relationships.

GLOSSARY OF RESEARCH TERMS

blind experiment: an experiment in which the subjects do not know whether they are members of the experimental group or the control group.

control group: a group of individuals similar in all possible respects to the experimental group except for the treatment. Ideally, the control group receives a placebo while the experimental group receives a real treatment.

correlation (CORE-ee-LAY-shun): the simultaneous increase, decrease, or change in two variables. If A increases as B increases, or if A decreases as B decreases, the correlation is **positive.** (This does not mean that A causes B or vice versa.) If A increases as B decreases, or if A decreases as B increases, the correlation is **negative.** (This does not mean that A prevents B or vice versa.) Some third factor may account for both A and B.

double-blind experiment: an experiment in which neither the subjects nor the researchers know which subjects are members of the experimental group and which are serving as control subjects, until after the experiment is over.

experimental group: a group of individuals similar in all possible respects to the control group except for the treatment. The experimental group receives the real treatment.

hypothesis (hi-POTH-eh-sis): an unproven statement that tentatively explains the relationships between two or more variables.

peer review: a process in which a panel of scientists rigorously evaluates a research study to assure that the scientific method was followed.

placebo (pla-SEE-bo): an inert, harmless medication given to provide comfort and hope; a sham treatment used in controlled research studies.

placebo effect: a change that occurs in reponse to expectations in the effectiveness of a treatment that actually has no pharmaceutical effects.

randomization (RAN-dom-ih-ZAY-shun): a process of choosing the members of the experimental and control groups without bias.

replication (REP-lih-KAY-shun): repeating an experiment and getting the same results. The skeptical scientist, on hearing of a new, exciting finding, will ask, "Has it been replicated yet?" If it hasn't, the scientist will withhold judgment regarding the finding's validity.

subjects: the people or animals participating in a research project.

theory: a tentative explanation that integrates many and diverse findings to further the understanding of a defined topic.

validity (va-LID-ih-tee): having the quality of being founded on fact or evidence.

variables: factors that change. A variable may depend on another variable (for example, a child's height depends on his age), or it may be independent (for example, a child's height does not depend on the color of her eyes). Sometimes both variables correlate with a third variable (a child's height and eye color both depend on genetics).

Correlations and Causes Researchers often examine the relationships between two or more **variables**—for example, daily vitamin C intake and the number of colds or the duration and severity of cold symptoms. Importantly, researchers must be able to observe, measure, or verify the variables selected. Findings sometimes suggest no **correlation** between variables (regardless of the amount of vitamin C consumed, the number of colds remains the same). Other times, studies find either a **positive correlation** (the more vitamin C, the more colds) or a **negative correlation** (the more vitamin C, the fewer colds). Correlational evidence proves only that variables are associated, not that one is the cause of the other. People often jump to conclusions when they notice correlations, but their conclusions are often wrong. To actually prove that A causes B, scientists have to find evidence of the *mechanism*—that is, an explanation of how A might cause B.

Cautious Conclusions When researchers record and analyze the results of their experiments, they must exercise caution in their interpretation of the findings. For example, in an epidemiological study, scientists may use a specific segment of the population—say, men 18 to 30 years old. When the scientists draw conclusions, they are careful not to generalize the findings to all people. Similarly, scientists performing research studies using animals are cautious in applying their findings to human beings. Conclusions from any one research study are always tentative and take into account findings from studies conducted by other scientists as well. As evidence accumulates, scientists gain confidence about making recommendations that affect people's health and lives. Still, their statements are worded cautiously, such as "A diet high in fruits and vegetables *may* protect against *some* cancers."

Quite often, as scientists approach an answer to one research question, they raise several more questions, so future research projects are never lacking. Further scientific investigation then seeks to answer questions such as "What substance or substances within fruits and vegetables provide protection?" If those substances turn out to be the vitamins found so abundantly in fresh produce, then, "How much is needed to offer protection?" "How do these vitamins protect against cancer?" "Is it their action as antioxidant nutrients?" "If not, might it be another action or even another substance that accounts for the protection fruits and vegetables provide against cancer?" (Highlight 11 explores the answers to these questions and reviews recent research on antioxidant nutrients and disease.)

Publishing Research

The findings from a research study are submitted to a board of reviewers composed of other scientists who rigorously evaluate the study to assure that the scientific method was followed—a process known as **peer review.** The reviewers critique the study's hypothesis, methodology, statistical significance, and conclusions. If the reviewers consider the conclusions to be well supported by the evidence—that is, if the research has **validity**—they endorse the work for publication in a scientific journal where others can read it. This raises an important point regarding information found on the Internet: much gets published without the rigorous scrutiny of peer review. Consequently, readers must assume greater responsibility for examining the data and conclusions presented—often without the benefit of journal citations.

Even when a new finding is published or released to the media, it is still only preliminary and not very meaningful by itself. Other scientists will need to confirm or disprove the findings through **replication.** To be accepted into the body of nutrition knowledge, a finding must stand up to rigorous, repeated testing in experiments performed by several different researchers. What we "know" in nutrition results from years of replicating study findings. Communicating the latest finding in its proper context without distorting or oversimplifying the message is a challenge for scientists and journalists alike.

With each report from scientists, the field of nutrition changes a little—each finding contributes another piece to the whole body of knowledge. People who

know how science works understand that single findings, like single frames in a movie, are just small parts of a larger story. Over years, the picture of what is "true" in nutrition gradually changes, and dietary recommendations change to reflect the current understanding of scientific research. Highlight 5 provides a detailed look at how dietary fat recommendations have evolved over the past several decades as researchers have uncovered the relationships between the various kinds of fat and their roles in supporting or harming health.

IN SUMMARY

Scientists learn about nutrition by conducting experiments that follow the protocol of scientific research. Researchers take care to establish similar control and experimental groups, large sample sizes, placebos, and blind treatments. Their findings must be reviewed and replicated by other scientists before being accepted as valid.

The characteristics of well-designed research have enabled scientists to study the actions of nutrients in the body. Such research has laid the foundation for quantifying how much of each nutrient the body needs.

Dietary Reference Intakes

Using the results of thousands of research studies, nutrition experts have produced a set of standards that define the amounts of energy, nutrients, other dietary components, and physical activity that best support health. These recommendations are called **Dietary Reference Intakes (DRI),** and they reflect the collaborative efforts of researchers in both the United States and Canada.*[8] The inside front covers of this book provide a handy reference for DRI values.

Don't let the DRI "alphabet soup" of nutrient intake standards confuse you. Their names make sense when you learn their purposes.

Dietary Reference Intakes (DRI): a set of nutrient intake values for healthy people in the United States and Canada. These values are used for planning and assessing diets and include:
- Estimated Average Requirements (EAR)
- Recommended Dietary Allowances (RDA)
- Adequate Intakes (AI)
- Tolerable Upper Intake Levels (UL)

requirement: the lowest continuing intake of a nutrient that will maintain a specified criterion of adequacy.

Establishing Nutrient Recommendations

The DRI Committee consists of highly qualified scientists who base their estimates of nutrient needs on careful examination and interpretation of scientific evidence. These recommendations apply to healthy people and may not be appropriate for people with diseases that increase or decrease nutrient needs. The next several paragraphs discuss specific aspects of how the committee goes about establishing the values that make up the DRI:

- Estimated Average Requirements (EAR)
- Recommended Dietary Allowances (RDA)
- Adequate Intakes (AI)
- Tolerable Upper Intake Levels (UL)

Estimated Average Requirements (EAR) The committee reviews hundreds of research studies to determine the **requirement** for a nutrient—how much is needed in the diet. The committee selects a different criterion for each nutrient based on its various roles in performing activities in the body and in reducing disease risks.

An examination of all the available data reveals that each person's body is unique and has its own set of requirements. Men differ from women, and needs change as people grow from infancy through old age. For this reason, the committee clusters its recommendations for people into groups based on age and gender. Even so, the exact requirements for people of the same age and gender are likely to be different. For example, person A might need 40 units of a particular nutrient each day; person B might need 35; and person C, 57. Looking at enough people might reveal that their individual requirements fall into a symmetrical distribution,

* The DRI reports are produced by the Food and Nutrition Board, Institute of Medicine of the National Academies, with active involvement of scientists from Canada.

with most near the midpoint and only a few at the extremes (see the left side of Figure 1-5). Using this information, the committee determines an **Estimated Average Requirement (EAR)** for each nutrient—the average amount that appears sufficient for half of the population. In Figure 1-5, the Estimated Average Requirement is shown as 45 units.

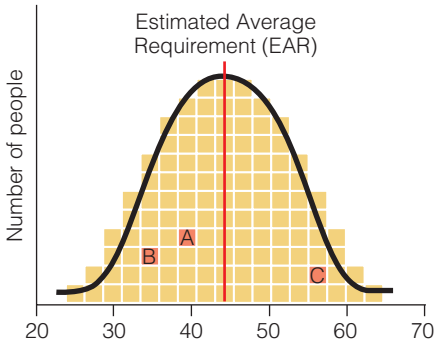
Recommended Dietary Allowances (RDA) Once a nutrient *requirement* is established, the committee must decide what intake to *recommend* for everybody—the **Recommended Dietary Allowance (RDA).** As you can see by the distribution in Figure 1-5, the Estimated Average Requirement (shown in the figure as 45 units) is probably closest to everyone's need. However, if people consumed exactly the average requirement of a given nutrient each day, half of the population would develop deficiencies of that nutrient—in Figure 1-5, for example, person C would be among them. Recommendations are therefore set high enough above the Estimated Average Requirement to meet the needs of most healthy people.

Small amounts above the daily requirement do no harm, whereas amounts below the requirement may lead to health problems. When people's nutrient intakes are consistently **deficient** (less than the requirement), their nutrient stores decline, and over time this decline leads to poor health and deficiency symptoms. Therefore, to ensure that the nutrient RDA meet the needs of as many people as possible, the RDA are set near the top end of the range of the population's estimated requirements.

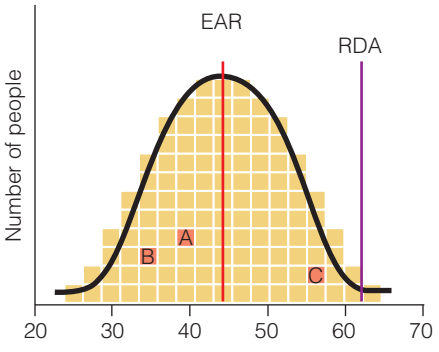
In this example, a reasonable RDA might be 63 units a day (see the right side of Figure 1-5). Such a point can be calculated mathematically so that it covers about 98 percent of a population. Almost everybody—including person C whose needs were higher than the average—would be covered if they met this dietary goal. Relatively few people's requirements would exceed this recommendation, and even then, they wouldn't exceed by much.

Adequate Intakes (AI) For some nutrients, there is insufficient scientific evidence to determine an Estimated Average Requirement (which is needed to set an RDA). In these cases, the committee establishes an **Adequate Intake (AI)** instead of an RDA. An AI reflects the average amount of a nutrient that a group of healthy people consumes. Like the RDA, the AI may be used as nutrient goals for individuals.

FIGURE 1-5 Estimated Average Requirements (EAR) and Recommended Dietary Allowances (RDA) Compared



Each square in the graph above represents a person with unique nutritional requirements. (The text discusses three of these people—A, B, and C.) Some people require only a small amount of nutrient X and some require a lot. Most people, however, fall somewhere in the middle. This amount that covers half of the population is called the Estimated Average Requirement (EAR) and is represented here by the red line.



The Recommended Dietary Allowance (RDA) for a nutrient (shown here in purple) is set well above the EAR, covering about 98% of the population.

Estimated Average Requirement (EAR): the average daily amount of a nutrient that will maintain a specific biochemical or physiological function in half the healthy people of a given age and gender group.

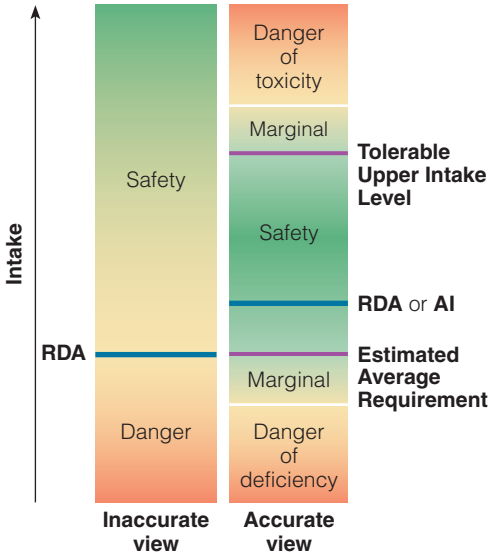
Recommended Dietary Allowance (RDA): the average daily amount of a nutrient considered adequate to meet the known nutrient needs of practically all healthy people; a goal for dietary intake by individuals.

deficient: the amount of a nutrient below which almost all healthy people can be expected, over time, to experience deficiency symptoms.

Adequate Intake (AI): the average daily amount of a nutrient that appears sufficient to maintain a specified criterion; a value used as a guide for nutrient intake when an RDA cannot be determined.

FIGURE 1-6 Inaccurate versus Accurate View of Nutrient Intakes

The RDA or AI for a given nutrient represents a point that lies within a range of appropriate and reasonable intakes between toxicity and deficiency. Both of these recommendations are high enough to provide reserves in times of short-term dietary inadequacies, but not so high as to approach toxicity. Nutrient intakes above or below this range may be equally harmful.



◆ Reference adults:
- Men: 19–30 yr, 5 ft 10 in., and 154 lb
- Women: 19–30 yr, 5 ft 4 in., and 126 lb

Tolerable Upper Intake Level (UL): the maximum daily amount of a nutrient that appears safe for most healthy people and beyond which there is an increased risk of adverse health effects.

Estimated Energy Requirement (EER): the average dietary energy intake that maintains energy balance and good health in a person of a given age, gender, weight, height, and level of physical activity.

Acceptable Macronutrient Distribution Ranges (AMDR): ranges of intakes for the energy nutrients that provide adequate energy and nutrients and reduce the risk of chronic diseases.

Although both the RDA and the AI serve as nutrient intake goals for individuals, their differences are noteworthy. An RDA for a given nutrient is based on enough scientific evidence to expect that the needs of almost all healthy people will be met. An AI, on the other hand, must rely more heavily on scientific judgments because sufficient evidence is lacking. The percentage of people covered by an AI is unknown; an AI is expected to exceed average requirements, but it may cover more or fewer people than an RDA would cover (if an RDA could be determined). For these reasons, AI values are more tentative than RDA. The table on the inside front cover identifies which nutrients have an RDA and which have an AI. Later chapters present the RDA and AI values for the vitamins and minerals.

Tolerable Upper Intake Levels (UL) As mentioned earlier, the recommended intakes for nutrients are generous, and they do not necessarily cover every individual for every nutrient. Nevertheless, it is probably best not to exceed these recommendations by very much or very often. Individual tolerances for high doses of nutrients vary, and somewhere above the recommended intake is a point beyond which a nutrient is likely to become toxic. This point is known as the **Tolerable Upper Intake Level (UL).** It is naive—and inaccurate—to think of recommendations as minimum amounts. A more accurate view is to see a person's nutrient needs as falling within a range, with marginal and danger zones both below and above it (see Figure 1-6).

Paying attention to upper levels is particularly useful in guarding against the overconsumption of nutrients, which may occur when people use large-dose supplements and fortified foods regularly. Later chapters discuss the dangers associated with excessively high intakes of vitamins and minerals, and the inside front cover (page C) presents tables that include the upper-level values for selected nutrients.

Establishing Energy Recommendations

In contrast to the RDA and AI values for nutrients, the recommendation for energy is not generous. Excess energy cannot be readily excreted and is eventually stored as body fat. These reserves may be beneficial when food is scarce, but they can also lead to obesity and its associated health consequences.

Estimated Energy Requirement (EER) The energy recommendation—called the **Estimated Energy Requirement (EER)**—represents the average dietary energy intake (kcalories per day) that will maintain energy balance in a person who has a healthy body weight and level of physical activity. ◆ Balance is key to the energy recommendation. Enough energy is needed to sustain a healthy and active life, but too much energy can lead to weight gain and obesity. Because *any* amount in excess of energy needs will result in weight gain, no upper level for energy has been determined.

Acceptable Macronutrient Distribution Ranges (AMDR) People don't eat energy directly; they derive energy from foods containing carbohydrate, fat, and protein. Each of these three energy-yielding nutrients contributes to the total energy intake, and those contributions vary in relation to each other. The DRI Committee has determined that the composition of a diet that provides adequate energy and nutrients and reduces the risk of chronic diseases is:

- 45–65 percent kcalories from carbohydrate
- 20–35 percent kcalories from fat
- 10–35 percent kcalories from protein

These values are known as **Acceptable Macronutrient Distribution Ranges (AMDR).**

Using Nutrient Recommendations

Although the intent of nutrient recommendations seems simple, they are the subject of much misunderstanding and controversy. Perhaps the following facts will help put them in perspective:

1. Estimates of adequate energy and nutrient intakes apply to *healthy* people. They need to be adjusted for malnourished people or those with medical problems who may require supplemented or restricted intakes.
2. *Recommendations* are not minimum requirements, nor are they necessarily optimal intakes for all individuals. Recommendations can only target "most" of the people and cannot account for individual variations in nutrient needs—yet. Given the recent explosion of knowledge about genetics, the day may be fast approaching when nutrition scientists will be able to determine an individual's optimal nutrient needs.[9] Until then, registered dietitians ◆ and other qualified health professionals can help determine if recommendations should be adjusted to meet individual needs.
3. Most nutrient goals are intended to be met through diets composed of a variety of *foods* whenever possible. Because foods contain mixtures of nutrients and nonnutrients, they deliver more than just those nutrients covered by the recommendations. Excess intakes of vitamins and minerals are unlikely when they come from foods rather than supplements.
4. Recommendations apply to *average* daily intakes. Trying to meet the recommendations for every nutrient every day is difficult and unnecessary. The length of time over which a person's intake can deviate from the average without risk of deficiency or overdose varies for each nutrient, depending on how the body uses and stores the nutrient. For most nutrients (such as thiamin and vitamin C), deprivation would lead to rapid development of deficiency symptoms (within days or weeks); for others (such as vitamin A and vitamin B_{12}), deficiencies would develop more slowly (over months or years).
5. Each of the DRI categories serves a unique purpose. For example, the Estimated Average Requirements are most appropriately used to develop and evaluate nutrition programs for *groups* such as schoolchildren or military personnel. The RDA (or AI if an RDA is not available) can be used to set goals for *individuals*. Tolerable Upper Intake Levels serve as a reminder to keep nutrient intakes below amounts that increase the risk of toxicity—not a common problem when nutrients derive from foods, but a real possibility for some nutrients if supplements are used regularly.

With these understandings, professionals can use the DRI for a variety of purposes.

◆ A **registered dietitian** is a college-educated food and nutrition specialist who is qualified to evaluate people's nutritional health and needs. See Highlight 1 for more on what constitutes a nutrition expert.

Comparing Nutrient Recommendations

At least 40 different nations and international organizations have published nutrient standards similar to those used in the United States and Canada. Slight differences may be apparent, reflecting differences both in the interpretation of the data from which the standards were derived and in the food habits and physical activities of the populations they serve.

Many countries use the recommendations developed by two international groups: FAO (Food and Agriculture Organization) and WHO (World Health Organization). ◆ The FAO/WHO recommendations are considered sufficient to maintain health in nearly all healthy people worldwide.

◆ Nutrient recommendations from FAO/WHO are provided in Appendix I.

IN SUMMARY

The Dietary Reference Intakes (DRI) are a set of nutrient intake values that can be used to plan and evaluate diets for healthy people. The Estimated Average Requirement (EAR) defines the amount of a nutrient that supports a specific function in the body for half of the population. The Recommended Dietary Allowance (RDA) is based on the Estimated Average Requirement and establishes a goal for dietary intake that will meet the needs of almost all

healthy people. An Adequate Intake (AI) serves a similar purpose when an RDA cannot be determined. The Estimated Energy Requirement (EER) defines the average amount of energy intake needed to maintain energy balance, and the Acceptable Macronutrient Distribution Ranges (AMDR) define the proportions contributed by carbohydrate, fat, and protein to a healthy diet. The Tolerable Upper Intake Level (UL) establishes the highest amount that appears safe for regular consumption.

Nutrition Assessment

What happens when a person doesn't get enough or gets too much of a nutrient or energy? If the deficiency or excess is significant over time, the person exhibits signs of **malnutrition.** With a deficiency of energy, the person may display the symptoms of **undernutrition** by becoming extremely thin, losing muscle tissue, and becoming prone to infection and disease. With a deficiency of a nutrient, the person may experience skin rashes, depression, hair loss, bleeding gums, muscle spasms, night blindness, or other symptoms. With an excess of energy, the person may become obese and vulnerable to diseases associated with **overnutrition** such as heart disease and diabetes. With a sudden nutrient overdose, the person may experience hot flashes, yellowing skin, a rapid heart rate, low blood pressure, or other symptoms. Similarly, over time, regular intakes in excess of needs may also have adverse effects.

