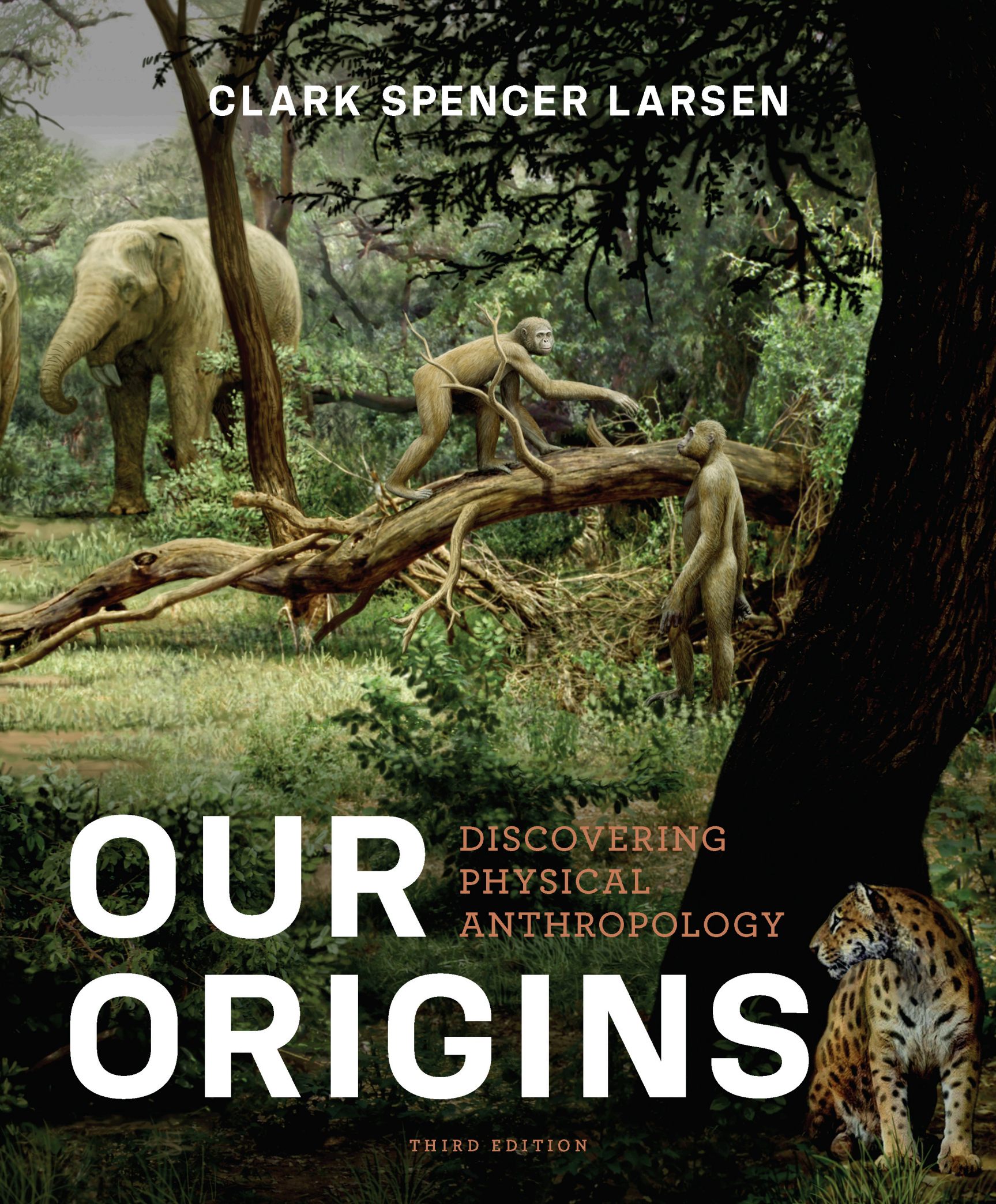
CLARK SPENCER LARSEN
OUR ORIGINS
DISCOVERING PHYSICAL ANTHROPOLOGY
THIRD EDITION

OUR ORIGINS

OUR ORIGINS

DISCOVERING PHYSICAL ANTHROPOLOGY

CLARK SPENCER LARSEN

THE OHIO STATE UNIVERSITY

THIRD EDITION

W. W. NORTON & COMPANY NEW YORK • LONDON

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Composition and page layout: Kenoza Type, Inc.—Brad Walrod
Illustrations: Imagineering—Cynthia Mutheardy, Project Manager
Manufacturing: Courier—Kendallville, IN

Library of Congress Cataloging-in-Publication Data
Larsen, Clark Spencer.
Our origins : discovering physical anthropology/Clark Spencer
Larsen, Ohio State University.—Third edition.
pages cm
Includes bibliographical references and index.
ISBN 978-0-393-92143-4 (pbk.)
1. Physical anthropology. I. Title.
GN50.4.l37 2014
599.9—dc23 2013037731

W. W. Norton & Company, Inc., 500 Fifth Avenue, New York, N.Y. 10110-0017
www.wwnorton.com
W. W. Norton & Company Ltd., Castle House, 75/76 Wells Street, London W1T 3QT

1 2 3 4 5 6 7 8 9 0

To Chris and Spencer,
with my deepest thanks
for their help, encouragement,
and (unwavering) patience.

ABOUT THE AUTHOR

CLARK SPENCER LARSEN heads the Department of Anthropology at The Ohio State University, Columbus. A native of Nebraska, he received his B.A. from Kansas State University and M.A. and Ph.D. from the University of Michigan. Clark's research is in bioarchaeology, skeletal biology, and paleoanthropology. He has worked in North America, Europe, and Asia. His current field work is in Turkey and Italy. He has taught at the University of Massachusetts, Northern Illinois University, Purdue University, and the University of North Carolina. Since 2001, he has been a member of the faculty at Ohio State, where he is Distinguished Professor of Social and Behavioral Sciences. He teaches introductory physical anthropology, osteology, bioarchaeology, and paleoanthropology. Clark has served as president of the American Association of Physical Anthropologists and as editor-in-chief of the *American Journal of Physical Anthropology.* In addition to *Our Origins,* he has authored or edited 25 books and monographs, including *Bioarchaeology: Interpreting Behavior from the Human Skeleton, Skeletons in Our Closet, Advances in Dental Anthropology,* and *A Companion to Biological Anthropology.*

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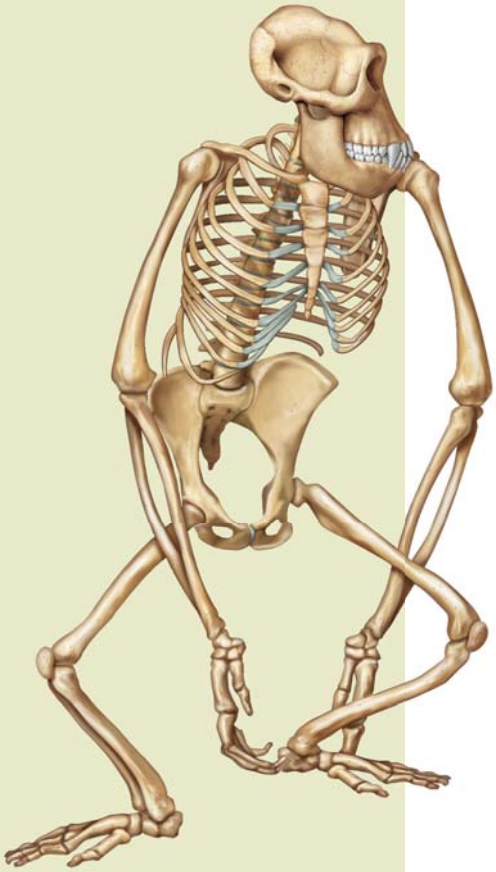
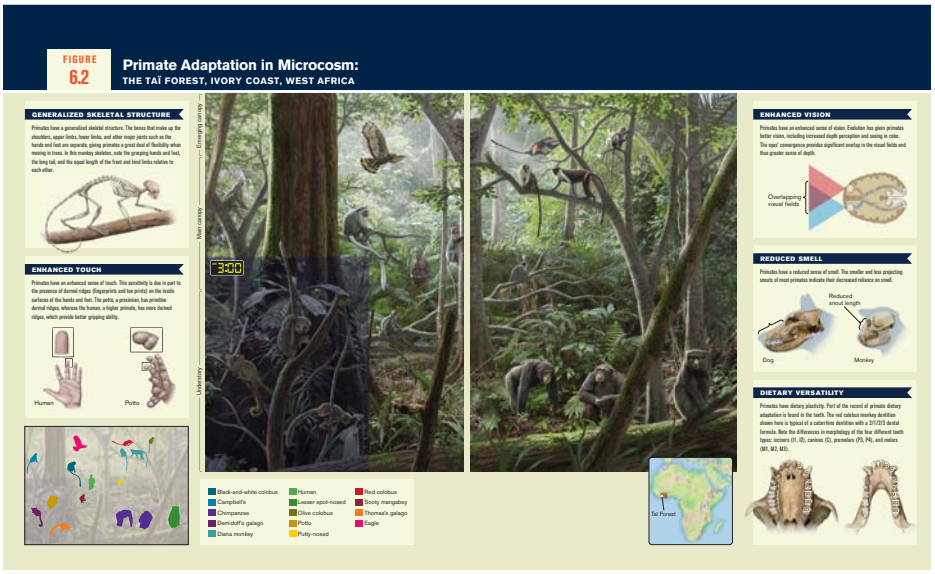


