

## Introduction to Kinesiology: The Science of Human Physical Activity

by Stephen Wallace

### Included in this preview:

- Copyright Page
- Table of Contents
- Excerpt of Chapter 1

For additional information on adopting this book for your class, please contact us at 800.200.3908 x501 or via e-mail at [info@cognella.com](mailto:info@cognella.com)

# Sneak Preview

# INTRODUCTION TO KINESIOLOGY

THE SCIENCE OF HUMAN  
PHYSICAL ACTIVITY

Stephen Wallace

Copyright © 2011 University Readers Inc. All rights reserved. No part of this publication may be reprinted, reproduced, transmitted, or utilized in any form or by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying, microfilming, and recording, or in any information retrieval system without the written permission of University Readers, Inc.

First published in the United States of America in 2011 by Cognella, a division of University Readers, Inc.

Trademark Notice: Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation without intent to infringe.

15 14 13 12 11 1 2 3 4 5

Printed in the United States of America

ISBN: 978-1-60927-801-4

Cover photograph, "Makaila Wallace," by Michael Slobodian.



[www.cognella.com](http://www.cognella.com) 800.200.3908

---

# CONTENTS

PREFACE	v
CHAPTER ONE <b>Kinesiology: The Emergence of a New Field of Study</b>	<b>1</b>
CHAPTER TWO <b>The History of Kinesiology</b>	<b>21</b>
CHAPTER THREE <b>Anatomical and Physiological Systems</b>	<b>67</b>
CHAPTER FOUR <b>Exercise Physiology Foundations</b>	<b>107</b>
CHAPTER FIVE <b>Biomechanical Foundations</b>	<b>137</b>
CHAPTER SIX <b>Motor Control and Motor Learning Foundations</b>	<b>163</b>
CHAPTER SEVEN <b>Psychological Foundations</b>	<b>203</b>
CHAPTER EIGHT <b>Developmental Foundations</b>	<b>235</b>

CHAPTER NINE  
**Sociocultural Foundations**

**271**

CHAPTER TEN  
**Epilogue**

**299**

## Preface

For humans and other animals, movement is critical for survival. Without movement, our ability to communicate through speech and gesturing to satisfy basic needs would be lost. Even a lack of adequate movement or physical activity negatively impacts our physiological and psychological states. Humans incarcerated for long time periods without the opportunity for physical activity suffer physiological and psychological deterioration. On the other hand, optimal amounts of physical activity provide benefits to our physical and mental conditions. In addition, how we actually produce movement is of great importance to coaches and teachers of aspiring athletes, to physical therapists who aid in the rehabilitation of physically impaired individuals, to engineers and ergonomists who build machines and construct work environments to match human abilities, and to scientists trying to unravel the great mysteries of how skilled movement is acquired. Given the importance of movement to our very survival and to our quality of life, the scientific study of human movement is clearly warranted. In short, movement matters.

Kinesiology, derived from the Greek terms *kinesis* (movement) and *logos* (the study of), is a field dedicated to the study of human physical activity. The earlier use of the term *kinesiology* was restricted to

applied biomechanics, but recently it is becoming more common to use the term for representing the entire scope of the study of human movement and physical activity.

What is this scope? All movements, large and small, simple and elaborate, are the result of complex interactions of anatomical (bones, muscles, tendons, etc.) and neurophysiological components. The millions of nerve cells in our nervous system allow us to formulate intentional behavior, react to stimuli and maintain balance and posture. Our anatomy serves as the “foundation” for all movement. Thus, human anatomy and physiology are essential elements of the field of study we call kinesiology. Biomechanical principles, adapted from physics, allow us to characterize the forces produced by the body and those that act on the body, such as gravity, as well as provide detailed description and efficiency of movement. Concepts in motor control and motor learning are required to help us understand how we coordinate movements and acquire new motor skills. Psychological factors, such as motivation and stress, are known to influence the quality of performance and determine our desire or aversion to participate in physical activity. Our physical and mental conditions are also affected by the aging process. A “life-span” developmental

kinesiology perspective is required to understand reflexive movement, the development of intentional skilled movement, and the decline in physiological and behavioral functions with age. Understanding of the sociocultural aspects of movement and physical activity is needed to answer questions related to differences in physical activity patterns of boys and girls, of different racial groups and older adults, and the influence of sport on the adoption of a physically active lifestyle. Another important element of any field of study is to have an understanding of its history. Identifying the important people and events that have influenced the development of kinesiology is useful in acquiring a perspective of how the field got to where it is, as well as trying to understand where it is going. Related to the historical understanding of kinesiology is the philosophical understanding of kinesiology as a field of study. In what ways can we view kinesiology as a field of study? For example, is kinesiology simply a collection of separate areas of study (biomechanics, exercise physiology, etc.), or does kinesiology provide a home for all the various subfields, such that integration of the contents of the subfields can occur?

Thus, an understanding of how we move, what motivates our actions, and the physiological and psychological benefits of physical activity requires a firm “grounding” in the areas of human anatomy and physiology, biomechanics, exercise physiology, motor learning and motor control, sport and exercise psychology, motor development, and the sociocultural aspects of human movement. It is also important to have a historical and philosophical perspective on human physical activity. The field of study called kinesiology provides a scholarly home for these areas. Today, many major universities in the country have a kinesiology department consisting of scholars in most or all of the above areas. Other related department names are used to describe this field, such as Exercise and Sport Science, Human Movement Studies, and so forth.

As the field of kinesiology continues to develop, I believe it is important to provide an introductory text that reviews the major concepts, principles, and experimental findings for the curious yet serious student. Most major fields of study have a text(s) that

provides this type of information in a readable yet scientifically rigorous format for the student. However, there are only a few texts today that specifically focus on the field of kinesiology as described above or that provide suitable introductory information. This text attempts to address this need.

This text is primarily designed for the student who either intends to enter the field of kinesiology or is simply curious about the field. It is my hope that this text will provide a scholarly introduction to the field of kinesiology for those students interested in careers in physical education, coaching, ergonomics, physical therapy, sport psychology, medicine and other health-related professions, for example. The text is also designed to help prepare students for future core courses taken in kinesiology such as biomechanics, exercise physiology, etc.

The ten chapters in the text are arranged in the order that I have taught an Introduction to Kinesiology class in the past. The order of the chapters could be changed to fit the needs of the instructor. Chapter One, **Kinesiology: The Emergence of a New Field of Study**, discusses the focus of kinesiology, defines the various subfields, and describes the cross- and interdisciplinary nature of kinesiological inquiry. In addition, Chapter One identifies the links to professional and performance areas, outlines a typical kinesiology degree, and describes career options for the undergraduate kinesiology student.

