



# **BIOLOGICAL ANTHROPOLOGY**

The Natural History  
of Humankind

FOURTH EDITION

Craig Stanford • John S. Allen • Susan C. Antón

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of Humankind







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# Biological Anthropology

## The Natural History of Humankind

Fourth Edition

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and to our long time publisher Nancy Roberts.”*



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# Preface

We are proud to introduce you to the fourth edition of *Biological Anthropology: The Natural History of Humankind*. We initially wrote this book because we felt there was a great need for a new textbook that introduced students to the evolutionary biology of humankind. Decades ago the field of physical anthropology was mainly about human anatomy, human fossils, and the study of racial variation. Over the past 40 years, the field has evolved from physical anthropology into biological anthropology. Modern biological anthropology is an integration of information from the fossil record and the human skeleton, the genetics of individuals and populations, our primate relatives, human adaptation, and human behavior, among other topics. The first three editions of our text have been very well received, and the fast pace of change in biological anthropology has led to this new, updated edition. The fourth edition combines updated, comprehensive coverage of the material that any traditional biological anthropology text explains, with a modern biological approach that includes fields that have become major areas of research by biological anthropologists. Though comprehensive, the book is written as accessibly as possible to be useful to students from community college to research-oriented university levels. We authors conduct our research in three of 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 areas of biological anthropology that the text covers.

Undergraduate enrollment in introductory biological anthropology courses has increased sharply as 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.

We authors are anthropologists with extensive backgrounds in both biological and social sciences, and we teach and conduct research. In a field changing as rapidly as human evolutionary science is today, we feel it is critical for active researchers to produce textbooks that portray recent advances in the field and 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.

In a field famous for intellectual disagreements over the meaning of fossils or interpretations of Darwinian theory, we feel it is essential to provide students with well-rounded views of the 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 Text

The book is organized in much the same way that we three authors have taught introductory courses in biological anthropology. Although we have different backgrounds within the discipline, we share the common intellectual thread that is also the heart and soul of biological anthropology: the theory of evolution by natural selection. This is the unifying aspect of each chapter, and indeed for the entire discipline. The Introduction and Part I, Mechanisms of Evolution (Chapters 1 through 5) reflect 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 1 reviews the roots of evolutionary thinking and how it became central to biological anthropology. Chapters 2 through 5 review at length the mechanisms of evolution and describe the applications of modern genetic research techniques to unraveling some of the mysteries of human evolution. Chapters 2 and 3 review cellular, molecular, and population genetics. Chapter 4 takes the discussion of genetics into modern evolutionary theory: the formation of species and the central topics of natural selection and adaptation. Chapter 5 surveys the field of human adaptation and the ways in which evolutionary forces mold human populations.

Part II, Primates (Chapters 6 and 7) presents the living nonhuman primates. We review their classification, their anatomical and behavioral adaptations, and their social life. We delve into new areas of research such as primate culture and tool use. We cautiously use the behavior of living monkeys and apes to understand what their ancestors, and therefore ours, may have been like.

Part III, Paleontology and Primate Evolution (Chapters 8 and 9) introduces the foundation for understanding primate and human evolution. In the most complete synthesis of its kind in a biological anthropology text, we explain how scientists interpret the environmental context and geological age of fossils, and we review the periods of Earth's history during which primates arose (Chapter 8).

We cover newly introduced dating techniques and controversies such as the changing age of the Zhoukoudian (Peking Man) fossils. We present the fossil evidence for primate evolution starting around 65 million years ago (Chapter 9), with new fossil evidence for *Darwinius masillae* among other finds.

Part IV, The Human Fossil Record (Chapters 10 through 13) presents the direct physical evidence for human origins. Chapter 10 describes the anatomical transition from an ape to human ancestor and the most up-to-date information on the earliest known hominins in Africa including newly published information on *Ardipithecus* and *Australopithecus* along with the most recent species, the South African *Australopithecus sediba* and the new Ethiopian *A. deriyemeda*. Chapter 11 introduces the genus *Homo*, including discussion of new fossils that push the origin of the genus much earlier in time and new sections on *H. habilis* and *H. rudolfensis*. An expanded treatment of *H. erectus*, and the causes and consequences of dispersal from Africa and a new discussion of the Rising Star fossil discoveries and other fossils form the Cradle of Humankind World Heritage site. Chapters 12 and 13 cover the more recent hominin fossils, including Neandertals, the origins of our own species, and our dispersal around the globe. We use new advances to consider the middle Pleistocene *Homo* fossils and Neandertal origins, up-to-the-minute discussion of the latest finds and DNA evidence for Neandertal contributions to the human genome, recent updates on the age estimates for the last Neandertals and the over lap with humans in Eurasia, the “Denisovans” of Siberia and their possible relationship to middle Pleistocene hominins. In Chapter 13, we provide a full discussion of modern human origins and include the most recent discoveries and new finds and DNA evidence that illuminate later dispersals, especially the Peopling of the New World.

