EDITION **15**

INTRODUCTION TO PHYSICAL ANTHROPOLOGY

Robert **Jurmain** | Lynn **Kilgore** | Wenda **Trevathan** | Russell L. **Ciochon** | Eric J. **Bartelink**

Major Fossil Hominin Sites

INTRODUCTION TO

Physical Anthropology

FIFTEENTH EDITION

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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. The addition of Eric Bartelink as a coauthor for the fifteenth edition also brings a fresh perspective to this text. To provide even greater assistance than in previous editions, we have added new photos and have expanded the scope of the text. All these changes reflect our long-term commitment to our textbook as an effective teaching and learning instrument.

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 through 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 social construct of "race"), patterns of adaptation in recent human populations, and the developmental changes experienced by humans through the course of their lives. In the 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.

New in the Fifteenth Edition

First, as previously mentioned, we have maintained 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 opens with a visual aid that clearly shows students the biological connections as they are organized within and between chapters. At the start of every chapter, we have provided student learning objectives (linked to the main chapter headings) and a short chapter outline; these tools provide a preview of the upcoming chapter content. Toward the end of each chapter, we have expanded the "How Do We Know?" text boxes, which summarize the basic scientific information

that allows physical anthropologists and other biologists to draw accurate conclusions regarding our evolutionary history. We have also incorporated a "What Do You Think?" activity that allows students to decide what to do next.

In Chapter 2, we have expanded the discussion of creationism, and have contextualized recent public debate on evolutionary theory between scientists and creationists. We also provide additional examples of natural selection in action.

As genetic technology continues to grow at an unprecedented pace, it is our task to present the most relevant new discoveries in as simple a manner as possible. In addition to discussing the newly developed synthetic bacterial cell in Chapter 3, we discuss the basis for genetic typing of biological materials used in forensic science. In Chapter 4, we provide additional examples of genetic disorders, and in Chapter 5, we have added additional information on classifying fossils and as well as a discussion of how and why fossils form.

Primatologists are regularly reporting on new discoveries about our closest relatives, the nonhuman primates, clarifying our continuity with them. Since many of our primate cousins are unfamiliar to our readers, we've updated several photos to provide new examples of primates in the wild or to highlight specific behaviors. In Chapter 6, we add a discussion of the genetic relationship between humans and our closest living relatives, the chimpanzees. Today, most nonhuman primates are endangered, and we hope to raise awareness of them among students who read this book. We've significantly updated the statistics on threatened primate species and provide a discussion of recent efforts in primate conservation. Chapter 7 provides an expanded discussion of evidence of culture among nonhuman primates.

Chapter 8 has been updated to include new discoveries as well as ongoing reinterpretations of fossil primates. These changes include an expanded section on the evolution of the platyrrhine lineage as well as the recent announcement of the discovery of a skull and partial skeleton of a new small-bodied ape, *Pliobates*, found in Catalonia, Spain. In addition, a discussion of another fossil ape, *Khoratpithecus*, has been added. This fossil appears to show a closer evolutionary relationship to the orangutan. The chapter includes new photographs of more recently discovered fossil primates.

Remarkable new discoveries of fossil hominins and evidence of their behavior are discussed in Chapters 9 through 13. In Chapter 9, we discuss evidence for the earliest known stone tools (tentatively dated to 3.3 million years ago) and provide a discussion of the scars of human evolution that result from being a bipedal primate.

Chapter 10 includes a discussion of a possible new hominin species discovered in Ethiopia (dated to 3.4 million years ago), expands the discussion of *Australopithecus sediba* based on the most recent research, and provides a heads-to-toe perspective on bipedal anatomy.

In Chapter 11, we have made the most extensive and critical updates to the book. We have included a discussion of a possible new hominin species, *Homo naledi*, recently discovered in the Rising Star Cave complex in South Africa. Although dates of these fossils are forthcoming, this discovery provides the most extensive assemblage of early hominin remains from Africa, and includes individuals of all age groups. Another very significant discovery is the remains of *Homo floresiensis* at a second locale (Mata Menge) on the island of Flores. This new discovery, dated to the Middle Pleistocene, indicates that *Homo floresiensis* underwent insular dwarfism very early on, supporting the notion that this lineage descended from a *Homo erectus* population. Further, new chronometric dates from Liang Bua Cave (the original Flores locale) indicate the fossils are actually much older than originally thought (between 100,000 and 60,000 years old). Due to these new discoveries, the entire discussion of *Homo floresiensis* has been shifted completely to Chapter 11. The chapter also has updates relating to the study of *Homo erectus* growth rates and estimation of body size, a new *Homo erectus* discovery from Dmanisi, Georgia, that represents the most complete skull of an early hominin, the earliest probable evidence for the systematic use of fire based on studies from Wonderwerk Cave in South Africa, new dating on a *Homo erectus* fossil from China, and an expanded discussion of the role of meat consumption in hominin evolution.