Chapter Two, **The History of Kinesiology**, provides an account of the promotion of physical activity in different civilizations and cultures throughout history. This chapter also identifies important names and events of scientific contributions to our understanding of the human engaged in physical activity, and summarizes the development of kinesiology as a field of study. Chapter Two is presented in a chronological (as opposed to a thematic) framework and is an attempt to provide some useful information on the development of inquiry into the study of and participation in physical activity throughout history.

Chapter Three, **Anatomical and Physiological Systems**, provides background information for the beginning student on several physiological systems of the human body. The knowledgeable reader will

notice that not all physiological systems are discussed. Only those systems I thought would be helpful in understanding the subsequent chapters were included.

Chapter Four, **Exercise Physiology Foundation**, provides information on energy utilization during movement and exercise, cardiovascular changes with exercise, and ventilatory changes with exercise. This chapter also provides some discussion of the importance of physical activity and exercise to health and fitness.

Chapter Five, **Biomechanical Foundation**, describes types of human motions, as well as linear and angular kinetics and kinematics. The chapter also discusses the nature of Newton's three laws of motion and how they may be applied to human motion.

Chapter Six, **Motor Control and Motor Learning Foundation**, gives an overview of the neuromuscular system and briefly describes some major models of motor control. The chapter also provides an account of variables affecting the speed and accuracy of movement. Finally, the chapter discusses some important factors affecting the learning of motor skills.

Chapter Seven, **Psychological Foundations**, describes major components within the subfield of sport and exercise psychology. This chapter overviews important psychological factors in human performance, cognitive strategies for enhancing performance, and some issues in health psychology related to physical activity.

Chapter Eight, **Developmental Foundations**, details some important developmental concepts and terms, anatomical and physiological developmental changes, and characteristics of motor development in the child. In addition, the influence of aging on health and performance is discussed.

Chapter Nine, **Sociocultural Foundations**, discusses the relevance of sociological and cultural factors to kinesiology, different sociology theories, and the influence of rationalization on participation in physical activity. A variety of sociocultural issues related to participation in sports and other physical activities is covered.

Finally, Chapter Ten, **Epilogue**, provides a rationale for an integrative approach to research and teaching

in the field of kinesiology. In addition, Chapter Ten discusses some philosophical issues related to the nature of inquiry in kinesiology and provides some closing remarks on the future of kinesiology.

Because of the large content in kinesiology, it was not possible to cover every aspect, issue, or scientific problem within each subfield. I am sure I will be criticized by some who may feel I have left out some important areas.

To improve the readability and hopefully the retention of the material, important words and names are highlighted in each chapter. Also, brief summaries after each section are provided in every chapter, and all chapters finish with a chapter summary. In addition, most of the chapters contain one or more highlighted boxes and several figures to enhance the material in the text. Important terms are listed at the end of each chapter. To challenge the reader's understanding of the material, I have included a section at the end of each chapter called "Integrating Kinesiology: Putting It All Together." These sections contain questions and exercises on the material that occasionally require the reader to refer to material in previous chapters. Finally, I have included some websites at the end of each chapter that provide additional information about the discussion material and important links to related information that will hopefully be interesting for the reader.

There are a number of people I must thank who have helped me in different ways throughout the duration of this writing project. Dennis Poremski was my teaching assistant at the University of Colorado at Boulder where I first began writing the text. Dennis provided considerable feedback as I was writing the text and teaching an introductory course in kinesiology that I developed. I want to thank Upen Patil, Elena Lazaretnik, Tamara Hellen Mull, and Claire Furlotte, students at San Francisco State University, who helped with some of the graphics and figures contained in the book. Brian Maraj and Bob Brustad provided helpful editorial comments and encouragement. Penny McCullagh gave me several suggestions and editorial comments. I would also like to thank Melissa Accornero and Brent Hannify at University Readers for all their help and support in the final



phases of this project. Finally, this book is dedicated to my parents, Ed and Jean, for their love and support throughout my career, and to my daughter, Makaila, a professional ballet dancer who has reinforced my belief that movement certainly does matter.

Stephen A. Wallace, Ph.D.

May 2010

---

# Chapter One

## Kinesiology: The Emergence of a New Field of Study

**The Physical Activity Focus**

**Levels of Analysis**

**Subfields in Kinesiology**

**Cross- and Interdisciplinary Fields of Study**

**Types of Knowledge in Kinesiology**

**The Degree in Kinesiology**

**Career Opportunities**

Physical Education

**Athletic Training**

**Physical Therapy**

Allopathic and Osteopathic Medicine

Physician's Assistant

Chiropractic

University Teaching and Research

**Chapter Summary**

Important Terms

Integrating Kinesiology: Putting It All Together

Kinesiology on the Web

References

# CHAPTER ONE

## Kinesiology: The Emergence of a New Field of Study

### STUDENT OBJECTIVES

1. To appreciate the focus of inquiry in kinesiology.
2. To identify the various subfields or foundations in kinesiology.
3. To know the difference between cross- and interdisciplinary fields of study.
4. To understand the nature of a degree in kinesiology.
5. To identify a number of career options following a degree in kinesiology.

### THE PHYSICAL ACTIVITY FOCUS

Since ancient times, there has always been an interest in how and why humans engage in physical activity. Recently, there have been serious efforts to embody this interest within a coherent, scholarly field of study. The field of study we call today kinesiology is the result of these efforts. The term kinesiology derives from the Greek words *kinesis* (movement) and *logos* (the study of). The emphasis in kinesiology inquiry is on human movement, although animal movements are studied and used to help us better understand the human condition.

In the preface, a rationale for understanding human movement from several viewpoints was discussed. In Chapter One, this rationale is further developed. A part of this rationale deals with the focus of inquiry in kinesiology. Should kinesiology as a field of study be restricted to a certain type of movement or physical activity? Should kinesiologists study sport? Is the study of dance within the focus of kinesiology? What about activities of daily living, such as tying one's shoes, doing the dishes, or driving a car? Is physical exercise within the scope of kinesiology? The basic answer to these questions is essentially *yes*. As argued by Newell (1990), kinesiological inquiry can be used to study all types of physical activity, from spontaneous play, exercise, rehabilitation, to recreational and competitive sports. Charles (1994) suggested that there are three major types of movement that can be scrutinized by kinesiology researchers:

- *Sportive movement*—refers to skill-related physical activity
- *Symbolic movement*—is physical activity that expresses thoughts and feelings through the symbolic medium of the body; the main emphasis is on physical expressiveness such as in dance, gestures, and speech
- *Supportive movement*—is physical activity of a functional nature necessary to support a certain lifestyle and the major emphasis is health-related physical activity, such as the activities of daily living, rehabilitation from injury, disease prevention, and work.

