2013–2014 Edition

INTRODUCTION TO PHYSICAL ANTHROPOLOGY




Robert Jurmain Lynn Kilgore Wenda Trevathan Russell L. Ciochon

Major Fossil Hominin Sites

INTRODUCTION TO

Physical Anthropology

ABOUT THE COVER IMAGE

Our closest evolutionary cousins, the nonhuman primates are among the most endangered animals on earth. The book cover shows four of the most endangered species, all of which are close to extinction due to destructive human practices.

2013–2014 Edition

INTRODUCTION TO Physical Anthropology

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Introduction to Physical Anthropology, 2013–2014 Edition

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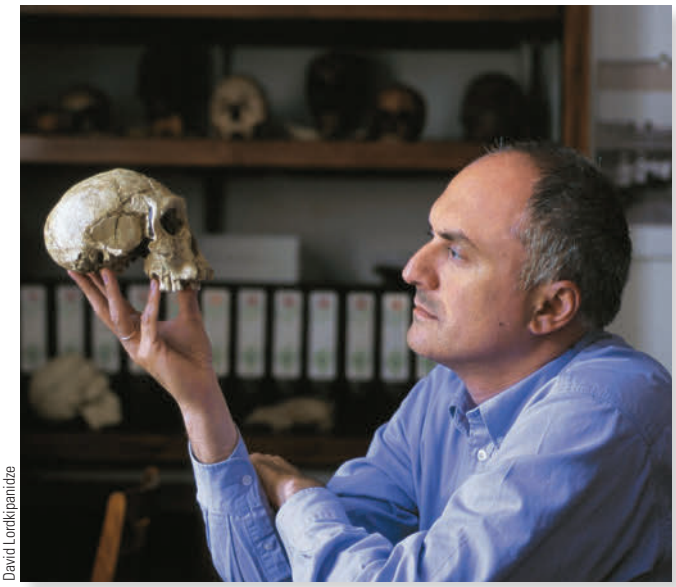

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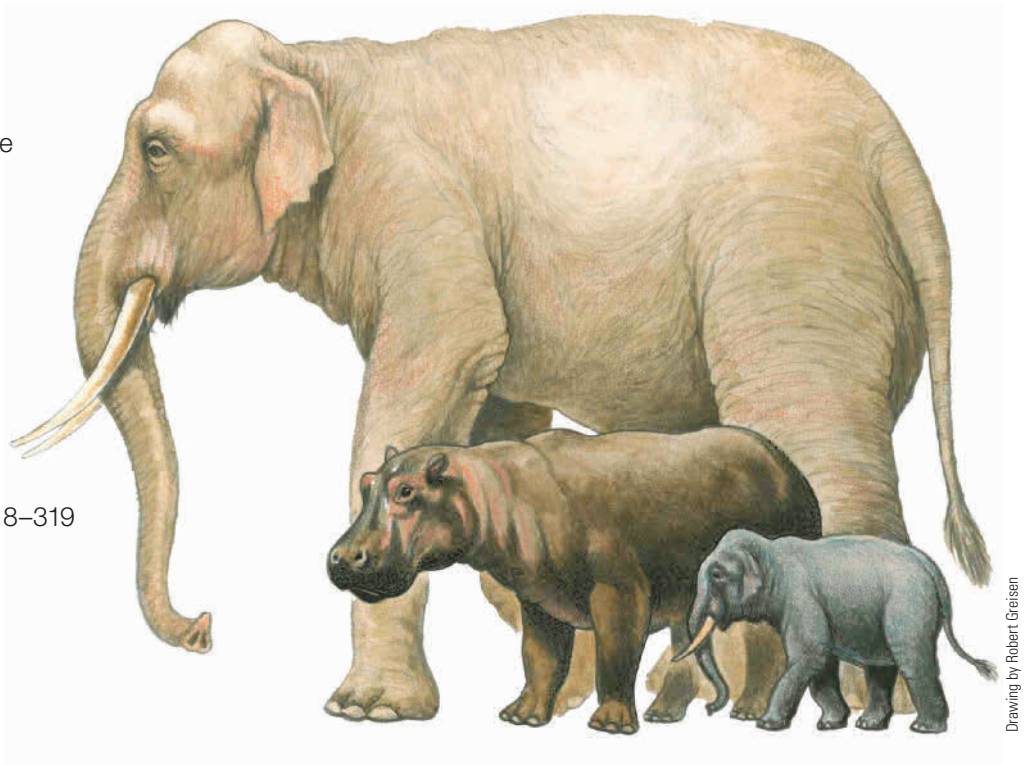

Drawing by Robert Greisen

At a Glance

Barbara Walton/epa/Corbis

Preface

This textbook is about where we come from and the scientific ways we can explore our beginnings. Our species, like all species on earth, evolved from earlier life-forms. As a result of this long shared ancestry, we and all other life are *connected* in a variety of ways: genetically, anatomically, physiologically, and even behaviorally. These connections are the main focus of the book and are highlighted in every chapter.

Physical anthropology, also called "biological anthropology," is the study of human adaptation, variability and evolution as well as of our living and fossil relatives from a biological perspective. Consequently, throughout this text, you will encounter topics that emphasize basic biological concepts. This broad biological framework allows us to connect our evolutionary history with that of other life-forms in order to better understand the evolutionary pressures that shaped our species.

In the last few years scientific knowledge in many fields has accumulated amazingly fast. What's more, the biological sciences are certainly among the most rapidly expanding areas of knowledge as information increases dramatically every year—indeed, every month. This edition has been updated to reflect these changes and to provide the most current information available.

But, in reality, our presentation is just a beginning for students new to this field of study. It is our goal to give students a strong foundation relating to the key aspects of evolutionary biology, which includes physical anthropology. Our aim is to provide fundamental information which will allow you to better understand some of the dramatic scientific advances that almost surely will directly affect you in coming years.