Part V, New Frontiers in Biological Anthropology (Chapters 14 through 17) is about the biology of modern people. We include coverage of the human brain and the evolution of language (Chapter 14), and biomedical anthropology (Chapter 15). Chapter 16 discusses biocultural aspects of the evolution of human behavior, including the lives of traditional foraging peoples, aspects of human sexual behavior, and how behavioral disease can be understood in an evolutionary context. The book concludes with a chapter on Bioarchaeology and Forensic Anthropology with new discussion of forensic genetics and the role of disease in understanding our later evolution (Chapter 17).

The appendices offer reference material on the brain (AppendixA), the primate skeleton (AppendixB), the Hardy–Weinberg equilibrium (AppendixC), and metric to imperial conversion factors (AppendixD).

Student-oriented pedagogy has been maintained in each chapter. We begin each chapter with a short **vignette** depicting the main topic of the chapter. The author of each

chapter has written a description of an event in the life and work of a biological anthropologist. It might, for example, be about how someone studying human fossils discovers, excavates and analyzes her discovery. Many of these are new to this edition, including those in Chapters 2, 3, 6, 7, 8, 9 and 17, chosen to highlight current trends and foundational principals. The vignettes should be read as a way to get a feel for the chapter topics and as an enjoyable and informative reflection on the text material.

Other features include a detailed margin **glossary** to define new terms as students encounter them and a complete glossary at the back of the book. Each chapter ends with a summary and many chapters include **critical thinking questions** intended to stimulate discussion as well as explore a topic. At the end of the book the **bibliography** contains all the references used and cited in the text.

## Innovation: Changes to the Fourth Edition

In the first three editions of *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 education and the field to make further changes.

New to this edition, we introduce **Learning Objectives** at the start of each chapter. These specific objectives are tied to the main chapter headings and guide students to important organizations questions for their study. Used in conjunction with the Summary and paired questions at the end of each chapter, they provide a road map for students to flesh out the outline of important concepts and key ideas.

We have added to our *Insights and Advances* boxes in each chapter. These insets expand on text material or call your attention to current events connected to our field, to emerging debates, or sometimes just to fascinating side stories. New *Insights and Advances* boxes are included on populations genetics and cultural history (Chapter 5), the locomotion of the last common ancestor of apes and humans (Chapter 10), the Cradle of Humankind World Heritage site in South Africa (Chapter 12), models for the transition to human cognition (Chapter 13), early menarche and later health (Chapter 15), and The Evolution of Languages (Chapter 16) and others in Chapter 7, 9, 10, and 13 have been substantially updated to include new perspectives and findings.

As innovative work has been growing, we increased the number of *Innovations* in the third edition and we’ve updated those here. *Innovations* provide an intense visual presentation of new, burgeoning areas of research in our field. These include The Wide World of RNA (Chapter 2), Culture in Nonhuman Primates (Chapter 7), Time in a Bottle (dating fossil sites, Chapter 8), Dikika and Development

(studying development in fossils, Chapter 10), Neandertal Genes (Chapter 12), Symbolism and Human Evolution (Chapter 13), Music, the Brain, and Evolution (Chapter 14), and Ancestry and Identity Genetics (Chapter 17).

## Chapter-by-Chapter Changes

### Chapter 2

- New opening vignette
- Updates on *Hox* genes, fetal stem cells, number of genes in complete genomes, importance of chromosomal events in human evolution

### Chapter 3

- Reworked opening vignette
- Updated sections on obesity and sickle cell disease
- Expanded and revised section on Insertion and Deletion Mutations
- New Genetic Section with material on the *BRCA1* (breast cancer) allele

### Chapter 4

- Reworked Linnaean chart

### Chapter 5

- Expanded and updated section on ABO blood system
- New Insights and Advances box on Bermuda population genetics and cultural history
- Update and expansion of discussion on lactase persistence genetics
- Updates on distribution of malaria and sickle cell disease
- Update on genetic adaptation to high altitude and connection between modern Tibetans and extinct Denisovans

### Chapter 6

- New opening vignette
- Updated explanation of strepsirhine/prosimian classification
- Updated explanation of origins of grasping hand and stereo vision
- Updated explanation of ape/human classification