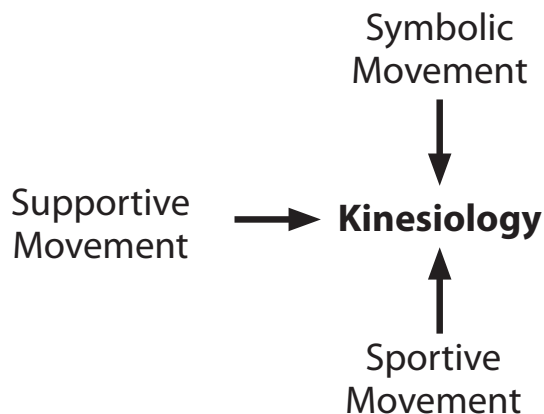
This distinction by no means implies that the categories of movement are mutually exclusive (Charles, 1994, p. 16). For example, a ballet dancer's movements are clearly symbolic but they are also sportive, in the sense that they reflect the skill of the dancer. In addition, ballet movements also may be supportive if the dancer considers their production as contributing to the dancer's health. Thus, any observed movement could fit into one or more categories.

Knowledge gained from the study of one type of movement may also apply to our understanding of the other types. For example, many supportive movements have to be learned first before they can be used. That is, whether one engages in supportive movement may depend on how well the movement can be executed. For example, a person with amputation, who could functionally benefit from the use of an artificial hand, often rejects using it because of the lack of sufficient motor control. As pointed out by McKensie (1970), "Learning to use an arm prosthesis never comes instinctively, and its effective use is an acquired skill, so much so that no worthwhile return in the way of function is apparent to the user, and rejection may result." This is just one example of how an understanding of one type of movement (sportive or skillful) can facilitate the understanding of another (supportive).

In addition to the three major types of movement studied by kinesiologists, there also are a variety of settings *where* they may be examined. We can expect the qualities of human movement to be at least partly dependent on the situation. For example, sportive, symbolic, and supportive movements all can be studied in the laboratory where the researcher can better control the environmental conditions. Much kinesiology research has been investigated in this setting. However, further insight into physical activity can be gained by studying human movement outside of the laboratory in more real-life conditions, such as in the workplace, the clinic, the gymnasium, the dance studio, the swimming pool, a city park, or on a mountain. There is much to learn about human physical activity in natural settings, where the difficulties of controlling environmental influences can be offset somewhat by the richness of the information gathered. In addition, some physiological and psychological contributions to movement will vary from one physical activity setting to another, while others will not. How we experience and ascribe meaning to physical activity may also likely depend on the physical activity setting.

Differences and similarities in human physical activity can be examined across cultures, racial and ethnic groups, socioeconomic status, between the sexes, and across different developmental ages. While the focus of kinesiology is on *human* physical activity, this does not imply a restriction to *only* human inquiry. Often, insight into human physical activity can be gained by studying other animals before applying this knowledge to the human. In addition, a growing amount of physical activity research utilizes computer technology, where the researcher relies on computer models and simulations of human and animal movement. Here, human or animal movement is investigated through the use of a set of derived equations! The researcher derives such equations to mimic a theoretical model of movement or factors affecting movement, and tests the model using computer simulations before applying the model to actual human behavior. Thus, some scientific inquiries of physical activity are not performed in the experimental laboratory or in the natural environment, but on the computer! In summary, restricting our inquiry to a certain type of movement, setting, type of individual, or model will only serve to limit our understanding of the various dimensions of human physical activity.

**Figure 1.1**  
**Types of movement, (adapted from Charles, 1994).**



## SUBFIELDS IN KINESIOLOGY

Figure 1.1 illustrates a conceptualization of kinesiology made up of various **subfields** and dimensions. In this conceptualization, the major subfields of kinesiology are biomechanics, exercise physiology, motor control and motor learning, motor development, sport and exercise psychology, and sociology of physical activity. Furthermore, there is a historical dimension of kinesiology that includes important people and events that have shaped the development of the field. There is a philosophical dimension to kinesiology dealing with how and why we view the field of kinesiology as a field of study. The circles representing the subfields are purposely placed close to one another and all connect to the field of kinesiology. As a result, the content of each subfield can be thought to be connected both to the field of kinesiology and to the other subfields. In this way, the field of kinesiology can be thought of as an “integrative” field of study.

In my view, no subfield is more important than another because without information from a subfield, a more complete understanding of how and why humans move, work, and perform in the environment is not possible. As we will see in subsequent chapters, each subfield focuses on a certain aspect of human physical activity. The subfields identified in Figure 1.1 have been well researched for a number of years and contain a number of facts, models, theories, and phenomena. Because each subfield has been thoroughly researched and has contributed to our understanding of kinesiology as a whole, each of them will be referred to as a **foundation**. This is not to suggest that a complete understanding of each foundation has been achieved because the body of knowledge within each is constantly expanding as research continues.

The chapter entitled **History of Kinesiology** documents, in more or less chronological order, the relative importance of physical activity to society from ancient to modern times. This chapter also identifies important people in history who have either studied physical activity or have affected the promotion of physical activity. Finally, the history of kinesiology as a developing field of study is examined.

The **Anatomical and Physiological Systems** chapter is an overview of some of the major anatomical structures and important physiological systems of the human body. This chapter has been included to give the reader some useful background before going into the various subfields within kinesiology.

The **Exercise Physiology Foundation** chapter is the study of how the structures and the various physiological systems in the body adapt acutely and chronically to the stress of exercise. The **Biomechanical Foundation** chapter provides detailed description of the muscular forces produced by the human body and the mechanics of human motion. How movements are controlled, coordinated, and learned are investigated within the **Motor Control and Motor Learning Foundation** chapter. The **Psychological Foundation** chapter explores the various cognitive, emotional, and social factors that affect both how and why we move and perform in a number of physical activity environments. Changes in both the structure and function of the human body over the life span are investigated within the **Developmental Foundation** chapter. Some may argue that development is not a separate foundation, but rather a dimension of the other subfields. I would not disagree. However, there

is sufficient accumulated knowledge of the human development and aging process to consider development as a unique foundation. The **Sociocultural Foundation** chapter examines the many social and cultural factors that influence human physical activity. Finally, the last chapter examines some of the philosophical elements of kinesiology.