Because genetic mechanisms lie at the heart of understanding evolution, in the early chapters (2 though 5) we address the basic aspects of life, cells, DNA, and the ways species change. In Chapters 6 and 7, we turn to an exploration of our evolutionary cousins, the nonhuman primates, and show how they are closely connected to us genetically, physically and behaviorally. In Chapters 8 through 13, we first discuss the evolutionary history of early primates and how they relate to living nonhuman primates and our own earliest ancestors (Chapter 8). In Chapters 9–13, we turn to a more detailed exploration of our specific human evolutionary history over the past 6 million years. This evolutionary journey begins with our small-brained, apelike ancestors in Africa and follows the development of their descendants through time and over an expanding geographical range into Asia and Europe, and much later into Australia and the Americas.

In the last section of this book (Chapters 14–17), we cover the most recent part of our evolutionary journey with a discussion of modern human biology, and we trace the ongoing evolution of our species. Major topics include the nature of human variation (including an anthropological discussion of the concept of "race"), patterns of adaptation in recent human populations, and the developmental changes experienced by humans through the course of their lives. In our new concluding chapter, "The Human Disconnection," we discuss how contemporary humans are severely altering the planet. We compare these recent and sudden developments with our species' long evolutionary past, when humans were not so numerous or so dependent on nonrenewable resources.

What's New in the 2013–2014 Edition

First, as previously mentioned, we have incorporated the unifying concept of our "connection" to all life as the framework for presenting material throughout the text. To further reinforce this central focus, each chapter now opens with a pedagogical aid that clearly shows students the biological connections as they are organized within and between chapters. Students are also now presented with the learning objectives they are expected to master after reading the chapter. In addition, at the end of each chapter we have included a new section (How Do We Know?) which briefly summarizes the basic scientific information that allows physical anthropologists and other biologists to draw accurate conclusions regarding our evolutionary history.

As genetic technology continues to grow at an unprecedented pace, it is our task to present the most rele-

vant new discoveries in as simple a manner as possible. Chapter 3 includes a new discussion of the ENCODE (Encyclopedia of DNA Elements) project that involves more than 400 geneticists from around the world. The goal of the project is to identify the functions of the "noncoding" DNA that comprises about 98 percent of the human genome. This discussion is important because some of this DNA is involved in regulatory functions and changes in regulatory genes are critical to the evolutionary process. We also increased our discussion of regulatory DNA and types of regulatory genes to emphasize their role in evolution.

A major change to this edition is the reduction of the number of nonhuman primate chapters from 3 to 2. This change was in response to reviewer comments that there be somewhat less coverage. However, all major topics have been retained, and there is added material on cooperation and empathy in nonhuman primates. We have also added more information emphasizing the endangered status of many nonhuman primates, both in the text, and in a new table (Table 6.1) that lists some of the 25 species considered most endangered by the IUCN (International Union for the Conservation of Nature). The table includes estimated numbers and the major threats to these species.

Chapter 8 (formerly Chapter 9) has been trimmed and extensively updated to include new discoveries as well as ongoing reinterpretations of fossil primates. These changes include a reassessment of molecular dating for primate origins and the evolution of all groups, as well as an updated and streamlined treatment of lower primates. This new approach relies less on nomenclature and instead emphasizes key trends in primate adaptation and relation to living groups. Three new "At a Glance" boxes call attention to significant transitional primate groups and act as handy study tools. A complete revision of ape origins is supplemented by a detailed map showing the dispersal patterns of early apes from Africa to Europe and Eurasia and then back into Africa. The chapter, as a whole, includes attractive new art emphasizing important primate traits and differences between groups in an easy-to-understand visual format.

Remarkable new discoveries of fossil hominins and evidence of their behavior are discussed in Chapters 9 through 13. In Chapter 9 we provide further information that sheds light on the controversial interpretation of what some researchers have claimed are the earliest stone tools (ostensibly used for butchering) as well the latest chemical evidence used to reconstruct early hominin diets. Chapter 10 covers the earliest hominins and presents varied interpretations, including further information about *Ardipithecus* as well as a new find of foot remains that suggest many of these early hominins were likely bipedal, but in a very different way from us or even some other contemporary hominin species.

Our coverage of *Homo erectus* in Chapter 11 covers a new find from Java as well as new and more precise dating of several key sites. Chapter 12 contains a new framework for understanding premodern humans, especially as they occupied wider areas of the Old World with some populations becoming more isolated. In addition, we cover the amazing new DNA results obtained from a finger bone found in Siberia that have allowed researchers to determine not only that the individual was female but also her hair, skin, and eye color. Chapter 13 concludes the section on fossil hominins with a discussion of the origins of modern humans. Updates include further evidence showing more precisely the evolutionary relationships of *Homo floresiensis* as well as new archaeological discoveries pushing back the dates of cave painting in western Europe and the development of sophisticated tools in southern Africa.

In Chapters 14 through 16, our focus turns to modern human biology. Our understanding of human variation (discussed in Chapter 14) has been completely transformed by more complete DNA data, published in just the last five years. We have updated and modified our main perspective in this chapter to reflect the remarkable new findings contributed by molecular biology. New data from contemporary hunter-gatherer populations in Africa tell us about human origins; other very recent research further clarifies how migrations outside of Africa led to the peopling of Eurasia, Australia, and the New World.

In Chapter 15, there's a new discussion of recent research demonstrating a population-wide genetic mutation in Tibetan highlanders that increases their ability to adapt to living at high altitude. We have also included a major new section on "Human Skeletal Biology: What Bones Can Tell Us about Ancient Diseases and Lifestyles." The discussion of diseases found in bone is linked to the overall human adaptation theme of the chapter and is heavily illustrated with new photos.

In Chapter 16, now titled "Legacies of Human Evolutionary History: Effects on the Individual," we focus on ways in which our biology, resulting from millions of years of evolution, seems to be mismatched with the lives we lead today, leading in some cases to compromised health. For example, the biology of women may not be well suited to the highly frequent menstrual cycling that results from the use of modern forms of birth control. Some health disorders that we are dealing with today may

stem from the dramatic differences between the diets of our ancestors and the foods we eat today.