### Chapter 7

- New opening vignette
- Reworked box on infanticide

### Chapter 8

- New opening vignette

### Chapter 9

- New opening vignette
- Updated Insights box on subfossil lemurs with new science on submerged fossils
- Updated timelines/art on Miocene hominoids
- Updated discussion of Miocene hominoid relationships

### Chapter 10

- New Chapter 10 is tightly integrated explanation of ape-human split, origin of bipedalism, and earliest hominins with descriptions of each species.
- New Insights and Advances box on the locomotion of the last common ancestor
- New discussion of the Burtele foot and the origin and mode of bipedality in early hominins
- New section on *Australopithecus deriyemeda* a new 3.5 million year old species from Ethiopia
- Updated Insights and Advances box on the Treasures of the Afar Triangle
- Updated section on *A. africanus* with new discussion of new dating and significance of the 'little foot skeleton' from Sterkfontein
- New discussion of the new isotopic and comparative findings about the diet of robust australopithecines
- New discussion of the earliest stone tools from 3.3 million years ago in West Turkana, Kenya

### Chapter 11

- New art based on the latest fossil finds and dating advances with updated timelines for early *Homo*
- New discussion of fossil finds from Ethiopia and Kenya that push back the origin of genus *Homo* and suggest the presence of multiple early species.
- New section on the history, anatomy and evolution of *Homo habilis*
- New section on the history, anatomy and evolution of *Homo rudolfensis*
- New Insights/Advances box, The Cradle of Human-kind Heritage Site, describes exciting finds from South African cave sites that have redefined our view of early human evolution. Includes a discussion of the recent Rising Star cave expeditions.
- New discussion of the recently discovered earliest stone tools and implications for foraging and of the oldest Acheulian tools



## Chapter 12

- New art based on the latest dating advances and fossil finds with updated timelines for middle Pleistocene *Homo* and Neanderthals
- New and expanded discussion of the role of archaic *H. sapiens* in human evolution, the possibility of multiple species in the middle Pleistocene and the potential relationship of Asian archaics to Denisovans.
- Updated Innovations feature on Neandertal Genes including new fossil work and a discussion of late introgression from Neandertals to modern human genomes
- Updated discussion of the alternate views on the phylogenetic position of archaic *H. sapiens*.

## Chapter 13

- New art based on the latest dating advances and new fossil finds with updated timelines for anatomically modern human fossil sites and the inclusion of a Neandertal timeline.
- New Insights and Advances box on Primate Intelligence: Why are Human Brains so Big?
- New discussion of recent findings of the Proto-Aurignacian tool industry and its associations with modern humans.
- Updated Innovations box Symbolism and Human Evolution with new art.
- Expanded discussion of new ancient DNA work from early modern humans including the Oase mandible and the Uist femur that suggest late Neandertal introgression into the human genome.
- New in-text section on the importance of Vitamin D for high latitude dispersal.
- New discussion of recent discoveries and new DNA from early fossil humans in the New World. New finds include Hoyo Negro girl from a submerged cavern in Mexico, and new DNA from Kennewick Man in Washington State.
- Expanded in-text discussion of the Peopling of the New World.
- Updated Insights box on The Peopling of the New World: Was Clovis First? with an overview of the genetic findings.

## Chapter 14

- Updates to section on brain anatomy, including neuron counts and endocast imaging
- Expansion and update of section on brain-size scaling across species, including new section on temporal lobe scaling
- Update on hyoid bone anatomy and the evolution of language

## Chapter 15

- Updated US mortality statistics in epidemiology section
- Extensive update of section on anorexia nervosa
- New Insights and Advances box on Early Menarche and Later Health
- Updated section on the "paleodiet"

## Chapter 16

- New section on progesterone and pre-menstrual syndrome
- New section on male violence and sexual competition
- New Insights and Advances box on The Evolution of Languages

## Chapter 17

- New opening vignette
- Updated Innovations feature Ancestry and Identity Genetics with an expanded discussion and comparison of results across services

## 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 provide you with the best possible photos and drawings of every topic covered in the book. The third edition featured more than 50 new anatomical illustrations especially prepared for this text by medical illustrator Joanna Wallington. These drawings replace our previous versions in Sections III and IV providing superior detail and anatomical accuracy and enhancing student insight into the morphological features of importance in human evolution. As new sites are found and better science substantially revises the age estimates of known sites, in this edition we have thoroughly revised the illustrative timelines provided in Chapters 9, 11, 12, and 13.

Most of the photographs of living primates, fossils, and fossil sites, were taken by one of the authors or were contributed by other biological anthropologists—and many of these have been updated and enhanced in this edition. Pearson 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 Pearson to be sure everything in this fourth edition is

depicted accurately and clearly, and we hope you will gain a better understanding of the science by studying the visual material as well.

