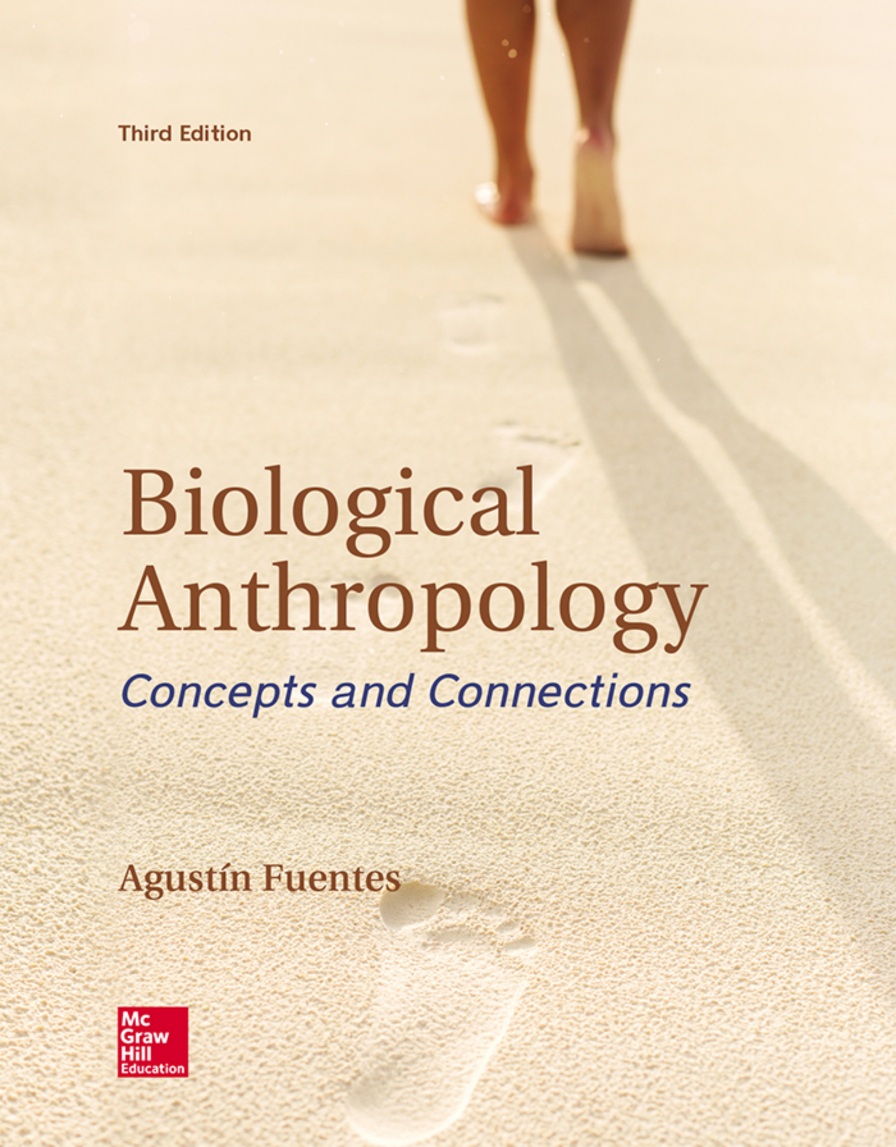

Third Edition

Biological Anthropology

Concepts and Connections

Agustín Fuentes

McGraw Hill Education

Biological Anthropology:

Concepts and Connections

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THIRD EDITION

Agustín Fuentes
University of Notre Dame

Mc Graw Hill Education

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This book is dedicated to three amazing teachers: my parents, Victor Fuentes and Elizabeth Fuentes, and my graduate mentor, Phyllis Dolhinow. The book itself is the result of all the students who sat through my lectures, asked questions, and pushed me to really, really think about what we teach and how we teach it. Because of them, I also dedicate this book to all who love the quest for knowledge and ask their teachers and themselves for more.

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Preface

Do your students struggle with complex concepts like genetics and evolution? Do they have difficulty seeing the relevance of biological anthropology to their lives? If so, I have written this text for you.