Finally, in the new concluding Chapter 17 ("The Human Disconnection"), we focus on another theme that runs through the book—why it is so crucial that we know and understand human evolutionary history, its impact on the world today, and how we have distanced ourselves from other living species with which we share so many connections. We humans and the consequences of our activities are probably the most important influences on evolution today, causing the extinction or near-extinction of thousands of other life-forms and threatening the very planet on which we live. Our disconnection from other species and from our own evolutionary past pose the biggest challenges our species has ever faced. Only by understanding how we got to this point can we begin to respond to the challenges that are in our future and the futures of our children and grandchildren.

We also expanded our treatment of climate change in Chapter 17, including two new figures. The discussion provides current information from the National Snow and Ice Data Center showing that in September 2012, the Arctic sea ice minimum was 49 percent less than the average figure for the years 1979 to 2000. We point out that there has been a steady decline in Arctic sea ice since the year 2000 and we briefly deal with the likely consequences of continued melting.

In-Chapter Learning Aids

Connections graphic at the beginning of each chapter shows the biological relationships emphasized in the chapter in the context of topics in other chapters.

Student Learning Objectives are listed on the opening page of each chapter.

A Closer Look boxes are high-interest features found throughout the book. They supplement chapter material and include more in-depth discussion of selected stimulating topics.

How Do We Know? chapter concluding sections summarize the basic scientific information used in drawing accurate conclusions about our evolutionary history.

Video Media Resources are now listed at the end of half of the chapters. Students are referred to the anthropology CourseMate at www.cengagebrain.com for access.

A running glossary in the margins provides definitions of terms immediately adjacent to the text where the term is first introduced. A full glossary is provided at the back of the book.

At a Glance boxes found throughout the book briefly summarize complex or controversial material in a visually simple fashion.

Figures, including numerous photographs, line drawings, and maps, most in full color, are carefully selected to clarify text materials and directly support the discussion in the text.

Critical Thinking Questions at the end of each chapter reinforce key concepts and encourage students to think critically about what they have read.

Full bibliographical citations throughout the book provide sources from which the materials are drawn. This type of documentation guides students to published, peer-reviewed source materials and illustrates for students the proper use of references. All cited sources are listed in the comprehensive bibliography at the back of the book.

Acknowledgments

Over the years, many friends and colleagues have assisted us with our books. For this edition we are especially grateful to the reviewers who so carefully commented on the manuscript and made such helpful suggestions: Jerusha Achterberg, Harvard University; Autumn Cahoon, Sierra College; Meredith Dorner, Saddleback College; Samantha Hens, California State University Sacramento; Melissa Remis, Purdue University West Lafayette; Kathleen Rizzo, University of Illinois at Chicago; Patricia Vinyard, University of Akron; and Brita Wynn, Sacramento City College.

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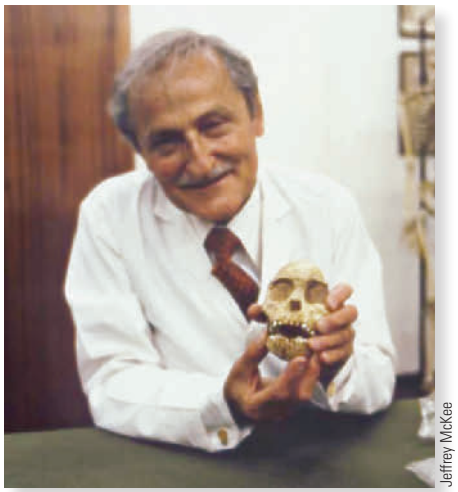
Robert Jurmain
Lynn Kilgore
Wenda Trevathan
Russell Ciochon
December 2012

In memory of Phillip Tobias



Jeffrey McKee

1925–2012

Supplements

Introduction to Physical Anthropology 2013–2014 comes with an outstanding supplements program to help instructors create an effective learning environment so students can more easily master the latest discoveries and interpretations in the field of physical anthropology.

Supplements for the Instructor

Online Instructor's Manual with Test Bank for *Introduction to Physical Anthropology 2013–2014 Edition*
This online resource includes a sample syllabus showing how to integrate the Anthropology Resource Center with the text, as well as chapter outlines, learning objectives, key terms and concepts, lecture suggestions, and enrichment topics, as well as 40–60 test questions per chapter.

PowerLecture™ with Exam View® (Windows/Macintosh) for *Introduction to Physical Anthropology 2013–2014 Edition*
This easy-to-use, one-stop digital library and presentation tool includes the following book-specific resources as well as direct links to many of Wadsworth's highly valued electronic resources for anthropology:

- Ready-to-use Microsoft® PowerPoint® lecture slides with photos and graphics from the text, make it easy for you to assemble, edit, publish, and present custom lectures for your course.
- ExamView® testing software, which provides all the test items from the text's *test bank* in electronic format, enabling you to create customized tests of up to 250 items that can be delivered in print or online.
- The text's *Instructor's Resource Manual and Test Bank* in electronic format.

Anthropology CourseMate
This website for *Introduction to Physical Anthropology 2013–2014 Edition* brings chapter topics to life with interactive learning, study, and exam preparation tools including quizzes and flashcards for each chapter's key terms and concepts. The site also provides an eBook version of the text with highlighting and note-taking capabilities. For instructors this text's CourseMate also includes Engagement Tracker, a first-of-its-kind tool that monitors student engagement in the course. Go to login.cengage.com to access these resources.

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Supplements for the Student

Anthropology CourseMate
This website for *Introduction to Physical Anthropology 2013–2014 Edition* brings chapter topics to life with interactive learning, study, and exam preparation tools, including quizzes, flash cards, videos, animations, and more! The site also provides an eBook version of the text with highlighting and note-taking capabilities. You can access this new learning tool and all other online resources through www.cengagebrain.com.

Telecourse Course Student Guide for *Introduction to Physical Anthropology, 2013–2014 Edition*
Entitled "Physical Anthropology: The Evolving Human," this distance-learning course provides online and print companion study guide options that include quizzing, study aids, interactive exercises, video, and more.

Classic and Contemporary Readings in Physical Anthropology
Edited by Mary K. Sandford and Eileen Jackson, this accessible reader presents primary articles with introductions and questions for discussion, helping students to better understand the nature of scientific inquiry. Students will read highly accessible classic and contemporary articles on key topics, including the science of physical anthropology, evolution and heredity, primates, human evolution, and modern human variation.