TWO-PAGE SPREADS



TO THE INSTRUCTOR

How This Book Can Help Your Students Discover Physical Anthropology

IT IS ABOUT ENGAGEMENT

Teaching is about engagement—connecting the student with knowledge, making it real to the student, and having the student come away from the course with an understanding of core concepts. *Our Origins: Discovering Physical Anthropology* seeks to engage the student in the learning process. Engaging the student is perhaps more of a challenge in the study of physical anthropology than in the study of other sciences, mainly because the student has likely never heard of the subject. The average student has probably taken a precollege course in chemistry, physics, or biology. Physical anthropology, though, is rarely mentioned or taught in precollege settings. Commonly, the student first finds out about the subject when an academic advisor explains that physical anthropology is a popular course that fulfills the college's natural science requirement.

Once taking the course, however, that same student usually connects quickly with the subject because so many of the topics are familiar—fossils, evolution, race, genetics, DNA, monkeys, forensic investigations, and origins of speech, to name a few. The student simply had not realized that these separately engaging topics come under the umbrella of one discipline, the subject of which is the study of human evolution and human variability.

Perhaps drawn to physical anthropology because it focuses on our past and our present as a species, the student quickly sees the fundamental importance of the discipline. In *Discover* magazine's 100 top stories of 2009, 18 were from physical anthropology. Three topics from the field were in the top 10, including the remarkable new discovery of our earliest human ancestor, *Ardipithecus.* So important was this discovery that *Science,* the leading international professional science journal, called it the "Breakthrough of the Year" for 2009. The discussions in this textbook of topics familiar and unfamiliar give the student stepping-stones to science and to the centrality of physical anthropology as a window into understanding our world. Whether the students find the material familiar or unfamiliar, they will see that the book relates the discipline to human life: real concerns about human bodies and human identity. They will see themselves from an entirely different point of view and gain new awareness.

In writing this book, I made no assumptions about what the reader knows, except to assume that the reader—the student attending your physical anthropology class—has very little or no background in physical anthropology. As I wrote the book, I constantly reflected on the core concepts of physical anthropology

and how to make them understandable. I combined this quest for both accuracy and clarity with my philosophy of teaching—namely, engage the student to help the student learn. Simply, teaching is about engagement. While most students in an introductory physical anthropology class do not intend to become professional physical anthropologists, some of these students become interested enough to take more courses. So this book is written for students who will not continue their study of physical anthropology, those who get "hooked" by this fascinating subject (a common occurrence!), and those who now or eventually decide to become professionals in the field.

The book is unified by the subject of physical anthropology. But equally important is the central theme of science—what it is, how it is done, and how scientists (in our case, anthropologists) learn about the natural world. I wrote the book so as to create a picture of who humans are as organisms, how we got to where we are over the last millions of years of evolution, and where we are going in the future in light of current conditions. In regard to physical anthropology, the student should finish the book understanding human evolution and how it is studied, how the present helps us understand the past, the diversity of organisms living and past, and the nature of biological change over time and across geography. Such knowledge should help the student answer questions about the world. For example, How did primates emerge as a unique group of mammals? Why do people look different from place to place around the world? Why is it important to gain exposure to sunlight yet unsafe to prolong that exposure? Why is it unhealthy to be excessively overweight? Throughout their history, what have humans eaten, and why is it important to know?

I have presented such topics so that the student can come to understand the central concepts and build from them a fuller understanding of physical anthropology. Throughout the book, I emphasize hypothesis testing, the core of the scientific method, and focus on that process and the excitement of discovery. The narrative style is personalized. Often I draw on my own experiences and those of scientists I know or am familiar with through their teaching and writing, to show the student how problems are addressed through fieldwork or through laboratory investigations.

Scientists do not just collect facts. Rather, they collect data and make observations that help them answer questions about the complex natural world we all inhabit. Reflecting this practice, *Our Origins: Discovering Physical Anthropology* is a collection not of facts for the student to learn but of answers to questions that help all of us understand who we are as living organisms and our place in the world. Science is a way of knowing, it is a learning process, and it connects our lives with our world. In these ways, it is liberating.

How the Book Is Organized

The book is divided into three parts. Following an introductory overview of anthropology and physical anthropology, Part I presents the key principles and concepts in biology, especially from an evolutionary perspective. This material draws largely on the study of living organisms, including humans and nonhuman primates. Because much of our understanding of the past is drawn from what we have learned from the present, this part lays the foundation for the presentation in Part II—the past record of primate and human evolution. In putting the record of the living up front, this book departs from the style of most other introductory physical anthropology textbooks, which start out with the earliest record and end with the living. This book takes the position that most of what we learn about the past is based on theory and principles learned from the living record. Just as all of Charles Darwin's ideas were first derived from seeing living plants and animals, much of our understanding of function and adaptation comes from living organisms as models. Therefore, this book views the living as the window onto what came before—the present contextualizes and informs our understanding of the past. It is no mistake, then, that *Our Origins* is the title of the book. The origins of who we are today do not just lie in the record of the past, but are very much embodied in the living. Our origins are expressed in our physical makeup (bone, teeth, and muscles), in our behavior, and in so many other ways that the student taking this course will learn about from this book and from you. You can teach individual chapters in any order, and that is partly because each chapter reinforces the central point: we understand our past via what we see in the living.

Part II presents evidence of the past, covering more than 50 million years of primate and human evolution. Most textbooks of this kind end the record of human evolution at about 25,000 years ago, when modern *Homo sapiens* evolved worldwide. This textbook also provides the record since the appearance of modern humans, showing that important biological changes occurred in just the last 10,000 years, largely relating to the shift from hunting and gathering to the domestication of plants and animals. Food production was a revolutionary development in the human story, and Part II presents this remarkable record, including changes in health and well-being that continue today. A new subdiscipline of physical anthropology, bioarchaeology, is contributing profound insights into the last 10,000 years, one of the most dynamic periods of human evolution. During this period, a fundamental change occurred in how humans obtained food. This change set the stage for our current environmental disruptions and modern living conditions.

Part III explores the record of continued evolution and discusses the impact of new developments, such as global warming, the alarming global increase in obesity, and the rise of health threats such as newly emerging infectious diseases, of which there is little understanding and for which scientists are far from finding cures. This part looks at the implications of these developments for evolution and for humans' future on Earth.

Changes in the Third Edition

Reflecting the dynamic nature of physical anthropology, there are numerous revisions and updates throughout this new, third edition of *Our Origins: Discovering Physical Anthropology*. These updates serve to provide content on the new and cutting-edge developments in the discipline, to give new ways of looking at older findings, and to keep the book engaging and timely for both you and your students. Although the core principles of the book remain the same, namely the focus on evolution, the revisions throughout the book present new insights, new discoveries, and new perspectives. Other changes are intended to give added focus and clarity and to increase the visual appeal that supports the pedagogy of engagement and learning:

- **New content on biocultural adaptation.** Anthropologists provide important insights into how humans' remarkable intelligence is related to their evolutionary success. This third edition presents new research on the role of *social learning* and the retention of knowledge—the accumulation of information—over many generations.
- **New primate taxonomy.** In order to bring the student to the latest developments in primate classification, the third edition has shifted from the traditional, grade-based approach used in the previous editions to the cladistics or phylogenetic approach. This approach provides the student with a classification based on ancestor-descendant evolutionary relationships.
- **New developments in genetics that are covered altering our understanding of phenotype.** Often considered "junk" DNA, we are learning that this non-protein coding DNA has important implications for various other instructions in the genome. Similarly, the rapidly expanding field of epigenetics is revealing evolutionary change without alteration of DNA.
- **New content on maladaptive human behavior and health outcomes like obesity.** The role of environment is fundamental in understanding patterns of health in very recent human evolution, including the impacts of the creation of obesogenic environments, the alarming rise in obesity globally, and the causes and consequences of these changing circumstances and outcomes.
- **New content on fossil primate and hominin discoveries.** Exciting new discoveries in early primate evolution from Africa and Asia are revealing the enormous variety and complexity of species. Anthropologists have long understood the complexities of the evolution of *Australopithecus*. New discoveries from East Africa reveal that although all australopithecines were bipedal, some retained arboreal behavior relatively late in the evolution of these early hominins. These discoveries continue to emphasize the complexity of early hominin evolution. New evidence from chemical and tooth wear analyses reveals that at least some later australopithecines were eating significant quantities of low-quality vegetation, including grasses on the African savanna, confirming the long-held notion that some had highly specialized diets.
- **New findings on the origins of cooking and its importance in human evolution.** Controlled use of fire dates to as early as 1 mya in South Africa. This innovation provided a means for cooking meats and starches, thereby increasing the digestibility of these foods. New research suggests that cooking and nutritional changes associated with cooking may have "fueled" the increase in brain and body size in early hominins.
- **New content on the appearance and evolution of modern *Homo sapiens* and the Neandertal genome.** Analysis of the direction and pattern of scratches on the incisors of Neandertals reveals that they were predominantly right-handed. In addition to showing this modern characteristic, this finding reveals that this earlier form of *H. sapiens* had brain laterality, a feature linked to speech. Neandertals talked. New genetic evidence reveals the presence of Neandertal genes in modern humans, consistent with the hypothesis that modern *H. sapiens* interbred with Neandertals. Newly discovered hominin fossils from Denisova, Siberia, dating to the late Pleistocene represent a genome that is different

from Neandertals' and modern *H. sapiens*'. This newly discovered "Denisovan" genome is also found in people living today in East Asia, suggesting that modern *H. sapiens* encountered Neandertals as well as other populations once in Europe.

- **New findings on the future of humankind.** The study of melting ice caps and glaciers around the world today reveals a dramatic warming trend. As temperatures rise, habitats are in the process of changing. These environmental changes will provide a context for evolution, both in plants and in animals. These factors, coupled with reduction in species diversity, are creating new health challenges for humans today and for the foreseeable future.
- **Revision of content to enhance clarity.** There is a continued focus on understanding core concepts, with considerable attention given to cell biology, genetics, DNA, race and human variation, primate taxonomy, locomotion, and dating methods. Like previous editions, I paid careful attention to the clarity of figure captions. The figure captions do not simply repeat text but rather offer the student additional details relevant to the topic and occasional questions about concepts that the figures convey.
- **Greatly enhanced art program.** The new edition contains over 100 new or revised figures, often using a new "photorealistic" style. The book adds several full-color two-page spreads developed by Mauricio Antón, a world-renowned artist with expertise in representing past life in wonderful visual presentations.
- **SmartWork.** New SmartWork online assessment is designed to be intuitive and easy to use; highly visual and active; and a snap to assign, assess, and report on student performance. It is a great resource for teaching in face-to-face, blended, or online class formats.
- **"Evolution Matters" sections.** At the end of each chapter, an "Evolution Matters" section summarizes material on evolution in each chapter and includes assignable questions about concepts and content. Suggested answers appear in the Instructor's Manual.
- **New teaching and learning tools.** Consistent with the highly visual nature of physical anthropology, the instructor media package has been greatly expanded. Please see the complete listing that starts on page xxvi. Newly featured in this third edition is an Update PowerPoint Service, giving instructors new minilectures on the latest discoveries in the discipline. Updated sets will be posted on the Norton Instructor's site every six months.

Aids to the Learning Process

Each chapter opens with a *vignette* telling the story of one person's discovery that relates directly to the central theme of the chapter. This vignette is intended to draw your students into the excitement of the topic and to set the stage for the Big Questions that the chapter addresses.

BIG QUESTION learning objectives are introduced early in the chapter to help your students organize their reading and understand the topic.

CONCEPT CHECKS are scattered throughout each chapter and immediately follow a major section. These aids are intended to help your students briefly revisit the key points they have been reading.

LOCATOR MAPS are placed liberally throughout the book. College-level instructors tend to hope that students have a good sense of geography, but like a lot of people who do not look at places around the world on a daily basis, students often need reminders about geography. In recognition of this, locator maps in the book's margins show the names and locations of places that are likely not common knowledge.

PHOTOREALISTIC ART YOU CAN "TOUCH" Designed to give students an even better appreciation for the feel of the discipline, the art program has been substantially reworked. Now most illustrations of bones and skeletons have an almost photorealistic feel, and most primates were redrawn for a high degree of realism. This book helps your students visualize what they are reading about by including hundreds of images, many specially prepared for the book. These illustrations tell the story of physical anthropology, including key processes, central players, and important concepts. As much thought went into the pedagogy behind the illustration program as into the writing of the text.

DEFINITIONS are also presented in the text's margins, giving your students ready access to what a term means in addition to its use in the associated text. For convenient reference, defined terms are signaled with boldface page numbers in the index.

A **HOW DO WE KNOW?** box in each chapter discusses in more detail how a particular scientist went about the process of discovery.

An **ANTHROPOLOGY MATTERS** box in each chapter makes the important point that what we learn from this discipline has practical applications of broader

significance in the "real" world. Students will come away from each box with a sense of how the material affects them.

At the end of each chapter, **ANSWERING THE BIG QUESTIONS** presents a summary of the chapter's central points organized along the lines of the Big Questions presented at the beginning of the chapter.

The study of evolution is the central core concept of physical anthropology. The newly introduced **EVOLUTION MATTERS** section at the end of each chapter discusses topics on evolution featured in the chapter and asks questions that will help the student develop a focused understanding of content and ideas.

SMARTWORK is our new online assessment service featuring visual, conceptual, and reading assessments keyed to the Big Question learning objectives, several of which are highlighted for your convenience at the end of each chapter. SmartWork helps you track and report on your students' progress and make sure they are better prepared for class.

Join me now in engaging your students in the excitement of discovering physical anthropology.

Tools for Teaching and Learning

The *Our Origins* teaching and learning package provides instructors and students with all the tools they need to visualize anthropological concepts, learn key vocabulary, and test knowledge.

FOR INSTRUCTORS

SmartWork

New SmartWork online assessment is available for use with *Our Origins*, Third Edition, featuring visual assignments with focused feedback. SmartWork includes animation, video, drag-and-drop, and other visual-based questions designed to help students better understand the core objectives of each chapter. Further questions on the reading help you check if students have worked through the chapter material. Designed to be intuitive and easy to use, SmartWork makes it a snap to assign, assess, and report on student performance and help keep your class on track.

Student Access Codes

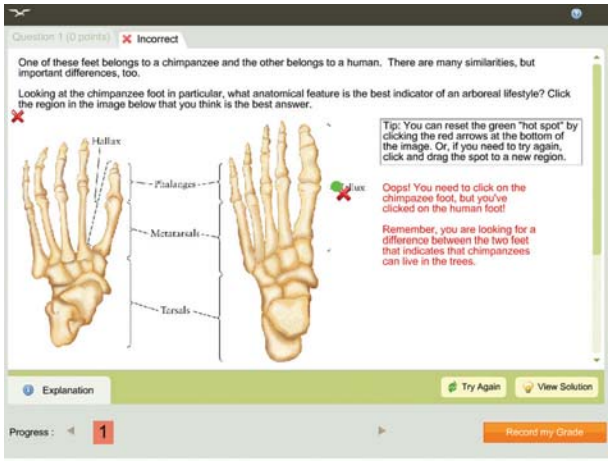
If students need to purchase an access code for SmartWork, they can order through their college bookstore using ISBN 978-0-393-92307-0 for SmartWork with ebook. Immediate online access can also be purchased at smartwork.wwnorton.com.

Coursepacks

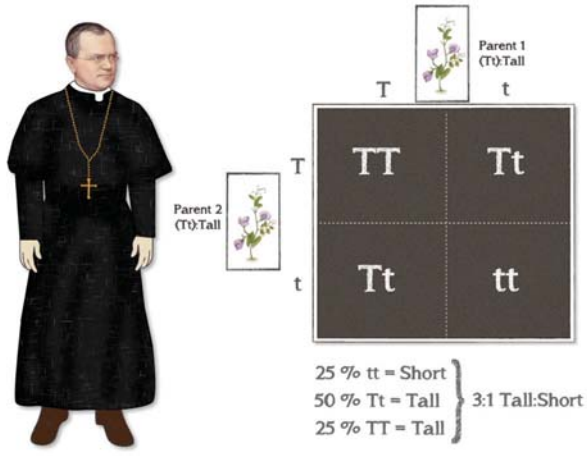
Available at no cost to professors or students, Norton Coursepacks for online or hybrid courses are available in a variety of formats, including all versions of Blackboard and WebCT. With just a simple download from wwnorton.com /instructors, instructors can bring high-quality Norton digital media into a new or existing online course (no extra student passwords required). Content includes new and engaging visual questions especially designed for the distance or blended learning environment. Further Norton animations and videos are also made available to integrate in your classes. Of course, Test Banks, flashcards, student study questions, and PowerPoint slides are all available for your use.