Malnutrition symptoms—such as diarrhea, skin rashes, and fatigue—are easy to miss because they resemble the symptoms of other diseases. But a person who has learned how to use assessment techniques to detect malnutrition can identify when these conditions are caused by poor nutrition and can recommend steps to correct it. This discussion presents the basics of nutrition assessment; many more details are offered in Chapter 17 and in Appendix E.

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A peek inside the mouth provides clues to a person's nutrition status. An inflamed tongue may indicate a B vitamin deficiency, and mottled teeth may reveal fluoride toxicity, for example.

malnutrition: any condition caused by excess or deficient food energy or nutrient intake or by an imbalance of nutrients.

- **mal** = bad

undernutrition: deficient energy or nutrients.

overnutrition: excess energy or nutrients.

nutrition assessment: a comprehensive analysis of a person's nutrition status that uses health, socioeconomic, drug, and diet histories; anthropometric measurements; physical examinations; and laboratory tests.

Nutrition Assessment of Individuals

To prepare a **nutrition assessment,** a registered dietitian or other trained health care professional uses:

- Historical information
- Anthropometric data
- Physical examinations
- Laboratory tests

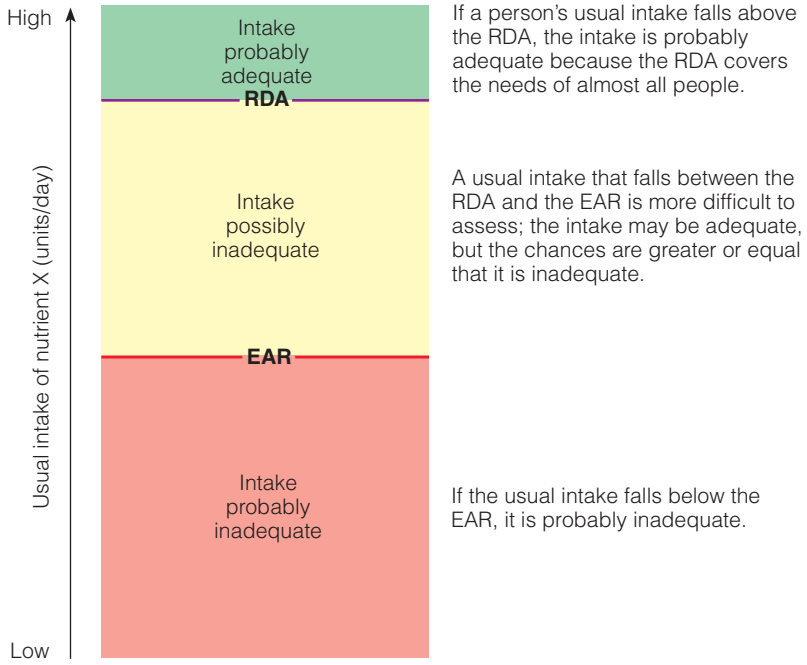
Each of these methods involves collecting data in various ways and interpreting each finding in relation to the others to create a total picture.

Historical Information One step in evaluating nutrition status is to obtain information about a person's history with respect to health status, socioeconomic status, drug use, and diet. The health history reflects a person's medical record and may reveal a disease that interferes with the person's ability to eat or the body's use of nutrients. The person's family history of major diseases is also noteworthy, especially for conditions such as heart disease that have a genetic tendency to run in families. Economic circumstances may show a financial inability to buy foods or inadequate kitchen facilities in which to prepare them. Social factors such as marital status, ethnic background, and educational level also influence food choices and nutrition status. A drug history, including all prescribed and over-the-counter medications as well as illegal substances, may highlight possible interactions that lead to nutrient deficiencies (as described in Chapter 19). A diet history that examines a person's intake of

foods, beverages, and supplements may reveal either a surplus or inadequacy of nutrients or energy.

To take a diet history, the assessor collects data about the foods a person eats. The data may be collected by recording the foods the person has eaten over a period of 24 hours, three days, or a week or more or by asking what foods the person typically eats and how much of each. The days in the record must be fairly typical of the person's diet, and portion sizes must be recorded accurately. To determine the amounts of nutrients consumed, the assessor usually enters the foods and their portion sizes into a computer using a diet analysis program. This step can also be done manually by looking up each food in a table of food composition such as Appendix H in this book. The assessor then compares the calculated nutrient intakes with the DRI to determine the probability of adequacy (see Figure 1-7).[10] Alternatively, the diet history might be compared against standards such as the USDA Food Guide or *Dietary Guidelines* (described in Chapter 2).

FIGURE 1-7 Using the DRI to Assess the Dietary Intake of a Healthy Individual



An estimate of energy and nutrient intakes from a diet history, when combined with other sources of information, can help confirm or rule out the *possibility* of suspected nutrition problems. A sufficient intake of a nutrient does not guarantee adequacy, and an insufficient intake does not always indicate a deficiency. Such findings, however, warn of possible problems.

Anthropometric Data A second technique that may help to reveal nutrition problems is taking **anthropometric** measures such as height and weight. The assessor compares a person's measurements with standards specific for gender and age or with previous measures on the same individual. (Chapter 8 presents information on body weight and its standards.)

Measurements taken periodically and compared with previous measurements reveal patterns and indicate trends in a person's overall nutrition status, but they provide little information about specific nutrients. Instead, measurements out of line with expectations may reveal such problems as growth failure in children, wasting or swelling of body tissues in adults, and obesity—conditions that may reflect energy or nutrient deficiencies or excesses.

Physical Examinations A third nutrition assessment technique is a physical examination looking for clues to poor nutrition status. Every part of the body that can be inspected may offer such clues: the hair, eyes, skin, posture, tongue, fingernails, and others. The examination requires skill because many physical signs reflect more than one nutrient deficiency or toxicity—or even nonnutrition conditions. Like the other assessment techniques, a physical examination alone does not yield firm conclusions. Instead, physical examinations reveal possible imbalances that must be confirmed by other assessment techniques, or they confirm results from other assessment measures.

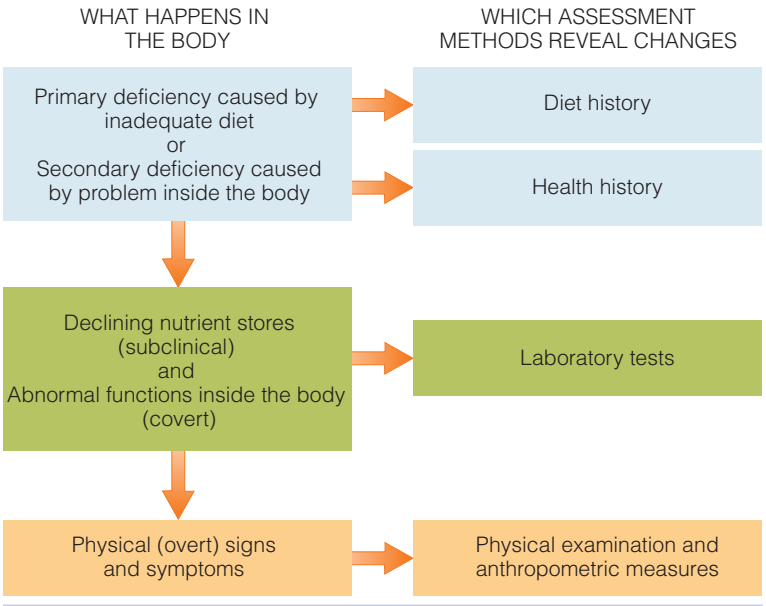
Laboratory Tests A fourth way to detect a developing deficiency, imbalance, or toxicity is to take samples of blood or urine, analyze them in the laboratory, and compare the results with normal values for a similar population. ◆ A goal of nutrition

◆ Assessment may one day depend on measures of how a nutrient influences genetic activity within the cells, instead of quantities in the blood or other tissues.

anthropometric (AN-throw-poe-MET-rick): relating to measurement of the physical characteristics of the body, such as height and weight.
- **anthropos** = human
- **metric** = measuring

FIGURE 1-8 Stages in the Development of a Nutrient Deficiency

Internal changes precede outward signs of deficiencies. However, outward signs of sickness need not appear before a person takes corrective measures. Laboratory tests can help determine nutrient status in the early stages.



assessment is to uncover early signs of malnutrition before symptoms appear, and laboratory tests are most useful for this purpose. In addition, they can confirm suspicions raised by other assessment methods.

Iron, for Example The mineral iron can be used to illustrate the stages in the development of a nutrient deficiency and the assessment techniques useful in detecting them. The **overt,** or outward, signs of an iron deficiency appear at the end of a long sequence of events. Figure 1-8 describes what happens in the body as a nutrient deficiency progresses and shows which assessment methods can reveal those changes.

First, the body has too little iron—either because iron is lacking in the person's diet (a **primary deficiency**) or because the person's body doesn't absorb enough, excretes too much, or uses iron inefficiently (a **secondary deficiency**). A diet history provides clues to primary deficiencies; a health history provides clues to secondary deficiencies.

Next, the body begins to use up its stores of iron. At this stage, the deficiency might be described as **subclinical.** It exists as a **covert** condition, and although it might be detected by laboratory tests, no outward signs are apparent.

Finally, the body's iron stores are exhausted. Now, it cannot make enough iron-containing red blood cells to replace those that are aging and dying. Iron is needed in red blood cells to carry oxygen to all the body's tissues. When iron is lacking, fewer red blood cells are made, the new ones are pale and small, and every part of the body feels the effects of oxygen shortage. Now the overt symptoms of deficiency appear—weakness, fatigue, pallor, and headaches, reflecting the iron-deficient state of the blood. A physical examination will reveal these symptoms.

Nutrition Assessment of Populations

To assess a population's nutrition status, researchers conduct surveys using techniques similar to those used on individuals. The data collected are then used by various agencies for numerous purposes, including the development of national health goals.

National Nutrition Surveys The National Nutrition Monitoring program coordinates the many nutrition-related surveys and research activities of various federal agencies. The integration of two major national surveys ◆ provides comprehensive data efficiently.[11] One survey collects data on the kinds and amounts of foods people eat.* Then researchers calculate the energy and nutrients in the foods and compare the amounts consumed with a standard. The other survey examines the people themselves, using anthropometric measurements, physical examinations, and laboratory tests.†[12] The data provide valuable information on several nutrition-related conditions, such as growth retardation, heart disease, and nutrient deficiencies. National nutrition surveys often oversample high-risk groups (low-income families, pregnant women, adolescents, the elderly, African Americans, and Mexican Americans) to glean an accurate estimate of their health and nutrition status.

The resulting wealth of information from the national nutrition surveys is used for a variety of purposes. For example, Congress uses this information to establish

◆ The new integrated survey is called *What We Eat in America*.

overt (oh-VERT): out in the open and easy to observe.
- **ouvrir** = to open

primary deficiency: a nutrient deficiency caused by inadequate dietary intake of a nutrient.

secondary deficiency: a nutrient deficiency caused by something other than an inadequate intake such as a disease condition or drug interaction that reduces absorption, accelerates use, hastens excretion, or destroys the nutrient.

subclinical deficiency: a deficiency in the early stages, before the outward signs have appeared.

covert (KOH-vert): hidden, as if under covers.
- **couvrir** = to cover

* This survey was formerly called the Continuing Survey of Food Intakes by Individuals (CSFII), conducted by the U.S. Department of Agriculture (USDA).
† This survey is known as the National Health and Nutrition Examination Survey (NHANES), conducted by the U.S. Department of Health and Human Services (DHHS).

public policy on nutrition education, food assistance programs, and the regulation of the food supply. Scientists use the information to establish research priorities. The food industry uses these data to guide decisions in public relations and product development.[13] The Dietary Reference Intakes and other major reports that examine the relationships between diet and health depend on information collected from these nutrition surveys. These data also provide the basis for developing and monitoring national health goals.

National Health Goals **Healthy People** is a program that identifies the nation's health priorities and guides policies that promote health and prevent disease. At the start of each decade, the program sets goals for improving the nation's health during the following ten years. The goals of Healthy People 2010 focus on "improving the quality of life and eliminating disparity in health among racial and ethnic groups."[14] Nutrition is one of many focus areas, each with numerous objectives. Table 1-4 lists the nutrition and overweight objectives for 2010, and Appendix J includes a table of nutrition-related objectives from other focus areas.

At mid-decade, the nation's progress toward meeting its nutrition and overweight Healthy People 2010 goals was somewhat bleak. Trends in overweight and obesity worsened. Objectives to eat more fruits, vegetables, and whole grains and to increase physical activity showed little or no improvement. Clearly, "what we eat in America" must change if we hope to meet the Healthy People 2010 goals.

National Trends What do we eat in America and how has it changed over the past 30 years?[15] The short answer to both questions is "a lot." We eat more meals away from home, particularly at fast-food restaurants. We eat larger portions. We drink more sweetened beverages and eat more energy-dense, nutrient-poor foods such as candy and chips. We snack frequently. As a result of these dietary habits, our energy intake has risen and, consequently, so has the incidence of overweight and obesity. Overweight and obesity, in turn, profoundly influence our health—as the next section explains.

Jesco Tscholitsch/Getty Images

Surveys provide valuable information about the kinds of foods people eat.

TABLE 1-4 Healthy People 2010 Nutrition and Overweight Objectives

- Increase the proportion of adults who are at a *healthy weight.*
- Reduce the proportion of adults who are *obese.*
- Reduce the proportion of children and adolescents who are *overweight* or *obese.*
- Reduce *growth retardation* among low-income children under age 5 years.
- Increase the proportion of persons aged 2 years and older who consume at least two daily servings of *fruit.*
- Increase the proportion of persons aged 2 years and older who consume at least three daily servings of *vegetables,* with at least one-third being dark green or orange vegetables.
- Increase the proportion of persons aged 2 years and older who consume at least six daily servings of *grain products,* with at least three being whole grains.
- Increase the proportion of persons aged 2 years and older who consume less than 10 percent of kcalories from *saturated fat.*
- Increase the proportion of persons aged 2 years and older who consume no more than 30 percent of kcalories from *total fat.*
- Increase the proportion of persons aged 2 years and older who consume 2400 mg or less of *sodium.*
- Increase the proportion of persons aged 2 years and older who meet dietary recommendations for *calcium.*
- Reduce *iron deficiency* among young children, females of childbearing age, and pregnant females.
- Reduce *anemia* among low-income pregnant females in their third trimester.
- Increase the proportion of children and adolescents aged 6 to 19 years whose intake of *meals and snacks at school* contributes to good overall dietary quality.
- Increase the proportion of worksites that offer *nutrition or weight management classes or counseling.*
- Increase the proportion of physician office visits made by patients with a diagnosis of cardiovascular disease, diabetes, or hyperlipidemia that include *counseling or education related to diet and nutrition.*
- Increase *food security* among U.S. households and in so doing reduce hunger.

NOTE: "Nutrition and Overweight" is one of 28 focus areas, each with numerous objectives. Several of the other focus areas have nutrition-related objectives, and these are presented in Appendix J.
SOURCE: Healthy People 2010, www.healthypeople.gov

Healthy People: a national public health initiative under the jurisdiction of the U.S. Department of Health and Human Services (DHHS) that identifies the most significant preventable threats to health and focuses efforts toward eliminating them.

IN SUMMARY

People become malnourished when they get too little or too much energy or nutrients. Deficiencies, excesses, and imbalances of nutrients lead to malnutrition diseases. To detect malnutrition in individuals, health care professionals use four nutrition assessment methods. Reviewing dietary data and health information may suggest a nutrition problem in its earliest stages. Laboratory tests may detect it before it becomes overt, whereas anthropometrics and physical examinations pick up on the problem only after it causes symptoms. National surveys use similar assessment methods to measure people's food consumption and to evaluate the nutrition status of populations.

Diet and Health

Diet has always played a vital role in supporting health. Early nutrition research focused on identifying the nutrients in foods that would prevent such common diseases as rickets and scurvy, the vitamin D– and vitamin C–deficiency diseases. With this knowledge, developed countries have successfully defended against nutrient deficiency diseases. World hunger and nutrient deficiency diseases still pose a major health threat in developing countries, however, but not because of a lack of nutrition knowledge. More recently, nutrition research has focused on **chronic diseases** associated with energy and nutrient excesses. Once thought to be "rich countries' problems," chronic diseases have now become epidemic in developing countries as well—contributing to three out of five deaths worldwide.[16]

Chronic Diseases

Table 1-5 lists the ten leading causes of death in the United States. These "causes" are stated as if a single condition such as heart disease caused death, but most chronic diseases arise from multiple factors over many years. A person who died of heart disease may have been overweight, had high blood pressure, been a cigarette smoker, and spent years eating a diet high in saturated fat and getting too little exercise.

Of course, not all people who die of heart disease fit this description, nor do all people with these characteristics die of heart disease. People who are overweight might die from the complications of diabetes instead, or those who smoke might die of cancer. They might even die from something totally unrelated to any of these factors, such as an automobile accident. Still, statistical studies have shown that certain conditions and behaviors are linked to certain diseases.

Notice that Table 1-5 highlights five of the top six causes of death as having a link with diet or alcohol. During the past 30 years, as knowledge about these diet and disease relationships grew, the death rates for four of these—heart disease, cancers, strokes, and accidents—decreased.[17] Death rates for diabetes—a chronic disease closely associated with obesity—increased.

Risk Factors for Chronic Diseases

Factors that increase or reduce the *risk* of developing chronic diseases can be identified by analyzing statistical data. A strong association between a **risk factor** and a disease means that when the factor is present, the *likelihood* of developing the disease increases. It does not mean that all people with the risk factor will develop the disease. Similarly, a lack of risk factors does not guarantee freedom from a given disease. On the average, though, the more risk factors in a person's life, the greater that person's chances of developing the disease. Conversely, the fewer risk factors in a person's life, the better the chances for good health.

TABLE 1-5 Leading Causes of Death in the United States

		Percentage of Total Deaths
1.	Heart disease	28.0
2.	Cancers	22.7
3.	Strokes	6.4
4.	Chronic lung diseases	5.2
5.	Accidents	4.5
6.	Diabetes mellitus	3.0
7.	Pneumonia and influenza	2.7
8.	Alzheimer's disease	2.6
9.	Kidney diseases	1.7
10.	Blood infections	1.4

NOTE: The diseases highlighted in green have relationships with diet; yellow indicates a relationship with alcohol.
SOURCE: National Center for Health Statistics: www.cdc.gov/nchs

chronic diseases: diseases characterized by a slow progression and long duration. Examples include heart disease, cancer, and diabetes.

risk factor: a condition or behavior associated with an elevated frequency of a disease but not proved to be causal. Leading risk factors for chronic diseases include obesity, cigarette smoking, high blood pressure, high blood cholesterol, physical inactivity, and a diet high in saturated fats and low in vegetables, fruits, and whole grains.

Physical activity can be both fun and beneficial.

TABLE 1-6 Factors Contributing to Deaths in the United States

Factors	Percentage of Deaths
Tobacco	18
Poor diet/inactivity	15
Alcohol	4
Microbial agents	3
Toxic agents	2
Motor vehicles	2
Firearms	1
Sexual behavior	1
Illicit drugs	1

SOURCE: A. H. Mokdad and coauthors, Actual causes of death in the United States, 2000, *Journal of the American Medical Association* 291 (2004): 1238–1245, with corrections from *Journal of the American Medical Association* 293 (2005): 298.

Risk Factors Persist Risk factors tend to persist over time. Without intervention, a young adult with high blood pressure will most likely continue to have high blood pressure as an older adult, for example. Thus, to minimize the damage, early intervention is most effective.

Risk Factors Cluster Risk factors tend to cluster. For example, a person who is obese may be physically inactive, have high blood pressure, and have high blood cholesterol—all risk factors associated with heart disease. Intervention that focuses on one risk factor often benefits the others as well. For example, physical activity can help reduce weight. The physical activity and weight loss will, in turn, help to lower blood pressure and blood cholesterol.

Risk Factors in Perspective The most prominent factor contributing to death in the United States is tobacco use, ◆ followed closely by diet and activity patterns, and then alcohol use (see Table 1-6).[18] Risk factors such as smoking, poor dietary habits, physical inactivity, and alcohol consumption are personal behaviors that can be changed. Decisions to not smoke, to eat a well-balanced diet, to engage in regular physical activity, and to drink alcohol in moderation (if at all) improve the likelihood that a person will enjoy good health. Other risk factors, such as genetics, gender, and age, also play important roles in the development of chronic diseases, but they cannot be changed. Health recommendations acknowledge the influence of such factors on the development of disease, but they must focus on the factors that are changeable. For the two out of three Americans who do not smoke or drink alcohol excessively, the one choice that can influence long-term health prospects more than any other is diet.