Lab Manual and Workbook for Physical Anthropology, Seventh Edition
Written by Diane L. France, this edition of the workbook and lab manual includes a new "Introduction to Science and Critical Thinking" that precedes the first. Using hands-on exercises, this richly illustrated full-color lab manual balances the study of genetics, human osteology, anthropometry, and forensic anthropology with the study of primates and human evolution. In addition to providing hands-on lab assignments that apply the field's perspectives and techniques to real situations, this edition provides more explanatory information and sample exercises throughout the text to help make the concepts of physical anthropology easier to understand. Contact your Cengage sales representative to package with the text.

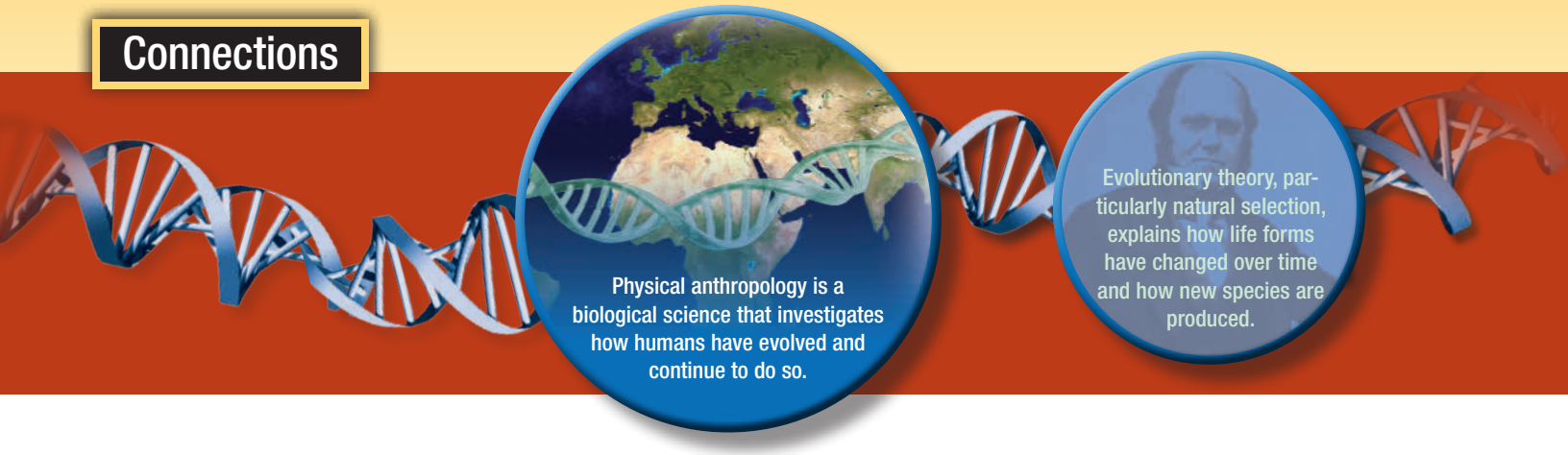
Physical Anthropology Lab Manual by John Kappelman offers a focused sampling of laboratory exercises that range across the breadth of the discipline, from examples of heredity and evolution to primate behavior, the fossil record of apes and early humans, and questions about human biology that are linked to environmental change. Exercises are designed with a succinct focus on particular problems, and the labs follow a fixed format with the introduction of a problem followed by the collection of data that are in turn used to test and evaluate the hypothesis. Students who complete the labs will greatly expand their knowledge of physical anthropology.

Basic Genetics in Anthropology CD-ROM: Principles and Applications, Version 2.0 by Jurmain/Kilgore/Trevathan
This student CD-ROM expands on basic biological concepts covered in the book, focusing on biological inheritance (such as genes and DNA sequencing) and its applications to modern human populations. Interactive animations and simulations bring these important concepts to life so that students can fully understand the essential biological principles underlying human evolution. Also available are quizzes and interactive flash cards for further study.

Hominid Fossils CD-ROM: An Interactive Atlas by James Ahern
This CD-based interactive atlas includes over 75 key fossils that are important for a clear understanding of human evolution. The QuickTime® Virtual Reality (QTVR) "object" movie format for each fossil will enable students to have a near-authentic experience working with these important finds by allowing them to rotate the fossil 360°. Unlike some VR media, QTVR objects are made using actual photographs of the real objects and thus better preserve details of color and texture. The fossils used are high-quality research casts and real fossils.

The organization of the atlas is nonlinear, with three levels and multiple paths, enabling students to start with a particular fossil and work their way "up" to see how the fossil fits into the map of human evolution in terms of geography, time, and evolution. The CD-ROM offers students an inviting, authentic learning environment, one that also contains a dynamic quizzing feature that will allow students to test their knowledge of fossil and species identification as well as provide more detailed information about the fossil record.

Connections



Physical anthropology is a biological science that investigates how humans have evolved and continue to do so.

Evolutionary theory, particularly natural selection, explains how life forms have changed over time and how new species are produced.

Cristina G. Mittermeier

Introduction to Physical Anthropology

1

Student Learning Objectives

After mastering the material in this chapter, you should be able to:

- Describe the discipline of anthropology as it is practiced in the United States, its subfields, and the general anthropological perspective on how humans are biologically and behaviorally connected to other species.
- Provide a brief description of the major subfields of physical or biological anthropology.
- Understand the fundamentals of the scientific method and the importance of hypothesis testing.
- Explain why scientific theories are not simply guesses or hunches, as the term (theory) is often incorrectly used and interpreted.
- Appreciate how understanding the nature of scientific research can lead to the development of critical thinking skills, which, in turn, are an extremely important outcome of a college education.

Introduction

One day, perhaps during the rainy season some 3.7 million years ago, two or three animals walked across a grassland **savanna** in what is now northern Tanzania, in East Africa. These individuals were early **hominins**, members of the same evolutionary lineage that includes our own **species**, *Homo sapiens*. Fortunately for us, a record of their passage on that long-forgotten day remains in the form of fossilized footprints, preserved in hardened volcanic deposits. As chance would have it, shortly after heels and toes were pressed into the damp soil, a nearby volcano erupted. The ensuing ash fall blanketed everything on the ground. In time, the ash layer hardened into a deposit that remarkably preserved the tracks of numerous animals, including those early hominins, for nearly 4 million years (**Fig. 1-1**).

