



Exploring Biological Anthropology

THE ESSENTIALS



SECOND
EDITION

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Second Edition

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*In memory of Marissa Feliberty (1968–2008),
our Marketing Manager Extraordinaire.
She made our work sparkle and left us too soon.*

Preface

After teaching biological anthropology for nearly twenty years, we felt there was a great need for a new textbook that presents the core information, concepts, and theories of biological anthropology in a modern light. Biological anthropology was once commonly called physical anthropology. This is because decades ago the field was mainly about human anatomy, human fossils, and the study of racial variation. Over the past twenty-five years, the field has evolved into biological anthropology, the evolutionary biology of humankind based on information from the fossil record and the human skeleton, the genetics of both individuals and populations, our primate relatives, human adaptation, and human behavior, among other topics. Our book combines up-to-date coverage of the core material with a modern biological approach that includes fields that have become major areas of research by biological anthropologists over the past decade. This core-concepts version of the book is written especially for students needing to obtain a strong grounding in biological anthropology without some of the detail into which our original text delved. We three coauthors conduct our research in the main areas of biological anthropology: the human fossil record (Susan Antón), primate behavior and ecology (Craig Stanford), and human biology and the brain (John Allen). This has allowed us to provide a specialist approach to each of the broad divisions of the field covered by the text. We are anthropologists with extensive backgrounds in both biological and social sciences and are both teachers and researchers.

In a field changing as rapidly as human evolutionary science is today, we feel it is critical for active researchers to produce textbooks that serve the needs of students. In addition to the strong biological orientation of the book, we try to frame questions about humankind in light of our understanding of culture and the ways in which culture interacts with biology to create the template for human nature.

Undergraduate enrollment in introductory biological anthropology courses has increased sharply because biological anthropology has become one way to fulfill the basic natural science requirement at many colleges and universities. We believe the changing field and the new audience have created a need for a text such as this one, integrating traditional physical anthropology with a modern Darwinian framework, and presented in a concise, clear format.

We have made an effort in the second edition of *Exploring Biological Anthropology* to present a concise coverage of the core material of the field, while preserving a comprehensive coverage of certain traditionally important topics. For instance, we have included a feature on biomedical anthropology, a large feature (in Chapter 14) on the brain, and behavior and biology of modern people,

from the study of foragers (hunter-gatherers) to that of the human psyche (evolutionary psychology). There is a discussion of the geological background for human paleontology (Chapter 9), and new chapter sections on bioarcheology (Chapter 13) and forensic anthropology (Chapter 15). We have added new double-page features to many chapters to present information in a more visual way, and we have added new information to this edition in the form of new text and figures, as well as special features in some chapters.

In a field famous for intellectual disagreements over the meaning of fossils or interpretations of Darwinian theory, we've tried to present the accepted facts and concise descriptions of debates about evidence. There are places where, because of the introductory nature of the text, we have not delved deeply into the details of some debates, but we have nevertheless tried to balance multiple views of ongoing unresolved questions.

FOUNDATION: ORGANIZATION OF THE BOOK

The book is organized in much the same way that we three authors have taught introductory courses in biological anthropology. The theory of evolution by natural selection is the unifying aspect of each chapter, and indeed for the entire discipline. Part I, "Foundations" (Chapters 1 and 2), reflects this. The text begins with an overview of the field of biological anthropology in the larger context of the social and life sciences, including a brief history of the field. Chapter 2 reviews the roots of evolutionary thinking and how it became central to biological anthropology. Part II, "Mechanisms of Evolution" (Chapters 3 through 6), reviews at length the mechanisms of evolution and describes the applications of modern genetic research techniques in unraveling some of the mysteries of human evolution. Chapters 3 and 4 review cellular, molecular, and population genetics. Chapter 5 takes the discussion of genetics into modern evolutionary theory: the formation of species and the central topics of natural selection and adaptation. Chapter 6 surveys the field of human adaptation and the ways in which evolutionary forces mold human populations.