Along with the *Innovations* features, additional special two-page figures appear in a number of chapters, especially in Part IV, and provide a snapshot of evolutionary development through time. These special figures 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 and they have been updated with new photo imagery, new finds, and substantially revised to reflect the latest age estimates for fossil localities.

## 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 mindset 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 in recent years is about 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), this dichotomy does not reflect

the currently understood molecular relationships among groups of primates. We have therefore divided the primates into the suborders haplorhines and strepsirhines, a concept familiar to current graduate students but perhaps not to instructors who have taught the former approach for many years. Haplorhines include all anthropoids and tarsiers, and strepsirhines include all prosimians except tarsiers. We use the terms *strepsirhine* and *haplorhine* rather than *prosimian* and *anthropoid*. Similarly, following the growing scientific consensus in biological anthropology, we have adopted the molecularly based terminology for grouping humans and our ancestors—now referring to us and our exclusive ancestors as *hominins* rather than *hominids*. We discuss both in some depth in Chapter 6.

## A Note 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).

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## Supplemental Resources

The ancillary materials that accompany *Biological Anthropology, Fourth 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 Manual with Tests (ISBN: 0-13-400593-7):** For each chapter in the text, this valuable resource provides a list of objectives, lecture outline, and lecture/discussion questions for each chapter. In addition, test questions in multiple-choice, true/false, and essay formats are available. The manual and the test bank are available for download at <http://www.pearsonhighered.com/irc>.
- **MyTest (ISBN: 0-13-400580-5):** This computerized software allows instructors to create their own personalized exams, edit any or all of the existing test questions, and add new questions. Other special features of the program include random generation of test questions, creation of alternate versions of the same test, scrambling question sequence, and test preview before printing. MyTest is available for download at <http://www.pearsonhighered.com/irc>.
- **PowerPoint® Presentation Slides (ISBN: 0-13-400591-0):** The PowerPoint slides provide text and graphics for each chapter to help instructors convey anthropology principles in a clear and engaging way. The PowerPoints are available for download at <http://www.pearsonhighered.com/irc>.
- **Method & Practice in Biological Anthropology: A Workbook and Laboratory Manual for Introductory Courses, Second Edition (0-13-382586-8):** Designed to complement a wide variety of introductory level laboratory courses in biological anthropology, this new manual written by Samantha Hens of California State University, Sacramento provides optimum flexibility to suit almost all laboratory environments. The manual is divided into four sections, reflecting the typical design of introductory courses in biological anthropology: genetics and evolution, the human skeleton, the nonhuman primates, and our fossil ancestors. Each chapter has similar pedagogical elements, beginning with a list of chapter objectives, an array of topical lab exercises to choose from, and a set of pre- and post-lab questions. For more information, please contact your local Pearson sales representative.

## Acknowledgments

Textbooks require the collaboration of many people with many areas of expertise, and this book made 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 more effectively taught. 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 decade we are most grateful to Nancy Roberts, our former publisher of anthropology at Pearson. We thank our current publisher Charlyce Jones-Owen and our development editor David Ploskonka for their work on the current edition. Cheryl Keenan production liaison at Pearson and Nancy Kincade at Lumina Datamatics did a remarkable job coordinating the entire process especially given the logistics of working with three different authors.

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All three of us cut our teeth teaching introductory biological anthropology as graduate students apprenticing as teaching assistants at the University of California at Berkeley. 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 in the classroom 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.

Graduate teaching assistants in our own courses at the University of Southern California, the University of Auckland, the University of Florida, Rutgers University, and New York University brought new enthusiasm and ideas, and we are grateful to them all.

This revision grew out of the comments of reviewers who helped to create and revise the brief version of this text, *Exploring Biological Anthropology*, as well as those who read earlier editions of this book. For their help and guidance, we thank the anonymous reviewers and:

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We've made a great effort to produce a comprehensive and fully accurate text, correcting minor errors from the second edition. We would be grateful for comments or corrections from students and instructors using *Biological Anthropology, Fourth Edition*, as we know that, inevitably, some errors may remain. And we hope you find this account of human evolution as fascinating and compelling as we do.

*Craig Stanford*  
*John S. Allen*  
*Susan C. Antón*

# About the Authors

**Craig Stanford** is a professor of anthropology and biological sciences at the University of Southern California, where he also co-directs the Jane Goodall Research Center. 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 130 scientific publications. Craig has received USC's highest teaching awards for his introductory biological anthropology course. In addition, he has published fifteen books on primates, animal behavior and human origins, including *Beautiful Minds* (2008) and *Planet Without Apes* (2012). He and his wife, Erin Moore, a cultural anthropologist at USC, live in South Pasadena, California, and have three children.