New Animations

These new animations of key concepts from each chapter are available in either the Coursepacks, from wwnorton.com /instructors, or on the Instructor's Resource Disc. Animations



The new SmartWork online assessment system features highly visual questions with immediate, answer-specific feedback.

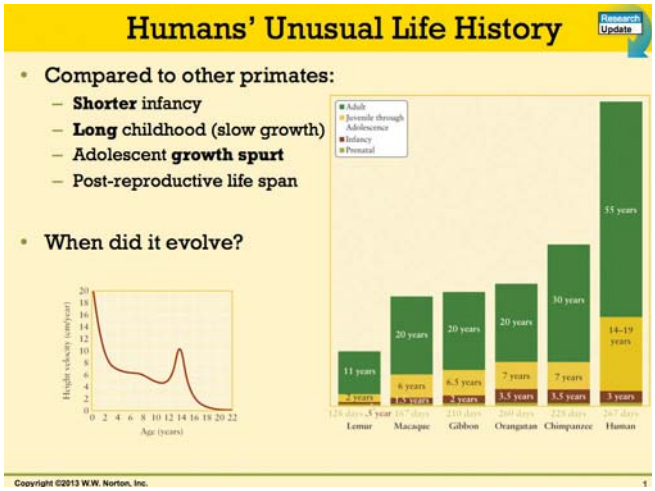


New animations are great for explaining concepts in class or in a distance-learning setting.

are brief, easy to use, and great for explaining concepts either in class or in a distance learning environment.

New Videos
This new streaming-video service is now available through Norton Coursepacks and at wwnorton.com/instructors. These one- to seven-minute educational film clips from across the discipline but with an emphasis on paleoanthropology and primatology help students see and think like anthropologists and make it easy for instructors to illustrate key concepts and spark classroom discussion.

New Update PowerPoint Service
To help cover what is new in the discipline, each semester we will provide a new set of supplemental lectures, notes, and assessment material covering current and breaking research. Prepared by Laurie Reitsema (University of Georgia), this material will be available for download at wwnorton.com /instructors.



Update PowerPoints are posted each semester at the Norton Instructor's site.

PowerPoint Slides and Art JPEGs
Designed for instant classroom use, these slides prepared by Jeremy DeSilva (Boston University) using art from the text are a great resource for your lectures. All art from the book is also available in PowerPoint and JPEG formats. Download these resources from wwnorton.com/instructors.

Prepare for Class with the *Our Origins* Instructor's Manual
Prepared by Nancy Tatarek (Ohio University), this innovative resource provides chapter summaries, chapter outlines, lecture ideas, discussion topics, suggested reading lists for instructors and students, a guide to "Writing about Anthropology," suggested answers to Evolution Matters questions, and teaching materials for each video.

Create Dynamic Classroom Presentations with the *Our Origins* Instructor's Resource Disc
The ultimate tool for classroom presentation, this disc features all the drawn art, all the photos, and a complete set of PowerPoint lecture outlines for every chapter.

Quickly and Easily Create Tests with the *Our Origins* Test Bank
Prepared by Renee Garcia (Saddleback College), this test bank contains multiple-choice and essay questions for each chapter. It is downloadable from Norton's Instructor's Website and available in Word, PDF, and *ExamView® Assessment Suite* formats. Visit **wwnorton.com/instructors.**

Ebook: Same Great Book, a Fraction of the Price! An affordable and convenient alternative, Norton ebooks retain the content and design of the print book and allow students to highlight and take notes with ease, print chapters as needed, and search the text.

Who Helped

I owe much to the many people who made this book possible, from the planning and writing of the first and second editions, and now this third edition. First and foremost, I thank my wife, Christine, and son, Spencer, who helped in innumerable ways. They were my captive audience: without protest, they listened to my ideas at the dinner table, on family trips, and in other places where we probably should have been talking about other things. Chris read many drafts of chapters and gave great advice on when and where to cut, add, or rethink. I thank my parents, the late Leon and Patricia Larsen, who introduced me to things old and sparked my interest in the human past.

Jack Repcheck first approached me about writing a textbook on introductory physical anthropology. His power of persuasion, combined with my own interest in the discipline and its presentation to college students, was instrumental in reeling me in and getting the project off the ground. Jack and others at W. W. Norton & Company made the process of writing the book a great experience in all ways, from writing to publication. On the first edition, I began work with editors John Byram and then Leo Wiegman. I am indebted to Pete Lesser, who took on the project after Leo. Pete gave direction on writing and production, provided very helpful feedback on presentation and pedagogy, and orchestrated

the process of review, revision, and production—all without a hitch. Under Pete's guidance, the first edition became the most widely used textbook in physical anthropology. Jack Repcheck continued the project in preparation for the second edition. The preparation of the third edition was overseen by editor Eric Svendsen. His advice and guidance were central to seeing the book come to fruition. Toni Magyar recently joined the team and has spearheaded the development of new media for this edition including SmartWork. Laura Musich continues to do an excellent job developing the core supplement package for each edition. Kurt Wildermuth edited the entire manuscript for all three editions. His skill as an editor and staying on top of content from beginning to end added enormously to the book's presentation and readability. Christine D'Antonio was instrumental in producing these pages and directing a wide variety of editing issues that arose, and the entire team is now supported by Lindsey Thomas. I welcome Meredith Leo, who crafted an expert marketing and promotional campaign. Ben Reynolds guided the process of production from beginning to end. I am also grateful to Mauricio Antón for his wonderful new illustrations of six "big events" of human evolution in chapter 1, the new rendition of the Taï Forest primates as a microcosm of primate adaptation in chapter 6, and the Eocene, Oligocene, and Miocene primates and their habitats in chapter 9. His illustration of early hominins in East Africa forms the basis of the cover of this edition of *Our Origins*. Renee Garcia and Nancy Tatarek's timely and efficient completion of the Test Bank and Instructor's Manual is much appreciated. Tracy Betsinger produced the instructor resources for our library of streaming video clips of anthropologists at work. Laurie Reitsema has been recently added to the team producing our valuable update PowerPoints each semester.

With the input of instructors and focus group attendees who are included in the reviewer list, we have created an extensive new media and assessment suite for the third edition. However, my thanks for extensive work in developing SmartWork and our new animations go to Tracy Betsinger of SUNY Oneonta, Kristina Killgrove of University of West Florida, Joanna Lambert of University of Texas at San Antonio, and Heather Worne of University of Kentucky, with further thanks to contributors Jaime Ullinger, Quinnipiac University, and Nancy Cordell, South Puget Sound Community College. And thanks to Sandra Wheeler of University of Central Florida, Ellen Miller of Wake Forest University, Bonnie Yoshida of Grossmont College, and again Nancy Cordell of South Puget Sound Community College for their important feedback and reviews of these resources.

Thanks go to former and current graduate students and faculty colleagues at Ohio State University who helped in so many ways. I offer a very special thanks to Tracy Betsinger, who assisted in a number of aspects of the book. For the first edition, she read drafts of chapters at various stages and helped in figure selection, in glossary compilation, and as a sounding board in general for ideas that went into the book. For the second edition, she offered very helpful suggestions for revisions. Thanks to Jaime Ullinger, who provided the content and data for the box on PTC tasting. Tracy, Jaime, Jim Gosman, Dan Temple, Haagen Klaus, and Josh Sadvari read parts or all of the manuscript and offered great advice. For all three editions, I had many helpful discussions with Scott McGraw about primate behavior, evolution, and taxonomy. Scott also provided advice on the production of the two-page spreads on both primate diversity and eagle predation in the Taï Forest, Ivory Coast (chapters 6 and 7). For this edition, John Fleagle provided valuable support reviewing details in most of the new primate illustrations, in particular the two-page spreads, and every new piece of art was reviewed by Arthur Durband, Andrew Kramer, and Sandra Wheeler. Doug Crews gave advice on the complexities of primate (including human) biology and life history. Haagen Klaus provided materials for and help on the two-page spread on the biological consequences of the agricultural revolution and many other helpful comments and suggestions for revision. Barbara Piperata advised me on key aspects of modern human biology and nutrition science, and Dawn Kitchen provided discussion and help on the fundamentals of primate communication and how best to present it. Josh Sadvari was indispensible in the creation of the Evolution Matters sections at the end of each chapter.