Part III, "Primates" (Chapters 7 and 8), is about the living nonhuman primates. We review their classification, their anatomical and behavioral adaptations, and their social life. We cautiously use the behavior of living monkeys and apes to understand what their ancestors, and therefore ours, may have been like.

Part IV, "The Fossil Record" (Chapters 9 through 13), describes the fossil record for humanity. We begin with the environmental context in which fossils are found and describe both the periods of Earth's history during

which primates arose and the fossil primates themselves (Chapter 9). We then examine the anatomical transition from an ape to human ancestor (Chapter 10) and present up-to-date information on the earliest known hominids in Africa. Chapter 11 introduces the genus *Homo* and the causes and consequences of dispersal from Africa. Chapters 12 and 13 cover the more recent hominid fossils, including Neandertals, and the origins of our own species. We have tried to provide up-to-the-minute information on the discovery of new human fossils, right up to the latest information about new early anthropoids and apes from India and Spain (Chapter 9), the new *Homo erectus* pelvis from Ethiopia, and crania from Kenya and Georgia (Chapter 11), as well as the recently published information about the earliest hominids from Spain (Chapter 11), the Dikika child from Ethiopia (Chapter 12), and a new chapter section on bioarcheology (Chapter 13). We have also included interpretive features to understand the significance of all these new finds.

Part V, “Biology and Behavior of Modern Humans” (Chapters 14 and 15), is about the biology of modern people. We include coverage of the brain and biocultural aspects of the lives of traditional foraging people (Chapter 14), and the human brain and biocultural issues of biomedical anthropology, as well as a new half chapter’s worth on forensic anthropology (Chapter 15), which explains how scientists use evolutionary theory and the methods of biological anthropology to identify human remains from mass disasters and victims of crime.

The appendices offer a section on the primate skeleton (Appendix A), the Hardy–Weinberg equilibrium (Appendix B), and metric-to-imperial-conversion factors (Appendix C).

INNOVATION: NEW TO THIS EDITION

In the first edition of *Exploring Biological Anthropology*, we tried to include topics not covered in many of the existing texts while preserving a comprehensive coverage of traditional topics. In this new edition, we have relied on instructor and student feedback as well as new events in the field to make further changes.

By popular demand, the first edition’s appendix on forensic anthropology (a topic not traditionally covered in introductory biological anthropology texts) has been expanded and included in a new chapter: Chapter 15, “Biomedical and Forensic Anthropology.” Bioarcheology, which includes a discussion of the consequences of colonization and agriculture and peopling of the Pacific, is covered in Chapter 13, “The Origin, Dispersal, and Bioarchaeology of *Homo sapiens*.”

Chapter 1 includes a new double-page feature that discusses the four fields of anthropology. The text, illustrations, and design all help to make this content come alive for students.

The discussion on skin color has been moved from the end of the text (Chapter 15), to Chapter 6, “Human Variation: Evolution, Adaptation, and Adaptability.”

As mentioned, in Part IV, we keep abreast of new fossil discoveries by including figures and discussion of the latest finds. This includes coverage of new fossil primate finds (Chapter 9), including *Pieralopithecus* and *Anthraxisimias*. A discussion of new fossil hominids (Chapters 11 through 13), including figures and interpretations of the oldest hominids in Europe from the Sima de Elefante, Spain, and the smallest *Homo erectus* from Ileret, Kenya, and the new *Homo erectus* pelvis from Ethiopia.

A new feature called **Innovations** has been added in select chapters. This feature provides an intense visual presentation of new, burgeoning areas of research in our field. These research areas include:

Chapter 3: DNA Barcoding

Chapter 4: A New Genetic Era

Chapter 8: Culture in Nonhuman Primates

Chapter 9: Time in a Bottle

Chapter 10: Dikika and Development

Chapter 11: What’s Size Got to Do with It?

Chapter 12: Neandertal Genes

Chapter 14: Music, the Brain, and Evolution

Chapter 15: Ancestry Genetics

Biological anthropology is a very rich and visual subject, and so we have created a new **Visual Summary** at the end of every chapter. Students will be able to easily review the key topics of each chapter, and then refer back into the chapter for a more extensive review.