**John Allen** is a research scientist in the Dornsife Cognitive Neuroscience Imaging Center and the Brain and Creativity Institute at the University of Southern California. He is also Research Associate in the Department of Anthropology, Indiana University. Previously, he was a neuroscience researcher at the University of Iowa College of Medicine and a faculty member in the Department of Anthropology at the University of Auckland, New Zealand, for several years. His primary research interests are the evolution of the human brain and behavior, and behavioral disease. He also has research experience in molecular genetics, nutritional anthropology, and the history of anthropology. He has conducted fieldwork in Japan, New Zealand, Papua New Guinea, and Palau. He has received university awards

for teaching introductory courses in biological anthropology both as a graduate student instructor at the University of California and as a faculty member at the University of Auckland. In addition to Biological Anthropology, he is also the author of *Medical Anthropology: A Biocultural Approach* (with Andrea S. Wiley; second edition, 2013), *The Lives of the Brain: Human Evolution and the Organ of Mind* (2009), *The Omnivorous Mind: Our Evolving Relationship with Food* (2012), and *Home: How Habitat Made Us Human* (2015). John and his wife, Stephanie Sheffield, have two sons, Reid and Perry.

**Susan Antón** is a 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 research on *H. erectus* in Kenya and Indonesia, for which she was elected as a fellow of the *American Association for the Advancement of Science (AAAS)*. She is the President of the *American Association of Physical Anthropologists* and past editor of the *Journal of Human Evolution*. She received awards for teaching as a graduate student instructor of introductory physical anthropology and anatomy at the University of California, was Teacher of the Year while at the University of Florida, and received a Golden Dozen teaching award and the Distinguished Teaching Medal from NYU. She has been twice elected to *Who's Who Among America's Teachers*. Susan and her husband, Carl Swisher, a geochronologist, raise Anatolian shepherd dogs.



## Introduction

# What Is Biological Anthropology?



## Learning Objectives

---

- I.1** Describe the subfields of anthropology and the role of biological anthropology in them.
- I.2** Describe the subfields within biological anthropology.
- I.3** Summarize the origins of modern biological anthropology.

A brilliant orange sun rises above a dusty plain in Ethiopia. The parched landscape will be unbearably hot by mid-morning, so there is no time to lose. The team of scientists, students, and assistants set off on a predetermined route that takes them over craggy hills and into steep ravines. As they walk, they stare at the ground, hoping to spot any bit of fossilized bone that the slanted morning sun may illuminate. It is tedious, sweaty work, usually without any reward to show for it. But this morning, one of the Ethiopian assistants, an older man famed for his ability to distinguish fossils from the thousands of rocks and pebbles strewn around them, spots something. He calls the team leader over, and as soon as she crouches to examine the small fragment emerging from the soil, she knows it is a primate. Gently brushing away a bit of soil, she gasps; what emerges appears to be the upper arm bone of a tiny ancient human. The team immediately maps the spot for the work of unearthing the fossilized skeleton of an early hominin.

Five hundred kilometers away, a different kind of scientist is also eagerly searching for primates. He is crawling nimbly through dense thickets in Gombe National Park, Tanzania, trying to find the party of chimpanzees that he was following all morning. They travel faster than he can in the thick undergrowth, and by the time he catches up to them, they've climbed a massive fig tree and are gobbling mouthfuls of the fruits. The scientist maps the location with his GPS device, then pulls out a notebook and begins recording the behavior of each of the chimpanzees. Most are eating figs, but a few infants play together. When one male tries to grab a fig from another's hand, a chaotic fight breaks out. Only when the alpha male arrives and charges through the apes in the tree canopy does order get restored, and the chimpanzees finish their morning meal.

On the other side of the world, a third scientist sits in front of a computer screen watching brain activity in bright reds and greens. In the next room, a musician—a famed cellist—sits in a functional MRI machine, listening to cello music piped in. As he listens, particular areas of the cortex of his brain light up, while other areas remain dim. His brain is hearing and processing the sound, and it's doing it in a way that reveals aspects of the inner working of the human mind. By moving the screen cursor, the scientist can study the brain's surface from every possible angle, making virtual slices through it to study its internal organization. He hopes to make a visual portrait of the musician's brain activity while listening to music, and in doing so to better understand the intense creativity that separates us from our primate relatives.

