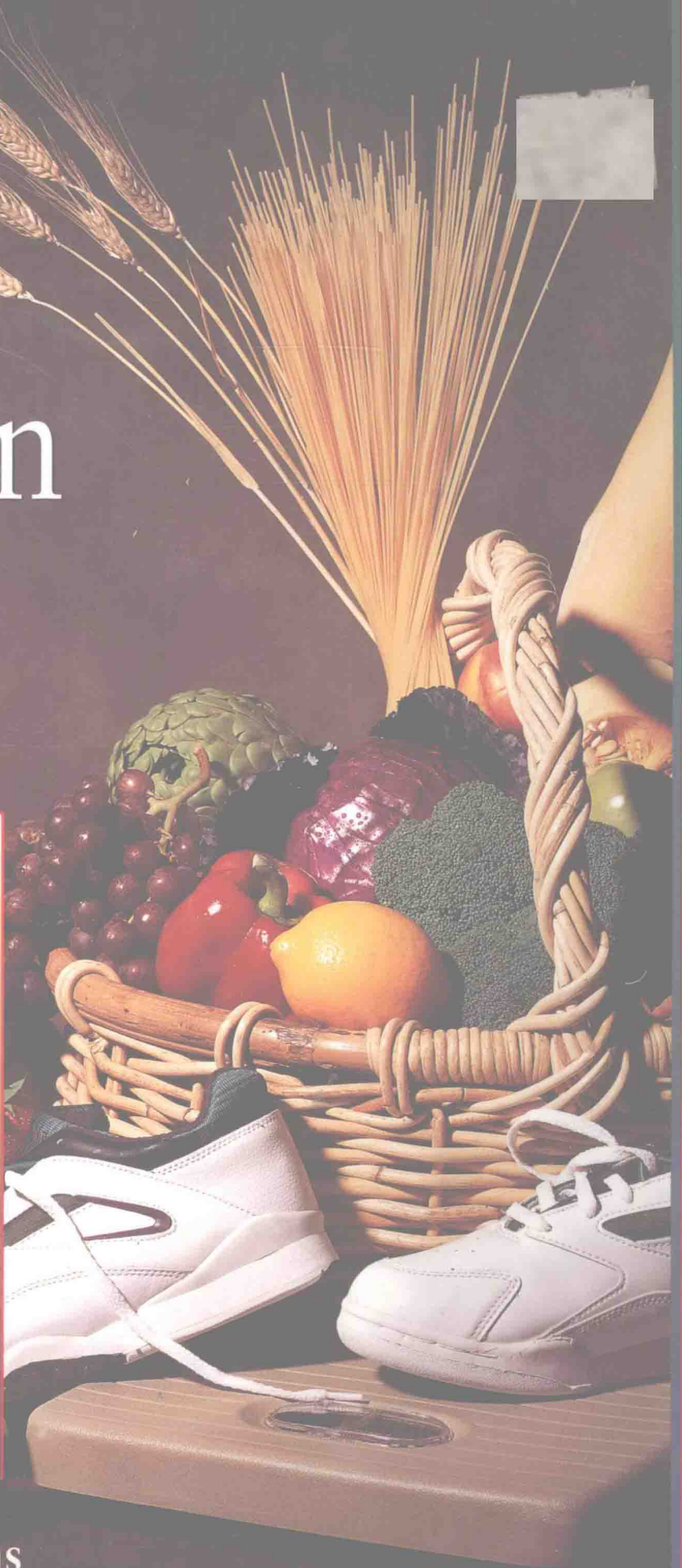


FIFTH EDITION

# Nutrition

FOR HEALTH,  
FITNESS  
&  
SPORT



Melvin H. Williams



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# Preface

**A**s we move toward the year 2000, our love affair with fitness and sports continues to grow. Americans and Canadians are no longer nations of spectators; more of us are becoming participants in physical activities such as aerobic dancing, bicycling, golf, running, swimming, tennis, weight lifting, and a host of other recreational activities and sports. Improvement in health and fitness is one of the major reasons that more and more people initiate an exercise program. But many also are finding the joy of athletic competition, such as participation in local 10-kilometer road races.