These now famous prints indicate that two individuals, one smaller than the other, perhaps walking side by side, left parallel sets of tracks. But because the larger individual's prints are obscured, possibly by those of a third, it's unclear how many actually made that journey so long ago. What is clear is that the prints were made by an animal that habitually walked **bipedally** (on two feet), and that fact tells us that those ancient travelers were hominins.

In addition to the footprints, scientists working at this site (called Laetoli) and at other locations have discovered many fossilized parts of skeletons of an animal we call *Australopithecus afarensis*. Because the remains have been extensively studied, we know that these hominins were anatomically similar to ourselves, although their brains were only about one-third the size of ours. They may have used stones and sticks as simple tools, but there is no evidence that they actually made stone tools. In fact, they were very much at the mercy of nature's whims. They certainly could not outrun most predators, and their canine teeth were fairly small, so compared to many other animals, they were pretty much defenseless.

We've asked hundreds of questions about the Laetoli hominins, but we will never be able to answer them all. They walked down a path into what became their future, and their journey ended so long ago that we cannot really grasp how much time has passed since that

savanna (also spelled savannah) A large flat grassland with scattered trees and shrubs. Savannas are found in many regions of the world with dry and warm-to-hot climates.

hominins Colloquial term for members of the evolutionary group that includes modern humans and now-extinct bipedal relatives.

species A group of organisms that can interbreed to produce fertile offspring. Members of one species are reproductively isolated from members of all other species (i.e., they cannot mate with them to produce fertile offspring).

bipedally On two feet; walking habitually on two legs.

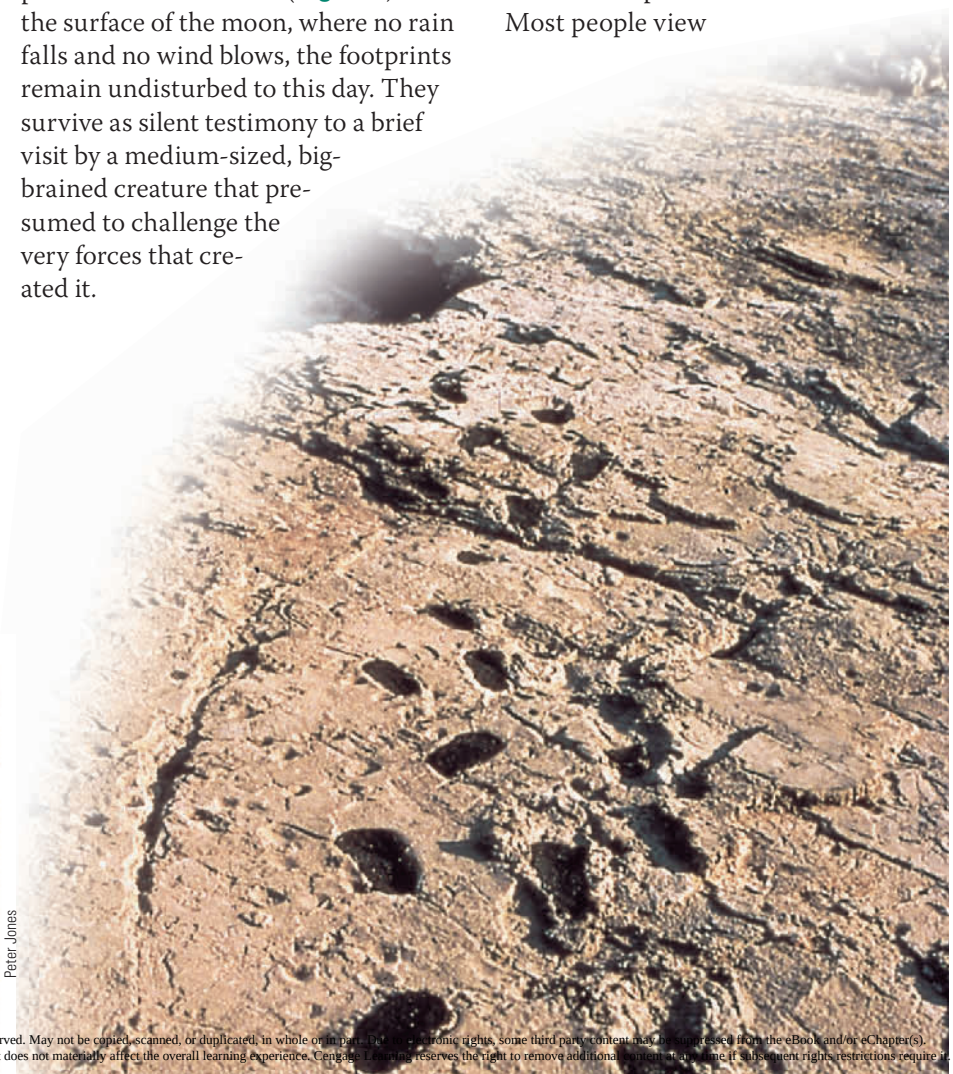
day. But it remains for us to learn as much as we can about them, and as we continue to do this, their greater journey continues.

On July 20, 1969, a television audience numbering in the hundreds of millions watched as two human beings stepped out of a spacecraft onto the surface of the moon. People born after that date have always lived in an age of space exploration, and many may now take that first moon landing more or less for granted. But the significance of that first moonwalk can't be overstated, because it represents humankind's presumed mastery over the natural forces that govern our presence on earth. For the first time ever, people actually walked upon the surface of a celestial body that, as far as we know, has never given birth to biological life.

As the astronauts gathered geological specimens and frolicked in near weightlessness, they left traces of their fleeting presence in the form of footprints in the lunar dust (**Fig. 1-2**). On the surface of the moon, where no rain falls and no wind blows, the footprints remain undisturbed to this day. They survive as silent testimony to a brief visit by a medium-sized, big-brained creature that presumed to challenge the very forces that created it.