Chapter 12 has been extensively revised to include an expanded discussion of the most recent genetic discoveries on Middle Pleistocene premodern humans, Neandertals, and Denisovans. These molecular discoveries show that Neandertals and Denisovans interbred with modern humans, and their genes can still be found in many contemporary human populations. A new discussion of Neandertal diets is provided based on analyses of stable isotopes of Neandertal bones and plant starch grains from dental calculus. In addition, we provide a discussion of a recent reanalysis of hominin cranial remains from the Upper Awash region of Ethiopia. These remains suggest the presence of *Homo heidelbergensis* around 850,000 years ago, thus providing the earliest potential evidence for this species in Africa. Finally, we have expanded on the discussion of the 300,000-year-old fossilized wooden spears recovered from Schöningen, Germany, based on several new studies and interpretations of these fascinating artifacts.

Chapter 13 expands on the origins of modern human populations, and highlights new genetic findings regarding Late Pleistocene migration events. We have updated the chapter to discuss early evidence for complex behaviors and artistic representations among early modern humans from South Africa and Indonesia. We have also added a section on the history of the molecular clock as a tool to study the origin of modern humans. Updated art and "At a Glance" features provide exciting visuals for students to compare different models for the origins of modern humans as well as the genetic relationships between different hominin populations during the Late Pleistocene.

In Chapters 14 through 16, our focus turns to modern human biology. We have updated information on the global issues of HIV and tuberculosis infection, the reemergence of infectious diseases due to the overuse of antibiotics and the anti-vaccination movement, and perspectives on human variation used in forensic anthropology.

One theme that we emphasize throughout the book is that we are the result of not only biological but also cultural evolutionary factors. In other words, we are a *biocultural* species. In Chapter 16, now titled "Legacies of Human Evolutionary History: Effects on the Life Course," we focus on ways in which biology and culture act on the human life course from conception, through reproduction, to the end of life. There are a number of 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. In this chapter, there's a new discussion of recent research on the human gut microbiome, human brain growth rates, infant dependency, menopause, pleiotropic genes, factors influencing cancer risk, and the Paleolithic diet trend.

Finally, in 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 poses 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 revised figures. The discussion provides current information from the National Snow and Ice Data Center showing that in September 2015, the Arctic sea ice extent was 1.94 million square miles, significantly lower than the average extent from 1982 to 2010. 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.

Four appendices are available as learning aids for the textbook. Appendix A provides an atlas of primate skeletal anatomy, including labeled diagrams of the skeleton of a human, a chimpanzee, and a macaque, as well as more detailed diagrams of the anatomical regions of the human skeleton. Appendix B is a guide to sex and age determination of human skeletal remains. Appendices C and D are available online in MindTap. Appendix C is a summary of the early hominin fossil record from Africa, and includes sketches and background information on various key discoveries. Appendix D provides additional information and population genetics examples that demonstrate microevolution in action.

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, corresponding to the main headings within the chapter, 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.

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.

How Do We Know? chapter concluding sections (with "What Do You Think?" scenarios) summarize the basic scientific information used in drawing accurate conclusions about our evolutionary history.

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 list of ***References*** at the back of the book.

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For the current and past four editions, John Fleagle has made anatomical diagrams available that were originally used in his book, *Primate Adaptation and Evolution* (Academic Press, 1999). Others who have assisted in forming the concepts that we have put into written form include David Begun, Eric Delson, John Fleagle, Gregg Gunnell, Terry Harrison, Pat Holroyd, Andrew Kitchen, Philip Rightmire, Kirstin Sterner, Nelson Ting, Tim White, and Iyad Zalmout.

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Dedication

In memory of Elwyn Simons (1930–2016).