Over the years, I have had helpful conversations with my teachers, colleagues, and students about areas of their expertise, and these people have influenced the development of the book in so many ways. I am grateful to Patricia J. O'Brien and Milford H. Wolpoff, my respective undergraduate and graduate advisors. Both were instrumental in developing my interest in science and the wonderful profession I work in. I thank Barry Bogin, Kristen Hawkes, Jim O'Connell, David Thomas, Bob Kelly, Jerry Milanich, Bruce Smith, Kris Gremillion, Bonnie McEwan, Matt Cartmill, Dale Hutchinson, Chris Ruff, Simon Hillson, Michael Schultz, Sam Stout, Doug Ubelaker, Dan Sellen, Clark Howell, Rick Steckel, Phil Walker, John Relethford, Mark Weiss, Margaret Schoeninger, Karen Rosenberg, Lynne Schepartz, Fred Smith, Brian Hemphill, Bruce Winterhalder, Meg Conkey, Desmond Clark, Erik Trinkaus, Katherine Russell, Vin Steponaitis, Mark Teaford, Richard Wrangham, Jerry Rose, Mark Cohen, William Bass, Loring Brace, Stanley Garn, Frank Livingstone, Phil Gingerich, T. Dale Stewart, Larry Angel, Mike Finnegan, Harriet Ottenheimer, Marty Ottenheimer, Roberto Frisancho, Randy Susman, Karen Strier, Joanna Lambert, Jim Hijiya, Cecil Brown, Bill Fash, Rich

Blanton, Henry Wright, James Griffin, Bill Jungers, David Frayer, Bill Pollitzer, George Armelagos, Jane Buikstra, Elwyn Simons, Steve Churchill, Neil Tubbs, Bob Bettinger, Tim White, Dean Falk, Owen Lovejoy, Scott Simpson, David Carlson, Alan Goodman, Bill Dancey, Debbie Guatelli-Steinberg, Sam Stout, Clark Mallam, and Chris Peebles.

The book benefited from the expertise of many anthropologists and other experts. I especially acknowledge the following reviewers for their insights, advice, and suggestions for revision of the text and creation of the support package:

Sabrina Agarwal, University of California, Berkeley
Paul Aiello, Ventura College
Lon Alterman, North Carolina State University
Tara Devi Ashok, University of Massachusetts Boston
Gerald Bacon, Coconino Community College
Philip de Barros, Palomar College
Thad Bartlett, University of Texas, San Antonio
Cynthia Beall, Case Western Reserve University
Owen Beattie, University of Alberta
Daniel Benyshek, University of Nevada, Las Vegas
Tracy Betsinger, College at Oneonta, State University of New York
Deborah Blom, University of Vermont
Amy Bogaard, Oxford University
Günter Bräuer, University of Hamburg
Emily Brunson, University of Washington
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Cynthia Smith, Ohio State University
Fred Smith, Illinois State University
Richard Smith, Washington University
Sara Smith, Delta College
Lilian Spencer, Glendale Community College
James Stewart, Columbus State Community College
Marissa Stewart, Ohio State University
Sara Stinson, Queens College, City University of New York
Christopher Stojanowski, Arizona State University
Margaret Streeter, Boise State University
Karen Strier, University of Wisconsin, Madison
Nancy Tatarek, Ohio University
Linda Taylor, University of Miami
Lonnie Thompson, Ohio State University
Victor Thompson, University of Georgia
Christopher Tillquist, University of Louisville
Sebina Trumble, Hartnell College
Lisa Valkenier, Berkeley City College
Dennis Van Gerven, University of Colorado, Boulder
Patricia Vinyard, University of Akron
Ronald Wallace, University of Central Florida
Brittany Walter, University of South Carolina
David Webb, Kutztown University
Daniel Wescott, Texas State University
Jessica Westin, Pennsylvania State University
Sandra Wheeler, University of Central Florida
Tim White, University of California, Berkeley
Janet Wiebold, Spokane Community College
Caleb Wild, Mira Costa College
Leslie Williams, Utah State University
Sharon Williams, Purdue University
Milford Wolpoff, University of Michigan
Thomas Wynn, University of Colorado, Colorado Springs

Thanks, everyone, for your help! Lastly, a very special thanks goes to all of the faculty around the globe who adopted the previous two editions of *Our Origins* for their introductory physical anthropology classes. I am also grateful to the hundreds of students who connected with the book—many of whom have written me with their comments. Please continue to send me your comments (Larsen.53@osu.edu).

Columbus, Ohio
December 1, 2013

TO THE STUDENT

Physical Anthropology Is about Discovering Who We Are

THINKING LIKE AN ANTHROPOLOGIST

Who are we? Where do we come from? Why do we look and act the way we do? This book is a journey that addresses these and other big questions about us, *Homo sapiens*. This journey emphasizes humans' discovery of the fascinating record of our diversity and of our evolution, a record that serves as a collective memory of our shared biological presence on Earth. From here to the end of the book, I will share with you all kinds of ideas that add up to our current understanding of human beings as living organisms. Along the way, you will experience scientific breakthroughs such as the Human Genome Project and forensics (you might even watch *CSI* and *Bones* in a whole new way). You will gain new understandings of phenomena such as race and human diversity, global warming and its impact on our evolution and our well-being, the origins of human violence, global disease, and the growing worldwide obesity epidemic. Like an anthropologist tackling important questions, you will discover places on nearly every continent and come to see what life was like for millions of years before the present, before the emergence and evolution of humans.

Neither your instructor nor I can expect you as an introductory student to understand all the developments in physical anthropology. Both of us can, however, present you with a clear and concise framework of the field. By the time you are finished reading this book and completing this course, you will have a solid background in the basic tenets of the discipline. This knowledge will help you understand your place in nature and the world that we—more than 7 billion of us and growing—live in. The framework for developing your understanding of physical anthropology is the scientific method, a universal approach to understanding the very complex natural world. You should not assume that this book and this course are about only knowing the right answers, the "facts" of physical anthropology. Rather, they are also about seeing how physical anthropologists know what they know—understanding the scientific method. So as you read, keep in mind the key questions that scientists try to answer, their processes and methods for finding the answers, and the answers themselves.

In writing this book, I have focused on the big questions in physical anthropology, how scientists have tackled them, and what key discoveries have been made. I have not shied away from identifying the scientists who made these discoveries—real people, young and old, from all over the world. Whether you need to learn all these individuals' names and what they contributed to the growth of physical

anthropology and to our knowledge of human evolution and variation is up to your instructor. But in the introductory physical anthropology class that I teach, I encourage my students to learn about the people behind the ideas. By seeing the field through these people's eyes, you can start thinking like an anthropologist.

SEEING LIKE AN ANTHROPOLOGIST

Thinking like an anthropologist includes seeing what anthropologists see. We anthropologists are constantly looking at things—fossilized human teeth, ancient DNA, excavated stone tools, primate skeletons, and much more—and using what we see to understand biology in the past and in the present. The photos and drawn art throughout this book have been chosen to help you see what anthropologists see. I strongly encourage you to pay close attention to the visuals in the book and their captions because much of our anthropological understanding is in the art program.

THE STRUCTURE OF THE BOOK

The book is divided into three parts. Following an overview of anthropology and physical anthropology (chapter 1), Part I provides the basic context for how we understand human (and our nonhuman primate relatives') biology in the present (and how that helps us understand the past). From this section of the book you should come away with an understanding of evolution and the biology associated with it. Evolution as an idea has a long history (chapter 2). You will need to fully grasp the meaning and power of this theory, which explains humans' biological variation today and in the past. Part I also has the important job of providing you with an understanding of genetics (chapters 3 and 4). This information is a central part of the evidence for evolution, from the level of the molecule to the level of the population.