### 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.

What do these three scientists—one studying ancient fossils, another observing primate behavior, and the third studying the evolution of the human brain—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 **hominin**. 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

### I.1 Describe the subfields of anthropology and the role of biological anthropology in them.

**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. In addition, applied anthropology—a method more than a discipline—is sometimes considered a fifth subfield. The majority of practicing anthropologists in the United States are cultural anthropologists, who typically make up more than half of the faculty of anthropology departments in universities and who are also employed in a variety of nonacademic settings, as you will see in this section.

### **biological anthropology**

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

### **hominin**

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



## Foundation | The Subfields of Anthropology

**Cultural anthropology** is the study of human societies in a cross-cultural perspective. The amazing variety of ways in which people lead their daily lives is at the heart of the field. **Ethnology**, one of the subfields of cultural anthropology, is the study of human societies and of the behavior of people within those societies. It might include everything from the way marriages and funerals are arranged, to the economic system, to the kinship system. The practice of ethnology is called **ethnography** (literally, “the describing of culture”). The study of the way in which foraging people track down their prey is ethnography. So is a written account of the initiation rituals of street gangs in Los Angeles. And so is the study of how parents in Boston care for their children relative to parenting among the Sherpas of highland Nepal. The common thread that runs through all these studies is that they seek to understand the workings of another culture by comparing it with the culture of the investigator.



**Linguistic anthropology** is the study of the form, function, and social context of language. Linguistic anthropologists usually are more interested in language use and the role that language plays in shaping culture than they are in the technical aspects of language structure. For instance, an anthropological linguist might study the aspects of Black English that set it apart from mainstream English—its word choice and usage—and be interested in the roots of Black English on slave plantations and in West Africa. People tend to use language to conform with their cultural, environmental, and social needs. In India, for instance, Hindi and Bengali speakers have specific labels for a far wider variety of kinship categories (such as a wife’s older brother) than English speakers use.

**Archaeology** is the study of how people used to live, based on the materials, or **artifacts**, they left behind. These artifacts, art, implements, and other objects of **material culture** form the basis for the analysis and interpretation of everything from what the members of an ancient culture ate to how they imagined the afterlife. Archaeologists come in many different stripes.



Archaeologists work at sites all over the world, studying time periods from the advent of stone tools 2.5 million years ago until the much more recent past. *Prehistoric archaeologists* study cultures that did not leave any recorded written history, from the early hominins to the preliterate antecedents of modern cultures from Hawaii to Africa. When a biological anthropologist excavates a 2-million-year-old fossil site in East Africa, a prehistoric archaeologist often works with the team to document the discovery, map the site, and analyze the primitive stone tools that may be found alongside the fossilized bones. *Historical archaeologists* study past civilizations that left a written record of their existence, whether in the hieroglyphics of Egyptian tombs, the Viking runes scratched onto rock across northern





Europe, or the diaries kept by the colonial settlers of New England. Other archaeologists study Revolutionary War battlefields, or sites of former slave plantations, or the land beneath New York City in an effort to understand how people lived and how their societies were structured.

Biological anthropology is vastly wider than the study of primates, fossils, and brain evolution. Any scientist studying



evolution as it relates to the human species, directly or indirectly, could be called a biological anthropologist. This includes paleoanthropology, skeletal biology and osteology, paleopathology, forensic anthropology, primatology, and human biology.

# The Scope of Biological Anthropology

## I.2 Describe the subfields within biological anthropology.

The scope of biological anthropology is vastly wider than the study of primates, fossils, and brain evolution. Any scientist studying evolution as it relates to the human species, directly or indirectly, could be called a biological anthropologist. This includes a number of related disciplines (Figure I.1).

### Paleoanthropology

When an exciting new fossil of an extinct form of human is found, paleoanthropologists usually are responsible (Figure I.2 on page 6). **Paleoanthropology** is the study of the fossil record for humankind, and fossilized remains are the most direct physical evidence of human ancestry that we have to understand where we came from. The discovery of skeletal evidence of new ancestral species, or additional specimens of existing species, revises our view of the human family tree. Discoveries of hominin

### cultural anthropology

The study of human societies, especially in a cross-cultural context; the subdivision of anthropology that includes ethnology, archaeology, and linguistics.

### ethnology

The study of human societies, their traditions, rituals, beliefs, and the differences between societies in these traits.

### ethnography

The practice of cultural anthropology. Ethnographers study the minute-to-minute workings of human societies, especially non-Western societies.

### linguistic anthropology

The study of language, its origins, and use; also called anthropological linguistics.

### archaeology

The study of the material culture of past peoples.