Research has shown that adults who become physically active also may become more interested in other aspects of their life-styles—particularly nutrition—that may affect their health in a positive way. Indeed, research findings continue to indicate that our diet is one of the most important determinants of our health status.

Moreover, individuals who compete athletically are always looking for a means to improve performance, be it a new piece of equipment or an improved training method. In this regard, proper nutrition may be an important factor in improving physical and athletic performance.

Nutrition is the study of foods and their effects upon health, development, and performance of the individual. The science of human nutrition has made a significant contribution to our knowledge of essential nutrient needs during the early part of this century. More recently, nutrition research has focused on the effects of foods, and their specific constituents, on health and performance. However, because most nutritional studies with humans cannot be controlled under exacting laboratory conditions, human nutrition science is not as precise as other scientific areas of study such as chemistry and physics. Given the basic physiological drives for food and fluid and the psychological overtones that surround our eating behaviors, certain individuals and commercial organizations have exploited this imprecise nature of human nutrition science for financial gains by distorting nutritional facts. Quackery represents fraudulent misrepresentation, and the area of nutrition is filled with numerous nutritional products and dietary supplements that may be classified as fraudulent and marketed to all segments of the population, from young children to the geriatric.

Because they are more likely to be interested in preserving their health, physically active individuals are major targets for those who market and sell nutritional supplements. A variety of media for active people, including the Internet and magazines, are filled with advertisements extolling the virtues of various supplements that are said to do everything from preventing aging to improving athletic performance. Some of these supplements include essential nutrients, such as calcium and vitamin E, whereas others contain compounds of dubious nutritional value, such as coenzyme Q<sub>10</sub> and vitamin B<sub>15</sub>, a nonvitamin. One purpose of this book is to help dispel the myths and misconceptions associated with nutrition for physically active individuals.

This book uses a question–answer approach, which is convenient when you have occasional short periods to study such as riding a bus or during a lunch break. In addition, the questions are arranged in a logical sequence, the answer to one question often leading into the question that follows. Where appropriate, cross-referencing within the text is used to expand the discussion. No deep scientific background is needed for the chemical aspects of nutrition and energy expenditure, as these have been simplified. Instructors who use this book as a course text may add details of biochemistry as they feel necessary.

Chapter 1 introduces you to the interrelationships between exercise and nutrition and their effects on health-related and sports-related fitness, while Chapter 2 provides a broad overview of sound guidelines relative to nutrition for optimal health and physical performance. Chapter 3 focuses upon energy and energy pathways in the body, the key to all physical activities.

Chapters 4 through 9 deal with the six basic nutrients—carbohydrate, fat, protein, vitamins, minerals, and water—with emphasis on the health and performance implications for the physically active individual. Chapters 10 through 12 review concepts of body composition and weight control, with suggestions on how to gain or lose body weight through diet and exercise, as well as the implications of such changes for health and athletic performance. Numerous appendixes complement the text, providing data on caloric expenditure during exercise, methods to determine body composition, how to use the

Internet to obtain sound information regarding nutrition and exercise, nutritional value of fast foods, and other information pertinent to physically active individuals.

Key concepts are presented at the beginning of each chapter, a kind of preliminary summary. These can be used for previewing the chapter and for reinforcement once the chapter has been completed. Key terms also are listed at the beginning of the chapter and highlighted, in most cases, when they are first defined in the text. Although some terms may appear in the text before they are defined, a thorough glossary includes the key terms as well as other terms warranting definition.