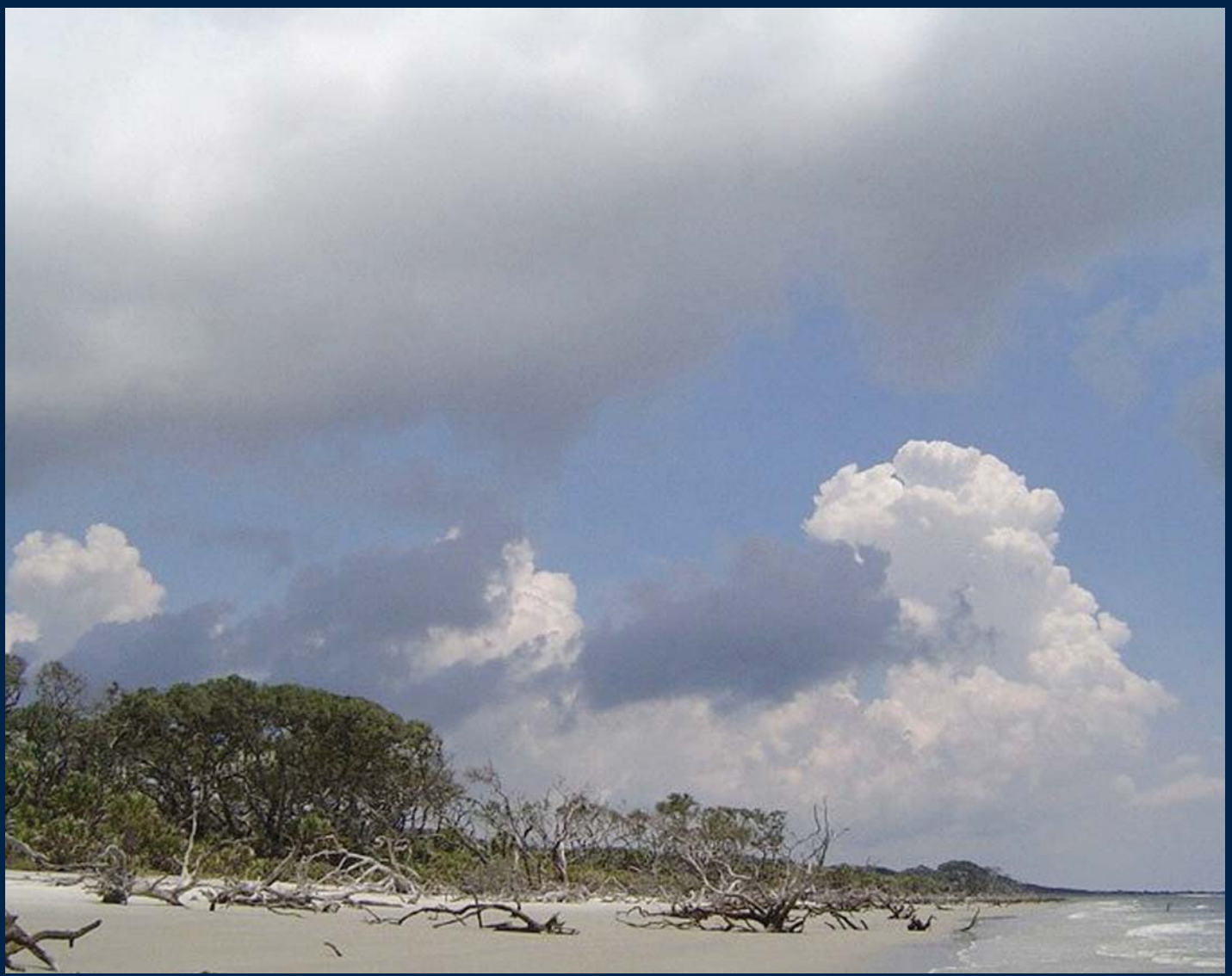
Part I also looks at the biology of living people, that of the other living primates, and the variation among primate species. I am keen on debunking the common notion that there are discrete categories—races—of human beings (chapter 5). In fact, nothing about the biology of people, present or past, indicates that we can be divided into distinct groups. After looking at how environment and culture help shape the way humans look and behave, I will look similarly at nonhuman primates (chapters 6 and 7). Because nonhuman primates' appearances are much more categorical than humans' are, nonhuman primate appearance lends itself to classification or taxonomy. In these chapters, we will look at what nonhuman primates do in the wild, what they are adapted to, and especially the environment's role in shaping their behavior and biology. By looking at living people and living nonhuman primates, we will be better equipped to understand the biological evidence drawn from the past.

Part II examines the processes and evidence physical anthropologists and other scientists use to understand the past (chapter 8), the evolution of prehuman primate ancestors that lived more than 50 million years ago (chapter 9), and both the emergence of our humanlike ancestors and their evolution into modern humans (chapters 10, 11, and 12). Contrary to popular (and some scientific) opinion, human evolution did not stop when anatomically modern people first made their appearance in various corners of the globe. Rather, even into the last 10,000 years a considerable amount of biological change has occurred. Anthropologists have learned that agriculture, which began some 10,000 years ago, has been a fundamental force behind population increase. The downside of this shift to new kinds of food and the resulting population increase was a general decline in health. The later section of Part II (chapter 13) explores the nature and cause of biological change, including the changes associated with health and well-being that led to the biological and environmental conditions we face today.

Part III (chapter 14) looks at the future of our species. Humans continue to undergo biological change—some of it genetic, some not. To understand nongenetic biological change, we will look closely at how modern technologies and diets are profoundly affecting human appearance and contributing to behavioral change. Technologies and diets are helping produce new diseases, new threats to animal and plant diversity, and a planet that is in some ways becoming a less desirable place to live. In particular, global warming's evolving threat is among the most important issues of our day and will prove even more important in the future. Chapters 1–13 will enable us to consider how humans can cope and thrive when faced with such daunting challenges.

With this book in hand and our goals—thinking and seeing like anthropologists—in mind, let us set off on this exciting journey. Consider it a voyage of discovery, on which our shipmates include your instructor and your fellow students. If we work hard and work together, we will find perhaps the most interesting thing on Earth: ourselves.

OUR ORIGINS



THE GEORGIA COAST was a focal point for Spanish colonization in the sixteenth and seventeenth centuries. European colonization set in motion changes in human living conditions that eventually affected human biology on a global scale.

1

What Is Physical Anthropology?

BIG QUESTIONS

1. **What is anthropology?**
2. **What is physical anthropology?**
3. **What makes us human and different from other animals?**
4. **How do physical anthropologists know what they know?**

In the heat of the midday summer sun, our boat slowly made its way across the five miles of water that separate mainland Georgia from St. Catherines Island, one of a series of barrier islands dotting the Atlantic seaboard. Today, the island is covered by dense vegetation typical of the subtropical American South—palmettos and other palm trees, pines, hickories, and live oaks—and is infested with a wide array of stinging and biting insects. It is hard to imagine that this setting was once a focal point of the Spanish colonial "New World," representing the northernmost extension of Spain's claim on eastern North America **(Figure 1.1)**. This was the location of the Roman Catholic church and mission Santa Catalina de Guale, where several hundred Indians and a dozen Spaniards lived and worked during the late 1500s and most of the 1600s.

What could possibly have motivated my field team and me to work for months under a blazing sun, fighting insects? Like any scientific investigation, our fieldwork was motivated by specific questions that we keenly wanted to answer. Buried in the sands of St. Catherines were the mortal remains—skeletons—of the native people who had lived at this long-abandoned place. These remains held answers to questions about the biology of modern people. Native Americans had lived in this area of the world for most of the last 10,000 years. We wanted to know about their biological evolution and variation: How had these people changed biologically over this time span? What caused these changes? What circumstances led to the changes that we hoped to identify and interpret?

FIGURE 1.1 Spanish Mission Sites Spanish colonization relied on the establishment of missions north and west of St. Augustine, Florida, along the coast of Georgia and the panhandle of northern Florida. These sites, such as Mission Santa Catalina de Guale (on St. Catherines Island), provide insight into what the missions might have looked like **(inset)**. Researchers have reconstructed the lifestyles of the Indians and the Spanish colonizers who inhabited the sites: by studying their skeletons, the researchers assessed how the inhabitants changed biologically following colonization.

When we first set foot on St. Catherines Island in the summer of 1982 to begin our work at Mission Santa Catalina, we were excited about our project, but little did we realize just what a spectacular scientific journey we were undertaking. The skeletons we sought turned out to provide wonderfully rich biological details about a little-understood region of the world, especially relating to the health consequences and behavioral consequences of European contact on native peoples. In setting up the research project, I had envisioned that our findings would provide a microcosm of what had unfolded globally—in the Americas, Asia, Africa, and Australia—during the previous 500 years of human history. During this period, significant biological changes had taken place in humans. Some of these changes were evolutionary—they resulted in genetic change. Other biological changes, nonevolutionary ones, reflected significant alterations in health and lifestyle, alterations that had left impressions on the skeletons we studied. Such study—of genetic and nongenetic changes—here and elsewhere in the world has proven fundamental to human beings' understanding of their biology in the early twenty-first century.