Some time ago, Jerry Barham (1963; 1966) conceptualized the various subfields in a unique way by using different adjectives in front of the noun kinesiology. For example, biomechanics was called *Mechanical Kinesiology*, and exercise physiology was called *Physiological Kinesiology*. Using Barham's conceptualization, it is possible to characterize the other subfields in a similar manner, as shown in Figure 1.2. For example, sport and exercise psychology could be called *Psychological Kinesiology* and sociology of physical activity could be called *Sociological Kinesiology*. Some kinesiology departments use these types of descriptions to describe subfield courses within their kinesiology curriculum. While the traditional names of the subfields are acceptable, using Barham's approach brings can bring some unity to the subfields by directly associating them with the overarching field of study, kinesiology.

One could argue that specific names for each subfield should be dropped altogether and replaced by a thematic area within kinesiology. For example, in 1990 Newell suggested the following five thematic areas that attempt to cover the entire scope of kinesiological inquiry: coordination, control, and skill; growth, development, and form; energy, work, and efficiency; involvement, achievement, and enculturation; aesthetics, meanings, and values.

There is merit to Newell's proposal because a thematic approach attempts to link the various subfields and helps promote cross-disciplinary knowledge (see below, and Chapter 10). The adjective descriptions of the subfields also bring a sense of unity to kinesiology inquiry. The traditional names of the subfields are probably adequate because they accurately represent the content within kinesiology and they are familiar to most people in the field. However, both the Barham and Newell proposals for describing the developing field of kinesiology have merit and are worthy of further consideration.

## LEVELS OF ANALYSIS

The antecedents (causes) and the consequences (outcomes) of human movement can be examined at different levels of analysis. A **level of analysis** can be thought of as representing the size of the unit under investigation. In describing the human engaged in physical activity, there are several levels of analysis: molecular, cellular, systems, behavioral, psychological, and sociocultural. Each subfield in kinesiology focuses on certain level(s) of analysis to evaluate the antecedents and consequences of physical activity.<sup>1</sup>

Figure 1.2: The Sub-Fields (Foundations) of Kinesiology

Excercise Physiology	Physiological Kinesiology
Biomechanics	Mechanical Kinesiology
Motor Learning and Control	Neuromuscular Kinesiology
Sport and Exercise Psychology	Social-Psychological Kinesiology
Motor Development	Developmental Kinesiology
Sociology	Socio-Cultural Kinesiology

The unit of study at the **molecular** level of analysis is extremely small. Observing and measuring events at this level of analysis require sophisticated tools such as the electron microscope. For example, the molecular level of analysis has been used by exercise physiologists to examine how muscle contraction occurs. Magnetic resonance imaging (MRI) measures the amount of certain atoms at different locations in the body. This technique has been used by motor control researchers to measure brain activity during movement. It also has been used by biomechanics and exercise physiology researchers to study a variety of anatomical and physiological functions.

At the **cellular** level of analysis, cellular events occurring in the nerve, bone, muscle, and other tissues are examined. The cellular level of analysis is used primarily by the biomechanics, exercise physiology, and motor learning and control subfields.

At the **systems** level of analysis, activity within the various physiological systems is evaluated, such as the nervous, skeletal, muscular, cardiovascular, and respiratory systems, to name a few. Once again, the biomechanics, exercise physiology, and motor learning and control subfields extensively examine this level of analysis. There are also some researchers in sport and exercise psychology who measure events occurring in certain physiological systems.

At the **behavioral** level of analysis, movements that are readily observable by the naked eye are measured or evaluated. At the behavioral level of analysis, we can examine the causes of antecedents of movement using the principles of **kinetics**, a major area of biomechanics that studies the forces produced by or exerted on the body. Kinetic measures such as force can be examined through the use of devices called strain gauges, force transducers, and force platforms. **Kinematics**, another major area with biomechanics, examines the various biomechanical descriptions of movement such as displacement, velocity, and acceleration of the limbs or body.<sup>2</sup> An example of a kinematic measurement tool is motion analysis technology, such as videotape analysis. Certain types of markers are strategically placed on the body, the motion is videotaped, and the changes in markers' positions during the movement are digitized and entered into a computer for analysis purposes. There also are other sophisticated technologies today that allow for kinematic measurement (see Magill, 2011).

Some years ago, Higgins (1977) proposed that the events at the behavioral level also could be examined using kinesic and subjective-description measurement. **Kinesic** measurement is a qualitative method to evaluate nonverbal communicative behavior of an individual or between individuals. It can be used to measure nonverbal communication of a performer, teacher, or coach, for example. **Subjective description** is another way to qualitatively evaluate movement based upon the opinion of the evaluator. A golf instructor evaluating a student's swing or an audience watching a dance performance are examples of subjective description of movement. The outcome of the movement, involving the consequence, efficiency, and effectiveness of the goal accomplishment of the movement, can also be evaluated (Higgins, 1977). Did the basketball go in the basket, did the dart hit the bull's-eye, is the amputee improving in the use of a new prosthesis, are examples of questions that can be raised about movement outcome. How efficient a movement is produced can also be examined. Thus, at the behavioral level of analysis, the causes, description, and outcome of movement can be evaluated. The behavioral level of analysis has been used by all the subfields in kinesiology.

At the **psychological** level of analysis, cognitive and emotional events of the human are evaluated. Measurement of cognitive and emotional events may take the form of validated questionnaires or interviews. These types of measurements assess the mental events associated with participating in physical activity such as the motivation of the individual. The psychological level of analysis is used primarily in the sport and exercise psychology subfield, but some of the other subfields also take measures at this level of analysis (Duda, 1998).

The **sociocultural** level of analysis examines the largest unit of study in kinesiology: the behavior of groups of people or societies. One example of a question addressed at this level of analysis is what sociocultural factors influence the participation of an individual or a large group of individuals in physical activity? Does the racial or



ethnic background of a group of people affect their participation in exercise? Does the socioeconomic status of a group of people have an effect on whether they choose to live a physically active lifestyle or not?