ILLUSTRATIONS

Illustrations play a major role in any textbook, and they are crucial learning tools in introductory science texts. The publisher and authors have worked together to try to provide you with the best possible photos and drawings of every topic covered in the book. Many of the photographs of living primates, and some of fossils and fossil sites, were taken by one of the authors, and others were contributed by other biological anthropologists. Prentice Hall has worked hard to produce some of the finest images of everything—from molecular genetics to stone tools—that have ever been published in a biological anthropology textbook. The maps have been specifically created for this book by Dorling Kindersley, a leading publisher of atlases for both the educational and consumer markets. These maps describe the geography of everything from the distribution of living primates in the world today to the locations of the continents in the distant past. We authors worked with Prentice Hall to be sure everything is depicted accurately and clearly, and we hope you will gain a better understanding of the text by studying the visual material as well.

Special two-page feature illustrations appear in a number of chapters and provide a snapshot of evolutionary

development through time. These special feature illustrations provide a concise way for the reader to easily grasp the evolutionary changes through a vast sweep of time that are presented in greater detail in the text.

A Note about Language

Authors must make decisions about language and terminology, and textbook authors make those choices with the knowledge that they may be influencing the mind-set of a generation of young scholars. Some of these choices are modest. For instance, we use the modern American spelling *Neandertal* instead of the more traditional European spelling *Neanderthal*. Other language choices are more central to the subject matter. Perhaps the most significant choice we have made is with regard to primate classification. Although the primate order historically has been subdivided into anthropoids (the apes and monkeys, including us) and prosimians (the “lower” primates, including lemurs, galagos, lorises, and tarsiers), the majority of scholars today think this dichotomy does not reflect evolutionary reality as well as a subdivision into haplorhines and strepsirhines. Haplorhines include all anthropoids and tarsiers, and strepsirhines include all prosimians except tarsiers. We discuss this distinction in some depth in Chapter 7 and use the terms *strepsirhine* and *haplorhine* rather than *prosimian* and *anthropoid*. In another case, we have opted to use the more traditional family-level designation *hominid* to refer to humans and our ancestors rather than the alternative tribal-level *hominin*, which is less broadly used in the literature. We discuss this classification in Chapter 11.

Regarding Abbreviations and Time

Because of the plethora of sometimes conflicting abbreviations used to refer to time throughout the text, we have attempted to spell out time ranges (e.g., “millions of years ago” or “thousands of years ago”). Where this is not feasible, such as in tables, we use the abbreviations most common to anthropology textbooks (MYA for “millions of years ago” and KYA for “thousands of years ago”). However, students should note that the standard usage in geology and paleontology is *Ma* (mega-annum) and *ka* (kilo-annum).

SUPPORT FOR INSTRUCTORS AND STUDENTS

The ancillary materials that accompany *Exploring Biological Anthropology, Second Edition* are part of a complete teaching and learning package and have been carefully created to enhance the topics discussed in the text.

Instructor’s Resource Manual with Tests (0-20-570796-3): For each chapter in the text, this valuable resource provides a detailed outline, list of objectives, discussion questions, and suggested readings and videos. In addition, test questions in multiple-choice, true-false, fill-in-the-blank, and short-answer formats are available

for each chapter; the answers are page-referenced to the text. For easy access, this manual is available within the instructor section of MyAnthroLab for *Exploring Biological Anthropology, Second Edition*, or at www.pearsonhighered.com.

MyTest (0-20-570804-8): This computerized software allows instructors to create their own personalized exams, to edit any or all of the existing test questions, and to add new questions. Other special features of this program include random generation of test questions, creation of alternate versions of the same test, scrambling question sequence, and test preview before printing. For easy access, this software is available within the instructor section of MyAnthroLab for *Exploring Biological Anthropology, Second Edition*, or at www.pearsonhighered.com.