The bibliographic references are of three types. Books listed provide broad coverage of the major topics in the chapter. Review articles are detailed analyses of selected topics, usually involving a synthesis and analysis of specific research studies. The specific studies listed are primary research studies. The reference lists have been completely updated for this fifth edition and provide the scientific basis for the new concepts or additional support for those concepts previously developed. These references provide greater in-depth reading materials for the interested student. Although the content of this book is based on appropriate scientific studies, a reference-citation style is not used, that is, each statement is not referenced by a bibliographic source. However, names of authors may be used to highlight a reference source where deemed appropriate.

Your involvement in practical activities is encouraged. There are a number of opportunities for the reader to get actively involved: estimation of your percent body fat, estimation of the number of Calories to maintain body weight, designing a 1,200-Calorie diet, calculating the caloric expenditure for a given exercise, or initiating a sound exercise program based upon contemporary principles of exercise prescription.

This book is designed primarily to serve as a college text in professional preparation programs in health and physical education, exercise science, sports medicine, and sports nutrition. It is also directed to the physically active individual interested in the nutritional aspects of physical and athletic performance.

Those who may desire to initiate a physical training program may also find the nutritional information useful, as well as the guidelines for initiating a training program. This book may serve as a handy reference for coaches, trainers, and athletes. With the tremendous expansion of youth sports programs, parents may find the information valuable relative to the nutritional requirements of their active children.

In summary, the major purpose of this book is to help provide a sound knowledge base relative to the role that nutrition, complemented by exercise, may play in the enhancement of both health and sport performance. Hopefully, the information provided in this text will help not only the reader to develop a more healthful diet, but communicate this information to others. Bon appetit!

## Supplementary Materials

### For instructors

#### ***Instructor's Manual and Test Bank***

The Instructor's Manual contains objectives, key terms, and outlines for each chapter, and the test bank section contains true-false and multiple-choice questions.

The fifth edition manual once again benefits from the expertise of Gayle A. Runke, M.S., who is presently an assistant professor in the Health, Physical Education, and Recreation department at Southwest Missouri State University. In addition to having co-authored the Instructor's Manual that accompanies the fourth edition of *Nutrition for Fitness & Sport*, she has also written two editions of the Instructor's Manuals that accompany *Lifetime Fitness and Wellness*, also by Melvin Williams.

***MicroTest III Computerized Test Bank*** Instructors who adopt this text can receive the computerized test bank for Windows or Macintosh. This software allows the instructor to select, edit, delete, or add questions, and print tests and answer keys.

***Transparencies*** Twenty-five two-color and black and white acetates feature key illustrations from the text.

***Nutrition Videos and Videodiscs*** Available to qualified adopters. Please contact your local WCB/McGraw-Hill sales representative or Customer Service at 800-338-3987.

***Nutri-News*** Upon request, adopters are given the password to this electronic newsletter (located on the WCB/McGraw-Hill nutrition web site at <http://www.mhhe.com/hper/nutrition/>) made up of nutrition-related articles.

### For students

***Workbook*** The Workbook is designed to help students review the concepts presented in the text, and put them to practical use. It contains a variety of exercises and activities including sample multiple-choice, matching, true-false, problems, and essay questions.

The Workbook was prepared by Charlene Harkins, M.Ed., R.D., L.D. Charlene is also certified with the American College of Sports Medicine (ACSM), and is a Fellow of the American Dietetics Association. She presently teaches health and nutrition classes at the University of Minnesota-Duluth.

***Annual Editions: Nutrition*** Supplement any of your nutrition texts with this compilation of carefully selected nutrition-related articles from magazines, newspapers, and journals, which is updated annually.

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software program that allows users to track energy intake and expenditure, set weight goals, and more. This software is available on disk or CD-ROM for Macintosh and Windows.