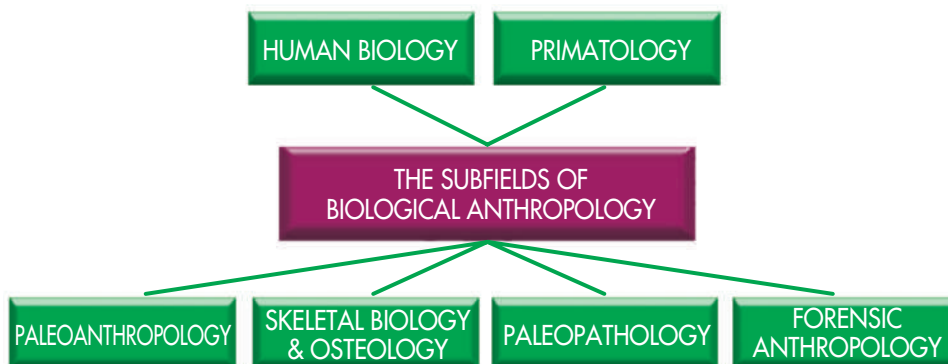
### artifacts

The objects, from tools to art, left by earlier generations of people.

### material culture

The objects or artifacts of past human societies.

**Figure I.1** Subfields of biological anthropology.





**Figure I.2** Paleoanthropologist Jane Moore maps sites at Kanapoi, Kenya.



**Figure I.3** Lucy, a partial hominin skeleton.



### paleoanthropology

The study of the fossil record of ancestral humans and their primate kin.

### osteology

The study of the skeleton.

fossils—some as famous as Peking Man or Lucy (Figure I.3) but many less known—have profoundly changed the way we view our place in nature. Paleoanthropology also includes the study of the fossil record of the other primates—apes, monkeys, and prosimians—dating back at least 65 million years. These early fossils give us key clues about how, where, and why hominins evolved millions of years later. There are fossil sites producing important fossils all over the world, and with more and more students and researchers searching, our fossil history grows richer every year. In fact, although the first half of the twentieth century witnessed discoveries of new human fossils every decade or so, the pace of discovery of new species of fossil humans has accelerated rapidly in recent years. This is because more students and researchers are searching for fossils and because global

and regional political changes have allowed researchers into areas that were long off-limits because of civil war or political unrest.

Paleoanthropological research begins in the field, where researchers search the landscape for new discoveries. Much of the scholarly work then takes place in museums and university laboratories around the world, where the specimens are archived and preserved for detailed study. Because we can safely assume that the evolutionary process taking place in the present also took place in the past, the study of the meaning of human and nonhuman primate fossils proceeds from comparisons between extinct and living forms. For example, the presence of large canine teeth in the male specimens of a fossil monkey species implies that in life, the species lived in multiple male groups in which males competed for mates because major differences in canine tooth size between males and females indicate mate competition in living monkeys.

As the fossil record has grown, we have begun to see that the evolutionary history of our species is extremely complicated; most lineages are now extinct, but many thrived for millions of years. The ladder of progress notion—an older, more linear view of our ancestry in which each species evolved into more complex forms—has been replaced by a family tree with many branches.

## Skeletal Biology and Human Osteology

**Osteology** is the study of the skeleton. The first order of business when a fossil is discovered is to figure out what sort of animal the fossil—often a tiny fragment—may have been in life, so osteologists must possess extraordinary skills of identification and a keen spatial sense of how a jigsaw puzzle–like array of bone chips fits together when they are trying to understand the meaning of fossils they have found.

Among the first generation of biological anthropologists (Figure I.4) were the *anthropometrists*, who made detailed measurements of the human body in all its forms, and their work is still important today. Understanding the relationship between genetics, human growth and stature, and geographic variation in human anatomy is vital to identifying the origins and patterns of human migration across the globe during prehistory, for example. When a 9,000-year-old skeleton was discovered some years ago on the banks of the Columbia River in the Pacific Northwest, osteologists with expertise in human variation in body form were among those who sought to identify its ethnic affinities.

*Skeletal biology*, like osteology, is the study of the human skeleton, but because the bones of the body develop in concert with other tissues, such as muscles and tendons, a skeletal biologist must know the patterns and processes of human growth, physiology, and development, not just anatomy.

**Figure I.4** An osteologist at work.



## Paleopathology and Bioarchaeology

Hand in hand with skeletal biology are **paleopathology** and **bioarchaeology**: the study of disease in ancient human populations, and the study of human remains in an archaeological context. When the Neandertal fossils first appeared in the mid-nineteenth century, there was much scientific debate about whether they represented a true species or “race,” or whether they were simply modern individuals who had suffered from some pathological condition. It took nearly thirty years and the discovery of several additional specimens to resolve the issue. Today, paleopathologists would help resolve such a debate much more quickly.