Other than the size of the unit, another distinguishing characteristic of the various levels of analysis are time-scale differences. **Time scales** can be thought of as the elapsed time between significant events occurring at a given level of analysis. The fastest time scale occurs at the molecular level of analysis (not including the atomic or subatomic levels) and the slowest time scale occurs at the sociocultural level of analysis. In other words, important changes in events occur at a much faster rate at the molecular level, sometimes on the order of nanoseconds (i.e., one billionth of a second), compared to the sociocultural level, where significant events may be separated by years, decades, or even centuries! One of the great challenges for kinesiologists is determining the proper time scale between important events at any given level of analysis and to make measurements that encompass that time scale. For example, the time scale for a given muscle contraction, say for flexing the elbow, might be no longer than a second or two. However, what is the time scale for understanding why a person chooses not to engage in a physically active lifestyle? The relevant time scale is certainly not as short as two seconds! But what *is* the relevant time scale in this case? Answering the question depends on the definition of what is meant by “a significant event” at a given level of analysis. The events that occur at a particular level are numerous. The researcher must determine which are the relevant and irrelevant events before a time scale can be determined. Determining what are relevant and irrelevant events at any given level of analysis is a difficult but nonetheless important challenge facing research in kinesiology as well as in other fields of study.

All the levels of analysis operate as an individual is engaged in physical activity. When we perform a golf swing, molecular events are occurring at unbelievable rates, contributing to both the physical and cognitive aspects of the performance. But superimposed on molecular events are all the other levels of analysis that contribute in certain ways to the swing. As a result of the many important processes occurring at different time scales of the various levels of analysis, the golf swing occurs! It must be the case that there is some relationship between what is happening at the molecular level and the other levels. Indeed, yet another major challenge to researchers in kinesiology (as well as other fields of study) is how the events at any one level of analysis relate to events at the other levels.

The last point I want to make in this section is that because all behavioral movements are influenced by all the levels of analysis, no one level of analysis is more important than another. Ignoring one or more levels of analysis results in an incomplete description of the movement. If we ignore the molecular, cellular or systems level of analysis, the physiological description of the movement is lost. If the psychological level is ignored, we fail to appreciate the motivation for performing the movement, for example. The sociocultural level of analysis provides the overall context of the movement, and probably helps define the meaning of the movement to the individual.

While all levels of analysis are required to fully describe a movement, a particular level of analysis might be more appropriate for certain situations. For example, the three types of movement, (i.e., sportive, symbolic, and supportive) can be investigated from several levels of analysis. In some cases, a particular level of analysis may be necessary to measure for a given type of movement or movement situation. For example, if a golfer is slicing the ball and wishes to improve the swing, the instructor may wish to analyze the behavioral level of analysis through videotaping. In this way, the student may be able to actually see what is wrong with the swing. In this situation, the student’s heart rate, one measure of the cardiovascular system, is probably irrelevant in terms of providing helpful information that could be used to correct the student’s slice. This example appears rather straightforward; however, determining the most useful level of analysis for understanding a certain movement or movement situation is another important challenge faced by kinesiologists. The reasoning is that movements, and their antecedents and consequences, are complex, and complex phenomena are difficult to describe and understand.

## CROSS- AND INTERDISCIPLINARY FIELDS OF STUDY

Each foundation of kinesiology has been investigated by scholars both within and outside of kinesiology. For example, medical researchers have contributed to the development of the Exercise Physiology Foundation and researchers in the field of psychology have helped in laying some of the groundwork in the Motor Learning/Control and Psychological Foundations. To some extent, each of the Foundations could be part of other disciplines, such as physiology or psychology. However, the *major* focus of kinesiology is human movement and physical activity from a number of perspectives. As such, it is different from the major focus of other academic disciplines.

If research in each subfield or foundation in kinesiology were to continue in an isolated fashion without any integration from the other subfields, then kinesiology would become an **interdisciplinary** field of study (see Henry, 1978, and Lawson and Morford, 1979, for excellent discussions). This type of academic discipline develops subfields that typically become highly specialized. Researchers in each subfield develop unique research skills and techniques, and speak a “different language” in describing the content within their specialized area. In this scenario, each subfield becomes so specialized that it could be encompassed within a traditional or parent discipline (e.g., biomechanics into physics, exercise physiology into biology, sport and exercise psychology into psychology). In some present-day departments of kinesiology, it is common for researchers in exercise physiology, for example, to have little interaction with their colleagues in sport and exercise psychology, in spite of the fact that there are many areas of potential overlap and issues of common interest. I suspect similar interdisciplinary trends are evident in many other scientific fields of study.

**Cross-disciplinary** means that the focus of the field of study is the communication and interaction *among* the subfields and not just the isolated advancement of each subfield. Many academic fields of study, such as psychology, physics, and chemistry, started out being cross-disciplinary but as time went on, tended to become more interdisciplinary in nature due to specialization and fragmentation. Suffice it to say, interdisciplinary research within each subfield of kinesiology is important, but a more comprehensive understanding of how and why we engage in physical activity is likely to be better achieved through cross-disciplinary research. With cross-disciplinary research, thematic problems within the field of kinesiology can be explored using expertise and knowledge from more than one subfield. For example, the question “How does one improve cardiovascular fitness?” can be addressed from several subfield perspectives. From an exercise physiology point of view, specific physiological training techniques can be evaluated. From a sport and exercise psychology perspective, the proper motivational orientation of the individual can be assessed. From a developmental viewpoint, the age of an individual can affect the type of training technique used and may have an influence on the individual’s motivation. Whether the individual initiates and adheres to a cardiovascular fitness program may depend on his or her socioeconomic background, information emphasized from a sociocultural point of view. Whether kinesiology as a field of study develops into an interdisciplinary or cross-disciplinary field of study is an open question.

## TYPES OF KNOWLEDGE IN KINESIOLOGY

As with other fields of study, the content of kinesiology consists of declarative and procedural knowledge (Ryle, 1949). One type of **declarative knowledge** is the theoretical and empirical information generated within a field of study as a result of scientific research. After decades of research in the various subfields, kinesiology as a field of study contains considerable declarative knowledge about the human engaged in physical activity. The views of Franklin Henry, expressed in two important papers (1964; 1978), had much to do with the emphasis on declarative knowledge in the kinesiology curriculum today in most universities.<sup>3</sup>

Another type of declarative knowledge is that generated by the practitioner, such as the physical education teacher, sports coach, and exercise trainer (Newell, 1990). We have all probably met practitioners in the field

such as physical education teachers or coaches who have declarative knowledge of their profession of a practical nature. The declarative knowledge they possess is about the real-world setting of their profession. For example, it is one thing to know about the biomechanics of a soccer kick, but it is quite another to be able to teach soccer to elementary school children. Any beginning student physical education teacher will confirm this point! There are many “tricks of the trade” in any profession, some gained with theoretical knowledge, but much usually gained from years of practical experience on the job. One reason for bringing up this distinction between types of knowledge is to emphasize that this book is primarily about declarative knowledge of the theoretical and empirical types within kinesiology. However, real-life examples of how theoretical information can be used in practical settings will be discussed throughout the book.