You may wonder why anyone would care about early hominin footprints and how they can possibly be relevant to your life. You may also wonder why a physical **anthropology** textbook would begin by discussing two such seemingly unrelated events as ancient hominins walking across an African savanna and a moonwalk. But the fact is, these two events are very closely connected.

Physical, or biological, anthropology (both terms are used) is a scientific discipline concerned with the biological and behavioral characteristics of human beings; our closest relatives, the nonhuman **primates** (apes, monkeys, tarsiers, lemurs, and lorises); and our ancestors. This kind of research helps us explain what it means to be human and how we came to be the way we are. This is an ambitious goal and it probably isn't fully attainable, but it's certainly worth pursuing. We're the only species to ponder our own existence and question how we fit into the spectrum of life on earth. Most people view



Peter Jones

▶ **Figure 1-1** Early hominin footprints at Laetoli, Tanzania. The tracks to the left were made by one individual, while those to the right appear to have been made by two individuals, the second stepping in the tracks of the first.

anthropology The field of inquiry that studies human culture and evolutionary aspects of human biology; includes cultural anthropology, archaeology, linguistics, and physical, or biological, anthropology.

primates Members of the mammalian order Primates (pronounced "pry-may´-tees"), which includes lemurs, lorises, tarsiers, monkeys, apes, and humans.

humanity as quite separate from the rest of the animal kingdom. But at the same time, many are curious about the similarities we share with other species. Maybe, as a child, you looked at your dog and tried to figure out how her front legs might correspond to your arms. Or perhaps during a visit to the zoo, you recognized the similarities between a chimpanzee's hands or facial expressions and your own. Maybe you wondered if he also shared your thoughts and feelings. If you've ever had thoughts and questions like these, then you've indeed been curious about humankind's place in nature.

How did *Homo sapiens*, a result of the same evolutionary forces that produced all other forms of life on this planet, gain the power to control the flow of rivers and even alter the climate on a global scale? As tropical animals, how were we able to leave the tropics and eventually occupy most of the earth's land surfaces? How did we adjust to different environmental conditions as we dispersed? How could our species, which numbered fewer than 1 billion until the mid-nineteenth century, come to number more than 7 billion worldwide today and, as we now do, add another billion people approximately every 11 years?

These are some of the many questions that physical anthropologists try to answer through the study of human **evolution**, variation, and **adaptation**. These issues, and many others, are covered in this textbook, because physical anthropology is, in large part, human biology seen from an evolutionary perspective. On hearing the term *evolution*, most people think of the appearance of new species. Certainly new species are one important consequence of evolution, but not the only one. Evolution is an ongoing biological process with more than one outcome. Simply stated, evolution is a change in the **genetic** makeup of a population from one generation to the next, and it can be defined and studied at two levels. Over time, some genetic changes in populations do result in the appearance of a new species (or *speciation*), especially when those populations are isolated from one another. Change at this level is called *macroevolution*. At the other level, there are genetic alterations *within* populations; and though this type of change may not lead to speciation, it does cause populations of a species to differ from one another in the frequency of certain traits. Evolution at this level is referred to as *microevolution*. Evolution at both these levels will be discussed in this book.

▲ **Figure 1-2** Human footprints left on the lunar surface during the *Apollo* mission.

The Human Connection

The unifying theme of this textbook is how human beings are linked to all other life on earth. We can see how we are connected to other organisms in countless ways, as you will learn throughout this book. For example, our DNA is structurally identical to that of every living thing. Indeed, we share genes that are involved in the most fundamental life processes with even the simplest of animals, such as sponges. These genes have changed very little over the course of several hundred million years of evolution. With few exceptions, our cells have the same structure and work the same way as in all life forms. Anatomically, we have the same muscles and bones as other animals. What's more, many aspects of our **behavior** have direct connections to nonhuman species, especially other primates.

The countless connections we share with other organisms show that

evolution A change in the genetic structure of a population. The term is also frequently used to refer to the appearance of a new species.

adaptation An anatomical, physiological, or behavioral response of organisms or populations to the environment. Adaptations result from evolutionary change (specifically as a result of natural selection).

genetic Having to do with the study of gene structure and action and the patterns of inheritance of traits from parent to offspring. Genetic mechanisms are the foundation of evolutionary change.

behavior Anything organisms do that involves action in response to internal or external stimuli; the response of an individual, group, or species to its environment. Such responses may or may not be deliberate, and they aren't necessarily the result of conscious decision making (which is absent in single-celled organisms, insects, and many other species).

humans are a product of the same evolutionary forces that produced all living things. But, clearly we aren't identical to any other species. In fact, all species are unique in some ways. We humans are one contemporary component of a vast biological **continuum** at a particular point in time; and in this regard, we aren't really all that special. Stating that humans are part of a continuum doesn't imply that we're at the peak of development on that continuum. Depending on the criteria used, humans can be seen to exist at one end of the spectrum or the other, or somewhere in between, but we don't occupy a position of inherent superiority over other species (**Fig. 1-3**).

However, human beings are unquestionably unique regarding one highly significant characteristic, and that is intellect. After all, humans are the only species, born of earth, to stir the lunar dust. We're the only species to develop language and complex culture as a means of buffering nature's challenges, and by doing so we have gained the power to shape the planet's very destiny.

Biocultural Evolution

Biological anthropologists don't just study physiological and biological systems. When these topics are considered within the broader context of human evolution, another factor must be considered, and that is **culture**. Culture is an extremely important concept, not only as it relates to modern humans but also because of its critical role in human evolution. Quite simply, and in a very broad sense, culture can be defined as the strategy by which humans adapt to the natural environment. In fact, culture has so altered and dominated our world that it's become the environment in which we live. Culture includes technologies ranging from stone tools to computers; subsistence patterns, from hunting and gathering to global agribusiness; housing types, from thatched huts to skyscrapers; and clothing, from animal skins to high-tech synthetic fibers (**Fig. 1-4**). Technology, religion, values, social organization, language, kinship, marriage rules, gender roles, dietary practices, inheritance of property, and so on are all aspects of culture. Each culture shapes people's perceptions of the external environment, or **worldview**, in particular ways that distinguish a particular society from all others.