Supplements

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

Supplements for the Instructor

Online Instructor's Manual for *Introduction to Physical Anthropology,* Fifteenth Edition
This online resource includes a sample syllabus showing how to integrate MindTap with the text, as well as chapter outlines, learning objectives, key terms and concepts, lecture suggestions, and enrichment topics.

Online Test Bank for *Introduction to Physical Anthropology,* Fifteenth Edition
Organize your course and capture your students' attention with the resources found in the test bank, including multiple-choice, true/false, short-answer, and essay questions—most with answers and page references for each chapter of the text.

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MindTap engages and empowers students to produce their best work—consistently. By seamlessly integrating course material with activities, apps, and much more, MindTap creates a unique learning path that fosters increased comprehension and efficiency.

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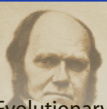
- Integrate your own content into the MindTap Reader using your own documents or pulling from sources like RSS feeds, YouTube videos, websites, Googledocs, and more.
- Use powerful analytics and reports that provide a snapshot of class progress, time in course, engagement, and completion.

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.

Introduction to Physical Anthropology

1

Student Learning Objectives

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

- Describe how all life-forms are interconnected through evolution.
- Define biocultural evolution and explain its relevance to human evolution.
- Describe the discipline of anthropology as it is practiced in the United States, including its four subfields.
- Articulate the fundamentals of the scientific method and the importance of hypothesis testing within physical anthropology.
- Explain how an anthropological perspective provides a holistic view of the human experience.

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 ashfall 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).

This illustration emphasizes the fact that all-life forms on earth, including humans, are ultimately connected by DNA.

NASA(map); iStockphoto.com/Jgroup(DNA); Top Images: © Cengage Learning; Bettmann/Corbis

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.

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 numerous questions about the Laetoli hominins, but we will never be able to answer them all. These early human ancestors left a fossilized trail for us to follow, and their journey ended so long ago that we cannot really grasp how much time has passed since that 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 had 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.

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 all 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).

Physical (or biological) anthropology is a scientific discipline concerned with the biological and behavioral characteristics of human beings, as well as those of 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 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.

NASA Images

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

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 7.3 billion worldwide today and, as we now do, add another billion people approximately every 12 or 13 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.

bipedally On two feet; walking habitually on two legs.

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.

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.

The Human Connection

The unifying theme of this textbook is how human beings are linked to all other life on earth. We are all 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 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. 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

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).

continuum A set of relationships in which all components fall along a single integrated spectrum (e.g., 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.

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 seen as the strategy by which humans adapt to the natural environment. In fact, culture has so altered and dominated our world that it has 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 their **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 transmitted from generation to generation through the process of *learning*, a process that begins, quite literally, at birth. We are all products of the culture in which we are raised, and since most human behavior is learned, it follows that most human behaviors, perceptions, values, and reactions are shaped by culture.