**Procedural knowledge** entails knowing *how* to do something. In the case of kinesiology, procedural knowledge may pertain to the ability to execute a movement or an action. Having procedural knowledge of a golf swing means being able to actually execute the golf swing. In many physical education degrees and some kinesiology degrees, it is required for students to demonstrate their ability to perform certain skills or exercises or be required to take physical activity classes. The emphasis on procedural knowledge is common in most dance degrees. Procedural knowledge also can be demonstrated in laboratories associated with lecture classes in kinesiology classes. The ability to perform certain measurement techniques at a given level of analysis indicates some mastery of procedural knowledge. Student demonstrations of a movement, skill, or exercise in a lecture or laboratory class are other examples of procedural knowledge. It is my view that declarative and procedural knowledge about humans engaged in physical activity should be part of the kinesiology curriculum.

### THREE ASPECTS OF KINESIOLOGY PROGRAMS

According to Newell (1990), a kinesiology program at the university level can consist of three emphases: disciplinary, professional and performance. The **disciplinary emphasis** relates primarily to the declarative knowledge within kinesiology: that is, the theoretical information within the various subfields. In most universities, a disciplinary emphasis is required in all fields of study. The **professional emphasis** focuses on preparing the student for a specific career or profession. In physical education departments and some kinesiology departments, students may major in physical education that will prepare them to become a physical education teacher in elementary or secondary school, a sports coach, or sports administrator, for example. In other kinesiology departments, the professional emphasis is not a part of the curriculum. The **performance emphasis** relates primarily to certain aspects of procedural knowledge within kinesiology—for example, the demonstration of skill for competitive or aesthetic purpose. According to Newell (1990), this emphasis greatly decreased in most physical education and kinesiology programs and probably has continued to do so. In fact, the field of dance, which used to be an inherent part of physical education before kinesiology evolved, moved out of physical education and formed its own degree program in many universities. The performance emphasis is typically less emphasized in most kinesiology curriculums across North America.

In my view, whether the three program emphases are a part of a given degree or not, people in a given emphasis can benefit from the knowledge generated in the other two. For instance, the theoretical knowledge generated by researchers in the disciplinary emphasis may be useful to both the physical activity practitioner and the performer. Examples of physical activity practitioners are physical education teachers, coaches, exercise leaders, physical therapists and other health professionals. Physical activity performers may include dancers and other athletes. While debated (Best, 1978; Newell, 1990), it is possible for the three types of emphases (theoretical, practitioner, and performance) to inform each other. Practitioners such as physical education teachers can apply principles of biomechanics, exercise physiology, and the other subfields to their teaching

of exercise habits and motor skill development. Basic knowledge of kinesiology can help physical therapists develop preventive injury or rehabilitation programs for their clients.

It is also possible, I believe, for the researcher to gain insight into theoretical physical activity problems by studying or interacting with professionals, clinicians, or performers. “Real-world” problems faced by these professionals, clinicians, and performers offer the researcher a steady reminder of the complexity of behaviors outside the laboratory. The kinesiology researcher can potentially gain great insight into a physical activity problem by conducting research outside of the laboratory. Field research is a common strategy used by researchers in the psychological and sociocultural areas, but also practiced by some researchers in the other subfields. Performers also can benefit from the other two areas. A dancer who interacts with a physical activity researcher may discover a better method to improve his or her leg strength. If the dancer becomes injured, knowledge gained by communication with a physical therapist may improve rehabilitation and help in preventing future injury.

## THE DEGREE IN KINESIOLOGY

Regardless of the desired career, it is important for kinesiology students to receive a strong liberal arts education. A liberal arts education exposes the student to a wide variety of areas of study outside of the student’s specific major. A liberal arts education is designed to provide the student with a greater perspective of the world and an appreciation of the importance of different fields of study, regardless of one’s specific interest. In addition, many liberal arts courses can provide important background for understanding the content in the various subfields of kinesiology. For example, general psychology provides an excellent foundation for the study of sport and exercise psychology. Chemistry and biology are important prerequisites for exercise physiology. Physics is important for a better understanding of biomechanics.

In my opinion, it is important that students take necessary prerequisite coursework that adequately prepares them for kinesiology. Table 1.1 illustrates one possible model of a kinesiology degree. While the model is not meant to represent the best or the only structure, it does serve to illustrate some of the important content necessary for a strong academic degree in kinesiology.

For some careers, more coursework may be necessary. For example, many physical therapy programs across North America require an entire year of physics or additional classes in chemistry.

The kinesiology core classes are designed to introduce students to the various subfields within kinesiology. Following these core classes, a number of elective classes in kinesiology are offered to further prepare students for specific careers in kinesiology or to expand on their interests.

## CAREER OPPORTUNITIES

Many students contemplating kinesiology as an undergraduate major ask the following question: “What can I do with a degree in kinesiology?” The highlight box provides some information to help answer that question. Listed here are a number of areas of study and career opportunities for students who start with an undergraduate degree in kinesiology or equivalent degree in Exercise, Sports, or Human Movement Science, as some departments have opted to call themselves. It should be emphasized that the undergraduate degree in kinesiology is usually not sufficient, as is the case in most other fields of study, to land a high-salaried job. In many cases, advanced degrees and practical experiences leading to certification in a specialty area are required.