◆ Cigarette smoking is responsible for almost one of every five deaths each year.

IN SUMMARY

Within the range set by genetics, a person's choice of diet influences long-term health. Diet has no influence on some diseases but is linked closely to others. Personal life choices, such as engaging in physical activity and using tobacco or alcohol, also affect health for the better or worse.

The next several chapters provide many more details about nutrients and how they support health. Whenever appropriate, the discussion shows how diet influences each of today's major diseases. Dietary recommendations appear again and again, as each nutrient's relationships with health is explored. Most people who follow the recommendations will benefit and can enjoy good health into their later years.

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Nutrition Portfolio

Each chapter in this book ends with simple Nutrition Portfolio activities that invite you to review key messages and consider whether your personal choices are meeting the dietary goals introduced in the text. By keeping a journal of these Nutrition Portfolio assignments, you can examine how your knowledge and behaviors change as you progress in your study of nutrition.

Your food choices play a key role in keeping you healthy and reducing your risk of chronic diseases.

- Identify the factors that most influence your food choices for meals and snacks.
- List the chronic disease risk factors and conditions (listed in the definition of risk factors on p. 24) that you or members of your family have.
- Describe lifestyle changes you can make to improve your chances of enjoying good health.

NUTRITION ON THE NET

For further study of topics covered in this chapter, log on to **academic.cengage.com/nutrition/rolfes/UNCN8e**. Go to Chapter 1, then to Nutrition on the Net.

- Search for "nutrition" at the U.S. Government health and nutrition information sites: **www.healthfinder.gov** or **www.nutrition.gov**
- Learn more about basic science research from the National Science Foundation and Research!America: **www.nsf.gov** and **researchamerica.org**
- Review the Dietary Reference Intakes: **www.nap.edu**
- Review nutrition recommendations from the Food and Agriculture Organization and the World Health Organization: **www.fao.org** and **www.who.org**
- View Healthy People 2010: **www.healthypeople.gov**
- Visit the Food and Nutrition section of the Healthy Living area in Health Canada: **www.hc-sc.gc.ca**
- Learn about the national nutrition survey: **www.cdc.gov/nchs/nhanes.htm**
- Get information from the Food Surveys Research Group: **www.barc.usda.gov/bhnrc/foodsurvey**
- Visit the food and nutrition center of the Mayo Clinic: **www.mayohealth.org**
- Create a chart of your family health history at the U.S. Surgeon General's site: **familyhistory.hhs.gov**

NUTRITION CALCULATIONS

CENGAGENOW™ For additional practice, log on to **academic.cengage.com/login.** Go to Chapter 1, then to Nutrition Calculations.

Several chapters end with problems to give you practice in doing simple nutrition-related calculations. Although the situations are hypothetical, the numbers are real, and calculating the answers (check them on p. 29) provides a valuable nutrition lesson. Once you have mastered these examples, you will be prepared to examine your own food choices. Be sure to show your calculations for each problem.

1. Calculate the energy provided by a food's energy-nutrient contents. A cup of fried rice contains 5 grams protein, 30 grams carbohydrate, and 11 grams fat.
   a. How many kcalories does the rice provide from these energy nutrients?
   _____ = ____ kcal protein
   _____ = ____ kcal carbohydrate
   _____ = ____ kcal fat
   Total = ____ kcal
   b. What percentage of the energy in the fried rice comes from each of the energy-yielding nutrients?
   _____ = ____ % kcal from protein
   _____ = ____ % kcal from carbohydrate
   _____ = ____ % kcal from fat
   Total = ____ %
   Note: The total should add up to 100%; 99% or 101% due to rounding is also acceptable.
   c. Calculate how many of the 146 kcalories provided by a 12-ounce can of beer come from alcohol, if the beer contains 1 gram protein and 13 grams carbohydrate. (Note: The remaining kcalories derive from alcohol.)
   1 g protein = ____ kcal protein
   13 g carbohydrate = ____ kcal carbohydrate
   = ____ kcal alcohol
   How many grams of alcohol does this represent?
   ____ g alcohol
2. Even a little nutrition knowledge can help you identify some bogus claims. Consider an advertisement for a new "super supplement" that claims the product provides 15 grams protein and 10 kcalories per dose. Is this possible? ____ Why or why not? _____ = ____ kcal

STUDY QUESTIONS

CENGAGENOW™
To assess your understanding of chapter topics, take the Student Practice Test and explore the modules recommended in your Personalized Study Plan. Log on to **academic.cengage.com/login.**

These questions will help you review this chapter. You will find the answers in the discussions on the pages provided.

1. Give several reasons (and examples) why people make the food choices that they do. (pp. 3–5)
2. What is a nutrient? Name the six classes of nutrients found in foods. What is an essential nutrient? (pp. 6–7)
3. Which nutrients are inorganic, and which are organic? Discuss the significance of that distinction. (pp. 7, 10)
4. Which nutrients yield energy, and how much energy do they yield per gram? How is energy measured? (pp. 7–10)
5. Describe how alcohol resembles nutrients. Why is alcohol not considered a nutrient? (pp. 8, 10)
6. What is the science of nutrition? Describe the types of research studies and methods used in acquiring nutrition information. (pp. 11–16)
7. Explain how variables might be correlational but not causal. (p. 15)
8. What are the DRI? Who develops the DRI? To whom do they apply? How are they used? In your description, identify the categories of DRI and indicate how they are related. (pp. 16–19)
9. What judgment factors are involved in setting the energy and nutrient recommendations? (pp. 17–18)
10. What happens when people get either too little or too much energy or nutrients? Define malnutrition, undernutrition, and overnutrition. Describe the four methods used to detect energy and nutrient deficiencies and excesses. (pp. 20–22)
11. What methods are used in nutrition surveys? What kinds of information can these surveys provide? (pp. 22–23)
12. Describe risk factors and their relationships to disease. (pp. 24–25)

These multiple choice questions will help you prepare for an exam. Answers can be found on p. 29.

1. When people eat the foods typical of their families or geographic region, their choices are influenced by:
   a. habit.
   b. nutrition.
   c. personal preference.
   d. ethnic heritage or tradition.
2. Both the human body and many foods are composed mostly of:
   a. fat.
   b. water.
   c. minerals.
   d. proteins.

3. The inorganic nutrients are:
   a. proteins and fats.
   b. vitamins and minerals.
   c. minerals and water.
   d. vitamins and proteins.
4. The energy-yielding nutrients are:
   a. fats, minerals, and water.
   b. minerals, proteins, and vitamins.
   c. carbohydrates, fats, and vitamins.
   d. carbohydrates, fats, and proteins.
5. Studies of populations that reveal correlations between dietary habits and disease incidence are:
   a. clinical trials.
   b. laboratory studies.
   c. case-control studies.
   d. epidemiological studies.
6. An experiment in which neither the researchers nor the subjects know who is receiving the treatment is known as:
   a. double blind.
   b. double control.
   c. blind variable.
   d. placebo control.
7. An RDA represents the:
   a. highest amount of a nutrient that appears safe for most healthy people.
   b. lowest amount of a nutrient that will maintain a specified criterion of adequacy.
   c. average amount of a nutrient considered adequate to meet the known nutrient needs of practically all healthy people.
   d. average amount of a nutrient that will maintain a specific biochemical or physiological function in half the people.
8. Historical information, physical examinations, laboratory tests, and anthropometric measures are:
   a. techniques used in diet planning.
   b. steps used in the scientific method.
   c. approaches used in disease prevention.
   d. methods used in a nutrition assessment.
9. A deficiency caused by an inadequate dietary intake is a(n):
   a. overt deficiency.
   b. covert deficiency.
   c. primary deficiency.
   d. secondary deficiency.
10. Behaviors such as smoking, dietary habits, physical activity, and alcohol consumption that influence the development of disease are known as:
   a. risk factors.
   b. chronic causes.
   c. preventive agents.
   d. disease descriptors.

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ANSWERS

Nutrition Calculations

1. a. 5 g protein × 4 kcal/g = 20 kcal protein
30 g carbohydrate × 4 kcal/g = 120 kcal carbohydrate
11 g fat × 9 kcal/g = 99 kcal fat
Total = 239 kcal

b. 20 kcal ÷ 239 kcal × 100 = 8.4% kcal from protein
120 kcal ÷ 239 kcal × 100 = 50.2% kcal from carbohydrate
99 kcal ÷ 239 kcal × 100 = 41.4% kcal from fat
Total = 100%.

c. 1 g protein = 4 kcal protein
13 g carbohydrate = 52 kcal carbohydrate
146 total kcal − 56 kcal (protein + carbohydrate)
= 90 kcal alcohol
90 kcal alcohol ÷ 7 g/kcal = 12.9 g alcohol

2. No. 15 g protein × 4 kcal/g = 60 kcal

Study Questions (multiple choice)

1. d 2. b 3. c 4. d 5. d 6. a 7. c 8. d
9. c 10. a

CHAPTER 2

Planning a Healthy Diet

CHAPTER OUTLINE

Chapter 1 explained that the body's many activities are supported by the nutrients delivered by the foods people eat. Food choices made over years influence the body's health, and consistently poor choices increase the risks of developing chronic diseases. This chapter shows how a person can select from the tens of thousands of available foods to create a diet that supports health. Fortunately, most foods provide several nutrients, so one trick for wise diet planning is to select a combination of foods that deliver a full array of nutrients. This chapter begins by introducing the diet-planning principles and dietary guidelines that assist people in selecting foods that will deliver nutrients without excess energy (kcalories).

Principles and Guidelines

How well you nourish yourself does not depend on the selection of any one food. Instead, it depends on the selection of many different foods at numerous meals over days, months, and years. Diet-planning principles and dietary guidelines are key concepts to keep in mind whenever you are selecting foods—whether shopping at the grocery store, choosing from a restaurant menu, or preparing a home-cooked meal.

Diet-Planning Principles

Diet planners have developed several ways to select foods. Whatever plan or combination of plans they use, though, they keep in mind the six basic diet-planning principles ◆ listed in the margin.

◆ Diet-planning principles:
- **A**dequacy
- **B**alance
- k**C**alorie (energy) control
- Nutrient **D**ensity
- **M**oderation
- **V**ariety

Adequacy **Adequacy** means that the diet provides sufficient energy and enough of all the nutrients to meet the needs of healthy people. Take the essential nutrient iron, for example. Because the body loses some iron each day, people have to replace it by eating foods that contain iron. A person whose diet fails to provide enough iron-rich foods may develop the symptoms of iron-deficiency anemia: the person may feel weak, tired, and listless; have frequent headaches; and find that even the smallest amount of muscular work brings disabling fatigue. To prevent these deficiency symptoms, a person must include foods that supply adequate iron. The same is true for all the other essential nutrients introduced in Chapter 1.

adequacy (dietary): providing all the essential nutrients, fiber, and energy in amounts sufficient to maintain health.

To ensure an adequate and balanced diet, eat a variety of foods daily, choosing different foods from each group.

◆ Balance in the diet helps to ensure adequacy.

Balance The art of balancing the diet involves consuming enough—but not too much—of each type of food. The essential minerals calcium and iron, taken together, illustrate the importance of dietary **balance.** Meats, fish, and poultry are rich in iron but poor in calcium. Conversely, milk and milk products are rich in calcium but poor in iron. Use some meat or meat alternates for iron; use some milk and milk products for calcium; and save some space for other foods, too, because a diet consisting of milk and meat alone would not be adequate. ◆ For the other nutrients, people need whole grains, vegetables, and fruits.

kCalorie (Energy) Control Designing an adequate diet without overeating requires careful planning. Once again, balance plays a key role. The amount of energy coming into the body from foods should balance with the amount of energy being used by the body to sustain its metabolic and physical activities. Upsetting this balance leads to gains or losses in body weight. The discussion of energy balance and weight control in Chapters 8 and 9 examines this issue in more detail, but the key to **kcalorie control** is to select foods of high **nutrient density.**

◆ Nutrient density promotes adequacy and kcalorie control.

Nutrient Density To eat well without overeating, select foods that deliver the most nutrients for the least food energy. Consider foods containing calcium, for example. You can get about 300 milligrams of calcium from either $1\frac{1}{2}$ ounces of cheddar cheese or 1 cup of fat-free milk, but the cheese delivers about twice as much food energy (kcalories) as the milk. The fat-free milk, then, is twice as calcium dense as the cheddar cheese; it offers the same amount of calcium for half the kcalories. Both foods are excellent choices for adequacy's sake alone, but to achieve adequacy while controlling kcalories, ◆ the fat-free milk is the better choice. (Alternatively, a person could select a low-fat cheddar cheese.) The many bar graphs that appear in Chapters 10 through 13 highlight the most nutrient-dense choices, and the accompanying "How to" describes how to compare foods based on nutrient density.

CENGAGENOW™
To practice comparing the nutrient density of foods, log on to **academic.cengage.com/login**, go to Chapter 2, then go to How To.

balance (dietary): providing foods in proportion to each other and in proportion to the body's needs.

kcalorie (energy) control: management of food energy intake.

nutrient density: a measure of the nutrients a food provides relative to the energy it provides. The more nutrients and the fewer kcalories, the higher the nutrient density.

HOW TO Compare Foods Based on Nutrient Density

One way to evaluate foods is simply to notice their nutrient contribution *per serving:* 1 cup of milk provides about 300 milligrams of calcium, and $1\frac{1}{2}$ cup of fresh, cooked turnip greens provides about 100 milligrams. Thus a serving of milk offers three times as much calcium as a serving of turnip greens. To get 300 milligrams of calcium, a person could choose either 1 cup of milk or $1\frac{1}{2}$ cups of turnip greens.

Another valuable way to evaluate foods is to consider their nutrient density—their nutrient contribution *per kcalorie.* Fat-free milk delivers about 85 kcalories with its 300 milligrams of calcium. To calculate the nutrient density, divide milligrams by kcalories:

$$\frac{300 \text{ mg calcium}}{85 \text{ kcal}} = 3.5 \text{ mg per kcal}$$

Do the same for the fresh turnip greens, which provide 15 kcalories with the 100 milligrams of calcium:

$$\frac{100 \text{ mg calcium}}{15 \text{ kcal}} = 6.7 \text{ mg per kcal}$$

The more milligrams per kcalorie, the greater the nutrient density. Turnip greens are more calcium dense than milk. They provide more calcium *per kcalorie* than milk, but milk offers more calcium *per serving.* Both approaches offer valuable information, especially when combined with a realistic appraisal. What matters most is which are you more likely to consume—$1\frac{1}{2}$ cups of turnip greens or 1 cup of milk? You can get 300 milligrams of calcium from either, but the greens will save you about 40 kcalories (the savings would be even greater if you usually use whole milk).

Keep in mind, too, that calcium is only one of the many nutrients that foods provide. Similar calculations for protein, for example, would show that fat-free milk provides more protein both *per kcalorie* and *per serving* than turnip greens—that is, milk is more protein dense. Combining variety with nutrient density helps to ensure the adequacy of all nutrients.

Just like a person who has to pay for rent, food, clothes, and tuition on a limited budget, we have to obtain iron, calcium, and all the other essential nutrients on a limited energy allowance. Success depends on getting many nutrients for each kcalorie "dollar." For example, a can of cola and a handful of grapes may both provide about the same number of kcalories, but the grapes deliver many more nutrients. A person who makes nutrient-dense choices, such as fruit instead of cola, can meet daily nutrient needs on a lower energy budget. Such choices support good health.

Foods that are notably low in nutrient density—such as potato chips, candy, and colas—are sometimes called **empty-kcalorie foods.** The kcalories these foods provide are called "empty" because they deliver energy (from sugar, fat, or both) with little, or no, protein, vitamins, or minerals.

Moderation Foods rich in fat and sugar provide enjoyment and energy but relatively few nutrients. In addition, they promote weight gain when eaten in excess. A person practicing **moderation** ◆ eats such foods only on occasion and regularly selects foods low in solid fats and added sugars, a practice that automatically improves nutrient density. Returning to the example of cheddar cheese versus fat-free milk, the fat-free milk not only offers the same amount of calcium for less energy, but it also contains far less fat than the cheese.

◆ Moderation contributes to adequacy, balance, and kcalorie control.

Variety A diet may have all of the virtues just described and still lack **variety,** if a person eats the same foods day after day. People should select foods from each of the food groups daily and vary their choices within each food group from day to day for several reasons. First, different foods within the same group contain different arrays of nutrients. Among the fruits, for example, strawberries are especially rich in vitamin C while apricots are rich in vitamin A. Variety improves nutrient adequacy.[1] Second, no food is guaranteed entirely free of substances that, in excess, could be harmful. The strawberries might contain trace amounts of one contaminant, the apricots another. By alternating fruit choices, a person will ingest very little of either contaminant. Third, as the adage goes, variety is the spice of life. A person who eats beans frequently can enjoy pinto beans in Mexican burritos today, garbanzo beans in Greek salad tomorrow, and baked beans with barbecued chicken on the weekend. Eating nutritious meals need never be boring.

Dietary Guidelines for Americans

What should a person eat to stay healthy? The answers can be found in the *Dietary Guidelines for Americans 2005.* These guidelines provide science-based advice to promote health and to reduce risk of chronic diseases through diet and physical activity.[2] Table 2-1 presents the nine *Dietary Guidelines* topics with their key recommendations. These key recommendations, along with additional recommendations for specific population groups, also appear throughout the text as their subjects are discussed. The first three topics focus on choosing nutrient-dense foods within energy needs, maintaining a healthy body weight, and engaging in regular physical activity. The fourth topic, "Food Groups to Encourage," focuses on the selection of a variety of fruits and vegetables, whole grains, and milk. The next four topics advise people to choose sensibly in their use of fats, carbohydrates, salt, and alcoholic beverages (for those who partake). Finally, consumers are reminded to keep foods safe. Together, the *Dietary Guidelines* point the way toward better health. Table 2-2 presents Canada's *Guidelines for Healthy Eating.*

Some people might wonder why *dietary* guidelines include recommendations for physical activity. The simple answer is that most people who maintain a healthy body weight do more than eat right. They also exercise—the equivalent of 60 minutes or more of moderately intense physical activity daily. As you will see repeatedly throughout this text, food and physical activity choices are integral partners in supporting good health.

empty-kcalorie foods: a popular term used to denote foods that contribute energy but lack protein, vitamins, and minerals.

moderation (dietary): providing enough but not too much of a substance.

variety (dietary): eating a wide selection of foods within and among the major food groups.

TABLE 2-1 Key Recommendations of the *Dietary Guidelines for Americans 2005*

Adequate Nutrients within Energy Needs

- Consume a variety of nutrient-dense foods and beverages within and among the basic food groups; limit intakes of saturated and *trans* fats, cholesterol, added sugars, salt, and alcohol.
- Meet recommended intakes within energy needs by adopting a balanced eating pattern, such as the USDA Food Guide (see pp. 41–47).

Weight Management

- To maintain body weight in a healthy range, balance kcalories from foods and beverages with kcalories expended (see Chapters 8 and 9).
- To prevent gradual weight gain over time, make small decreases in food and beverage kcalories and increase physical activity.

Physical Activity

- Engage in regular physical activity and reduce sedentary activities to promote health, psychological well-being, and a healthy body weight.
- Achieve physical fitness by including cardiovascular conditioning, stretching exercises for flexibility, and resistance exercises or calisthenics for muscle strength and endurance.

Food Groups to Encourage

- Consume a sufficient amount of fruits, vegetables, milk and milk products, and whole grains while staying within energy needs.
- Select a variety of fruits and vegetables each day, including selections from all five vegetable subgroups (dark green, orange, legumes, starchy vegetables, and other vegetables) several times a week. Make at least half of the grain selections whole grains. Select fat-free or low-fat milk products.

Fats

- Consume less than 10 percent of kcalories from saturated fats and less than 300 milligrams of cholesterol per day, and keep *trans* fats consumption as low as possible (see Chapter 5).
- Keep total fat intake between 20 and 35 percent of kcalories; choose from mostly polyunsaturated and monounsaturated fat sources such as fish, nuts, and vegetable oils.
- Select and prepare foods that are lean, low fat, or fat-free and low in saturated and/or *trans* fats.

Carbohydrates

- Choose fiber-rich fruits, vegetables, and whole grains often.
- Choose and prepare foods and beverages with little added sugars (see Chapter 4).
- Reduce the incidence of dental caries by practicing good oral hygiene and consuming sugar- and starch-containing foods and beverages less frequently.

Sodium and Potassium

- Choose and prepare foods with little salt (less than 2300 milligrams sodium or approximately 1 teaspoon salt daily). At the same time, consume potassium-rich foods, such as fruits and vegetables (see Chapter 12).