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*Melvin H. Williams  
Virginia Beach, Virginia*





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# Introduction to Nutrition for Health, Fitness and Sports Performance



## CHAPTER 1

### KEY CONCEPTS

- Six of the ten chronic diseases in the United States and Canada (heart diseases, cancer, stroke, lung diseases, diabetes, and liver diseases) may be prevented by appropriate life-style behaviors.
- The two primary determinants of health status are genetics and lifestyle.
- Two of the key health promotion objectives set by the Public Health Service in *Healthy People 2000* are increased levels of physical activity and exercise and improved dietary practices.
- Health-related fitness includes a healthy body weight, cardiovascular-respiratory fitness, adequate muscular strength and endurance, and sufficient flexibility.
- Physical inactivity may be dangerous to your health. As documented in the *Surgeon General's Report on Physical Activity and Health*, exercise, as a form of physical activity, is becoming increasingly important as a means to help prevent, and even treat, many chronic diseases.
- One of the key points of the Surgeon General's report is that physical activity need not be strenuous to achieve health benefits, but additional benefits may be gained through greater amounts of physical activity.
- The primary purpose of the food we eat is to provide us with nutrients essential for the numerous physiological and biochemical functions that support life.

- Poor eating habits span all ages. The Public Health Service in *Healthy People 2000* notes that poor nutrition is a major health problem in the United States.
- Basic guidelines for A Healthy North American Diet include maintenance of proper body weight and consumption of a wide variety of natural foods high in complex carbohydrates and low in fat.
- Although both proper exercise and sound nutrition habits may confer health benefits separately, health benefits may be maximized when both healthy exercise and nutrition life-styles are adopted.
- Success in sports is primarily dependent on genetic endowment and proper training, but nutrition also can be an important contributing factor.
- Studies reveal that although athletes desire to eat a diet that may enhance sport performance, their knowledge of nutrition is inadequate. Surveys indicate athletes are consuming less than the RDA for several nutrients, particularly those attempting to lose weight for competition, and many are not meeting the recommendations of sports nutritionists.
- A dietary supplement is a food product, added to the total diet, that may contain a number of ingredients, including vitamins, minerals, herbs or botanicals, amino acids, metabolites, constituents, extracts, or any combination of the above.

### KEY TERMS

A Healthy North American Diet  
antipromoters  
chronic-training effect  
dietary supplement  
doping  
ergogenic aids  
epidemiological research  
exercise  
experimental research  
health-related fitness  
malnutrition  
meta-analysis  
nutraceutical  
nutrient  
nutrition  
physical activity  
physical fitness  
promoters  
quackery  
risk factor  
sports nutrition  
sports-related fitness  
structured physical activity  
unstructured physical activity



- Although some people may need dietary supplements for various reasons, the use of supplements should not be routine practice for most individuals. Obtain nutrients through natural foods.
- Probably the most prevalent ergogenic aids used to increase sport performance are those classified as nutritional, for theoretical nutritional aids may be found in all six classes of nutrients.
- There appears to be no sphere of nutrition in which faddism, misconceptions, ignorance, and quackery are more obvious than in athletics.
- Nutritional quackery persists in sports for a variety of reasons, including the imitation

of dietary practices of star athletes, misleading articles in sports magazines, inadequate nutritional knowledge of coaches, and direct advertising.

- There are a number of guidelines to help identify false claims of dietary supplements, but one of the critical points to consider is if the claim simply appears to be too good to be true.
- The best means to counteract nutritional quackery in sports is to possess a good background in nutrition.
- Prudent nutritional recommendations for enhancement of health or athletic performance are based on reputable research.

## INTRODUCTION

There are two major focal points of this book. One is the role that nutrition, complemented by physical activity and exercise, may play in determining one's health status. The other is the role that nutrition may play in the enhancement of fitness and sports performance.