PowerPoint Presentation for Biological Anthropology: These PowerPoint slides combine text and graphics for each chapter to help instructors convey anthropological principles in a clear and engaging way. For easy access, they are available within the instructor section of MyAnthroLab for *Exploring Biological Anthropology, Second Edition*, or at www.pearsonhighered.com.

Strategies in Teaching Anthropology (0-13-603466-7): Unique in focus and content, this book focuses on the “how” of teaching anthropology across all four fields and provides a wide array of associated learning outcomes and student activities. It is a valuable, single-source compendium of strategies and teaching “tricks of the trade” from a group of seasoned teaching anthropologists, working in a variety of teaching settings, who share their pedagogical techniques, knowledge, and observations.



MyAnthroLab is an interactive and instructive multimedia site designed to help students and instructors save time and improve results. It offers access to a wealth of resources geared to meet the individual teaching and learning needs of every instructor and student. Combining an ebook, video, audio, multimedia simulations, research support, and assessment, MyAnthroLab engages students and gives them the tools they need to enhance their performance in the course. Please see your Pearson sales representative for more information about **MyAnthroLab** or visit www.myanthrolab.com.

ACKNOWLEDGMENTS

Textbooks require the collaboration of many people with many areas of expertise, and this book makes good use of all of those involved. The process begins with each author compiling his or her notes from years of teaching biological anthropology and thinking about how the course could be taught more effectively. Over the years, the students in our courses have helped us to assess what did and did not work in conveying the information and excitement of

biological anthropology, and for this we are extremely grateful. For her vision and steady guidance over the past four years, we are most grateful to Nancy Roberts, Publisher of Anthropology at Prentice Hall. We also thank Nancy's assistant, Nart Varoqua, for keeping the chapters flowing, and media editor, David Alick, for the media that accompanies this text. The outstanding efforts of Anne Bonanno Nieglos and Ilze Lemesis in coordinating and creating all design elements resulted in this beautiful text. Marianne Peters-Riordan, production editor at Prentice Hall, did a remarkable job of coordinating the entire production process. We appreciate the diligence of copyeditor Marianne L'Abbate and the creativity of photo researcher Rachel Lucas. Thanks also to Senior Marketing Manager Laura Lee Manley for directing the marketing campaign.

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All three of us cut our teeth teaching introductory biological anthropology as graduate students apprenticing as teaching assistants (TAs) at the University of California. Our fellow TAs shared their ideas and our tasks, for which we are thankful. We are most grateful to the triumvirate of faculty with whom we apprenticed and from whom we learned much about the subject matter, how to teach it, and how an introductory course can be made a rewarding, enriching experience for undergraduates. Our heartfelt thanks go to Katharine Milton, Vincent Sarich, and Tim White.

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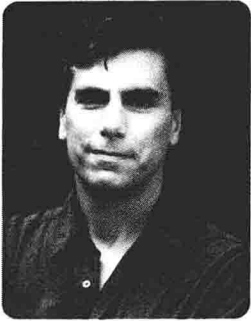
We've made a great effort to produce a comprehensive and fully accurate text, but as is always the case, errors may remain. We would be grateful for comments or corrections from students and instructors using *Exploring Biological Anthropology, Second Edition*. And we hope you find this account of human evolution as fascinating and compelling as we do.

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About the Authors



Craig Stanford is a Professor of Anthropology and Biological Sciences at the University of Southern California, where he also directs the Jane Goodall Research Center and chairs the Department of Anthropology. He has conducted field research on primate behavior in south Asia, Latin America, and East Africa. He is well known for his long-term studies of meat-eating among wild chimpanzees in Gombe, Tanzania, and of the relationship between mountain gorillas and chimpanzees in the Impenetrable Forest of Uganda. He has authored or coauthored more than 100 scientific publications. Craig has received USC's highest teaching awards for his introductory Biological Anthropology course. In addition, he has published more than a dozen books on primate behavior and human origins, including *Significant Others* (2001) and *Upright* (2003). He and his wife, Erin Moore, a cultural anthropologist at USC, live in South Pasadena, California, and have three children.