Alcoholic Beverages

- Those who choose to drink alcoholic beverages should do so sensibly and in moderation (up to one drink per day for women and up to two drinks per day for men).
- Some individuals should not consume alcoholic beverages (see Highlight 7).

Food Safety

- To avoid microbial foodborne illness, keep foods safe: clean hands, food contact surfaces, and fruits and vegetables; separate raw, cooked, and ready-to-eat foods; cook foods to a safe internal temperature; chill perishable food promptly; and defrost food properly.
- Avoid unpasteurized milk and products made from it; raw or undercooked eggs, meat, poultry, fish, and shellfish; unpasteurized juices; raw sprouts.

NOTE: These guidelines are intended for adults and healthy children ages 2 and older.
SOURCE: The *Dietary Guidelines for Americans 2005*, available at **www.healthierus.gov/dietaryguidelines**.

TABLE 2-2 Canada's *Guidelines for Healthy Eating*

- Enjoy a variety of foods.
- Emphasize cereals, breads, other grain products, vegetables, and fruits.
- Choose lower-fat dairy products, leaner meats, and foods prepared with little or no fat.
- Achieve and maintain a healthy body weight by enjoying regular physical activity and healthy eating.
- Limit salt, alcohol, and caffeine.

SOURCE: These guidelines derive from *Action Towards Healthy Eating—Canada's Guidelines for Healthy Eating and Recommended Strategies for Implementation.*

IN SUMMARY

A well-planned diet delivers adequate nutrients, a balanced array of nutrients, and an appropriate amount of energy. It is based on nutrient-dense foods, moderate in substances that can be detrimental to health, and varied in its selections. The 2005 *Dietary Guidelines* apply these principles, offering practical advice on how to eat for good health.

Diet-Planning Guides

To plan a diet that achieves all of the dietary ideals just outlined, a person needs tools as well as knowledge. Among the most widely used tools for diet planning are **food group plans** that build a diet from clusters of foods that are similar in nutrient content. Thus each group represents a set of nutrients that differs somewhat from the nutrients supplied by the other groups. Selecting foods from each of the groups eases the task of creating an adequate and balanced diet.

USDA Food Guide

The 2005 *Dietary Guidelines* encourage consumers to adopt a balanced eating plan, such as the USDA's Food Guide (see Figure 2-1 on pp. 42–43). The USDA Food Guide assigns foods to five major groups ◆ and recommends daily amounts of foods from each group to meet nutrient needs. In addition to presenting the food groups, the figure lists the most notable nutrients of each group, the serving equivalents, and the foods within each group sorted by nutrient density. Chapter 15 provides a food guide for young children, and Appendix I presents Canada's food group plan, the *Food Guide to Healthy Eating*.

◆ Five food groups:
- Fruits
- Vegetables
- Grains
- Meat and legumes
- Milk

Dietary Guidelines for Americans 2005

Meet recommended intakes within energy needs by adopting a balanced eating pattern, such as the USDA Food Guide or the DASH eating plan. (The DASH eating plan is presented in Chapter 12.)

◆ Chapter 8 explains how to determine energy needs. For an approximation, turn to the DRI Estimated Energy Requirement (EER) on the inside front cover.

Recommended Amounts All food groups offer valuable nutrients, and people should make selections from each group daily. Table 2-3 specifies the amounts of foods from each group needed daily to create a healthful diet for several energy (kcalorie) levels. ◆ Estimated daily kcalorie needs for sedentary and active men and

food group plans: diet-planning tools that sort foods into groups based on nutrient content and then specify that people should eat certain amounts of foods from each group.

TABLE 2-3 Recommended Daily Amounts from Each Food Group

	1600 kcal	1800 kcal	2000 kcal	2200 kcal	2400 kcal	2600 kcal	2800 kcal	3000 kcal
Fruits	1½ c	1½ c	2 c	2 c	2 c	2 c	2½ c	2½ c
Vegetables	2 c	2½ c	2½ c	3 c	3 c	3½ c	3½ c	4 c
Grains	5 oz	6 oz	6 oz	7 oz	8 oz	9 oz	10 oz	10 oz
Meat and legumes	5 oz	5 oz	5½ oz	6 oz	6½ oz	6½ oz	7 oz	7 oz
Milk	3 c	3 c	3 c	3 c	3 c	3 c	3 c	3 c
Oils	5 tsp	5 tsp	6 tsp	6 tsp	7 tsp	8 tsp	8 tsp	10 tsp
Discretionary kcalorie allowance	132 kcal	195 kcal	267 kcal	290 kcal	362 kcal	410 kcal	426 kcal	512 kcal

FIGURE 2-1 USDA Food Guide, 2005

Key:
- ● Foods generally high in nutrient density (choose most often)
- ▲ Foods lower in nutrient density (limit selections)

FRUITS

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Consume a variety of fruits and no more than one-third of the recommended intake as fruit juice.

These foods contribute folate, vitamin A, vitamin C, potassium, and fiber.

½ c fruit is equivalent to ½ c fresh, frozen, or canned fruit; 1 small fruit; ¼ c dried fruit; ½ c fruit juice.

- ● Apples, apricots, avocados, bananas, blueberries, cantaloupe, cherries, grapefruit, grapes, guava, kiwi, mango, oranges, papaya, peaches, pears, pineapples, plums, raspberries, strawberries, watermelon; dried fruit (dates, figs, raisins); unsweetened juices.
- ▲ Canned or frozen fruit in syrup; juices, punches, ades, and fruit drinks with added sugars; fried plantains.

VEGETABLES

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Choose a variety of vegetables from all five subgroups several times a week.

These foods contribute folate, vitamin A, vitamin C, vitamin K, vitamin E, magnesium, potassium, and fiber.

½ c vegetables is equivalent to ½ c cut-up raw or cooked vegetables; ½ c cooked legumes; ½ c vegetable juice; 1 c raw, leafy greens.

- ● Dark green vegetables: Broccoli and leafy greens such as arugula, beet greens, bok choy, collard greens, kale, mustard greens, romaine lettuce, spinach, and turnip greens.
- ● Orange and deep yellow vegetables: Carrots, carrot juice, pumpkin, sweet potatoes, and winter squash (acorn, butternut).
- ● Legumes: Black beans, black-eyed peas, garbanzo beans (chickpeas), kidney beans, lentils, navy beans, pinto beans, soybeans and soy products such as tofu, and split peas.
- ● Starchy vegetables: Cassava, corn, green peas, hominy, lima beans, and potatoes.
- ● Other vegetables: Artichokes, asparagus, bamboo shoots, bean sprouts, beets, brussels sprouts, cabbages, cactus, cauliflower, celery, cucumbers, eggplant, green beans, iceberg lettuce, mushrooms, okra, onions, peppers, seaweed, snow peas, tomatoes, vegetable juices, zucchini.
- ▲ Baked beans, candied sweet potatoes, coleslaw, French fries, potato salad, refried beans, scalloped potatoes, tempura vegetables.

GRAINS

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Make at least half of the grain selections whole grains.

These foods contribute folate, niacin, riboflavin, thiamin, iron, magnesium, selenium, and fiber.

1 oz grains is equivalent to 1 slice bread; ½ c cooked rice, pasta, or cereal; 1 oz dry pasta or rice; 1 c ready-to-eat cereal; 3 c popped popcorn.

- ● Whole grains (amaranth, barley, brown rice, buckwheat, bulgur, millet, oats, quinoa, rye, wheat) and whole-grain, low-fat breads, cereals, crackers, and pastas; popcorn.
- ● Enriched bagels, breads, cereals, pastas (couscous, macaroni, spaghetti), pretzels, rice, rolls, tortillas.
- ▲ Biscuits, cakes, cookies, cornbread, crackers, croissants, doughnuts, French toast, fried rice, granola, muffins, pancakes, pastries, pies, presweetened cereals, taco shells, waffles.

FIGURE 2-1 USDA Food Guide, 2005, continued

MEAT, POULTRY, FISH, LEGUMES, EGGS, AND NUTS

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Make lean or low-fat choices. Prepare them with little, or no, added fat.

Meat, poultry, fish, and eggs contribute protein, niacin, thiamin, vitamin B_6, vitamin B_{12}, iron, magnesium, potassium, and zinc; legumes and nuts are notable for their protein, folate, thiamin, vitamin E, iron, magnesium, potassium, zinc, and fiber.

1 oz meat is equivalent to 1 oz cooked lean meat, poultry, or fish; 1 egg; ¼ c cooked legumes or tofu; 1 tbs peanut butter; ½ oz nuts or seeds.

- ● Poultry (no skin), fish, shellfish, legumes, eggs, lean meat (fat-trimmed beef, game, ham, lamb, pork); low-fat tofu, tempeh, peanut butter, nuts (almonds, filberts, peanuts, pistachios, walnuts) or seeds (flaxseeds, pumpkin seeds, sunflower seeds).
- ▲ Bacon; baked beans; fried meat, fish, poultry, eggs, or tofu; refried beans; ground beef; hot dogs; luncheon meats; marbled steaks; poultry with skin; sausages; spare ribs.

MILK, YOGURT, AND CHEESE

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Make fat-free or low-fat choices. Choose lactose-free products or other calcium-rich foods if you don't consume milk.

These foods contribute protein, riboflavin, vitamin B_{12}, calcium, magnesium, potassium, and, when fortified, vitamin A and vitamin D.

1 c milk is equivalent to 1 c fat-free milk or yogurt; 1½ oz fat-free natural cheese; 2 oz fat-free processed cheese.

- ● Fat-free milk and fat-free milk products such as buttermilk, cheeses, cottage cheese, yogurt; fat-free fortified soy milk.
- ▲ 1% low-fat milk, 2% reduced-fat milk, and whole milk; low-fat, reduced-fat, and whole-milk products such as cheeses, cottage cheese, and yogurt; milk products with added sugars such as chocolate milk, custard, ice cream, ice milk, milk shakes, pudding, sherbet; fortified soy milk.

OILS

Matthew Farruggio

Select the recommended amounts of oils from among these sources.

These foods contribute vitamin E and essential fatty acids (see Chapter 5), along with abundant kcalories.

1 tsp oil is equivalent to 1 tbs low-fat mayonnaise; 2 tbs light salad dressing; 1 tsp vegetable oil; 1 tsp soft margarine.

- ● Liquid vegetable oils such as canola, corn, flaxseed, nut, olive, peanut, safflower, sesame, soybean, and sunflower oils; mayonnaise, oil-based salad dressing, soft *trans*-free margarine.
- ● Unsaturated oils that occur naturally in foods such as avocados, fatty fish, nuts, olives,
seeds (flaxseeds, sesame seeds), and shellfish.

SOLID FATS AND ADDED SUGARS

Matthew Farruggio

Limit intakes of food and beverages with solid fats and added sugars.

Solid fats deliver saturated fat and *trans* fat, and intake should be kept low. Solid fats and added sugars contribute abundant kcalories but few nutrients, and intakes should not exceed the discretionary kcalorie allowance—kcalories to meet energy needs after all nutrient needs have been met with nutrient-dense foods. Alcohol also contributes abundant kcalories but few nutrients, and its kcalories are counted among discretionary kcalories. See Table 2-3 for some discretionary kcalorie allowances.

- ▲ Solid fats that occur in foods naturally such as milk fat and meat fat (see ▲ in previous lists).
- ▲ Solid fats that are often added to foods such as butter, cream cheese, hard margarine, lard, sour cream, and shortening.
- ▲ Added sugars such as brown sugar, candy, honey, jelly, molasses, soft drinks, sugar, and syrup.
- ▲ Alcoholic beverages include beer, wine, and liquor.

TABLE 2-4 Estimated Daily kCalorie Needs for Adults

	Sedentary[a]	Active[b]
Women		
19–30 yr	2000	2400
31–50 yr	1800	2200
51+ yr	1600	2100
Men		
19–30 yr	2400	3000
31–50 yr	2200	2900
51+ yr	2000	2600

[a]Sedentary describes a lifestyle that includes only the activities typical of day-to-day life.
[b]Active describes a lifestyle that includes physical activity equivalent to walking more than 3 miles per day at a rate of 3 to 4 miles per hour, in addition to the activities typical of day-to-day life. kCalorie values for active people reflect the midpoint of the range appropriate for age and gender, but within each group, older adults may need fewer kcalories and younger adults may need more.
NOTE: In addition to gender, age, and activity level, energy needs vary with height and weight (see Chapter 8 and Appendix F).

◆ Reminder: *Phytochemicals* are the nonnutrient compounds found in plant-derived foods that have biological activity in the body.

◆ The USDA nutrients of concern are fiber, vitamin A, vitamin C, vitamin E, and the minerals calcium, magnesium, and potassium.

legumes (lay-GYOOMS, LEG-yooms): plants of the bean and pea family, with seeds that are rich in protein compared with other plant-derived foods.

women are shown in Table 2-4. A sedentary young women needing 2000 kcalories a day, for example, would select 2 cups of fruit; 2 1/2 cups of vegetables (dispersed among the vegetable subgroups); 6 ounces of grain foods (with at least half coming from whole grains); 5 1/2 ounces of meat, poultry, or fish, or the equivalent of **legumes,** eggs, seeds, or nuts; and 3 cups of milk or yogurt, or the equivalent amount of cheese or fortified soy products. Additionally, a small amount of unsaturated oil, such as vegetable oil, or the oils of nuts, olives, or fatty fish, is required to supply needed nutrients.

All vegetables provide an array of vitamins, fiber, and the mineral potassium, but some vegetables are especially good sources of certain nutrients and beneficial phytochemicals. ◆ For this reason, the USDA Food Guide sorts the vegetable group into five subgroups. The dark green vegetables deliver the B vitamin folate; the orange vegetables provide vitamin A; legumes supply iron and protein; the starchy vegetables contribute carbohydrate energy; and the other vegetables fill in the gaps and add more of these same nutrients.

In a 2000-kcalorie diet, then, the recommended 2 1/2 cups of daily vegetables should be varied among the subgroups over a week's time, as shown in Table 2-5. In other words, consuming 2 1/2 cups of potatoes or even nutrient-rich spinach every day for seven days does *not* meet the recommended vegetable intakes. Potatoes and spinach make excellent choices when consumed in balance with vegetables from other subgroups. Intakes of vegetables are appropriately averaged over a week's time—it is not necessary to include every subgroup every day.

Notable Nutrients As Figure 2-1 notes, each food group contributes key nutrients. This feature provides flexibility in diet planning because a person can select any food from a food group and receive similar nutrients. For example, a person can choose milk, cheese, or yogurt and receive the same key nutrients. Importantly, foods provide not only these key nutrients, but small amounts of other nutrients and phytochemicals as well.

Because legumes contribute the same key nutrients—notably, protein, iron, and zinc—as meats, poultry, and fish, they are included in the same food group. For this reason, legumes are useful as meat alternatives, and they are also excellent sources of fiber and the B vitamin folate. To encourage frequent consumption, the USDA Food Guide also includes legumes as a subgroup of the vegetable group. Thus legumes count in either the vegetable group or the meat and legume group. In general, people who regularly eat meat, poultry, and fish count legumes as a vegetable, and vegetarians and others who seldom eat meat, poultry, or fish count legumes in the meat and legumes group.

The USDA Food Guide encourages greater consumption from certain food groups to provide the nutrients most often lacking ◆ in the diets of Americans. In general, most people need to eat:

- *More* dark green vegetables, orange vegetables, legumes, fruits, whole grains, and low-fat milk and milk products

TABLE 2-5 Recommended Weekly Amounts from the Vegetable Subgroups

Table 2-3 specifies the recommended amounts of total vegetables per *day.* This table shows those amounts dispersed among five vegetable subgroups per *week.*

Vegetable Subgroups	1600 kcal	1800 kcal	2000 kcal	2200 kcal	2400 kcal	2600 kcal	2800 kcal	3000 kcal
Dark green	2 c	3 c	3 c	3 c	3 c	3 c	3 c	3 c
Orange and deep yellow	1½ c	2 c	2 c	2 c	2 c	2½ c	2½ c	2½ c
Legumes	2½ c	3 c	3 c	3 c	3 c	3½ c	3½ c	3½ c
Starchy	2½ c	3 c	3 c	6 c	6 c	7 c	7 c	9 c
Other	5½ c	6½ c	6½ c	7 c	7 c	8½ c	8½ c	10 c

- *Less* refined grains, total fats (especially saturated fat, *trans* fat, and cholesterol), added sugars, and total kcalories

Nutrient Density The USDA Food Guide provides a foundation for a healthy diet by emphasizing nutrient-dense options within each food group. By consistently selecting nutrient-dense foods, a person can obtain all the nutrients needed and still keep kcalories under control. In contrast, eating foods that are low in nutrient density makes it difficult to get enough nutrients without exceeding energy needs and gaining weight. For this reason, consumers should select low-fat foods from each group and foods without added fats or sugars—for example, fat-free milk instead of whole milk, baked chicken without the skin instead of hot dogs, green beans instead of French fries, orange juice instead of fruit punch, and whole-wheat bread instead of biscuits. Notice that the key in Figure 2-1 indicates which foods *within each group* are high or low in nutrient density. Oil is a notable exception: even though oil is pure fat and therefore rich in kcalories, a small amount of oil from sources such as nuts, fish, or vegetable oils is necessary every day to provide nutrients lacking from other foods. Consequently these high-fat foods are listed among the nutrient-dense foods (see Highlight 5 to learn why).

Dietary Guidelines for Americans 2005

Consume a variety of nutrient-dense foods and beverages within and among the basic food groups while choosing foods that limit the intake of saturated and *trans* fats, cholesterol, added sugars, salt, and alcohol.

Discretionary kCalorie Allowance At each kcalorie level, people who consistently choose nutrient-dense foods may be able to meet their nutrient needs without consuming their full allowance of kcalories. The difference between the kcalories needed to supply nutrients and those needed for energy—known as the **discretionary kcalorie allowance**—is illustrated in Figure 2-2. Table 2-3 (p. 41) includes the discretionary kcalorie allowance for several kcalorie levels. A person with discretionary kcalories available might choose to:

- Eat additional nutrient-dense foods, such as an extra serving of skinless chicken or a second ear of corn.
- Select a few foods with fats or added sugars, such as reduced-fat milk or sweetened cereal.
- Add a little fat or sugar to foods, such as butter or jelly on toast.
- Consume some alcohol. (Highlight 7 explains why this may not be a good choice for some individuals.)

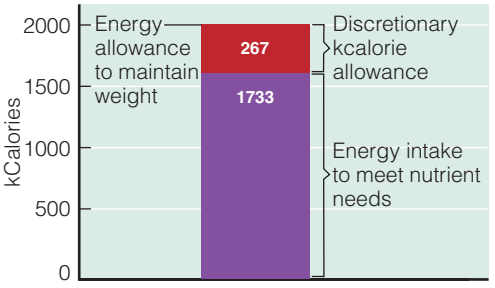
Alternatively, a person wanting to lose weight might choose to:

- *Not* use the kcalories available from the discretionary kcalorie allowance.

Added fats and sugars are always counted as discretionary kcalories. The kcalories from the fat in higher-fat milks and meats are also counted among discretionary kcalories. It helps to think of fat-free milk as "milk" and whole milk or reduced-fat milk as "milk with added fat." Similarly, "meats" should be the leanest; other cuts are "meats with added fat." Puddings and other desserts made from whole milk provide discretionary kcalories from both the sugar added to sweeten them and the naturally occurring fat in the whole milk they contain. Even fruits, vegetables, and grains can carry discretionary kcalories into the diet in the form of peaches canned in syrup, scalloped potatoes, or high-fat crackers.

Discretionary kcalories must be counted separately from the kcalories of the nutrient-dense foods of which they may be a part. A fried chicken leg, for example, provides discretionary kcalories from two sources: the naturally occurring fat of the chicken skin and the added fat absorbed during frying. The kcalories of the skinless chicken underneath are not discretionary kcalories—they are necessary to provide the nutrients of chicken.

FIGURE 2-2 Discretionary kCalorie Allowance for a 2000-kCalorie Diet Plan



discretionary kcalorie allowance: the kcalories remaining in a person's energy allowance after consuming enough nutrient-dense foods to meet all nutrient needs for a day.

◆ For quick and easy estimates, visualize each portion as being about the size of a common object:
- 1 c fruit or vegetables = a baseball
- 1/4 c dried fruit = a golf ball
- 3 oz meat = a deck of cards
- 2 tbs peanut butter = a marshmallow
- 1 1/2 oz cheese = 6 stacked dice
- 1/2 c ice cream = a racquetball
- 4 small cookies = 4 poker chips

Serving Equivalents Recommended serving amounts for fruits, vegetables, and milk are measured in cups and those for grains and meats, in ounces. Figure 2-1 provides equivalent measures among the foods in each group specifying, for example, that 1 ounce of grains is equivalent to 1 slice of bread or 1/2 cup of cooked rice.