Like any scientific investigation, the research project at Mission Santa Catalina did not develop in a vacuum. Prior to our work there, my team and I had devoted nearly a decade to studying hundreds of skeletons we had excavated from the region, dating from before the arrival of Spaniards. We had learned from archaeological evidence that before AD 1000 or so the people there ate exclusively wild animals, fish, and wild plants—they were hunters and gatherers. Never settling into one place for any period of time, they moved from place to place over the year, hunting animals, fishing on the coastline, and collecting plants. Then, their descendants—the ancestors of the mission Indians—acquired corn agriculture, becoming the first farmers in the region. These people did lots of fishing, but farming produced the mainstay of their diet. This major shift in lifestyle led to the establishment of semipermanent villages. In comparison with the hunter–gatherers living before AD 1000, the later agricultural people were shorter, their skulls and limb bones were smaller, and they had more dental disease and more infections. All of this information—scientific discoveries about the prehistoric people, their biological changes, and their adaptations—set the stage for our return to the island to study the people who lived at Santa Catalina, the descendants of the prehistoric hunter–gatherers and later farmers. From our study of their remains, we learned that after the Spaniards' arrival the native people worked hard, they became more focused on producing and eating corn, and their health declined. The combination of declining quality of life and new diseases introduced by the Spaniards led to the native people's extinction in this area of North America.

The research just described is one small part of the broader discipline known as *physical anthropology*. My work concerns life on the southeastern United States Atlantic coast, but physical anthropologists explore and study *everywhere* humans and their ancestors lived. This enterprise covers a lot of ground and a lot of time, basically the entire world and the last 50 million years or so! The territorial coverage of physical anthropology is so widespread and so diverse because the field addresses broad issues, seeking to understand human evolution—*what* we were in the past, *who* we are today, and *where* we will go in the future. Physical anthropologists seek answers to questions about *why* we are what we are as biological organisms. How we answer these questions is oftentimes difficult. The questions, though, motivate

physical anthropologists to spend months in the subtropics of coastal Georgia, learning about an extinct native people; in the deserts of central Ethiopia, finding and studying the remains of people who lived hundreds, thousands, or even millions of years ago; or at the high altitudes of the Andes Mountains, studying living people and their responses and long-term adaptation to low oxygen and extreme cold, to name just a few of the settings you will learn about in this book. In this chapter, we will explore in more detail the nature of physical anthropology and its subject matter.

What Is Anthropology?

When European explorers first undertook transcontinental travel (for example, Marco Polo into Asia in the late 1200s) or transoceanic voyages to faraway lands (for example, Christopher Columbus to the Americas in the late 1400s and early 1500s), they encountered people that looked, talked, dressed, and behaved very differently from themselves. When these travelers returned to their home countries, they described the peoples and cultures they saw. Building on these accounts, early scholars speculated on the relationships between humans living in Europe and those encountered in distant places. Eventually, later scholars developed new ideas about other cultures, resulting in the development of the discipline of anthropology.

Anthropology is the study of humankind, viewed from the perspective of all people and all times. As it is practiced in the United States, it includes four branches or subdisciplines: **cultural anthropology, archaeology, linguistic anthropology,** and **physical anthropology,** also called **biological anthropology** **(Figure 1.2)**.

Cultural anthropologists typically study present-day societies in non-Western settings, such as in Africa, South America, or Australia. **Culture**—defined as learned behavior that is transmitted from person to person—is the unifying theme of study in cultural anthropology.

culture Learned behavior that is transmitted from person to person.

Archaeologists study past human societies, focusing mostly on their material remains—such as animal and plant remains and places where people lived in the past. Archaeologists are best known for their study of material objects—**artifacts**—from past cultures, such as weaponry and ceramics. Archaeologists study the processes behind past human behaviors—for example, why people lived where they did, why some societies were simple and others complex, and why people shifted from hunting and gathering to agriculture beginning more than 10,000 years ago. Archaeologists are the cultural anthropologists of the past—they seek to reassemble cultures of the past as though those cultures were alive today.

artifacts Material objects from past cultures.

Linguistic anthropologists study the construction and use of language by human societies. **Language**—defined as a set of written or spoken symbols that refer to things (people, places, concepts, etc.) other than themselves—makes possible the transfer of knowledge from one person to the next and from one generation to the next. Popular among linguistic anthropologists is a subfield called **sociolinguistics,** the investigation of language's social contexts.

language A set of written or spoken symbols that refer to things (people, places, concepts, etc.) other than themselves.

sociolinguistics The science of investigating language's social contexts.

Physical (or biological) anthropologists study all aspects of present and past human biology. As we will explore in the next section, physical anthropology deals with the evolution of and variation among human beings and their living and past relatives.

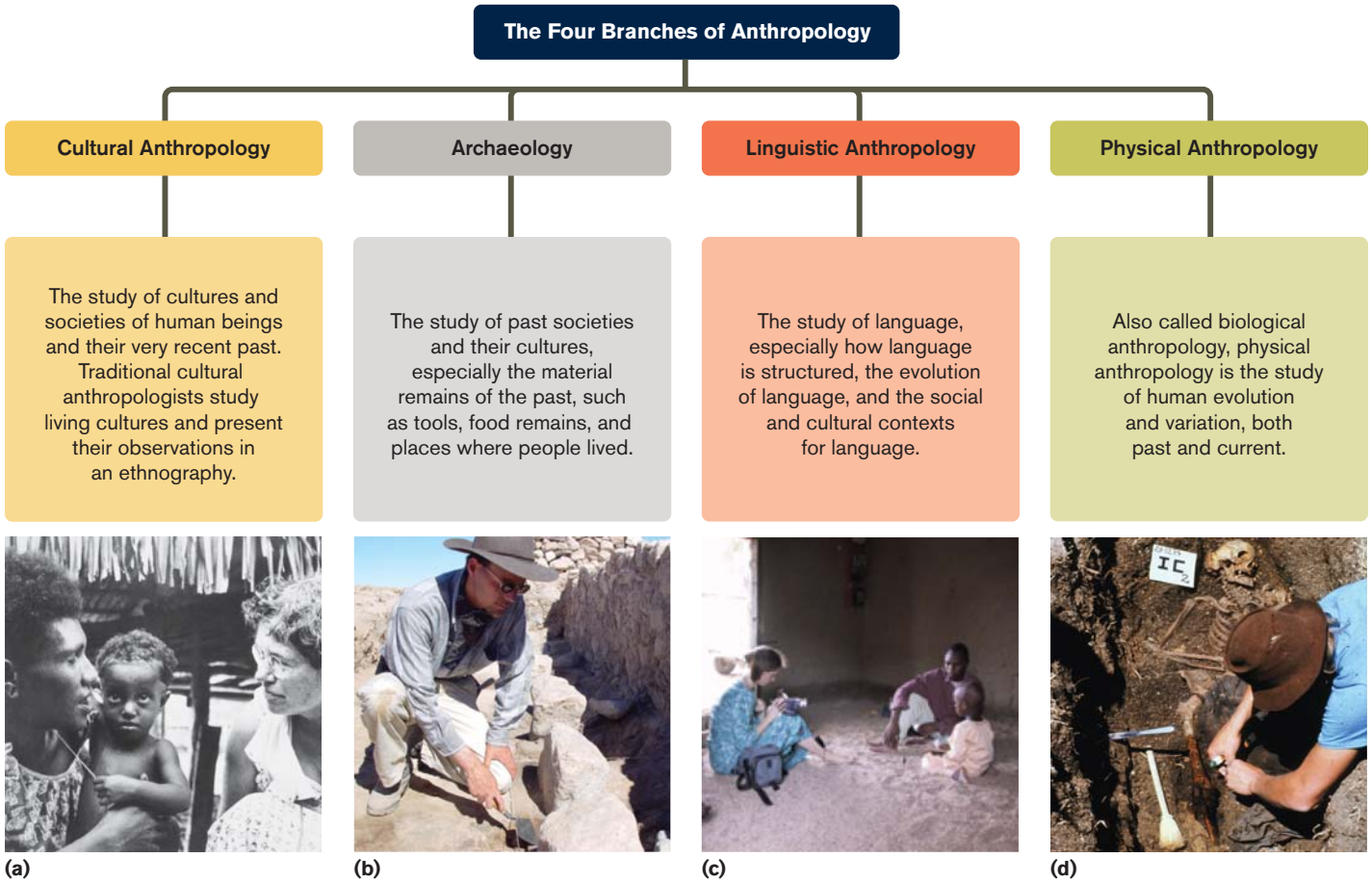


FIGURE 1.2 The Four Branches of Anthropology **(a)** *Cultural anthropologists,* who study living populations, often spend time living with cultural groups to gain more intimate perspectives on those cultures. The American anthropologist Margaret Mead (1901–1978), one of the most recognizable names in cultural anthropology, studied the peoples of the Admiralty Islands, near Papua New Guinea. **(b)** *Archaeologists* study past human behaviors by investigating material remains that humans leave behind, such as buildings and other structures. In the Peruvian Andes, this archaeologist examines the remnants of a brewery used by the Wari Empire (ca. AD 750–1000). **(c)** *Linguistic anthropologists* study all aspects of language and language use. Here, Leslie Moore, a linguistic anthropologist working in a Fulbe community in northern Cameroon, records as a teacher guides a boy in memorizing Koranic verses. **(d)** *Physical anthropologists* study human evolution and variation. Some physical anthropologists study skeletons from the past to investigate evolution and variation throughout human history. Those working in **forensic anthropology,** a specialty within physical anthropology, examine skeletons to identify who they were in life. Such an identification may be of a single person or of thousands. For example, the forensic anthropologist pictured here was called on to help identify the estimated 30,000 victims of Argentina's "Dirty War," which followed the country's 1976 coup.

biocultural approach The scientific study of the interrelationship between what humans have inherited genetically and culture.