One important point to remember is that culture isn't genetically passed from one generation to the next. We aren't born with innate knowledge that leads us to behave in ways appropriate to our own culture. Culture is *learned*, and the process of learning one's culture begins, quite literally, at birth. All people are products of the culture they're raised in, and since most human behavior is learned, it follows that most human behaviors, perceptions, values, and reactions are shaped by culture.

It's important to emphasize that even though culture isn't genetically determined, the human predisposition to assimilate culture and function within it is very much influenced by biological factors. Most nonhuman animals rely to varying degrees on learned behavior. This is especially true of the great apes (gorillas, chimpanzees, bonobos, and orangutans), which exhibit several aspects of culture.

The predisposition for culture is perhaps the most critical component of human evolutionary history, and it was inherited from our early hominin or even prehominin ancestors. In fact, the common ancestor we share with chimpanzees may have had this predisposition. But during the course of human evolution, the role of culture became increasingly important. Over time, as you will see, culture influenced many aspects of our biological makeup; in turn, aspects of biology influenced cultural practices. For this reason, humans are the result of long-term interactions between biology and culture. We call these interactions **biocultural evolution**; and in this respect, humans are unique.

continuum A set of relationships in which all components fall along a single integrated spectrum (for example, color). All life reflects a single biological continuum.

culture Behavioral aspects of human adaptation, including technology, traditions, language, religion, marriage patterns, and social roles. Culture is a set of learned behaviors transmitted from one generation to the next by nonbiological (i.e., nongenetic) means.

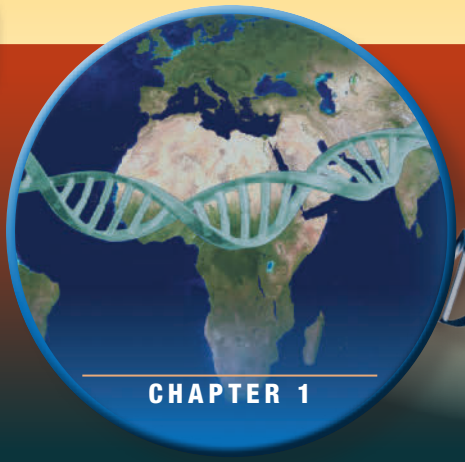
worldview General cultural orientation or perspective shared by the members of a society.

biocultural evolution The mutual interactive evolution of human biology and culture; the concept that biology (anatomy, neurological attributes, etc.) makes culture possible and that developing culture further influences the direction of biological evolution; this is a basic concept in understanding the unique components of human evolution.

▶ **Figure 1-3** Traditional and recent technologies. (**a**) An early stone tool from East Africa. This artifact represents one of the oldest types of stone tools found anywhere. (**b**) The Hubble Space telescope, a late twentieth-century tool, orbits the earth every 96 minutes at an altitude of 360 miles. Because it is above the earth's atmosphere, it provides distortion-free images of objects in deep space. (**c**) A cuneiform tablet. Cuneiform, the earliest form of writing, involved pressing symbols into clay tablets. It originated in southern Iraq some 5,000 years ago. (**d**) Text messaging, a fairly recent innovation in satellite communication, has generated a new language of sorts. Today, more than 500 million text messages are sent every day worldwide. (**e**) A Samburu woman in East Africa building a traditional but complicated dwelling of stems, small branches, and mud. (**f**) These Hong Kong skyscrapers are typical of cities in industrialized countries today.

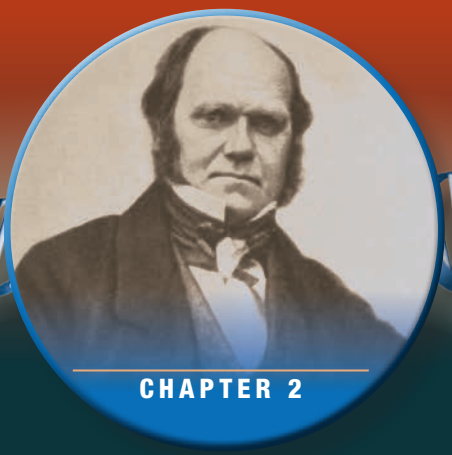
Connections

Figure 1-4
Humans are biologically connected to all forms of life. This central theme will be addressed in every chapter of this textbook as shown in this figure.



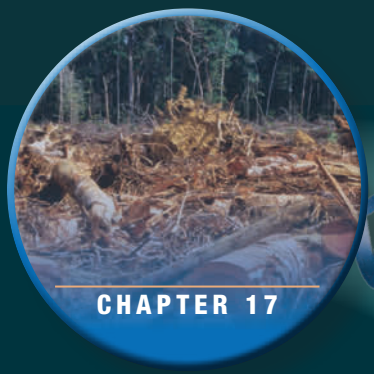
CHAPTER 1

Physical anthropology is a biological science that investigates how humans have evolved and continue to do so.



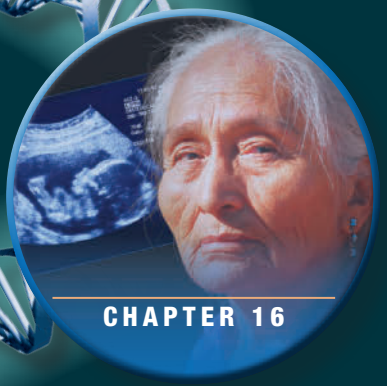
CHAPTER 2

Evolutionary theory, particularly natural selection, explains how life forms have changed over time and how new species are produced.



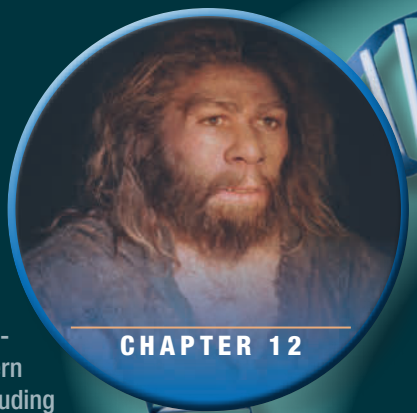
CHAPTER 17

Humans have recently become disconnected from other life and are rapidly altering the planet.