A person using the USDA Food Guide can become more familiar with measured portions by determining the answers to questions such as these: ◆ What portion of a cup is a small handful of raisins? Is a "helping" of mashed potatoes more or less than a half-cup? How many ounces of cereal do you typically pour into the bowl? How many ounces is the steak at your favorite restaurant? How many cups of milk does your glass hold? Figure 2-1 (pp. 42–43) includes the serving sizes and equivalent amounts for foods within each group.

Mixtures of Foods Some foods—such as casseroles, soups, and sandwiches—fall into two or more food groups. With a little practice, users can learn to see these mixtures of foods as items from various food groups. For example, from the USDA Food Guide point of view, a taco represents four different food groups: the taco shell from the grains group; the onions, lettuce, and tomatoes from the "other vegetables" group; the ground beef from the meat group; and the cheese from the milk group.

Vegetarian Food Guide Vegetarian diets rely mainly on plant foods: grains, vegetables, legumes, fruits, seeds, and nuts. Some vegetarian diets include eggs, milk products, or both. People who do not eat meats or milk products can still use the USDA Food Guide to create an adequate diet.[3] ◆ The food groups are similar, and the amounts for each serving remain the same. Highlight 2 defines vegetarian terms and provides details on planning healthy vegetarian diets.

Ethnic Food Choices People can use the USDA Food Guide and still enjoy a diverse array of culinary styles by sorting ethnic foods into their appropriate food groups. For example, a person eating Mexican foods would find tortillas in the grains group, jicama in the vegetable group, and guava in the fruit group. Table 2-6 features ethnic food choices.

TABLE 2-6 Ethnic Food Choices

	Grains	Vegetables	Fruits	Meats and legumes	Milk
Asian 	Rice, noodles, millet	Amaranth, baby corn, bamboo shoots, chayote, bok choy, mung bean sprouts, sugar peas, straw mushrooms, water chestnuts, kelp	Carambola, guava, kumquat, lychee, persimmon, melons, mandarin orange	Soybeans and soy products such as soy milk and tofu, squid, duck eggs, pork, poultry, fish and other seafood, peanuts, cashews	Usually excluded
Mediterranean 	Pita pocket bread, pastas, rice, couscous, polenta, bulgur, focaccia, Italian bread	Eggplant, tomatoes, peppers, cucumbers, grape leaves	Olives, grapes, figs	Fish and other seafood, gyros, lamb, chicken, beef, pork, sausage, lentils, fava beans	Ricotta, provolone, parmesan, feta, mozzarella, and goat cheeses; yogurt
Mexican 	Tortillas (corn or flour), taco shells, rice	Chayote, corn, jicama, tomato salsa, cactus, cassava, tomatoes, yams, chilies	Guava, mango, papaya, avocado, plantain, bananas, oranges	Refried beans, fish, chicken, chorizo, beef, eggs	Cheese, custard

MyPyramid—Steps to a Healthier You The USDA created an educational tool called MyPyramid to illustrate the concepts of the *Dietary Guidelines* and the USDA Food Guide. Figure 2-3 presents a graphic image of MyPyramid, which was designed to encourage consumers to make healthy food and physical activity choices every day.

The abundant materials that support MyPyramid help consumers choose the kinds and amounts of foods to eat each day (**MyPyramid.gov**). In addition to creating a personal plan, consumers can find tips to help them improve their diet and lifestyle by "taking small steps each day."

◆ **MyPyramid.gov** offers information on vegetarian diets in its Tips & Resources section.

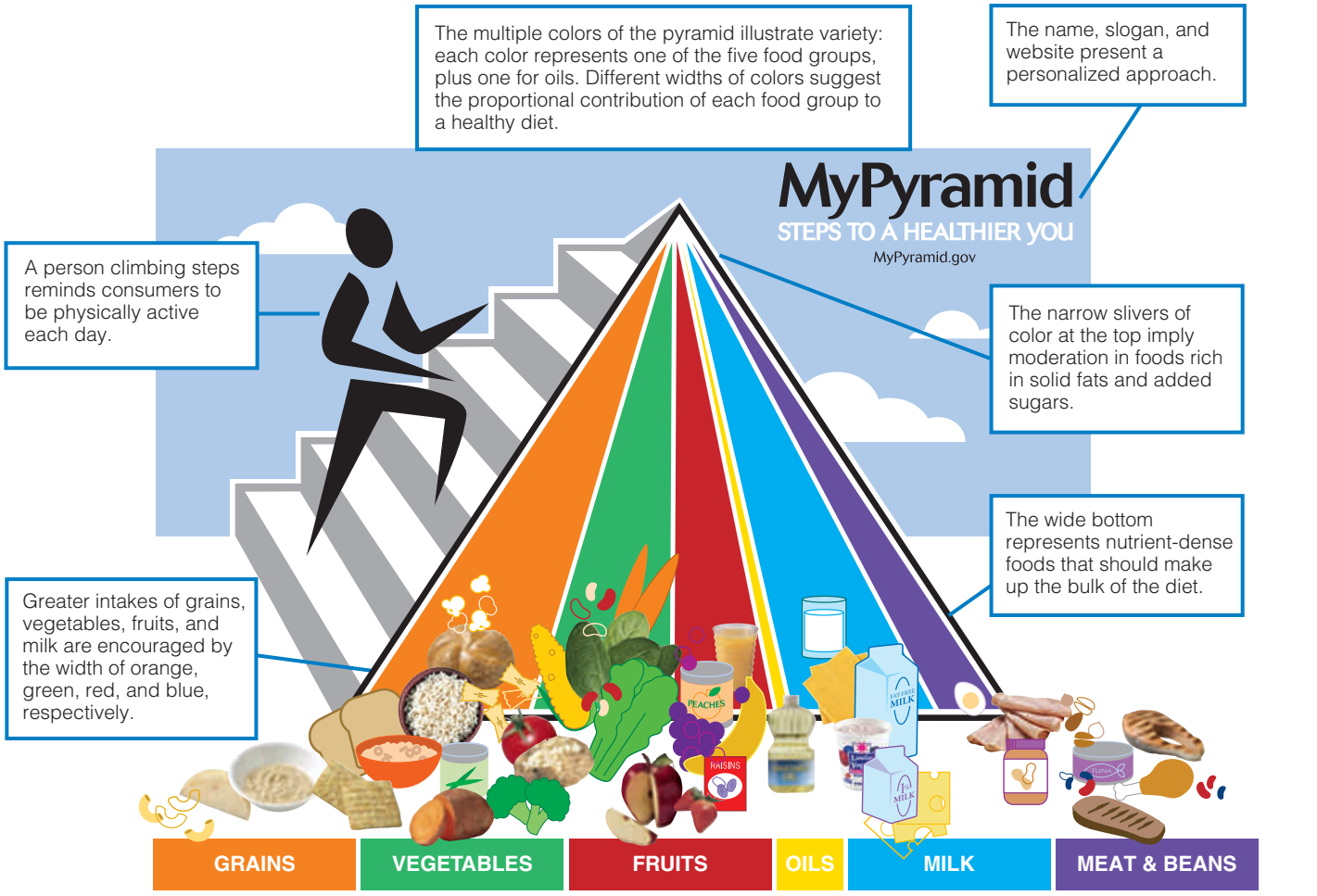
Exchange Lists

Food group plans are particularly well suited to help a person achieve dietary adequacy, balance, and variety. **Exchange lists** provide additional help in achieving kcalorie control and moderation. Originally developed for people with diabetes, exchange systems have proved useful for general diet planning as well.

Unlike the USDA Food Guide, which sorts foods primarily by their vitamin and mineral contents, the exchange system sorts foods according to their energy-nutrient contents. Consequently, foods do not always appear on the exchange list where you might first expect to find them. For example, cheeses are grouped with meats because, like meats, cheeses contribute energy from protein and fat but provide negligible carbohydrate. (In the USDA Food Guide presented earlier, cheeses are grouped with milk because they are milk products with similar calcium contents.)

exchange lists: diet-planning tools that organize foods by their proportions of carbohydrate, fat, and protein. Foods on any single list can be used interchangeably.

FIGURE 2-3 MyPyramid: Steps to a Healthier You



SOURCE: USDA, 2005

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Most bagels today weigh in at 4 ounces or more—meaning that a person eating one of these large bagels for breakfast is actually getting four or more grain servings, not one.

For similar reasons, starchy vegetables such as corn, green peas, and potatoes are listed with grains on the starch list in the exchange system, rather than with the vegetables. Likewise, olives are not classed as a "fruit" as a botanist would claim; they are classified as a "fat" because their fat content makes them more similar to oil than to berries. Bacon and nuts are also on the fat list to remind users of their high fat content. These groupings highlight the characteristics of foods that are significant to energy intake. To learn more about this useful diet-planning tool, study Appendix G, which gives details of the exchange system used in the United States, and Appendix I, which provides details of *Beyond the Basics,* a similar diet-planning system used in Canada.

Putting the Plan into Action

Familiarizing yourself with each of the food groups is the first step in diet planning. Table 2-7 shows how to use the USDA Food Guide to plan a 2000-kcalorie diet. The amounts listed from each of the food groups (see the second column of the table) were taken from Table 2-3 (p. 41). The next step is to assign the food groups to meals (and snacks), as in the remaining columns of Table 2-7.

Now, a person can begin to fill in the plan with real foods to create a menu. For example, the breakfast calls for 1 ounce grain, 1/2 cup fruit, and 1 cup milk. A person might select a bowl of cereal with banana slices and milk:

1 cup cereal = 1 ounce grain

1 small banana = 1/2 cup fruit

1 cup fat-free milk = 1 cup milk

Or 1/2 bagel and a bowl of cantaloupe pieces topped with yogurt:

1/2 small bagel = 1 ounce grain

1/2 cup melon pieces = 1/2 cup fruit

1 cup fat-free plain yogurt = 1 cup milk

Then the person can continue to create a diet plan by creating menus for lunch, dinner, and snacks. The final plan might look like the one in Figure 2-4. With the addition of a small amount of oils, this sample diet plan provides about 1850 kcalories and adequate amounts of the essential nutrients.

As you can see, we all make countless food-related decisions daily—whether we have a plan or not. Following a plan, such as the USDA Food Guide, that incorporates health recommendations and diet-planning principles helps a person make wise decisions.

From Guidelines to Groceries

Dietary recommendations emphasize nutrient-rich foods such as whole grains, fruits, vegetables, lean meats, fish, poultry, and low-fat milk products. You can design such a diet for yourself, but how do you begin? Start with the foods you enjoy

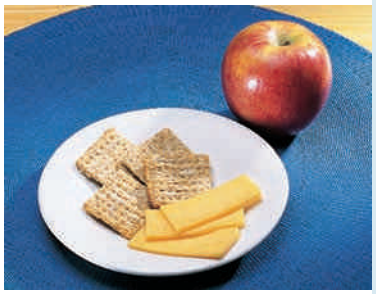
TABLE 2-7 Diet Planning Using the USDA Food Guide

This diet plan is one of many possibilities. It follows the amounts of foods suggested for a 2000-kcalorie diet as shown in Table 2-3 on p. 41 (with an extra ½ cup of vegetables).

Food Group	Amounts	Breakfast	Lunch	Snack	Dinner	Snack
Fruits	2 c	½ c		½ c	1 c	
Vegetables	2½ c		1 c		1½ c	
Grains	6 oz	1 oz	2 oz	½ oz	2 oz	½ oz
Meat and legumes	5½ oz		2 oz		3½ oz	
Milk	3 c	1 c		1 c		1 c
Oils	5½ tsp		1½ tsp		4 tsp	
Discretionary kcalorie allowance	267 kcal					

FIGURE 2-4 A Sample Diet Plan and Menu

This sample menu provides about 1850 kcalories and meets dietary recommendations to provide 45 to 65 percent of its kcalories from carbohydrate, 20 to 35 percent from fat, and 10 to 35 percent from protein. Some discretionary kcalories were spent on the fat in the low-fat cheese and in the sugar added to the graham crackers; about 150 discretionary kcalories remain available in this 2000-kcalorie diet plan.



Amounts	SAMPLE MENU	Energy (kcal)
	Breakfast	
1 oz whole grains	1 c whole-grain cereal	108
1 c milk	1 c fat-free milk	83
1/2 c fruit	1 small banana (sliced)	105
	Lunch	
2 oz whole grains, 2 oz meats	1 turkey sandwich on roll	272
1 1/2 tsp oils	1 1/2 tbs low-fat mayonnaise	75
1 c vegetables	1 c vegetable juice	53
	Snack	
1/2 oz whole grains	4 whole-wheat, reduced-fat crackers	86
1 c milk	1 1/2 oz low-fat cheddar cheese	74
1/2 c fruit	1 small apple	72
	Dinner	
1/2 c vegetables	1 c salad	8
1 oz meats	1/4 c garbanzo beans	71
2 tsp oils	2 tbs oil-based salad dressing and olives	81
1/2 c vegetables, 2 1/2 oz meats, 2 oz enriched grains	Spaghetti with meat sauce	425
1/2 c vegetables	1/2 c green beans	22
2 tsp oils	2 tsp soft margarine	67
1 c fruit	1 c strawberries	49
	Snack	
1/2 oz enriched grains	3 graham crackers	90
1 c milk	1 c fat-free milk	83

processed foods: foods that have been treated to change their physical, chemical, microbiological, or sensory properties.

fortified: the addition to a food of nutrients that were either not originally present or present in insignificant amounts. Fortification can be used to correct or prevent a widespread nutrient deficiency or to balance the total nutrient profile of a food.

refined: the process by which the coarse parts of a food are removed. When wheat is refined into flour, the bran, germ, and husk are removed, leaving only the endosperm.

enriched: the addition to a food of nutrients that were lost during processing so that the food will meet a specified standard.

whole grain: a grain milled in its entirety (all but the husk), not refined.

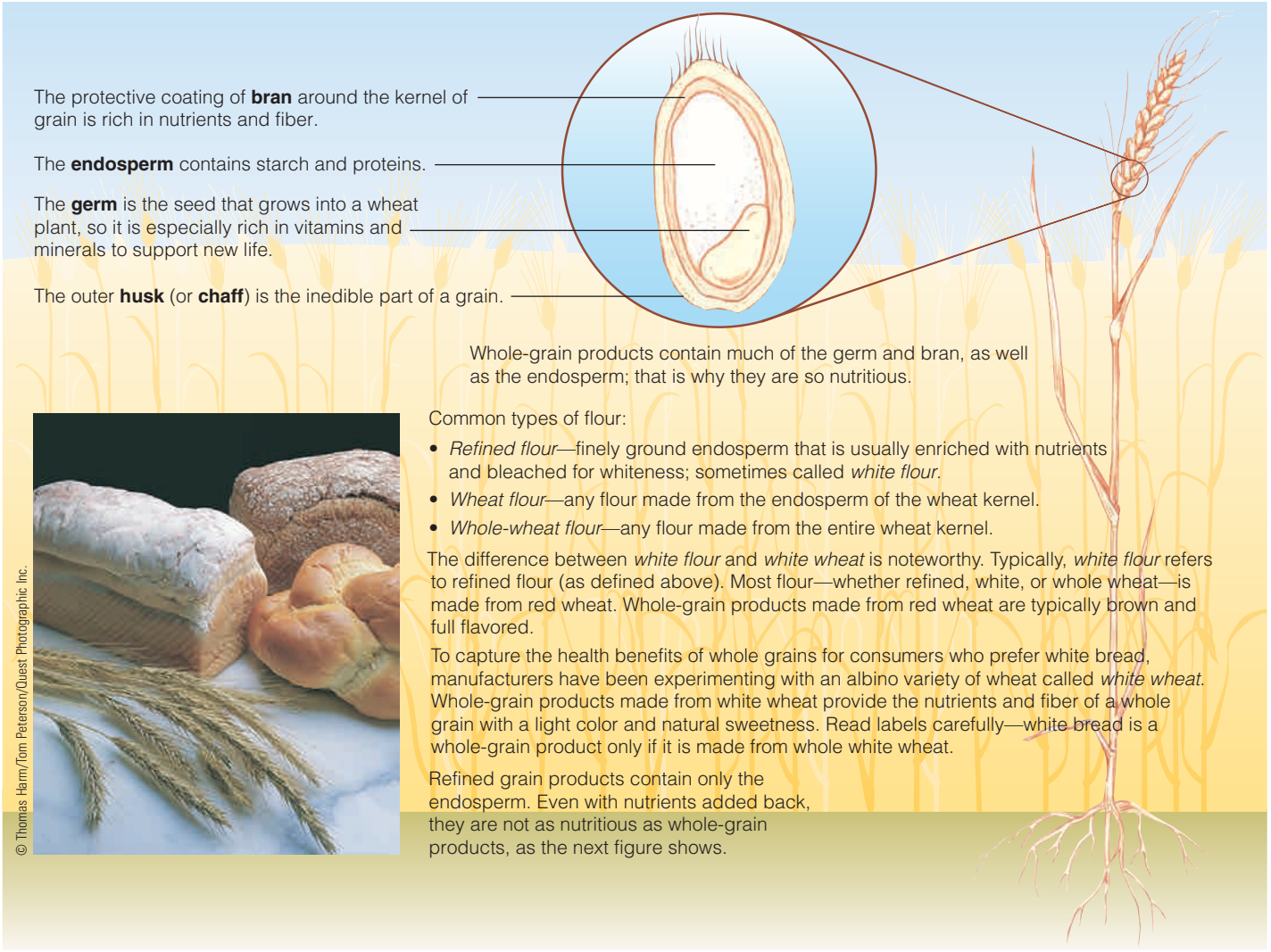
eating. Then try to make improvements, little by little. When shopping, think of the food groups, and choose nutrient-dense foods within each group.

Be aware that many of the 50,000 food options available today are **processed foods** that have lost valuable nutrients and gained sugar, fat, and salt as they were transformed from farm-fresh foods to those found in the bags, boxes, and cans that line grocery-store shelves. Their value in the diet depends on the starting food and how it was prepared or processed. Sometimes these foods have been **fortified** to improve their nutrient contents.

Grains When shopping for grain products, you will find them described as *refined, enriched,* or *whole grain*. These terms refer to the milling process and the making of grain products, and they have different nutrition implications (see Figure 2-5). **Refined** foods may have lost many nutrients during processing; **enriched** products may have had some nutrients added back; and **whole-grain** products may be rich in fiber and all the nutrients found in the original grain. As such, whole-grain products support good health and should account for at least half of the grains daily.

When it became a common practice to refine the wheat flour used for bread by milling it and throwing away the bran and the germ, consumers suffered a tragic loss of many nutrients.[4] As a consequence, in the early 1940s Congress passed legislation requiring that all grain products that cross state lines be enriched with iron,

FIGURE 2-5 A Wheat Plant



Dietary Guidelines for Americans 2005

Consume 3 or more ounce-equivalents of whole-grain products per day, with the rest of the recommended grains coming from enriched or whole-grain products. In general, at least half the grains should come from whole grains.

thiamin, riboflavin, and niacin. In 1996, this legislation was amended to include folate, a vitamin considered essential in the prevention of some birth defects. Most grain products that have been refined, such as rice, wheat pastas like macaroni and spaghetti, and cereals (both cooked and ready-to-eat types), have subsequently been enriched, ◆ and their labels say so.