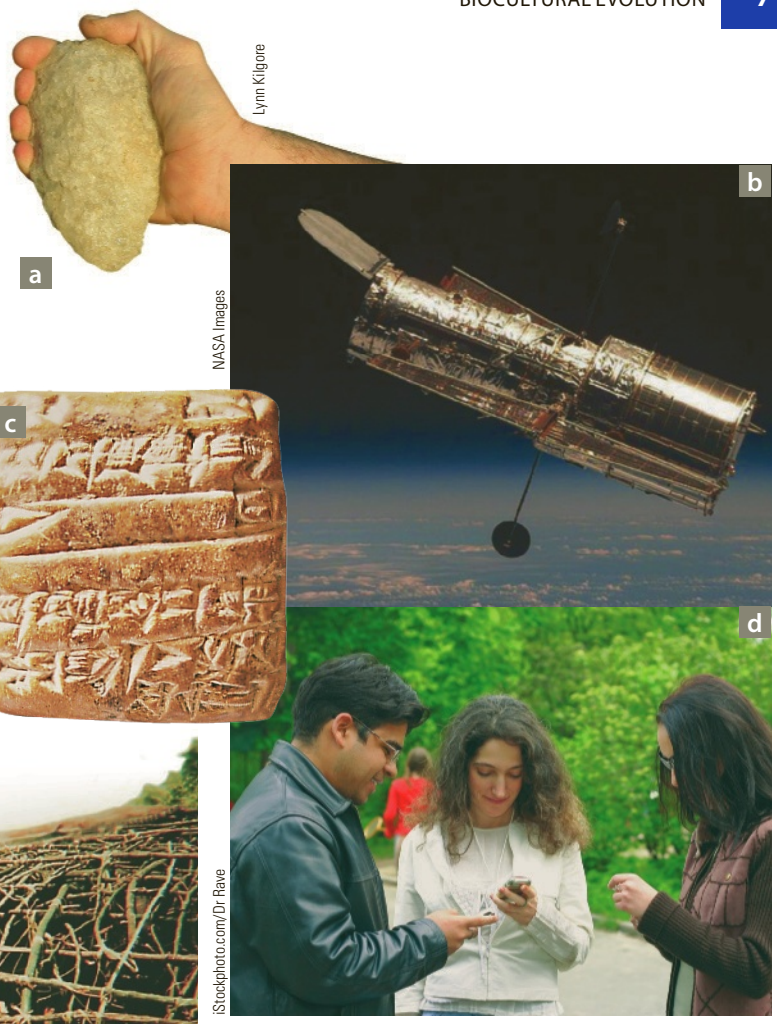
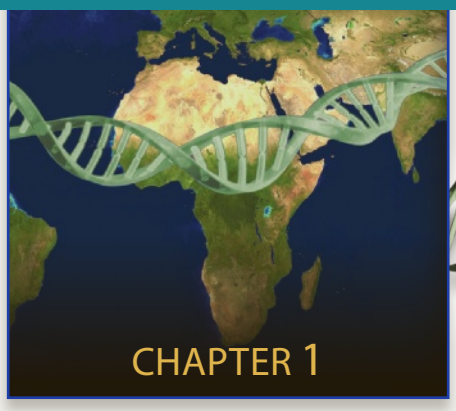


Figure 1-3

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.

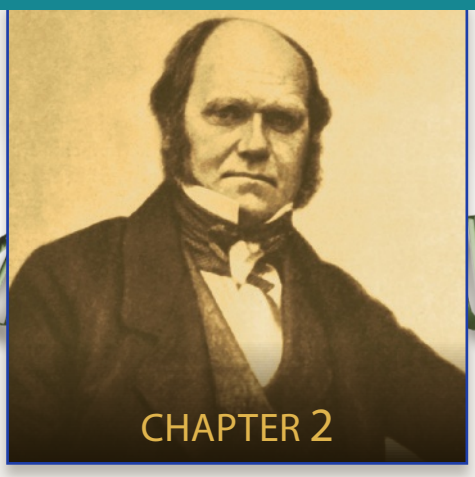
CONNECTIONS

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.



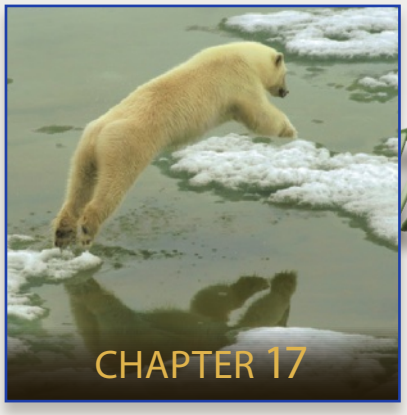
Physical anthropology is a biological science that investigates how humans have evolved and continue to do so.

NASA



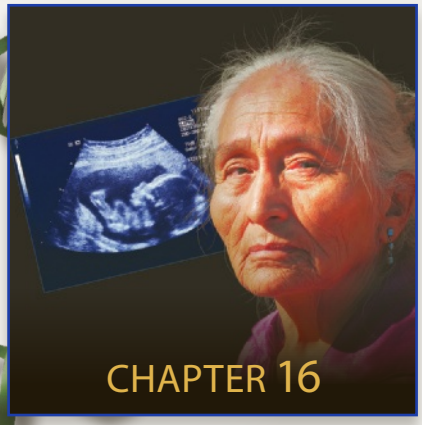
Evolutionary theory, particularly natural selection, explains how life forms have changed over time and how new species are produced.

Bettmann/Corbis



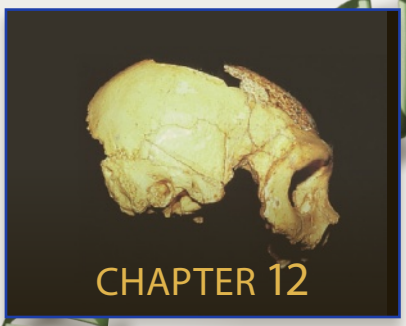
Humans have recently become disconnected from other life and are rapidly altering the planet.