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Susan Antón is an Associate Professor in the Center for the Study of Human Origins, Department of Anthropology at New York University, where she also directs the M.A. program in Human Skeletal Biology. Her field research concerns the evolution of genus *Homo* in Indonesia and human impact on island ecosystems in the South Pacific. She is best known for her work on the evolution of the genus *Homo* in Asia and Africa, for which she was elected as a fellow of the *American Association for the Advancement of Science* (AAAS) in 2008. She is joint editor of the *Journal of Human Evolution*. She received awards for teaching as a graduate student instructor at the University of California and was Teacher of the Year at the University of Florida. She has been twice elected to *Who's Who Among America's Teachers*. She recently received a Golden Dozen award for excellence in undergraduate teaching at New York University. Susan and her husband, Carl Swisher, a geochronologist, raise Anatolian Shepherd dogs.

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INTRODUCTION: What Is Biological Anthropology?

Chapter

1

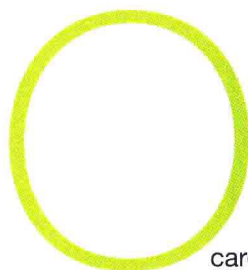
Chapter Outline

Anthropology and Its
Subfields

The Scope of Biological
Anthropology

The Roots of Modern
Biological Anthropology

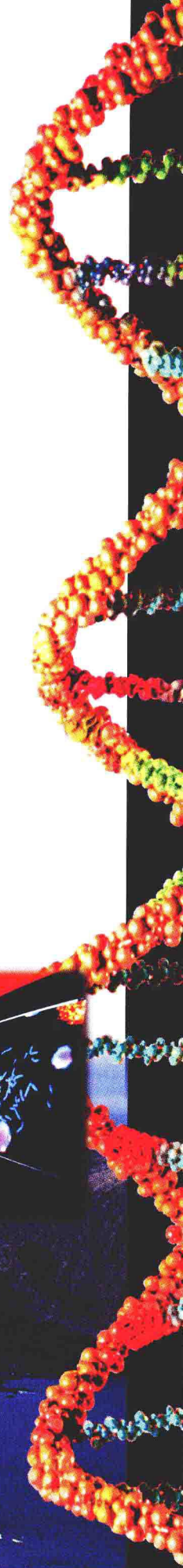
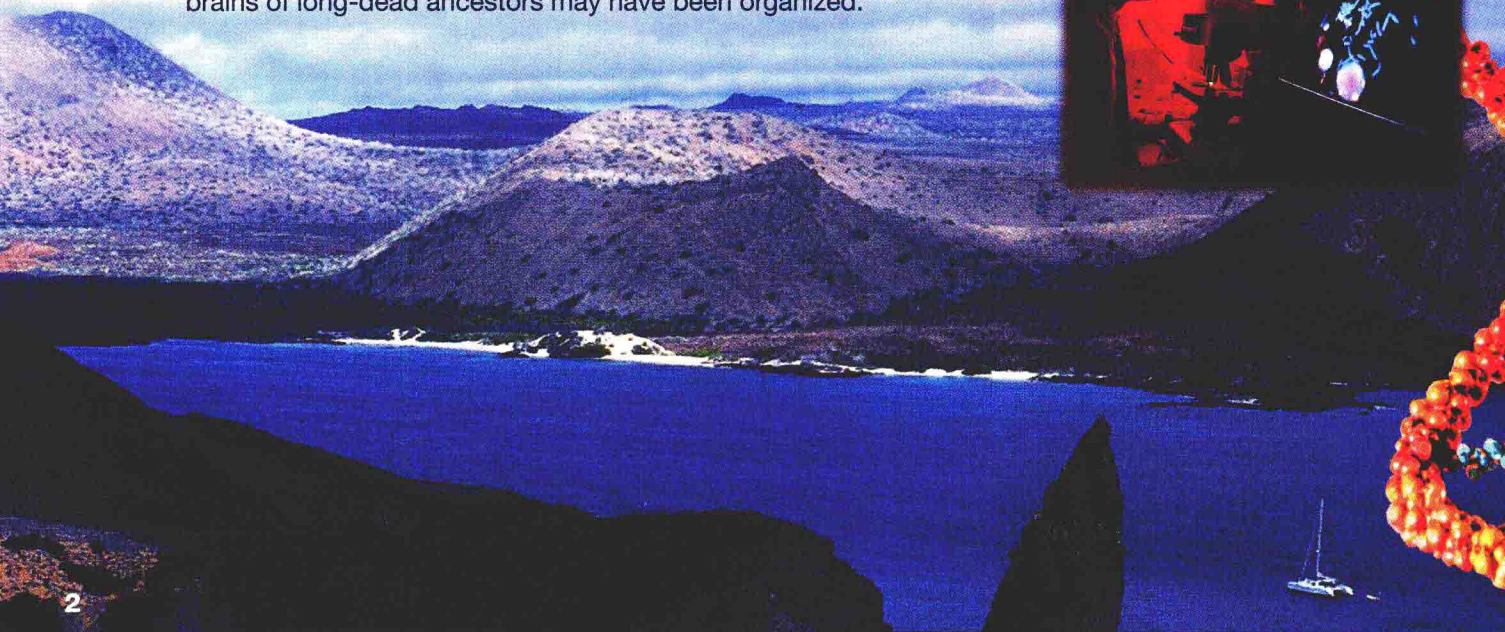
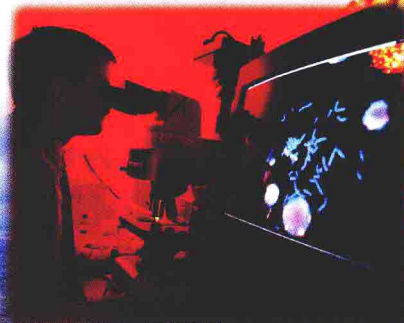