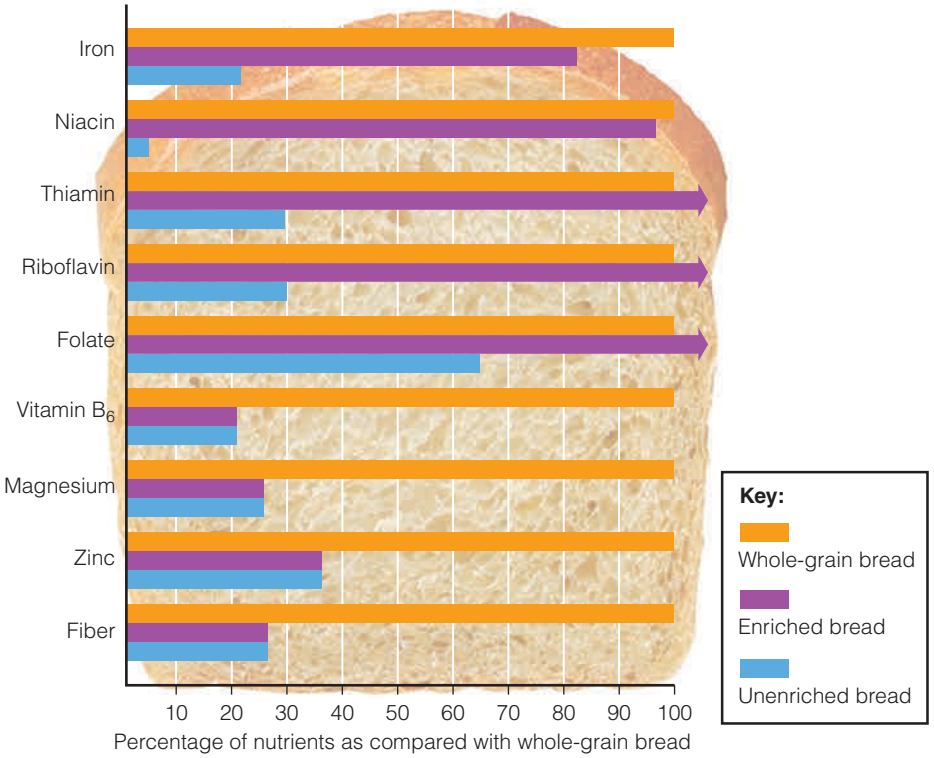
◆ Grain enrichment nutrients:
- Iron
- Thiamin
- Riboflavin
- Niacin
- Folate

Enrichment doesn't make a slice of bread rich in these added nutrients, but people who eat several slices a day obtain significantly more of these nutrients than they would from unenriched bread. Even though the enrichment of flour helps to prevent deficiencies of these nutrients, it fails to compensate for losses of many other nutrients and fiber. As Figure 2-6 shows, whole-grain items still outshine the enriched ones. Only *whole-grain* flour contains all of the nutritive portions of the grain. Whole-grain products, such as brown rice or oatmeal, provide more nutrients and fiber and contain less salt and sugar than flavored, processed rice or sweetened cereals.

Speaking of cereals, ready-to-eat breakfast cereals are the most highly fortified foods on the market. Like an enriched food, a *fortified* food has had nutrients added during processing, but in a fortified food, the added nutrients may not have been present in the original product. (The terms *fortified* and *enriched* may be used interchangeably.[5]) Some breakfast cereals made from refined flour and fortified with high doses of vitamins and minerals are actually more like supplements disguised

FIGURE 2-6 Nutrients in Bread

Whole-grain bread is more nutritious than other breads, even enriched bread. For iron, thiamin, riboflavin, niacin, and folate, enriched bread provides about the same quantities as whole-grain bread and significantly more than unenriched bread. For fiber and the other nutrients (those shown here as well as those not shown), enriched bread provides less than whole-grain bread.



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When shopping for bread, look for the descriptive words *whole grain* or *whole wheat* and check the fiber contents on the Nutrition Facts panel of the label—the more fiber, the more likely the bread is a whole-grain product.

FIGURE 2-7 Eat 5 to 9 a Day for Better Health

The "5 to 9 a Day" campaign (**www.5aday.gov**) encourages consumers to eat a variety of fruits and vegetables. Because "everyone benefits from eating more," the campaign's slogan and messages are being revised to say *Fruits and Veggies—More Matters.*

as cereals than they are like whole grains. They may be nutritious—with respect to the nutrients added—but they still may fail to convey the full spectrum of nutrients that a whole-grain food or a mixture of such foods might provide. Still, fortified foods help people meet their vitamin and mineral needs.[6]

Vegetables Posters in the produce section of grocery stores encourage consumers to "eat 5 a day." Such efforts are part of a national educational campaign to increase fruit and vegetable consumption to 5 to 9 servings every day (see Figure 2-7). To help consumers remember to eat a variety of fruits and vegetables, the campaign provides practical tips, such as selecting from each of five colors.

Choose fresh vegetables often, especially dark green leafy and yellow-orange vegetables like spinach, broccoli, and sweet potatoes. Cooked or raw, vegetables are good sources of vitamins, minerals, and fiber. Frozen and canned vegetables without added salt are acceptable alternatives to fresh. To control fat, energy, and sodium intakes, limit butter and salt on vegetables.

Choose often from the variety of legumes available. ◆ They are an economical, low-fat, nutrient- and fiber-rich food choice.

◆ Legumes include a variety of beans and peas:
- Adzuki beans
- Black beans
- Black-eyed peas
- Fava beans
- Garbanzo beans
- Great northern beans
- Kidney beans
- Lentils
- Lima beans
- Navy beans
- Peanuts
- Pinto beans
- Soybeans
- Split peas

Dietary Guidelines for Americans 2005

Choose a variety of fruits and vegetables each day. In particular, select from all five vegetable subgroups (dark green, orange, legumes, starchy vegetables, and other vegetables) several times a week.

Fruit Choose fresh fruits often, especially citrus fruits and yellow-orange fruits like cantaloupes and peaches. Frozen, dried, and canned fruits without added sugar are acceptable alternatives to fresh. Fruits supply valuable vitamins, minerals, fibers, and phytochemicals. They add flavors, colors, and textures to meals, and their natural sweetness makes them enjoyable as snacks or desserts.

Combining legumes with foods from other food groups creates delicious meals.

Add rice to red beans for a hearty meal.

Enjoy a Greek salad topped with garbanzo beans for a little ethnic diversity.

A bit of meat and lots of spices turn kidney beans into chili con carne.

Fruit juices are healthy beverages but contain little dietary fiber compared with whole fruits. Whole fruits satisfy the appetite better than juices, thereby helping people to limit food energy intakes. For people who need extra food energy, though, juices are a good choice. Be aware that sweetened fruit "drinks" or "ades" contain mostly water, sugar, and a little juice for flavor. Some may have been fortified with vitamin C or calcium but lack any other significant nutritional value.

Dietary Guidelines for Americans 2005

Consume a sufficient amount of fruits and vegetables while staying within energy needs.

Meat, Fish, and Poultry Meat, fish, and poultry provide essential minerals, such as iron and zinc, and abundant B vitamins as well as protein. To buy and prepare these foods without excess energy, fat, and sodium takes a little knowledge and planning. When shopping in the meat department, choose fish, poultry, and lean cuts of beef and pork named "round" or "loin" (as in top round or pork tenderloin). As a guide, "prime" and "choice" cuts generally have more fat than "select" cuts. Restaurants usually serve prime cuts. Ground beef, even "lean" ground beef, derives most of its food energy from fat. Have the butcher trim and grind a lean round steak instead. Alternatively, **textured vegetable protein** can be used instead of ground beef in a casserole, spaghetti sauce, or chili, saving fat kcalories.

Weigh meat after it is cooked and the bones and fat are removed. In general, 4 ounces of raw meat is equal to about 3 ounces of cooked meat. Some examples of 3-ounce portions of meat include 1 medium pork chop, $^1/_2$ chicken breast, or 1 steak or hamburger about the size of a deck of cards. To keep fat intake moderate, bake, roast, broil, grill, or braise meats (but do not fry them in fat); remove the skin from poultry after cooking; trim visible fat before cooking; and drain fat after cooking. Chapter 5 offers many additional strategies for moderating fat intake.

Milk Shoppers find a variety of fortified foods in the dairy case. Examples are milk, to which vitamins A and D have been added, and soy milk, ◆ to which calcium, vitamin D, and vitamin B_{12} have been added. In addition, shoppers may find **imitation foods** (such as cheese products), **food substitutes** (such as egg substitutes), and functional foods ◆ (such as margarine with added plant sterols). As food technology advances, many such foods offer alternatives to traditional choices that may help people who want to reduce their fat and cholesterol intakes. Chapter 5 gives other examples.

When shopping, choose fat-free ◆ or low-fat milk, yogurt, and cheeses. Such selections help consumers meet their vitamin and mineral needs within their energy and fat allowances.[7] Milk products are important sources of calcium, but can provide too much sodium and fat if not selected with care.

◆ Be aware that not all soy milks have been fortified. Read labels carefully.

◆ Reminder: *Functional foods* contain physiologically active compounds that provide health benefits beyond basic nutrition.

◆ Milk descriptions:
- **Fat-free** milk may also be called **non-fat**, **skim**, **zero-fat**, or **no-fat.**
- **Low-fat** milk refers to 1% milk.
- **Reduced-fat** milk refers to 2% milk; it may also be called **less-fat.**

Dietary Guidelines for Americans 2005

Consume 3 cups per day of fat-free or low-fat milk or equivalent milk products.

IN SUMMARY

Food group plans such as the USDA Food Guide help consumers select the types and amounts of foods to provide adequacy, balance, and variety in the diet. They make it easier to plan a diet that includes a balance of grains, vegetables, fruits, meats, and milk products. In making any food choice, remember to view the food in the context of your total diet. The combination of many different foods provides the abundance of nutrients that is so essential to a healthy diet.

textured vegetable protein: processed soybean protein used in vegetarian products such as soy burgers.

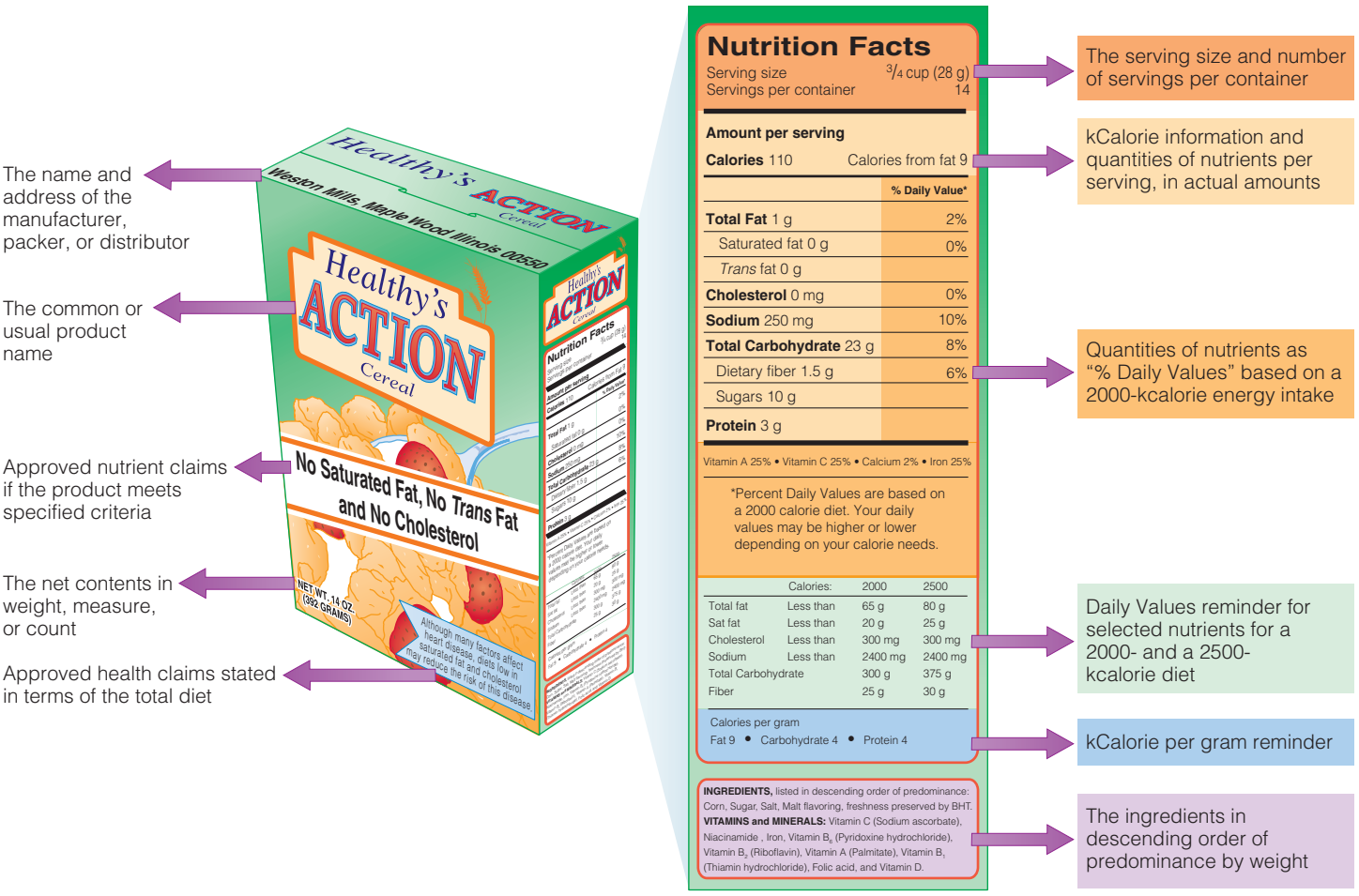
imitation foods: foods that substitute for and resemble another food, but are nutritionally inferior to it with respect to vitamin, mineral, or protein content. If the substitute is not inferior to the food it resembles and if its name provides an accurate description of the product, it need not be labeled "imitation."

food substitutes: foods that are designed to replace other foods.

Food Labels

Many consumers read food labels to help them make healthy choices.[8] Food labels appear on virtually all processed foods, and posters or brochures provide similar nutrition information for fresh meats, fruits, and vegetables (see Figure 2-8). A few foods need not carry nutrition labels: those contributing few nutrients, such as plain coffee, tea, and spices; those produced by small businesses; and those prepared and sold in the same establishment. Producers of some of these items, however, voluntarily use labels. Even markets selling nonpackaged items voluntarily present nutrient information, either in brochures or on signs posted at the point of purchase. Restaurants need not supply complete nutrition information for menu items unless claims such as "low fat" or "heart healthy" have been made. When ordering such items, keep in mind that restaurants tend to serve extra-large portions—two to three times standard serving sizes. A "low-fat" ice cream, for example, may have only 3 grams of fat per 1/2 cup, but you may be served 2 cups for a total of 12 grams of fat and all their accompanying kcalories.

FIGURE 2-8 Example of a Food Label



The Ingredient List

All packaged foods must list all ingredients on the label in descending order of predominance by weight. Knowing that the first ingredient predominates by weight, consumers can glean much information. Compare these products, for example:

- A beverage powder that contains "sugar, citric acid, natural flavors . . ." versus a juice that contains "water, tomato concentrate, concentrated juices of carrots, celery . . ."
- A cereal that contains "puffed milled corn, sugar, corn syrup, molasses, salt . . ." versus one that contains "100 percent rolled oats"
- A canned fruit that contains "sugar, apples, water" versus one that contains simply "apples, water"

In each of these comparisons, consumers can see that the second product is the more nutrient dense.

Serving Sizes

Because labels present nutrient information *per serving,* they must identify the size of the serving. The Food and Drug Administration (FDA) has established specific serving sizes for various foods and requires that all labels for a given product use the same serving size. For example, the serving size for all ice creams is $^1/_2$ cup and for all beverages, 8 fluid ounces. This facilitates comparison shopping. Consumers can see at a glance which brand has more or fewer kcalories or grams of fat, for example. Standard serving sizes are expressed in both common household measures, such as cups, and metric measures, such as milliliters, to accommodate users of both types of measures (see Table 2-8).

When examining the nutrition facts on a food label, consumers need to compare the serving size on the label with how much they actually eat and adjust their calculations accordingly. For example, if the serving size is four cookies and you only eat two, then you need to cut the nutrient and kcalorie values in half; similarly, if you eat eight cookies, then you need to double the values. Notice, too, that small bags or individually wrapped items, such as chips or candy bars, may contain more than a single serving. The number of servings per container is listed just below the serving size.

Be aware that serving sizes on food labels are not always the same as those of the USDA Food Guide.[9] For example, a serving of rice on a food label is 1 cup, whereas in the USDA Food Guide it is $^1/_2$ cup. Unfortunately, this discrepancy, coupled with each person's own perception (oftentimes misperception) of standard serving sizes, sometimes creates confusion for consumers trying to follow recommendations.

TABLE 2-8 Household and Metric Measures

- 1 teaspoon (tsp) = 5 milliliters (mL)
- 1 tablespoon (tbs) = 15 mL
- 1 cup (c) = 240 mL
- 1 fluid ounce (fl oz) = 30 mL
- 1 ounce (oz) = 28 grams (g)

NOTE: The Aids to Calculation section at the back of the book provides additional weights and measures.

Nutrition Facts

In addition to the serving size and the servings per container, the FDA requires that the "Nutrition Facts" panel on food labels present nutrient information in two ways—in quantities (such as grams) and as percentages of standards called the **Daily Values.** The Nutrition Facts panel must provide the nutrient amount, percent Daily Value, or both for the following:

- Total food energy (kcalories)
- Food energy from fat (kcalories)
- Total fat (grams and percent Daily Value)
- Saturated fat (grams and percent Daily Value)
- *Trans* fat (grams)
- Cholesterol (milligrams and percent Daily Value)
- Sodium (milligrams and percent Daily Value)

Daily Values (DV): reference values developed by the FDA specifically for use on food labels.

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Consumers read food labels to learn about the nutrient contents of a food or to compare similar foods.

- Total carbohydrate, which includes starch, sugar, and fiber (grams and percent Daily Value)
- Dietary fiber (grams and percent Daily Value)
- Sugars, which includes both those naturally present in and those added to the food (grams)
- Protein (grams)

The labels must also present nutrient content information as a percentage of the Daily Values for the following vitamins and minerals:

- Vitamin A
- Vitamin C
- Iron
- Calcium

The Daily Values

The FDA developed the Daily Values for use on food labels because comparing nutrient amounts against a standard helps make the numbers more meaningful to consumers. Table 2-9 presents the Daily Value standards for nutrients that are required to provide this information. Food labels list the amount of a nutrient in a product as a percentage of its Daily Value. A person reading a food label might wonder, for example, whether 1 milligram of iron or calcium is a little or a lot. As Table 2-9 shows, the Daily Value for iron is 18 milligrams, so 1 milligram of iron is enough to notice—it is more than 5 percent, and that is what the food label will say. But because the Daily Value for calcium on food labels is 1000 milligrams, 1 milligram of calcium is insignificant, and the food label will read "0%."

The Daily Values reflect dietary recommendations for nutrients and dietary components that have important relationships with health. The "% Daily Value" column on a label provides a ballpark estimate of how individual foods contribute to the total diet. It compares key nutrients in a serving of food with the goals of a person consuming 2000 kcalories per day. A 2000-kcalorie diet is considered about right for sedentary younger women, active older women, and sedentary older men.

TABLE 2-9 Daily Values for Food Labels

Food labels must present the "% Daily Value" for these nutrients.

Food Component	Daily Value	Calculation Factors
Fat	65 g	30% of kcalories
Saturated fat	20 g	10% of kcalories
Cholesterol	300 mg	—
Carbohydrate (total)	300 g	60% of kcalories
Fiber	25 g	11.5 g per 1000 kcalories
Protein	50 g	10% of kcalories
Sodium	2400 mg	—
Potassium	3500 mg	—
Vitamin C	60 mg	—
Vitamin A	1500 µg	—
Calcium	1000 mg	—
Iron	18 mg	—

NOTE: Daily Values were established for adults and children over 4 years old. The values for energy-yielding nutrients are based on 2000 kcalories a day. For fiber, the Daily Value was rounded up from 23.

Young children and sedentary older women may need fewer kcalories. Most labels list, at the bottom, Daily Values for both a 2000-kcalorie and a 2500-kcalorie diet, but the "% Daily Value" column on all labels applies only to a 2000-kcalorie diet. A 2500-kcalorie diet is considered about right for many men, teenage boys, and active younger women. People who are exceptionally active may have still higher energy needs. Labels may also provide a reminder of the kcalories in a gram of carbohydrate, fat, and protein just below the Daily Value information (review Figure 2-8).

People who consume 2000 kcalories a day can simply add up all of the "% Daily Values" for a particular nutrient to see if their diet for the day fits recommendations. People who require more or less than 2000 kcalories daily must do some calculations to see how foods compare with their personal nutrition goals. They can use the calculation column in Table 2-9 or the suggestions presented in the accompanying "How to" feature.

Daily Values help consumers see easily whether a food contributes "a little" or "a lot" of a nutrient. ◆ For example, the "% Daily Value" column on a label of macaroni and cheese may say 20 percent for fat. This tells the consumer that each serving of this food contains about 20 percent of the day's allotted 65 grams of fat. A person consuming 2000 kcalories a day could simply keep track of the percentages of Daily Values from foods eaten in a day and try not to exceed 100 percent. Be aware that for some nutrients (such as fat and sodium) you will want to select foods with a low "% Daily Value" and for others (such as calcium and fiber) you will want a high "% Daily Value." To determine whether a particular food is a wise choice, a consumer needs to consider its place in the diet among all the other foods eaten during the day.

◆ % Daily Values:
- ≥ 20% = high or excellent source
- 10-19% = good source
- ≤ 5% = low

Daily Values also make it easy to compare foods. For example, a consumer might discover that frozen macaroni and cheese has a Daily Value for fat of 20 percent, whereas macaroni and cheese prepared from a boxed mix has a Daily Value of 15 percent. By comparing labels, consumers who are concerned about their fat intakes can make informed decisions.