Keenpress/Getty Images



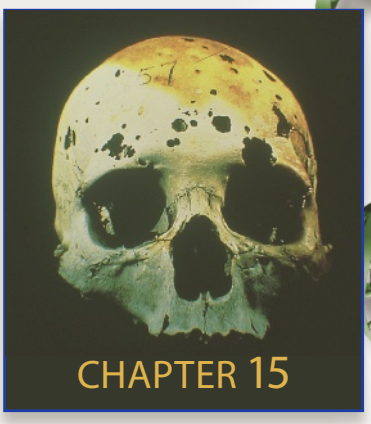
Human development and adaptation is best understood from an evolutionary perspective.

David P. Smith/Shutterstock.com



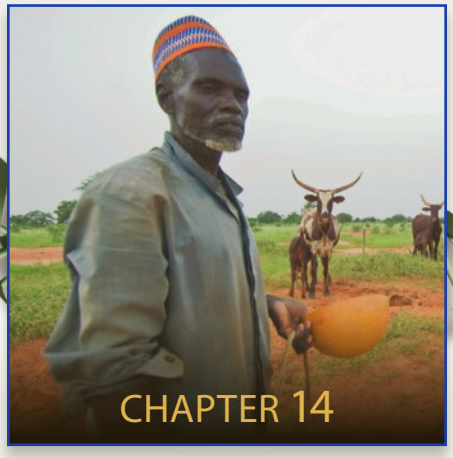
The immediate predecessors of modern humans, including the Neandertals, were much like us, but had some anatomical and behavioral differences. Human development and adaptation is best understood from an evolutionary perspective.

Fred Smith



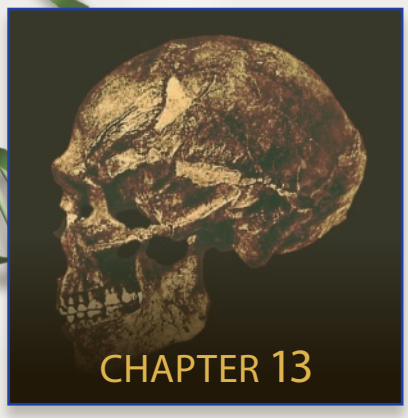
Through natural selection, humans have and continue to adapt to environmental factors including solar radiation, cold, altitude, and, most importantly, infectious disease.

Robert Jumain



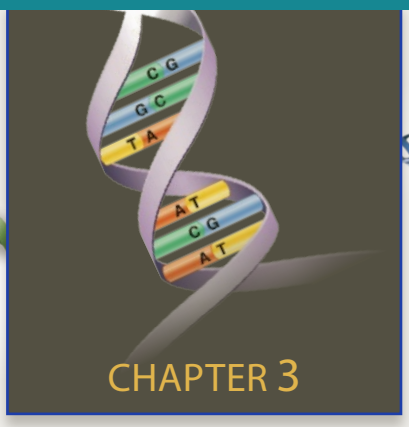
Modern human variation is best understood by examining similarities and differences in DNA among populations.

Guido Cozzi/Terra/Atlantide Phototravel/Corbis



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

Harry Nelson



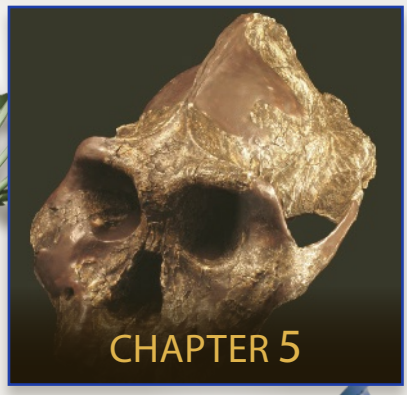
CHAPTER 3

The DNA molecule is the basis of all life.