**Table 1.1**  
**An Example Undergraduate Degree in Kinesiology**

<b>Pre-Kinesiology Requirements</b>	
General Biology	1 year
General Chemistry	1 year
General Physics	1 year
Algebra and/or Calculus	1 semester minimum
Introductory Psychology	1 semester
College Writing	1 semester
<b>Kinesiology Major Requirements*</b>	
Human Anatomy **	
Human Physiology **	
Physical Activity Classes (emphasizing procedural knowledge)	1 or more semesters
Introduction to Kinesiology	1 semester
Introduction to Statistics and Research Methods	1 semester
Exercise Physiology	1 semester
Biomechanics	1 semester
Motor Learning and Motor Control	1 semester
Sport and Exercise Psychology	1 semester
Motor Development	1 semester
History/Philosophy of Kinesiology	1 or more semesters
Sociocultural Kinesiology	1 semester
Senior Seminar—Integrative Kinesiology (see Ch. 10 for discussion)	1 semester
<i>* Ideally these courses should be accompanied by laboratory experiences</i>	
<i>** These courses could be offered in other departments (e.g., Biology)</i>	
<b>A Sample of Kinesiology Electives</b>	
Aging and Performance	
Athletic Training	
Human Factors	
Honors Thesis in Kinesiology	
Independent Study in Kinesiology	
Internship in Kinesiology	
Management of Exercise and Wellness Programs	
Nutrition and Performance	
Physical Education Methods	
Prevention and Treatment of Performance and Sports Injuries	
Selected Topics in Kinesiology	
Sports Medicine	

## HIGHLIGHT

### What can I do with a degree in kinesiology?

First of all, countless studies have concluded that a college degree in any major is an asset in many ways in later life. Most liberal arts degrees (e.g., psychology, biology, and mathematics) are not designed to lead to a specific employment opportunity, but rather to provide a well-rounded education and to develop the basic knowledge and skills inherent in almost any occupation. One of the requirements of a liberal arts degree is a concentration of work in one specific area known as a major. In most cases, students naturally select an area of interest in which to major in and, of course, it makes sense that this might lead to some related employment situation in the future. Thus the question, “What can I do with a degree in kinesiology?”

In an attempt to answer this question, the following occupations and fields related to kinesiology were compiled:

Adapted Physical Education	Health Care Management
Aerospace Medicine	Health Club/Management
Allied Health	Health Education
Anatomical Science	Health Fitness Management
Anatomy	Health Promotion
Anesthesiology Education	Health Records
Applied Physiology	Health Science Admin.
Aquatics Director	Health Services
Athletic Clubs	Health Services
Athletic Director	Health Spa Management
Athletic Training	Health and Wellness
Athletic or Sports Administration	Home Economics/Nutrition
Biobehavioral Science	Hotel Programs
Biodynamics	Human Biology
Biomedical Engineering	Human Factors
Biomedical Science	Human Nutrition
Buying and Selling Equipment	Industrial Fitness Programs
Camp Director	Industrial Hygiene and Safety
Cardiac Rehabilitation	Leisure Management
Cardiopulmonary Technology	Leisure Studies
Cardiorespiratory Science	Manager–Recreational
Cell Biology	Medical Assistant
Chiropody	Medical Biology
Chiropractic	Medical Laboratory Technician
Clinical Biology	Medical Records Administration
Clinical Medicine	Medical Sciences
Coaching	Medical Technology
Corporate Fitness/Wellness	Medicine
Health Administration	Mental Health

Microbiology	Radiation Therapy
Naturopathic Medicine	Radiological Technology
Nuclear Medicine Technology	Recreation
Nursing	Recreation Administration
Nutrition	Recreation Leadership
Nutrition Biochemistry	Recreational Therapy
Nutrition Science	Recreation and Leisure
Occupational Therapy	Recreation and Parks
Ophthalmology	Rehabilitation Specialist
Optometry	Research Assistant
Orthopedic Assistant	Resort Programs
Orthopedic Medicine	Sport Information
Osteopathic Therapy	Sport Psychologist
Osteopathy	Sport Sociologist
Outdoor Education	Sports Clubs
Paramedic	Sports Communication
Park and Recreation Resources	Sports Health
Pharmacology	Sports Journalism
Physical Ed/Special Population	Sports Management
Physical Education	Sports Medicine
Physical Therapist	Sports Sciences
Physical Therapy/Aid	Sports Studies
Physical Therapy Assistant	Strength and Conditioning Director
Physician's Assistant	Stress Management
Physiology	Surgeon Assistant
Podiatry	Surgical Technician
Preschool Program	Therapeutic Recreation
Preventive Medicine	Therapy Pool Manager
Private Sports/Rec Clubs	Underwater EMT
Promotional Manager—Sports Equipment	Veterinary Medicine
Psychiatric Medicine	Veterinary Technology
Psychomotor Therapy	Vision Science
Public Health	Wellness Centers
Radiation Technology	YMCA

*List originally compiled by Dale Mood, Department of Kinesiology, University of Colorado at Boulder.*

As one can see, there are a number of possible career opportunities awaiting kinesiology graduates. In the next section, six career opportunities are briefly discussed to provide additional detail for the interested student: physical education, physical therapy, physician assistant, allopathic and osteopathic medicine, chiropractic, and university teaching and research.

## Physical Education

As we will see in the next chapter, the field of kinesiology evolved from physical education, the traditional area of study for those interested in teaching physical education or coaching sports. One of the goals in teaching physical education in the schools is to improve the quality of children's lives through participation in various types of physical activity, including sports (Lumpkin, 2011). The National Association for Sport and Physical Education (NASPE) has been given responsibility from the National Council for Accreditation of Teaching Education (NCATE) to ensure that physical education undergraduate and graduate programs meet the minimum standards for accreditation. The general competencies required of physical education and sport teachers are the following:

- understanding the scientific and philosophical bases of physical education and sport
- developing a comprehensive knowledge about analyzing movement
- developing a wide range of motor skills, especially those related to the area of teaching
- studying the teaching-learning processes specifically related to the area of physical education and sport
- becoming knowledgeable about planning, organizing, administering, supervising, evaluating, and interpreting various aspects of a balanced physical education and sport program (from Lumpkin, 2011).

There are more specific competencies for elementary, middle and secondary physical education and sport teachers.

An undergraduate degree in either kinesiology or physical education is required to teach at the elementary, middle, or secondary levels. Students also are required to teach in a nearby school for at least one semester before graduation. In some programs, an additional year is required for teaching certification. In addition, some degrees in kinesiology or physical education offer concentrations or minors allowing the student to specialize in a given area. Some of the various concentrations within physical education are coaching, fitness, sport management, exercise and sport science, adapted physical education, therapeutic recreation, and teaching (Lumpkin, 2011). It should be noted that many departments of physical education have dropped the teaching professional focus of their programs to concentrate more on the disciplinary emphasis or the academic orientation, as some have called it (e.g., Siedentop, 2009). Thus, students interested in the teaching and coaching profession should make sure departments of their interest have accredited teaching certification programs.

## Athletic Training

A student interested in preventing, recognizing, managing, and rehabilitating sports injuries may very well wish to pursue a career in athletic training. In actuality, it is possible to specialize in a number of areas within the profession of athletic training, including prevention of athletic injuries, recognition, evaluation and immediate care of athletic injuries, rehabilitation and reconditioning of athletic injuries, health care administration, and finally, education and counseling. The American Medical Association recognizes athletic training as an allied health care profession. Athletic training is listed by the Bureau of Labor Statistics as one of the fast growing professions.