n a sunny morning in East Africa, with the temperature already climbing past 90 degrees, a scientist stands in a shallow pit, carefully examining the dusty ground. All around her are the tools of her trade: shovels, dental picks, whisk brooms, surveying equipment. Something glinting in the morning light catches her eye. She bends over to examine a tiny fragment of whitish bone, then another and another. Realizing that her week of hard, sweaty work has just paid off, she beckons her assistants to see the prize, then carefully begins to map the spot for the work that now begins: unearthing the fossilized skeleton of an ancient primate, perhaps the forerunner of all modern apes. Weeks later, returning to the capital city and its museum, the scientist compares the new fossils with previously collected specimens. She finds that a few of the pieces her team has excavated fit together with the long-neglected bones of a fossil ape discovered at the site in the 1930s. The scientist devotes long hours to studying every detail of the skeleton. A new picture emerges: This ancient ape may have been the first to come down from the trees and venture forth on the ground below.

A few hundred miles away, another scientist sits in the tall grass of a high mountain meadow. All around him are massive, shaggy-haired mountain gorillas, happily munching on wild celery. A bright-eyed baby gorilla ambles up to the scientist and toys with the laces of his boot, then runs quickly back to its mother. Two silverbacks, majestic 400-pound males wearing saddles of gray hair across their backs, sit like enormous statues a few yards away. The scientist uses the tools of his trade: a notebook and checklist to record behavior, plus a handheld global positioning system unit to map the animals' travels. As the gorilla group finishes its lunch, the silverbacks get up and head off into the forest, bulldozing a trail that the females, babies, and scientist obediently follow.

At the same time, half a world away, a third scientist is sitting in a laboratory intently studying a computer monitor. He looks at a three-dimensional, high-resolution image of a human brain. Millimeter by millimeter, he examines the frontal lobe, a region of the brain thought to be of key importance in the evolution of modern people. By moving the screen cursor slightly, he can study the brain's surface from every possible angle, making virtual slices through it to study its internal organization. Unlike skulls, brains do not become preserved as fossils, so the scientist uses images of the brains of living humans and other primates to reconstruct the way in which the brains of long-dead ancestors may have been organized.