CHAPTER 4

Biophoto Associates/Science Source

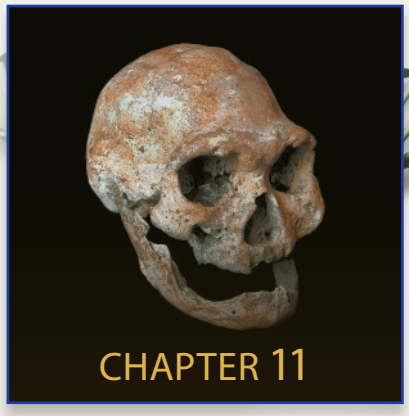
Evolution occurs when DNA changes and genetic variation is further influenced by natural selection and other factors.



CHAPTER 5

Russell L. Ciochon

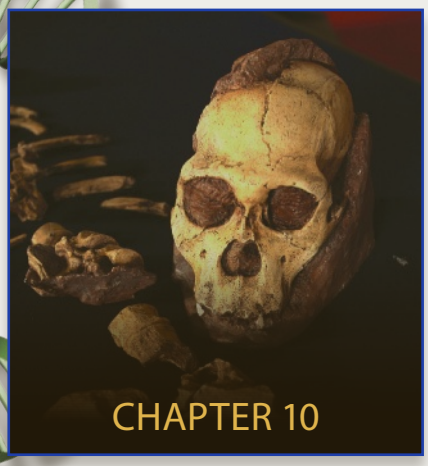
Humans are both vertebrates and mammals, and their evolutionary history over many millions of years explains our early roots.



CHAPTER 11

David Lordkipanidze

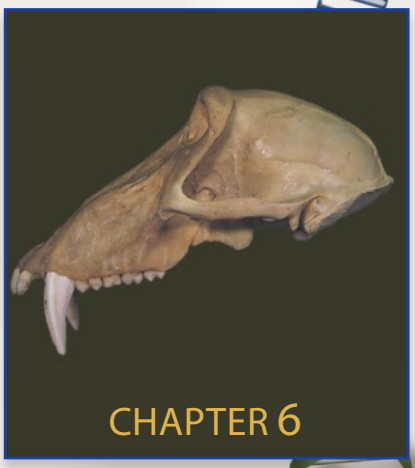
Hominins began to disperse out of Africa around 2 million years ago, and during the next 1 million years inhabited much of Eurasia.



CHAPTER 10

Raj Wong/FeatureChina/Newscom

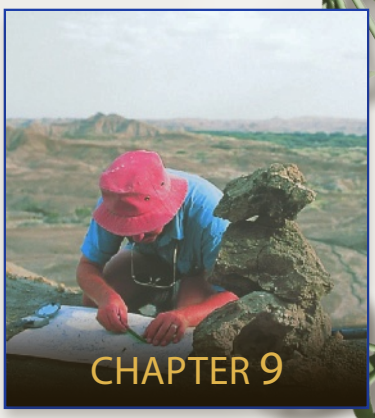
The first more human-like animals (hominins) appeared in Africa around 6 mya ago and evolved into a variety of different species.



CHAPTER 6

Lynn Kilgore

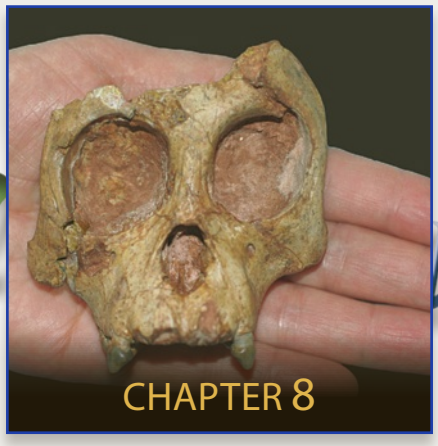
Humans are primates and share many biological characteristics with other primates.



CHAPTER 9

Institute of Human Origins, photo by Nancí Kahn

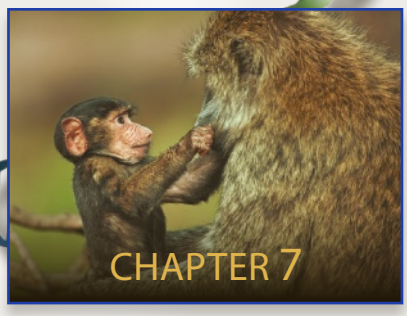
Paleoanthropology, which includes physical anthropology, archaeology, and geology, provides the scientific basis to understand hominin evolution.



CHAPTER 8

Russell L. Ciochon

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



CHAPTER 7

Anup Shah/Getty Images

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