The athletic trainer typically works under the direction of a physician and within a team of allied health professionals. Athletic trainers are consulted to develop physical conditioning and injury rehabilitation programs, prepare athletes for competition and practice using recognized procedures for taping, bandaging, and bracing injured areas, and to determine whether an athlete requires further medical treatment. Athletic trainers may



find employment in secondary schools, colleges and universities, professional sports and sports medicine clinics, corporate health programs, health clubs, clinical and industrial health care programs, and athletic training curriculum programs.

To become a certified athletic trainer, it is necessary to graduate from an accredited athletic training program with either an undergraduate or graduate degree or meet internship requirements established by the National Athletic Trainers' Association Board of Certification. Many kinesiology degrees offered at universities also have certified programs in athletic training.

## Physical Therapy

One of the more popular careers open for kinesiology graduates is the field of Physical Therapy. It should be noted that physical therapy is a much-desired profession, and entrance into a physical therapy program is a highly competitive process, not unlike medical school. Nonetheless, highly qualified kinesiology graduates have had success getting accepted into physical therapy schools.

Physical therapy is a type of health care profession involved in the promotion of optimal health using scientific principles to prevent, assess, and correct movement dysfunction. Physical therapists commonly work with other health care providers, such as physicians, occupational therapists, rehabilitation nurses, psychologists, social workers, dentists, podiatrists, and speech pathologists and audiologists (American Physical Therapy Association). A large number of physical therapists work in hospitals, but more than 70 percent can also be found in private physical therapy offices, community health centers, corporate or industrial health centers, sports facilities, research institutions, rehabilitation centers, nursing homes, home health agencies, schools, pediatric centers, and colleges and universities across North America. In Canada and Europe, physical therapists are called *physiotherapists*.

Physical therapists or physiotherapists often are involved in evaluating and assessing patients recovering from injury, surgery, or disease, and they help develop and implement treatment programs. They can teach patients how to use artificial limbs and other assistive devices. Physical therapists also can provide instruction and home programs to patients and their families to continue the recovery process once the patient is free from the physical therapist's direct care.

According to a 2008 report by the U.S. Department of Labor's Bureau of Labor Statistics, physical therapy (and physical therapy assistants) is one of the fastest growing health care occupations. There are over 185,000 practicing physical therapists in the United States alone. Today, graduates from physical therapy programs receive either master's or doctoral degrees in physical therapy.

Another related employment opportunity is a physical therapy assistant. Physical therapy assistants work under the supervision of the physical therapist and assist the therapist in a wide range of activities such as implementing treatment and rehabilitation programs, training patients in exercises and activities of daily living, and monitoring and reporting patient progress. Training in physical therapy usually involves two years of academic and clinical experiences following the completion of a four-year undergraduate degree (such as in kinesiology). Physical therapy assistants must complete a two-year education program, usually offered in a community or junior college. Training consists of one year of general education and one year of technical courses on physical therapy procedures and clinical experience (American Physical Therapy Association).

## Allopathic and Osteopathic Medicine

Kinesiology students who wish to receive a medical degree actually have a choice between the standard medical degree (MD) and a degree in osteopathy (DO). The degrees are comparable in that medical and osteopathic

students both complete four years of medical college, complete a residency program, pass similar state boards, practice in fully accredited and licensed hospitals and medical centers, can become specialists, and can prescribe drugs and perform surgery. The difference between them is their philosophy of health care. Allopathic medicine, ascribed to by the conventional medical community, centers on the treatment of the disease, primarily through medication and surgery.

Osteopathic physicians also utilize medication and surgery, but in addition receive 300–500 hours of extensive training in body manipulation, including the spine, joints, and connective tissue. The osteopath's philosophy is not to treat the disease but the whole person, and the focus is on prevention as well as curing disease or injury. Osteopathic medicine takes a more holistic approach, emphasizing the interconnectedness of various physiological systems (e.g., muscular, nervous, skeletal) to the psychological and even spiritual state of the patient. This holistic approach may be appealing especially to kinesiology graduates (see Chapter 10 for a discussion). There are approximately 40,000 practicing DOs in the United States, compared to 600,000 allopathic physicians. As of this writing, there are 28 osteopathy schools compared with 130 traditional medical schools in the United States.

### *Physician Assistants*

Another rapidly growing health care profession is physician assistant (PA). These are formally trained professionals who assist physicians in routine tasks such as taking medical histories, performing physical examinations, ordering laboratory tests, ordering X-rays, making preliminary diagnoses, and giving inoculations. In 30 states and the District of Columbia, PAs can prescribe medication. They can perform about 80 percent of physicians' duties but they are not medical doctors and must be under a physician's supervision. Most assistants are in hospitals and doctors' offices, but demand is rising for their help in family practice and health maintenance organizations. There are about 75,000 practicing PAs in the United States and the U.S. Department of Labor expects a nearly 30 percent increase by 2018. There are 142 PA programs in the United States that usually involve two years of academic and clinical training and one year of internship experience. According to the American Academy of Physician Assistants, there are many jobs available for every graduating PA. Of course, while it is not possible to predict with certainty how long this demand will continue, a career as a physician assistant appears to be an attractive one going into the 21st century.

### *Chiropractic*

There was a time when chiropractic medicine was considered quackery and even illegal, but this view is changing. Today, all 50 states in the United States, the District of Columbia, and Puerto Rico have statutes recognizing and regulating the practice of chiropractic. The word chiropractic, taken from the Greek words *cheri* (hand) and *prato* (I do), means “done by hand.” The chiropractic profession is an approach to health that 1) utilizes the body's inherent and natural recuperative powers; that 2) places emphasis on maintaining the structural integrity of the body; and which 3) does not utilize drugs or surgery. Chiropractors, like DOs, ascribe to a more holistic approach to health and make use of massage and manipulation techniques to help patients with pain and disabilities. However, chiropractors are not licensed physicians. There are over 53,000 chiropractics in the United States alone. About 1 in 20 Americans sees a chiropractor during the course of a year (Purvis, 1991). As such, chiropractic is the second largest of the three primary health care providers in the United States (medical, chiropractic, and osteopathy, Peterson, 1989). To become a doctor of chiropractic (DC), students must complete general college-level studies (in some states, an undergraduate degree is required), complete four years of training at an accredited chiropractic college, pass required National Board or other exams, and meet