*Nutrition, fitness, and health.* At a national level, the health care of Americans and Canadians has improved tremendously over the past century. Primarily because of the dedicated work of medical researchers, we no longer fear the scourge of acute infectious diseases such as polio, smallpox, or tuberculosis. However, we have become increasingly concerned with the treatment and prevention of chronic diseases. Six of the ten leading causes of death in the United States are chronic diseases. Given with rank in parentheses, they include: (1) diseases of the heart, (2) cancer, (3) stroke, (4) chronic lung diseases, (7) diabetes, and (10) chronic liver disease and cirrhosis. These diseases cause over 80 percent of all deaths and this figure is destined to rise as the U.S. population becomes increasingly older, particularly during the first quarter of the twenty-first century when the baby boomers of the 1940s and 1950s reach their senior years.

The two primary factors that influence one's health status are genetics and life-style. Most diseases have a genetic basis, but whether or not an individual develops a particular disease may be dependent more upon his or her life-style. For example, cancer is a disease with a strong genetic link, but bad habits and an unhealthy life-style, such as smoking, poor diet, and lack of exercise cause about two-thirds of cancer deaths.

Although the treatment of these major chronic diseases has greatly improved through techniques such as coronary artery bypass surgery, radiation treatment, and drug therapy, the healing process may be prolonged and

very expensive. Foreseeing a financial health care crisis for the government in the twenty-first century, most health professionals have advocated prevention as the best approach to address this potential major health problem. In this regard, the Public Health Service of the United States Department of Health and Human Services has published a report entitled *Healthy People 2000: National Health Promotion/Disease Prevention Objectives*. One of the major sections of this report deals with health promotion, which includes a number of life-style factors that are basically under the control of the individual. C. Everett Koop, the former Surgeon General of the United States, has noted that the best way to decrease the demand for health care is for each one of us to take charge of our own health.

Over the years, scientists in the field of epidemiology have identified a number of life-style factors considered to be health risks; these life-style factors are known as risk factors. A **risk factor** is a health behavior that has been associated with a particular disease, such as cigarette smoking being linked to lung cancer. As we shall see, exercise and proper nutrition, both individually and combined, may reduce many of the risk factors associated with the development of chronic diseases. These healthful benefits will be addressed at appropriate points throughout the book.

*Nutrition, fitness, and sport.* Sport is now most commonly defined as a competitive athletic activity requiring skill or physical prowess, for example, baseball, basketball, soccer, football, racing, wrestling, tennis, and golf. As with health status, athletic ability and subsequent success in sport are based primarily upon two factors: natural genetic endowment and state of training. To be successful at high levels of competition, the athlete must possess the appropriate biomechanical, physiological, and psychological genetic characteristics associated with success

in a given sport, and these genetic characteristics must be developed maximally through proper biomechanical, physiological, and psychological coaching and training.

Specialized exercise training is the major means to improve athletic performance. Athletes at all levels of competition, whether for an Olympic gold medal or an age-group award in a local road race, are always interested in ways to improve their performance and gain an edge on the competition. There is nothing an athlete can do to modify his or her genetic endowment, but training programs have become more intense and individualized, resulting in significant performance gains.

Proper nutrition is also an important component in the total training program of the athlete. Certain nutrient

deficiencies can seriously impair performance, while supplementation of other nutrients may help delay fatigue and improve performance. Over the past three decades, research has provided us with many answers about the role of nutrition in athletic performance, but unfortunately some findings have been misinterpreted or exaggerated so that a number of misconceptions still exist.

The purpose of this chapter is to provide a broad overview of the role that nutrition may play relative to health, fitness, and sport, and how prudent recommendations may be determined. More detailed information regarding specific relationships of nutritional practices to health and sports performance is provided in the following chapters.

## Nutrition, Exercise, and Health-Related Fitness

**Physical fitness** may be defined, in general terms, as a set of abilities individuals possess to perform specific types of physical activity. The development of physical fitness is an important concern of many professional health organizations, including the American Alliance for Health, Physical Education, Recreation, and Dance (AAHPERD), which has categorized fitness components into two different categories. In general, these two categories may be referred to as health-related fitness and sports-related fitness. Both types of fitness may be influenced by nutrition and exercise.