The Daily Values used on labels are based in part on values from the 1968 Recommended Dietary Allowances. Since 1997, Dietary Reference Intakes that reflect scientific research on diet and health have been released. Efforts to update the Daily Values based on these current recommendations and to make labels more effective and easier to understand are underway.[10]

HOW TO Calculate Personal Daily Values

The Daily Values on food labels are designed for a 2000-kcalorie intake, but you can calculate a personal set of Daily Values based on your energy allowance. Consider a 1500-kcalorie intake, for example. To calculate a daily goal for fat, multiply energy intake by 30 percent:

1500 kcal × 0.30 kcal from fat
= 450 kcal from fat

The "kcalories from fat" are listed on food labels, so you can add all the "kcalories from fat" values for a day, using 450 as an upper limit. A person who prefers to count grams of fat can divide this 450 kcalories from fat by 9 kcalories per gram to determine the goal in grams:

450 kcal from fat ÷ 9 kcal/g
= 50 g fat

Alternatively, a person can calculate that 1500 kcalories is 75 percent of the 2000-kcalorie intake used for Daily Values:

1500 kcal ÷ 2000 kcal = 0.75
0.75 × 100 = 75%

Then, instead of trying to achieve 100 percent of the Daily Value, a person consuming 1500 kcalories will aim for 75 percent. Similarly, a person consuming 2800 kcalories would aim for 140 percent:

2800 kcal ÷ 2000 kcal = 1.40 or 140%

Table 2-9 includes a calculation column that can help you estimate your personal daily value for several nutrients.

CENGAGENOW™
To calculate your personal daily values, log on to **academic.cengage.com/login**, then go to Chapter 2, then go to How To.

Nutrient Claims

Have you noticed phrases such as "good source of fiber" on a box of cereal or "rich in calcium" on a package of cheese? These and other **nutrient claims** may be used on labels as long as they meet FDA definitions, which include the conditions under which each term can be used. For example, in addition to having less than 2 milligrams of cholesterol, a "cholesterol-free" product may not contain more than 2 grams of saturated fat and *trans* fat combined per serving. The accompanying glossary defines nutrient terms on food labels, including criteria for foods described as "low," "reduced," and "free."

Some descriptions *imply* that a food contains, or does not contain, a nutrient. Implied claims are prohibited unless they meet specified criteria. For example, a claim that a product "contains no oil" *implies* that the food contains no fat. If the product is truly fat-free, then it may make the no-oil claim, but if it contains another source of fat, such as butter, it may not.

nutrient claims: statements that characterize the quantity of a nutrient in a food.

GLOSSARY OF TERMS ON FOOD LABELS

GENERAL TERMS

free: "nutritionally trivial" and unlikely to have a physiological consequence; synonyms include "without," "no," and "zero." A food that does not contain a nutrient naturally may make such a claim, but only as it applies to all similar foods (for example, "applesauce, a fat-free food").

good source of: the product provides between 10 and 19% of the Daily Value for a given nutrient per serving.

healthy: a food that is low in fat, saturated fat, cholesterol, and sodium and that contains at least 10% of the Daily Values for vitamin A, vitamin C, iron, calcium, protein, or fiber.

high: 20% or more of the Daily Value for a given nutrient per serving; synonyms include "rich in" or "excellent source."

less: at least 25% less of a given nutrient or kcalories than the comparison food (see individual nutrients); synonyms include "fewer" and "reduced."

light or **lite:** one-third fewer kcalories than the comparison food; 50% or less of the fat or sodium than the comparison food; any use of the term other than as defined must specify what it is referring to (for example, "light in color" or "light in texture").

low: an amount that would allow frequent consumption of a food without exceeding the Daily Value for the nutrient. A food that is naturally low in a nutrient may make such a claim, but only as it applies to all similar foods (for example, "fresh cauliflower, a low-sodium food"); synonyms include "little," "few," and "low source of."

more: at least 10% more of the Daily Value for a given nutrient than the comparison food; synonyms include "added" and "extra."

organic: on food labels, that at least 95% of the product's ingredients have been grown and processsed according to USDA regulations defining the use of fertilizers, herbicides, insecticides, fungicides, preservatives, and other chemical ingredients.

ENERGY

kcalorie-free: fewer than 5 kcal per serving.

low kcalorie: 40 kcal or less per serving.

reduced kcalorie: at least 25% fewer kcalories per serving than the comparison food.

FAT AND CHOLESTEROL[a]

percent fat-free: may be used only if the product meets the definition of *low fat* or *fat-free* and must reflect the amount of fat in 100 g (for example, a food that contains 2.5 g of fat per 50 g can claim to be "95 percent fat free").

fat-free: less than 0.5 g of fat per serving (and no added fat or oil); synonyms include "zero-fat," "no-fat," and "nonfat."

low fat: 3 g or less fat per serving.

less fat: 25% or less fat than the comparison food.

saturated fat-free: less than 0.5 g of saturated fat and 0.5 g of *trans* fat per serving.

low saturated fat: 1 g or less saturated fat and less than 0.5 g of *trans* fat per serving.

less saturated fat: 25% or less saturated fat and *trans* fat combined than the comparison food.

***trans* fat-free:** less than 0.5 g of *trans* fat and less than 0.5 g of saturated fat per serving.

cholesterol-free: less than 2 mg cholesterol per serving and 2 g or less saturated fat and *trans* fat combined per serving.

low cholesterol: 20 mg or less cholesterol per serving and 2 g or less saturated fat and *trans* fat combined per serving.

less cholesterol: 25% or less cholesterol than the comparison food (reflecting a reduction of at least 20 mg per serving), and 2 g or less saturated fat and *trans* fat combined per serving.

extra lean: less than 5 g of fat, 2 g of saturated fat and *trans* fat combined, and 95 mg of cholesterol per serving and per 100 g of meat, poultry, and seafood.

lean: less than 10 g of fat, 4.5 g of saturated fat and *trans* fat combined, and 95 mg of cholesterol per serving and per 100 g of meat, poultry, and seafood.

CARBOHYDRATES: FIBER AND SUGAR

high fiber: 5 g or more fiber per serving. A high-fiber claim made on a food that contains more than 3 g fat per serving and per 100 g of food must also declare total fat.

sugar-free: less than 0.5 g of sugar per serving.

SODIUM

sodium-free and **salt-free:** less than 5 mg of sodium per serving.

low sodium: 140 mg or less per serving.

very low sodium: 35 mg or less per serving.

[a]Foods containing more than 13 grams total fat per serving or per 50 grams of food must indicate those contents immediately after a cholesterol claim. As you can see, all cholesterol claims are prohibited when the food contains more than 2 grams saturated fat and *trans* fat combined per serving.

Health Claims

Until 2003, the FDA held manufacturers to the highest standards of scientific evidence before approving **health claims** on food labels. Consumers reading "Diets low in sodium may reduce the risk of high blood pressure," for example, knew that the FDA had examined enough scientific evidence to establish a clear link between diet and health. Such reliable health claims make up the FDA's "A" list (see Table 2-10). The FDA refers to these health claims as "unqualified"—not that they lack the necessary qualifications, but that they can stand alone without further explanation or qualification.

These reliable health claims still appear on some food labels, but finding them may be difficult now that the FDA has created three additional categories of claims based on scientific evidence that is less conclusive (see Table 2-11). These categories were added after a court ruled: "Holding only the highest scientific standard for claims interferes with commercial free speech." Food manufacturers had argued that they should be allowed to inform consumers about possible benefits based on less than clear and convincing evidence. The FDA must allow manufacturers to provide information about nutrients and foods that show preliminary promise in preventing disease. These health claims are "qualified"—not that they meet the necessary qualifications, but that they require a qualifying explanation. For example, "Very limited and preliminary research suggests that eating one-half to one cup of tomatoes and/or tomato sauce a week may reduce the risk of prostate cancer. FDA concludes that there is little scientific evidence supporting the claim." Consumer groups argue that such information is confusing. Even with required disclaimers for health claims graded "B," "C," or "D," distinguishing "A" claims from others is difficult, as the next section shows. (Health claims on supplement labels are presented in Highlight 10.)

TABLE 2-10 Food Label Health Claims—The "A" List

- Calcium and reduced risk of osteoporosis
- Sodium and reduced risk of hypertension
- Dietary saturated fat and cholesterol and reduced risk of coronary heart disease
- Dietary fat and reduced risk of cancer
- Fiber-containing grain products, fruits, and vegetables and reduced risk of cancer
- Fruits, vegetables, and grain products that contain fiber, particularly soluble fiber, and reduced risk of coronary heart disease
- Fruits and vegetables and reduced risk of cancer
- Folate and reduced risk of neural tube defects
- Sugar alcohols and reduced risk of tooth decay
- Soluble fiber from whole oats and from psyllium seed husk and reduced risk of heart disease
- Soy protein and reduced risk of heart disease
- Whole grains and reduced risk of heart disease and certain cancers
- Plant sterol and plant stanol esters and heart disease
- Potassium and reduced risk of hypertension and stroke

Structure-Function Claims

Unlike health claims, which require food manufacturers to collect scientific evidence and petition the FDA, **structure-function claims** can be made without any FDA approval. Product labels can claim to "slow aging," "improve memory," and "build strong bones" without any proof. The only criterion for a structure-function claim is that it must not mention a disease or symptom. Unfortunately, structure-function claims can be deceptively similar to health claims. Consider these statements:

- "May reduce the risk of heart disease."
- "Promotes a healthy heart."

Most consumers do not distinguish between these two types of claims.[11] In the statements above, for example, the first is a health claim that requires FDA approval and the second is an unproven, but legal, structure-function claim. Table 2-12 lists examples of structure-function claims.

health claims: statements that characterize the relationship between a nutrient or other substance in a food and a disease or health-related condition.

structure-function claims: statements that characterize the relationship between a nutrient or other substance in a food and its role in the body.

TABLE 2-11 The FDA's Health Claims Report Card

Grade	Level of Confidence in Health Claim	Required Label Disclaimers
A	High: Significant scientific agreement	These health claims do not require disclaimers; see Table 2-10 for examples.
B	Moderate: Evidence is supportive but not conclusive	"[Health claim.] Although there is scientific evidence supporting this claim, the evidence is not conclusive."
C	Low: Evidence is limited and not conclusive	"Some scientific evidence suggests [health claim]. However, FDA has determined that this evidence is limited and not conclusive."
D	Very low: Little scientific evidence supporting this claim	"Very limited and preliminary scientific research suggests [health claim]. FDA concludes that there is little scientific evidence supporting this claim."

TABLE 2-12 Examples of Structure-Function Claims

- Builds strong bones
- Promotes relaxation
- Improves memory
- Boosts the immune system
- Supports heart health
- Defends your health
- Slows aging
- Guards against colds
- Lifts your spirits

NOTE: Structure-function claims cannot make statements about diseases. See Table 2-10 on p. 59 for examples of health claims.

Consumer Education

Because labels are valuable only if people know how to use them, the FDA has designed several programs to educate consumers. Consumers who understand how to read labels are best able to apply the information to achieve and maintain healthful dietary practices.

Table 2-13 shows how the messages from the 2005 *Dietary Guidelines,* the USDA Food Guide, and food labels coordinate with each other. To promote healthy eating and physical activity, the "Healthier US Initiative" coordinates the efforts of national educational programs developed by government agencies.[12] The mission of this initiative is to deliver simple messages that will motivate consumers to make small changes in their eating and physical activity habits to yield big rewards.

TABLE 2-13 From Guidelines to Groceries

Dietary Guidelines	USDA Food Guide/MyPyramid	Food Labels
Adequate nutrients within energy needs	Select the recommended amounts from each food group at the energy level appropriate for your energy needs.	Look for foods that describe their vitamin, mineral, or fiber contents as a *good source* or *high.*
Weight management	Select nutrient-dense foods and beverages within and among the food groups. Limit high-fat foods and foods and beverages with added fats and sugars. Use appropriate portion sizes.	Look for foods that describe their kcalorie contents as *free, low, reduced, light,* or *less.*
Physical activity	Be phyisically active for at least 30 minutes most days of the week. Children and teenagers should be physically active for 60 minutes every day, or most days.	
Food groups to encourage	Select a variety of fruits each day. Include vegetables from all five subgroups (dark green, orange, legumes, starchy vegetables, and other vegetables) several times a week. Make at least half of the grain selections whole grains. Select fat-free or low-fat milk products.	Look for foods that describe their fiber contents as *good source* or *high.* Look for foods that provide at least 10% of the Daily Value for fiber, vitamin A, vitamin C, iron, and calcium from a variety of sources.
Fats	Choose foods within each group that are lean, low fat, or fat-free. Choose foods within each group that have little added fat.	Look for foods that describe their fat, saturated fat, *trans* fat, and cholesterol contents as *free, less, low, light, reduced, lean,* or *extra lean.* Look for foods that provide no more than 5% of the Daily Value for fat, saturated fat, and cholesterol.
Carbohydrates	Choose fiber-rich fruits, vegetables, and whole grains often. Choose foods and beverages within each group that have little added sugars.	Look for foods that describe their sugar contents as *free* or *reduced.* A food may be high in sugar if its ingredients list begins with or contains several of the following: *sugar, sucrose, fructose, maltose, lactose, honey, syrup, corn syrup, high-fructose corn syrup, molasses, evaporated cane juice,* or *fruit juice concentrate.*
Sodium and potassium	Choose foods within each group that are low in salt or sodium. Choose potassium-rich foods such as fruits and vegetables.	Look for foods that describe their salt and sodium contents as *free, low,* or *reduced.* Look for foods that provide no more than 5% of the Daily Value for sodium. Look for foods that provide at least 10% of the Daily Value for potassium.
Alcoholic beverages	Use sensibly and in moderation (no more than one drink a day for women and two drinks a day for men).	*Light* beverages contain fewer kcalories and less alcohol than regular versions.
Food safety		Follow the *safe handling instructions* on packages of meat and other safety instructions, such as *keep refrigerated,* on packages of perishable foods.

IN SUMMARY

Food labels provide consumers with information they need to select foods that will help them meet their nutrition and health goals. When labels contain relevant information presented in a standardized, easy-to-read format, consumers are well prepared to plan and create healthful diets.

This chapter provides the links to go from dietary guidelines to buying groceries and offers helpful tips for selecting nutritious foods. For information on foodborne illnesses, turn to Highlight 18.

Nutrition Portfolio

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The secret to making healthy food choices is learning to incorporate the 2005 *Dietary Guidelines* and the USDA Food Guide into your decision-making process.

- Compare the foods you typically eat daily with the USDA Food Guide recommendations for your energy needs (see Table 2-3 on p. 41 and Table 2-4 on p. 44), making note of which food groups are usually over- or underrepresented.
- Describe your choices within each food group from day to day and include realistic suggestions for enhancing the variety in your diet.
- Write yourself a letter describing the dietary changes you can make to improve your chances of enjoying good health.

NUTRITION ON THE NET

For further study of topics covered in this chapter, log on to **academic.cengage.com/nutrition/rolfes/UNCN8e**. Go to Chapter 2, then to Nutrition on the Net.

- Search for "diet" and "food labels" at the U.S. Government health information site: **www.healthfinder.gov**
- Learn more about the *Dietary Guidelines for Americans:* **www.healthierus.gov/dietaryguidelines**
- Find Canadian information on nutrition guidelines and food labels at: **www.hc-sc.gc.ca**
- Learn more about the USDA Food Guide and MyPyramid: **mypyramid.gov**
- Visit the USDA Food Guide section (including its ethnic/cultural pyramids) of the U.S. Department of Agriculture: **www.nal.usda.gov/fnic**
- Visit the Traditional Diet Pyramids for various ethnic groups at Oldways Preservation and Exchange Trust: **www.oldwayspt.org**
- Search for "exchange lists" at the American Diabetes Association: **www.diabetes.org**
- Learn more about food labeling from the Food and Drug Administration: **www.cfsan.fda.gov**
- Search for "food labels" at the International Food Information Council: **www.ific.org**
- Assess your diet at the CNPP Interactive Healthy Eating Index: **www.usda.gov/cnpp**
- Get healthy eating tips from the "5 a day" programs: **www.5aday.gov** or **www.5aday.org**

NUTRITION CALCULATIONS

CENGAGENOW™ For additional practice log on to **academic.cengage.com/login**. Go to Chapter 2, then to Nutrition Calculations.

These problems will give you practice in doing simple nutrition-related calculations. Although the situations are hypothetical, the numbers are real, and calculating the answers (check them on p. 63) provides a valuable nutrition lesson. Be sure to show your calculations for each problem.

1. *Read a food label.* Look at the cereal label in Figure 2-8 and answer the following questions:
   a. What is the size of a serving of cereal?
   b. How many kcalories are in a serving?
   c. How much fat is in a serving?
   d. How many kcalories does this represent?
   e. What percentage of the kcalories in this product comes from fat?
   f. What does this tell you?
   g. What is the % Daily Value for fat?
   h. What does this tell you?
   i. Does this cereal meet the criteria for a low-fat product (refer to the glossary on p. 58)?
   j. How much fiber is in a serving?
   k. Read the Daily Value chart on the lower section of the label. What is the Daily Value for fiber?
   l. What percentage of the Daily Value for fiber does a serving of the cereal contribute? Show the calculation the label-makers used to come up with the % Daily Value for fiber.
   m. What is the predominant ingredient in the cereal?
   n. Have any nutrients been added to this cereal (is it fortified)?
2. *Calculate a personal Daily Value.* The Daily Values on food labels are for people with a 2000-kcalorie intake.
   a. Suppose a person has a 1600-kcalorie energy allowance. Use the calculation factors listed in Table 2-9 to calculate a set of personal "Daily Values" based on 1600 kcalories. Show your calculations.
   b. Revise the % Daily Value chart of the cereal label in Figure 2-8 based on your "Daily Values" for a 1600-kcalorie diet.

STUDY QUESTIONS

CENGAGENOW™
To assess your understanding of chapter topics, take the Student Practice Test and explore the modules recommended in your Personalized Study Plan. Log on to **academic.cengage.com/login**.

These questions will help you review this chapter. You will find the answers in the discussions on the pages provided.

1. Name the diet-planning principles and briefly describe how each principle helps in diet planning. (pp. 37–39)
2. What recommendations appear in the *Dietary Guidelines for Americans*? (pp. 39–40)
3. Name the five food groups in the USDA Food Guide and identify several foods typical of each group. Explain how such plans group foods and what diet-planning principles the plans best accommodate. How are food group plans used, and what are some of their strengths and weaknesses? (pp. 41–47)
4. Review the *Dietary Guidelines*. What types of grocery selections would you make to achieve those recommendations? (pp. 40, 48–53)
5. What information can you expect to find on a food label? How can this information help you choose between two similar products? (pp. 54–57)
6. What are the Daily Values? How can they help you meet health recommendations? (pp. 55–57)
7. Describe the differences between nutrient claims, health claims, and structure-function claims. (pp. 58–59)

These multiple choice questions will help you prepare for an exam. Answers can be found on p. 63.

1. The diet-planning principle that provides all the essential nutrients in sufficient amounts to support health is:
   a. balance.
   b. variety.
   c. adequacy.
   d. moderation.
2. A person who chooses a chicken leg that provides 0.5 milligram of iron and 95 kcalories instead of two tablespoons of peanut butter that also provide 0.5 milligram of iron but 188 kcalories is using the principle of nutrient:
   a. control.
   b. density.
   c. adequacy.
   d. moderation.
3. Which of the following is consistent with the *Dietary Guidelines for Americans*?
   a. Choose a diet restricted in fat and cholesterol.
   b. Balance the food you eat with physical activity.
   c. Choose a diet with plenty of milk products and meats.
   d. Eat an abundance of foods to ensure nutrient adequacy.
4. According to the USDA Food Guide, added fats and sugars are counted as:
   a. meats and grains.
   b. nutrient-dense foods.
   c. discretionary kcalories.
   d. oils and carbohydrates.
5. Foods within a given food group of the USDA Food Guide are similar in their contents of:
   a. energy.
   b. proteins and fibers.
   c. vitamins and minerals.
   d. carbohydrates and fats.
6. In the exchange system, each portion of food on any given list provides about the same amount of:
   a. energy.
   b. satiety.
   c. vitamins.
   d. minerals.
7. Enriched grain products are fortified with:
   a. fiber, folate, iron, niacin, and zinc.
   b. thiamin, iron, calcium, zinc, and sodium.
   c. iron, thiamin, riboflavin, niacin, and folate.
   d. folate, magnesium, vitamin B_6, zinc, and fiber.