Bioarchaeologists work with archaeologists excavating ancient humans to study the effects of trauma, epidemics, nutritional deficiencies, and infectious diseases. If archaeologists find evidence that an ancient civilization crashed precipitously, a paleopathologist will study the remains of the bodies for signs of anything from outbreaks of sexually transmitted disease to poor nutrition.

## Forensic Anthropology

Although biological anthropology is concerned primarily with basic research into human origins, biological anthropologists also play roles in our daily lives. **Forensic anthropology**, the study of the identification of skeletal remains and of the means by which the individual died, is a contemporary application of biological anthropology. Forensic anthropologists take their knowledge of osteology and paleopathology and apply it to both historical and criminal investigations (Figure I.5). During the war crime

### **paleopathology**

The study of diseases in ancestral human populations.

### **bioarchaeology**

The study of human remains in an archaeological context.

### **forensic anthropology**

The study of human remains applied to a legal context.

**Figure I.5** Forensic anthropologists use skeletal remains to identify victims of war in Bosnia.





**Figure I.6** Recovery team at work at the World Trade Center Ground Zero following the September 11, 2001, attack.



investigations into mass graves in Bosnia, forensic anthropologists were called in to attempt to identify victims, as they were also after the terrorist attacks in New York, Washington, and Pennsylvania on September 11, 2001 (Figure I.6). When police investigate a murder, forensic scientists may use footprints left at the crime scene to try to reconstruct the height and weight of the murderer. This is not so different from what paleoanthropologists did when they discovered a set of tiny human-like footprints embedded in fossilized ash at Laetoli in northern Tanzania. They used forensic skills to try to reconstruct the likely height and weight of the creatures that had left those prints nearly 4 million years ago.

## Primatology

### primatology

The study of the nonhuman primates and their anatomy, genetics, behavior, and ecology.

**Primatology** is the branch of biological anthropology that is best known to the public through the highly publicized work of renowned primatologists Jane Goodall and Dian Fossey. Primatologists study the anatomy, physiology, behavior, and genetics of both living and extinct monkeys, apes, and prosimians. Behavioral studies of nonhuman primates in their natural environments gained prominence in the 1960s and 1970s, when the pioneering work of Goodall was publicized widely in the United States and elsewhere. In the early days of primate behavior study, the researchers were mainly psychologists. By the late 1960s, however, biological anthropology had become the domain of primate behavior study, especially in North America.

Primatologists study nonhuman primates for a variety of reasons, including the desire to learn more about their intrinsically fascinating patterns of behavior (Figure I.7). Within an anthropological framework, primatologists study the nonhuman primates for the lessons they can provide on how evolution has molded the human species. For example, male baboons fight among themselves for the chance

**Figure I.7** Jane Goodall is a pioneering primatologist whose studies of wild chimpanzees changed our view of human nature.



to mate with females. They are also much larger and more aggressive than females. Do larger, more macho males father more offspring than their smaller and gentler brothers? If so, these traits appear to have appeared slowly through generations of evolutionary change, and the size difference between males and females is the result of selection for large body size. Then, what about the body size difference between men and women of our own species? Is it the result of competition between men in prehistory, or perhaps a preference by women in prehistory for tall men? The clues that we derive about human nature from the behavior and anatomy of living primates must be interpreted cautiously but can be vitally important in our understanding of who we are and where we came from.

Biological anthropologists trained as primatologists find careers not only in universities but also in museums, zoos, and conservation agencies. Many important wildlife conservation projects seeking to protect endangered primate species are being carried out around the world by biological anthropologists.

## Human Biology

In addition to paleoanthropology and primatology, biological anthropologists span a wide range of interests that are often labeled **human biology**. Some work in the area of *human adaptation*, learning how people adjust physiologically to the extremes of Earth's physical environments. For instance, how are children affected by growing up high in the Andes mountain range of South America at elevations over 14,000 feet (4,270 m)? Other human biologists work as *nutritional anthropologists*, studying the interrelationship of diet, culture, and evolution. Biological anthropologists interested in demography examine the biological and cultural forces that shape the composition of human populations. Other biological anthropologists are particularly interested in how various hormones in the human body influence human behavior and how, in turn, the environment affects the expression of these hormones. The study of *human variation* deals with the many ways in which people differ in their anatomy throughout the world.

At an earlier time in history, the scholarly study of physical traits such as height, skull shape, and especially skin color was tainted with the possibility that the

### human biology

Subfield of biological anthropology dealing with human growth and development, adaptation to environmental extremes, and human genetics.