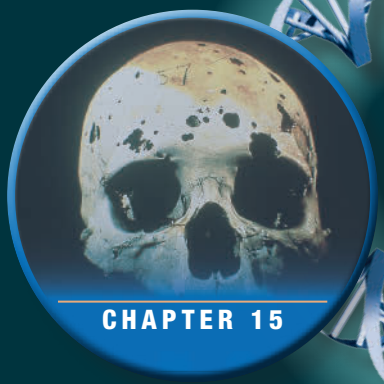
CHAPTER 16

Human development and adaptation is best understood from an evolutionary perspective.



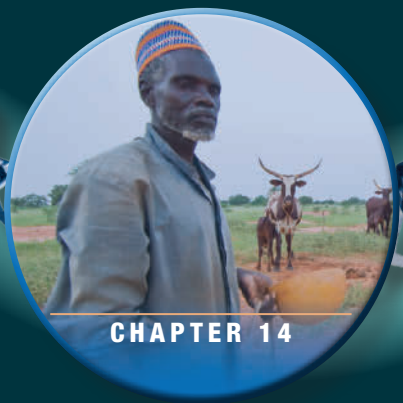
CHAPTER 12

The immediate predecessors of modern humans, including the Neandertals, were much like us, but had some anatomical and behavioral differences.



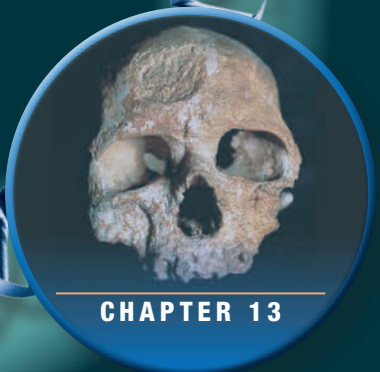
CHAPTER 15

Through natural selection, humans have and continue to adapt to environmental factors including solar radiation, cold, altitude, and, most importantly, infectious disease.



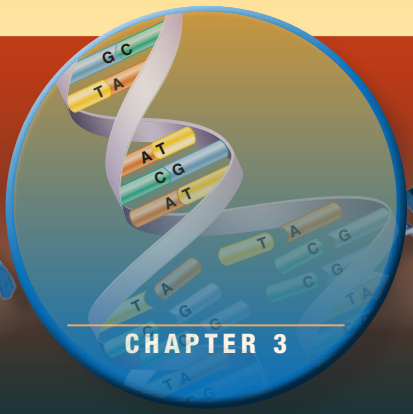
CHAPTER 14

Modern human variation is best understood by examining similarities and differences in DNA among populations.



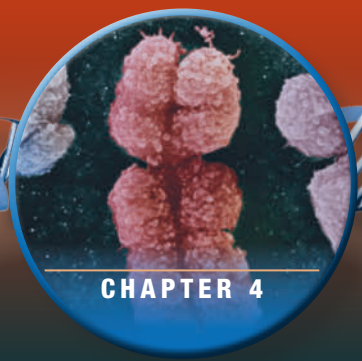
CHAPTER 13

Modern humans first evolved in Africa and later spread to other areas of the world, where they occasionally interbred with Neandertals and other pre-modern humans.



CHAPTER 3

The DNA molecule is the basis of all life.

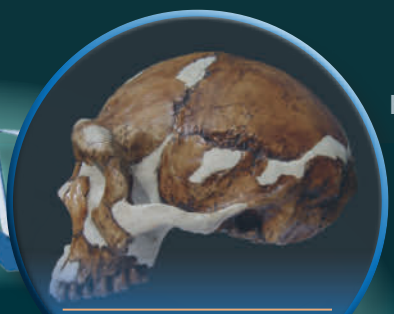


CHAPTER 4

Evolution occurs when DNA changes and genetic variation is further influenced by natural selection and other factors.

CHAPTER 5

Humans are both vertebrates and mammals, and their evolutionary history over many millions of years explains our early roots.



CHAPTER 11

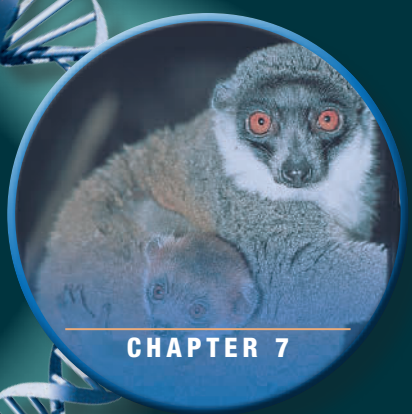
Hominins began to disperse out of Africa around 2 million years ago, and during the next 1 million years inhabited much of Eurasia.

CHAPTER 6

Humans are primates and share many biological characteristics with other primates.

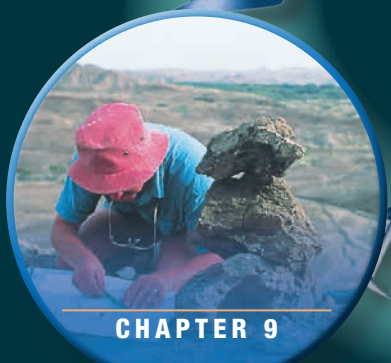
CHAPTER 10

The first more human-like animals (hominins) appeared in Africa around 6 mya ago and evolved into a variety of different species.



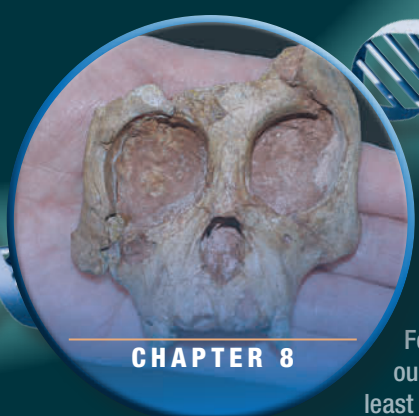
CHAPTER 7

Partly because of common evolutionary history, many human behaviors are also seen in other primates.



CHAPTER 9

Paleoanthropology, which includes physical anthropology, archaeology, and geology, provides the scientific basis to understand hominin evolution.



CHAPTER 8

Fossil evidence indicates our primate origins date to at least 65 million years ago.