8. Food labels list ingredients in:
   a. alphabetical order.
   b. ascending order of predominance by weight.
   c. descending order of predominance by weight.
   d. manufacturer's order of preference.
9. "Milk builds strong bones" is an example of a:
   a. health claim.
   b. nutrition fact.
   c. nutrient content claim.
   d. structure-function claim.
10. Daily Values on food labels are based on a:
   a. 1500-kcalorie diet.
   b. 2000-kcalorie diet.
   c. 2500-kcalorie diet.
   d. 3000-kcalorie diet.

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ANSWERS

Nutrition Calculations

1. a. ¾ cup (28 g)
   b. 110 kcalories
   c. 1 g fat
   d. 9 kcalories
   e. 9 kcal ÷ 110 kcal = 0.08
      0.08 × 100 = 8%
   f. This cereal derives 8 percent of its kcalories from fat
   g. 2%
   h. A serving of this cereal provides 2 percent of the 65 grams of fat recommended for a 2000-kcalorie diet
   i. Yes
   j. 1.5 g fiber
   k. 25 g
   l. 1.5 g ÷ 25 g = 0.06
      0.06 × 100 = 6%
   m. Corn
   n. Yes

2. a. Daily Values for 1600-kcalorie diet:
   Fat: 1600 kcal × 0.30 = 480 kcal from fat
   480 kcal ÷ 9 kcal/g = 53 g fat
   Saturated fat: 1600 kcal × 0.10 = 160 kcal from saturated fat
   160 kcal ÷ 9 kcal/g = 18 g saturated fat
   Cholesterol: 300 mg
   Carbohydrate: 1600 kcal × 0.60 = 960 kcal from carbohydrate
   960 kcal ÷ 4 kcal/g = 240 g carbohydrate
   Fiber: 1600 kcal ÷ 1000 kcal = 1.6
   1.6 × 11.5 g = 18.4 g fiber
   Protein: 1600 kcal × 0.10 = 160 kcal from protein
   160 kcal ÷ 4 kcal/g = 40 g protein
   Sodium: 2400 mg
   Potassium: 3500 mg

   b.

Total fat	2%	(1 g ÷ 53 g)
Saturated fat	0%	(0 g ÷ 18 g)
Cholesterol	0%	(no calculation needed)
Sodium	10%	(no calculation needed)
Total carbohydrate	10%	(23 g ÷ 240 g)
Dietary fiber	8%	(1.5 g ÷ 18.4 g)

Study Questions (multiple choice)

1. c 2. b 3. b 4. c 5. c 6. a 7. c 8. c 9. d 10. b

HIGHLIGHT 2

Vegetarian Diets

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The waiter presents this evening's specials: a fresh spinach salad topped with mandarin oranges, raisins, and sunflower seeds, served with a bowl of pasta smothered in a mushroom and tomato sauce and topped with grated parmesan cheese. Then this one: a salad made of chopped parsley, scallions, celery, and tomatoes mixed with bulgur wheat and dressed with olive oil and lemon juice, served with a spinach and feta cheese pie. Do these meals sound good to you? Or is something missing . . . a pork chop or ribeye, perhaps?

Would vegetarian fare be acceptable to you some of the time? Most of the time? Ever? Perhaps it is helpful to recognize that dietary choices fall along a continuum—from one end, where people eat no meat or foods of animal origin, to the other end, where they eat generous quantities daily. Meat's place in the diet has been the subject of much research and controversy, as this highlight will reveal. One of the missions of this highlight, in fact, is to identify the *range* of meat intakes most compatible with health. The health benefits of a primarily vegetarian diet seem to have encouraged many people to eat more vegetarian meals. The popular press refers to these "part-time vegetarians" who eat small amounts of meat from time to time as "flexitarians."

People who choose to exclude meat and other animal-derived foods from their diets today do so for many of the same reasons the Greek philosopher Pythagoras cited in the sixth century B.C.: physical health, ecological responsibility, and philosophical concerns. They might also cite world hunger issues, economic reasons, ethical concerns, or religious beliefs as motivating factors. Whatever their reasons—and even if they don't have a particular reason—people who exclude meat will be better prepared to plan well-balanced meals if they understand the nutrition and health implications of vegetarian diets.

Vegetarians generally are categorized, not by their motivations, but by the foods they choose to exclude (see the glossary below). Some people exclude red meat only; some also exclude chicken or fish; others also exclude eggs; and still others exclude milk and milk products as well. In fact, finding agreement on the definition of the term *vegetarian* is a challenge.[1]

As you will see, though, the foods a person *excludes* are not nearly as important as the foods a person *includes* in the diet. Vegetarian diets that include a variety of whole grains, vegetables, legumes, nuts, and fruits offer abundant complex carbohydrates and fibers, an assortment of vitamins and minerals, a mixture of phytochemicals, and little fat—characteristics that reflect current dietary recommendations aimed at promoting health and reducing obesity. Each of these foods—whole grains, vegetables, legumes, nuts, and fruits—independently reduces the risk for several chronic diseases.[2] This highlight examines the health benefits and potential problems of vegetarian diets and shows how to plan a well-balanced vegetarian diet.

GLOSSARY

lactovegetarians: people who include milk and milk products, but exclude meat, poultry, fish, seafood, and eggs from their diets.
- **lacto** = milk

lacto-ovo-vegetarians: people who include milk, milk products, and eggs, but exclude meat, poultry, fish, and seafood from their diets.
- **ovo** = egg

macrobiotic diets: extremely restrictive diets limited to a few grains and vegetables; based on metaphysical beliefs and not on nutrition. A macrobiotic diet might consist of brown rice, miso soup, and sea vegetables, for example.

meat replacements: products formulated to look and taste like meat, fish, or poultry; usually made of textured vegetable protein.

omnivores: people who have no formal restriction on the eating of any foods.
- **omni** = all
- **vores** = to eat

tempeh (TEM-pay): a fermented soybean food, rich in protein and fiber.

textured vegetable protein: processed soybean protein used in vegetarian products such as soy burgers; see also *meat replacements.*

tofu (TOE-foo): a curd made from soybeans, rich in protein and often fortified with calcium; used in many Asian and vegetarian dishes in place of meat.

vegans (VEE-gans): people who exclude all animal-derived foods (including meat, poultry, fish, eggs, and dairy products) from their diets; also called **pure vegetarians, strict vegetarians,** or **total vegetarians.**

vegetarians: a general term used to describe people who exclude meat, poultry, fish, or other animal-derived foods from their diets.

Health Benefits of Vegetarian Diets

Research on the health implications of vegetarian diets would be relatively easy if vegetarians differed from other people only in not eating meat. Many vegetarians, however, have also adopted lifestyles that may differ from many **omnivores:** they typically use no tobacco or illicit drugs, use little (if any) alcohol, and are physically active. Researchers must account for these lifestyle differences before they can determine which aspects of health correlate just with diet. Even then, *correlations* merely reveal what health factors *go with* the vegetarian diet, not what health effects may be *caused by* the diet. Despite these limitations, research findings suggest that well-planned vegetarian diets offer sound nutrition and health benefits to adults.[3] Dietary patterns that include very little, if any, meat may even increase life expectancy.[4]

Weight Control

In general, vegetarians maintain a lower and healthier body weight than nonvegetarians.[5] Vegetarians' lower body weights correlate with their high intakes of fiber and low intakes of fat. Because obesity impairs health in a number of ways, this gives vegetarians a health advantage.

Blood Pressure

Vegetarians tend to have lower blood pressure and lower rates of hypertension than nonvegetarians. Appropriate body weight helps to maintain a healthy blood pressure, as does a diet low in total fat and saturated fat and high in fiber, fruits, vegetables, and soy protein.[6] Lifestyle factors also influence blood pressure: smoking and alcohol intake raise blood pressure, and physical activity lowers it.

Heart Disease

The incidence of heart disease and related deaths is much lower for vegetarians than for meat eaters. The dietary factor most directly related to heart disease is saturated animal fat, and in general, vegetarian diets are lower in total fat, saturated fat, and cholesterol than typical meat-based diets.[7] The fats common in plant-based diets—the monounsaturated fats of olives, seeds, and nuts and the polyunsaturated fats of vegetable oils—are associated with a decreased risk of heart disease.[8] Furthermore, vegetarian diets are generally higher in dietary fiber, antioxidant vitamins, and phytochemicals—all factors that help control blood lipids and protect against heart disease.[9]

Many vegetarians include soy products such as **tofu** in their diets. Soy products may help to protect against heart disease because they contain polyunsaturated fats, fiber, vitamins, and minerals, and little saturated fat.[10] Even when intakes of energy, protein, carbohydrate, total fat, saturated fat, unsaturated fat, alcohol, and fiber are the same, people eating meals based on tofu have lower blood cholesterol and triglyceride levels than those eating meat. Some research suggests that soy protein and phytochemicals may be responsible for some of these health benefits (as Highlight 13 explains in greater detail).[11]

Cancer

Vegetarians have a significantly lower rate of cancer than the general population. Their low cancer rates may be due to their high intakes of fruits and vegetables (as Highlight 11 explains). In fact, the ratio of vegetables to meat may be the most relevant dietary factor responsible for cancer prevention.[12]

Some scientific findings indicate that vegetarian diets are associated not only with lower cancer mortality in general, but also with lower incidence of cancer at specific sites as well, most notably, colon cancer.[13] People with colon cancer seem to eat more meat, more saturated fat, and fewer vegetables than do people without colon cancer. High-protein, high-fat, low-fiber diets create an environment in the colon that promotes the development of cancer in some people. A high-meat diet has been associated with stomach cancer as well.[14]

Other Diseases

In addition to obesity, hypertension, heart disease, and cancer, vegetarian diets may help prevent diabetes, osteoporosis, diverticular disease, gallstones, and rheumatoid arthritis.[15] These health benefits of a vegetarian diet depend on wise diet planning.

Vegetarian Diet Planning

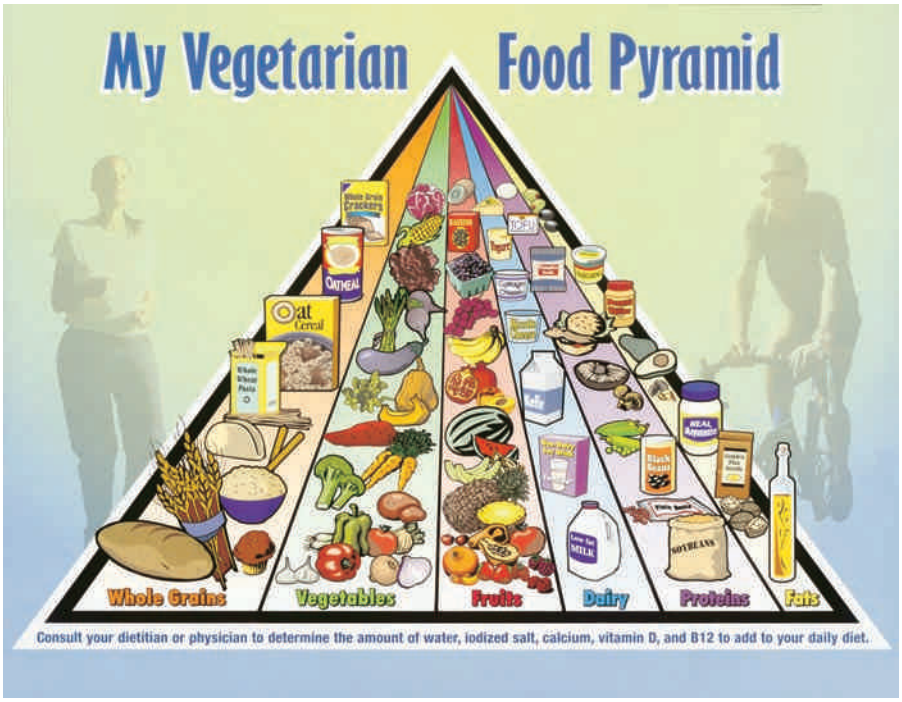
The vegetarian has the same meal-planning task as any other person—using a variety of foods to deliver all the needed nutrients within an energy allowance that maintains a healthy body weight (as discussed in Chapter 2). Vegetarians who include milk products and eggs can meet recommendations for most nutrients about as easily as nonvegetarians. Such diets provide enough energy, protein, and other nutrients to support the health of adults and the growth of children and adolescents.

Vegetarians who exclude milk products and eggs can select legumes, nuts, and seeds and products made from them, such as peanut butter, **tempeh,** and tofu, from the meat group. Those who do not use milk can use soy "milk"—a product made from soybeans that provides similar nutrients if fortified with calcium, vitamin D, and vitamin B_{12}.

The MyPyramid resources include tips for planning vegetarian diets using the USDA Food Guide. In addition, several food guides have been developed specifically for vegetarian diets.[16] They all address the particular nutrition concerns of vegetarians, but differ slightly. Figure H2-1 presents one version. When selecting from the vegetable and fruit groups, vegetarians should emphasize particularly good sources of calcium and iron, respectively. Green leafy vegetables, for example, provide almost five times as much calcium per serving as other vegetables. Similarly, dried fruits deserve special notice in the fruit group because they deliver six

FIGURE H2-1 An Example of a Vegetarian Food Pyramid

Review Figure 2–1 and Table 2–3 to find recommended daily amounts from each food group, serving size equivalents, examples of common foods within each group, and the most notable nutrients for each group. Tips for planning a vegetarian diet can be found at **MyPyramid.gov.**



SOURCE: © GC Nutrition Council, 2006, adapted from USDA 2005 Dietary Guidelines and www.mypyramid.gov. Copies can be ordered from 301-680-6717.

times as much iron as other fruits. The milk group features fortified soy milks for those who do not use milk, cheese, or yogurt. The meat group is called "proteins" and includes legumes, soy products, nuts, and seeds. A group for oils encourages the use of vegetable oils, nuts, and seeds rich in unsaturated fats and omega-3 fatty acids. To ensure adequate intakes of vitamin B_{12}, vitamin D, and calcium, vegetarians need to select fortified foods or take supplements daily. The vegetarian food pyramid is flexible enough that a variety of people can use it: people who have adopted various vegetarian diets, those who want to make the transition to a vegetarian diet, and those who simply want to include more plant-based meals in their diet. Like MyPyramid, this vegetarian food pyramid also encourages physical activity.

Most vegetarians easily obtain large quantities of the nutrients that are abundant in plant foods: thiamin, folate, and vitamins B_6, C, A, and E. Vegetarian food guides help to ensure adequate intakes of the main nutrients vegetarian diets might otherwise lack: protein, iron, zinc, calcium, vitamin B_{12}, vitamin D, and omega-3 fatty acids.

Protein

The protein RDA for vegetarians is the same as for others, although some have suggested that it should be higher because of the lower digestibility of plant proteins.[17] **Lacto-ovo-vegetarians,** who use animal-derived foods such as milk and eggs, receive high-quality proteins and are likely to meet their protein needs. Even those who adopt only plant-based diets are likely to meet protein needs provided that their energy intakes are adequate and the protein sources varied.[18] The proteins of whole grains, legumes, seeds, nuts, and vegetables can provide adequate amounts of all the amino acids. An advantage of many vegetarian sources of protein is that they are generally lower in saturated fat than meats and are often higher in fiber and richer in some vitamins and minerals.

Vegetarians sometimes use **meat replacements** made of **textured vegetable protein** (soy protein). These foods are formulated to look and taste like meat, fish, or poultry. Many of these products are fortified to provide the vitamins and minerals found in animal sources of protein. A wise vegetarian learns to use a variety of whole, unrefined foods often and commercially prepared foods less frequently. Vegetarians may also use soy products such as tofu to bolster protein intake.

Iron

Getting enough iron can be a problem even for meat eaters, and those who eat no meat must pay special attention to their iron intake. The iron in plant foods such as legumes, dark green leafy vegetables, iron-fortified cereals, and whole-grain breads and cereals is poorly absorbed.[19] Because iron absorption from a vegetarian diet is low, the iron RDA for vegetarians is higher than for others (see Chapter 13 for more details).

Fortunately, the body seems to adapt to a vegetarian diet by absorbing iron more efficiently. Furthermore, iron absorption is enhanced by vitamin C, and vegetarians typically eat many vitamin C–rich fruits and vegetables. Consequently, vegetarians suffer no more iron deficiency than other people do.[20]

Zinc

Zinc is similar to iron in that meat is its richest food source, and zinc from plant sources is not well absorbed.[21] In addition, soy, which is commonly used as a meat alternative in vegetarian meals, interferes with zinc absorption. Nevertheless, most vegetarian adults are not zinc deficient. Perhaps the best advice to vegetarians regarding zinc is to eat a variety of nutrient-dense foods; include whole grains, nuts, and legumes such as black-eyed peas, pinto beans, and kidney beans; and maintain an adequate energy intake. For those who include seafood in their diets, oysters, crabmeat, and shrimp are rich in zinc.

Calcium

The calcium intakes of **lactovegetarians** are similar to those of the general population, but people who use no milk products risk

deficiency. Careful planners select calcium-rich foods, such as calcium-fortified juices, soy milk, and breakfast cereals, in ample quantities regularly. This advice is especially important for children and adolescents. Soy formulas for infants are fortified with calcium and can be used in cooking, even for adults. Other good calcium sources include figs, some legumes, some green vegetables such as broccoli and turnip greens, some nuts such as almonds, certain seeds such as sesame seeds, and calcium-set tofu.* The choices should be varied because calcium absorption from some plant foods may be limited (as Chapter 12 explains).

Vitamin B_{12}

The requirement for vitamin B_{12} is small, but this vitamin is found only in animal-derived foods. Consequently, vegetarians, in general, and **vegans** who eat no foods of animal original, in particular, may not get enough vitamin B_{12} in their diets.[22] Fermented soy products such as tempeh may contain some vitamin B_{12} from the bacteria, but unfortunately, much of the vitamin B_{12} found in these products may be an inactive form. Seaweeds such as nori and chlorella supply some vitamin B_{12}, but not much, and excessive intakes of these foods can lead to iodine toxicity. To defend against vitamin B_{12} deficiency, vegans must rely on vitamin B_{12}–fortified sources (such as soy milk or breakfast cereals) or supplements. Without vitamin B_{12}, the nerves suffer damage, leading to such health consequences as loss of vision.

Vitamin D

People who do not use vitamin D–fortified foods and do not receive enough exposure to sunlight to synthesize adequate vitamin D may need supplements to defend against bone loss. This is particularly important for infants, children, and older adults. In northern climates during winter months, young children on vegan diets can readily develop rickets, the vitamin D–deficiency disease.

Omega-3 Fatty Acids

Both Chapter 5 and Highlight 5 describe the health benefits of unsaturated fats, most notably the omega-3 fatty acids commonly found in fatty fish. To obtain sufficient amounts of omega-3 fatty acids, vegetarians need to consume flaxseed, walnuts, soybeans, and their oils.

* Calcium salts are often added during processing to coagulate the tofu.

Healthy Food Choices

In general, adults who eat vegetarian diets have lowered their risks of mortality and several chronic diseases, including obesity, high blood pressure, heart disease, and cancer. But there is nothing mysterious or magical about the vegetarian diet; vegetarianism is not a religion like Buddhism or Hinduism, but merely an eating plan that selects plant foods to deliver needed nutrients. The quality of the diet depends not on whether it includes meat, but on whether the other food choices are nutritionally sound. A diet that includes ample fruits, vegetables, whole grains, legumes, nuts, and seeds is higher in fiber, antioxidant vitamins, and phytochemicals, and lower in saturated fats than meat-based diets. Variety is key to nutritional adequacy in a vegetarian diet. Restrictive plans, such as **macrobiotic diets,** that limit selections to a few grains and vegetables cannot possibly deliver a full array of nutrients.

If not properly balanced, any diet—vegetarian or otherwise—can lack nutrients. Poorly planned vegetarian diets typically lack iron, zinc, calcium, vitamin B_{12}, and vitamin D; without planning, the meat eater's diet may lack vitamin A, vitamin C, folate, and fiber, among others. Quite simply, the negative health aspects of any diet, including vegetarian diets, reflect poor diet planning. Careful attention to energy intake and specific problem nutrients can ensure adequacy.

Keep in mind, too, that diet is only one factor influencing health. Whatever a diet consists of, its context is also important: no smoking, alcohol consumption in moderation (if at all), regular physical activity, adequate rest, and medical attention when needed all contribute to a healthy life. Establishing these healthy habits early in life seems to be the most important step one can take to reduce the risks of later diseases (as Highlight 15 explains).

NUTRITION ON THE NET

For further study of topics covered in this chapter, log on to **academic.cengage.com/nutrition/rolfes/UNCN8e**. Go to Chapter 2, then to Nutrition on the Net.

- Search for "vegetarian" at the Food and Drug Administration's site: **www.fda.gov**
- Visit the Vegetarian Resource Group: **www.vrg.org**
- Review another vegetarian diet pyramid developed by Oldways Preservation & Exchange Trust: **www.oldwayspt.org**