## Exercise and Health-Related Fitness

### What is health-related fitness?

As mentioned above, one's health status is influenced strongly by hereditary predisposition and life-style behaviors, particularly appropriate physical activity and a high-quality diet. As we shall see in various sections of this book, one of the key factors in preventing the development of chronic disease is maintaining a healthful body weight.

Proper physical activity may certainly improve one's health status by helping to prevent excessive weight gain, but it may also enhance other facets of health-related fitness as well. **Health-related fitness** includes not only a healthy body weight and composition, but also cardiovascular-respiratory fitness, adequate muscular strength and endurance, and sufficient flexibility (Figure 1.1). Several health professional organizations, such as the American College of Sports Medicine (ACSM), have indicated that various forms of physical activity may be used to enhance health.

In general, **physical activity** involves any bodily movement caused by muscular contraction that results in the expenditure of energy. For purposes of studying its effects on health, epidemiologists classify physical activity as either unstructured or structured.

**Unstructured physical activity** includes many of the usual activities of daily life, such as walking, climbing stairs, leisurely cycling, dancing, gardening and yard work, various domestic and occupational activities, and games and other childhood pursuits.

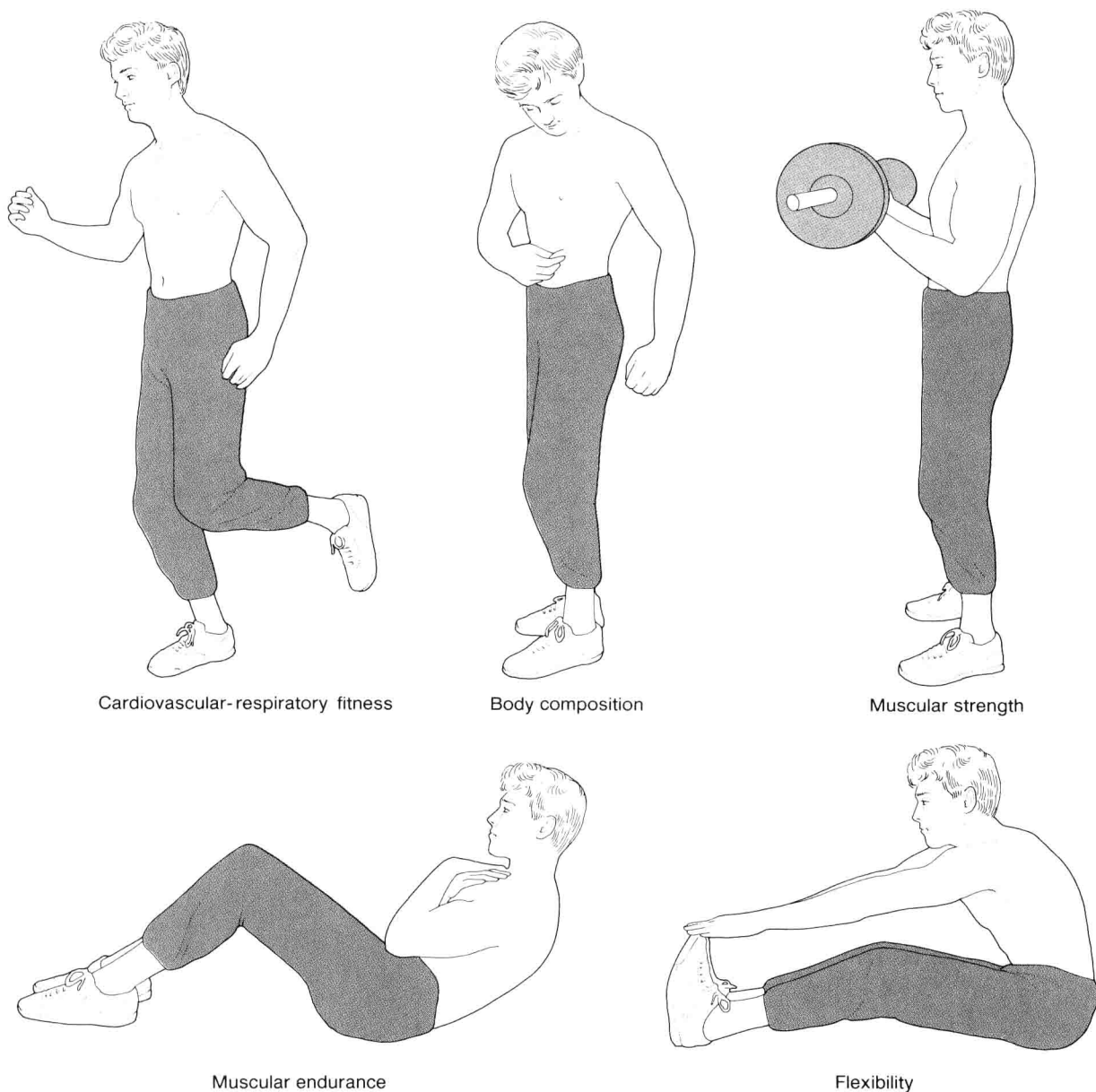
**Structured physical activity**, as the name implies, is a planned program of physical activities usually designed to improve physical fitness, including health-related fitness. For the purpose of this book, we shall refer to structured physical activity as **exercise**, particularly some form of planned vigorous exercise.