No anthropologist is expected to be an expert in all four branches. Anthropologists in all four areas and with very different interests, however, acknowledge the diversity of humankind in all contexts. No other discipline embraces the breadth of the human condition in this manner. In fact, this remarkably diverse discipline differs from other disciplines in its commitment to the notion that, unlike other animals, humans are biocultural—both biological and cultural beings. Anthropologists are interested in the interrelationship between biology and culture. Anthropologists call this focus the **biocultural approach.** Anthropology also differs from other disciplines in emphasizing a broad comparative approach to the study of biology and culture, looking at all people (and their ancestors) and all cultures in all times and all places. They are interested in people and their ancestors, wherever or whenever they lived. Simply, you are studying a field that is holistic, unlike any you have studied before.

What Is Physical Anthropology?

The short answer to this question is, *Physical anthropology is the study of human biological evolution and human biocultural variation.* Two key concepts underlie this definition.

Number one, every person is a product of evolutionary history, or all the biological changes that have brought humanity to its present form. The remains of humanlike beings, or **hominins,** indicate that the earliest human ancestors, in Africa, date to sometime around 6–8 million years ago (mya). Since that time, the physical appearance of hominins and their descendants, including modern humans, has changed dramatically. Our physical appearance, our intelligence, and everything else that makes us distinctive biological organisms evolved in our predecessors, whose genes led to the species we are today. (Genes and species are among the subjects of chapters 3 and 4.)

hominin Humans and humanlike ancestors.

Number two, each of us is the product of his or her own individual life history. From the moment you were conceived, your biological makeup has been determined mostly by your genes. (The human **genome**—that is, all the genetic material in a person—includes some 20,000–25,000 genes.) Your biological makeup is also strongly influenced by your environment. *Environment* here refers not just to the obvious factors such as climate but to everything that has affected you—the physical activities you have engaged in (which have placed stress on your muscles and bones), the food you have eaten, and many other factors that affect overall health and well-being. Environment also includes social and cultural factors. A disadvantaged social environment, such as one in which infants and children receive poor-quality nutrition, can result in negative consequences such as poor health, reduced height, and shortened life expectancy. The Indian child who lived after the shift from foraging to farming on the Georgia coast ate more corn than did the Indian child who lived in the same place before AD 1000. Because of the corn-rich diet, the later child's teeth had more cavities. Each child's condition reflects millions of years of evolution as well as more immediate circumstances, such as diet, exposure to disease, and the stresses of day-to-day living.

genome The complete set of genetic information—chromosomal and mitochondrial DNA—for an organism or species that represents all of the inheritable traits.

WHAT DO PHYSICAL ANTHROPOLOGISTS DO?

Physical anthropologists routinely travel to places throughout the United States and around the world to investigate populations. Some physical anthropologists study living people, while others study extinct and living species of our nearest biological relatives, **primates** such as lemurs, monkeys, and apes. I am among the physical anthropologists who travel to museum collections and archaeological localities to study past societies. When I tell people outside the field what I do for a living, they often think physical anthropology is quite odd, bizarre even. Frequently they ask, "Why would anyone want to study dead people and old bones and teeth?" Everyone has heard of physics, chemistry, and biology; but the average person has never heard of this field. Compared to other areas of science, physical anthropology is small. But smallness does not make it unimportant. It is practical and important, providing answers to fundamental questions that have been asked by scholars and scientists for centuries, such as *Who are we as a species? What does it mean to be human? Where did we come from?* Moreover, physical anthropology plays a vital role in addressing questions that are central to our society, sometimes involving circumstances that all of us wish had never come about. For example, the tragedy that Americans identify as 9/11 called immediately for the assistance of specialists from forensic anthropology.

primates A group of mammals in the order Primates that have complex behavior, varied forms of locomotion, and a unique suite of traits, including large brains, forward-facing eyes, fingernails, and reduced snouts.

HOW DO WE KNOW?

Franz Boas Invents Anthropology, American Style

The origins of academic anthropology in the United States go back to the late 1800s. More than anyone else, Franz Boas (1858–1942) pulled together the various scholarly themes that give the discipline its distinctive identity in the United States. German by birth and by education, Boas attended graduate school, majoring in physics and geography. He was expected to know a lot about a lot of different things. By the time he received his Ph.D. from the University of Kiel in 1881, he had developed a passionate interest in studying other cultures, drawing the conclusion that human societies were best understood from as many angles as possible, including the cultural side (culture, technology, and society) and the biological side (variation, physical characteristics, and adaptation). He was also trained to observe the natural world and to record it in detail, not just to collect facts but to answer questions. This perspective grew from his exposure to senior scholars with interdisciplinary approaches and to scientists who focused on empirical, measurable evidence. Among his teachers was the leading European anthropologist of the nineteenth century, Rudolf Virchow (1821–1902).

Franz Boas on board the *Germania* in 1883, on his expedition to Baffin Island.

In the late spring of 1883, Boas left his hometown of Minden, Germany,

The discipline as practiced in the United States began in the first half of the twentieth century, especially under the guidance of three key figures: Franz Boas for American anthropology generally (see "How Do We Know?: Franz Boas Invents Anthropology, American Style"); Czech-born Aleš Hrdlička, who started the professional scientific journal and professional society devoted to the field; and Earnest Hooton, who trained most of the first generation of physical anthropologists. While the theory and methods of physical anthropologists today have changed greatly since the early 1900s, the same basic topics first envisioned by these founders form what we do.

Physical anthropologists study all aspects of human biology, specifically looking at

for his first anthropological expedition, to spend a year observing the Inuit (Eskimos) living on Baffin Island in the eastern Arctic of North America. His education and training had convinced him that he needed to find out as much as he could on the cultural and biological sides of the human condition, in this case as they applied to the Inuit. This endeavor was a central element of the birth of anthropology in the United States.

Boas's objective in his fieldwork was simple. In his own words, he wanted to research "the simple relationships between the land and the people." His work represented a fundamental development in the history of anthropology because it brought together different perspectives, seeking to understand the Inuit's living and past cultures, language, and biology. Today, these emphases comprise the four main branches of anthropology: cultural anthropology, archaeology, linguistic anthropology, and physical anthropology.

After Boas moved to the United States, he served, during the 1890s, as one of the first scientific curators of anthropology at the American Museum of Natural History in New York City. He then, over the next half-century, taught full-time at Columbia University, instilling in his students a central tenet of anthropology: we learn about cultures, societies, and peoples' biology via *direct* observation and *careful* attention to detail. Boas trained the first generation of American academic anthropologists, all leaders in the field: Ruth Benedict, Margaret Mead, Edward Sapir, Alfred Kroeber, Robert Lowie, and Melville Herskovits, to name a few. He was also an important force in founding one of the primary professional organizations, the American Anthropological Association, and its journal, the *American Anthropologist,* and played leading roles in the founding of other anthropological organizations, including the American Association of Physical Anthropologists, the professional organization of physical anthropologists in the United States. By basing his research and his teaching on questions such as *How do we know*?, Boas laid the foundation for scientific anthropology: reliance on the scientific method, with its focus on the collection of evidence, for addressing hypotheses and answering questions about past and living people.

Boas, here dressed and equipped for Arctic exploration, sought to learn how the Inuit people interacted with their environment and how the environment affected their biology. He also studied their language and material culture during this yearlong, physically and emotionally taxing expedition.

the evolution and variation of human beings and their living and past relatives. This focus on biology means that physical anthropologists practice a ***biological science***. But they also practice a *social science,* in that they study biology within the context of culture and behavior. Depending on their areas of interest, physical anthropologists might examine molecular structure, bones and teeth, blood types, breathing capacity and lung volume, genetics and genetic history, infectious and other types of disease, origins of language and speech, nutrition, reproduction, growth and development, aging, primate origins, primate social behavior, brain biology, and many other topics dealing with variation in both the living and the dead—sometimes the very long dead **(Figure 1.3)**!