What do these three scientists—one studying ancient fossils, another observing primate behavior, and the third studying the evolution of the human brain—all have in common? They are biological anthropologists, engaged in the scientific study of humankind (from *anthropos*, meaning “human”, and *-ology*, “the study of.”). Despite our exalted intellect, our mind-boggling technology, and our intricately complex social behavior, we are nonetheless biological creatures. Humans are **primates** and share a recent ancestry with the living great apes. Like the apes, we are the products of millions of years of **evolution** by natural selection.

The famed geneticist Theodosius Dobzhansky once said, “Nothing in biology makes sense except in the light of evolution.” Biological anthropologists spend their careers trying to understand the details of the evolutionary process and the ways in which it has shaped who we are today. They use a central, unifying set of biological principles in their work, first set down by Charles Darwin nearly 150 years ago. The frequency of a particular trait and the genes that control it can change from one generation to the next; this is evolution. This elegantly simple idea forms the heart and soul of **biological anthropology**.

The evolutionary process usually is slow and inefficient, but over many generations it can mold animals and plants into a bewildering variety of forms. Our ancestry includes many animals that little resemble us today. Biological anthropology is particularly concerned with the evolutionary transformations that occurred over the past 6 million years, as an ape-like primate began to walk on two legs and became something different: a **hominid**. From the perspective of evolutionary theory, humans are like all other biological species, the product of the same long process of **adaptation**.

ANTHROPOLOGY AND ITS SUBFIELDS

Anthropology is the study of humankind in all its forms. But of course, this would not distinguish it from other disciplines that study the human condition, such as psychology, history, and sociology. The critical aspect of anthropology that sets it apart is its cross-cultural, holistic nature. That is, we try to understand the inner workings of a group of people who hold different worldviews, values, and traditions than we do. The unusual thing about the human animal is that we have **culture**. Although it often seems that anthropologists spend their careers arguing about how to define culture, we can say simply that culture is the sum total of learned traditions of a group of people. Language is culture (although the ability to use language is biological), as is religion, as are the way people dress and the food they eat. These human behaviors vary greatly from one culture to the next. But what about the universal taboo on incestuous relations with one’s siblings? Or the observation that across many human societies, women tend to marry older men? Are these common threads of human cultures the result of learned traditions, passed down across the generations, or is there a biological influence at work? As we will see, the interplay between biology and culture provides many of the most intriguing and perplexing clues about the roots of our humanity. It also creates many of the most intense debates; for decades, scholars have debated whether genes or the environment have played the more important role in molding intelligence and other human qualities.

The dichotomy between biological and cultural influences on humankind is a false one, as we examine in detail later in the book. In earliest humans, biological evolution produced the capacity for culture: Intelligence had to evolve before learned traditions such as tool using could flourish, as we see in wild apes today. Our biology produced culture, but culture can also influence biology. We study these patterns under the rubric of **biocultural anthropology**.

Anthropology is divided into four subfields: biological anthropology, cultural anthropology, linguistic anthropology, and archaeology. Some anthropologists consider linguistics and archaeology as subfields within cultural anthropology.

primate Member of the mammalian order Primates, including prosimians, monkeys, apes, and humans, defined by a suite of anatomical and behavioral traits.

evolution A change in the frequency of a gene or a trait in a population over multiple generations.

biological anthropology The study of humans as biological organisms, considered in an evolutionary framework; sometimes called physical anthropology.

hominid A member of the primate family Hominidae, distinguished by bipedal posture and, in more recently evolved species, large brain.

adaptation A trait that increases the reproductive success of an organism, produced by natural selection in the context of a particular environment.

anthropology The study of humankind in a cross-cultural context. Anthropology includes the subfields cultural anthropology, linguistic anthropology, archaeology, and biological anthropology.

culture The sum total of learned traditions, values, and beliefs that groups of people (and a few species of highly intelligent animals) possess.

biocultural anthropology The study of the interaction between biology and culture, which plays a role in most human traits.