### What is the role of exercise in health promotion?

As is for physical activity, exercise is becoming increasingly important as a means to help prevent, and even treat, many of the chronic diseases that afflict developed societies, including coronary artery disease, stroke, hypertension, cancer, diabetes, arthritis, osteoporosis, chronic lung disease, and obesity. Indeed, some physicians indicate that exercise is the best medicine of all because it offers such an array of health benefits.

Numerous scientific reports have detailed the health benefits of regular physical activity, including *Physical Activity, Fitness and Health* by Claude Bouchard, Roy Shephard, and Thomas Stephens; the World Forum International Scientific Consensus Conference on Physical Activity, Health, and Well Being; the National Institutes of Health (NIH) Consensus Development Conference on Physical Activity and Cardiovascular Health; the ACSM and Centers for Disease Control and Prevention (CDC) report on Physical Activity and Public Health; and, most notably, the recent release of *The Surgeon General's Report on Physical Activity and Health*. Collectively, as presented in Table 1.1, these reports document the significant health benefits of habitual physical activity. These benefits may accrue to males and females of all races across all age spans. You are never too young or too old to reap the health benefits of exercise.

In essence, physically active individuals enjoy a higher quality of life, a *joie de vivre*, because they are less likely to



**Figure 1.1** Health-related fitness components. The most important physical fitness components related to personal health

include cardiovascular-respiratory fitness, body and composition, muscular strength, muscular endurance, and flexibility.

suffer the disabling symptoms often associated with chronic diseases, such as loss of ambulation experienced by some stroke victims. Indeed, physical activity may also increase the quantity of life. Lee and Paffenbarger estimated that a physically active life-style may add approximately two years of life by averting premature mortality.

The role that exercise may play in the prevention of some chronic diseases, such as diabetes, and other associated risk factors, such as obesity, are discussed throughout this book where relevant.

### Do most of us exercise enough?

In general, no. Surveys reveal that most Americans have little or no physical activity in their daily lives. Although

about 15 percent of U.S. adults engage regularly in vigorous physical activity at least three times a week during leisure time, more than 60 percent do not engage in recommended amounts of physical activity and approximately 25 percent are not active at all. Physical activity is more common among men than women, but decreases with age. Nearly half of American youths are not vigorously active on a regular basis, and participation in all types of physical activity declines strikingly as age or grade in school increases.

In *Healthy People 2000*, the Public Health Service has established various physical activity and fitness objectives to increase both unstructured and structured physical activity for children, adolescents, and adults in order to develop cardiovascular fitness, to increase muscular