How this book will help you . . .

I am a firm believer in the incredible importance of anthropology in our everyday lives. Yet, in speaking with colleagues around the country and reading McGraw-Hill's research, I've learned that instructors' greatest frustrations in teaching introductory biological anthropology are helping students understand certain key concepts (i.e., genetics, evolution) and—perhaps even more importantly—making them see the relevance of this course material to their lives.

. . . by helping your students

Biological anthropology classes are packed with information that is directly relevant to all of us and should be both interesting and exciting. Biological anthropologists are making exciting discoveries that change the way we view ourselves today, our understanding of our past, and our future as a species. Yet students often walk away from their textbooks with no understanding of how the information they have just read applies to their lives. That's why, in this book, I've introduced the theme of "Connections."

. . . connect the concepts to their lives

This text directly speaks to students and relates the concepts of biological anthropology to their lives. It does so in several ways:

Connections boxes

Several times in each Chapter, I include a "Connections" feature that directly shows students the relevance of the particular topic being discussed to them and their everyday lives. For example, in Chapter 5, we explore whether male aggression is an evolutionary trait; in Chapter 7, why bipedality made childbirth more difficult; and in Chapter 9, why humans feel a special connection to dogs.

Chapter-opening stories

In addition, each chapter begins with an example, taken from the headlines, of an important question biological anthropologists have asked or answered: How do steroids affect athletes (Chapter 2)? What do discoveries about primate culture tell us about what makes humans unique (Chapter 8)? What is race and what is it not? (Chapter 10)?

Connecting students to related information

Callouts in the margin show students other places in the text a topic is covered, allowing the student either to review material that they have already studied or read more about a topic that interests them.

Understanding key concepts

By focusing on the key concepts and presenting them in a straightforward manner, this text encourages students to think about, assess, and use the information presented, not just memorize it and recite it back on a test. Several aspects of this text are designed to help students deal with challenging concepts:

- **The Introduction,** set up as a series of FAQs ("How old is the planet?" "Have humans changed over time?" "Where does modern science come from?") presents background information students need but do not always have access to.
- **Chapter 2: Basics of Human Biology** contains a review of human anatomy and biology, a chapter unique among introductory texts but extremely important to students' understanding of human evolution and variation.
- **Key terms,** defined in the margin where they are introduced, help students with new vocabulary and provide an easy review for exams.

The importance of critical thinking and the scientific process

To understand science, students must understand how scientists develop new knowledge, how new knowledge is determined to be valid, and what remains to be discovered. They need to understand how biological anthropologists "do" science. This is a key concern of this book.

- **Scientific Discovery.** The Introduction and early chapters focus on the process of discovery—not just what we know, but how we know it. I explore how scientific discovery builds on earlier knowledge. So, for example, I don't just tell the student about Darwin's theory of natural selection; I explain how Darwin built on earlier knowledge to form a unified and cohesive explanation for how life evolved.
- In addition, at the end of each chapter, students find a unique critical-thinking feature, **What We Know/Questions That Remain.** This feature summarizes key knowledge presented in the chapter and highlights the most important questions that remain to be answered. It will help students see that science is an ongoing process and that our current state of knowledge is subject to change. Most importantly, it demonstrates the exciting nature of ongoing research in biological anthropology.
- **Critical Thinking Questions** at the end of each chapter ask the student to analyze and synthesize material rather than just memorize it.
- **Focus on humanity's place in the natural world.** As a biological anthropologist and primatologist, I focus on humans as a part of the primate order. My goal is to give students a wide perspective on what it means to be human and to help them think critically about important issues that face all of humanity. Chapter 5 discusses human behavioral ecology in the context of primate behavior. Chapters 7 through 9 present an overview of human evolution in the context of the evolution of the entire primate order. Chapter 11 explains that humans are still evolving and speculates on what this means for global ecology.

How is this book organized?

This book is organized into an Introduction and 11 chapters.

- The Introduction, as described above, presents crucial background information set up as an engaging series of FAQs.
- Chapters 1 through 4 introduce students to the field of anthropology, the science of biological anthropology, Darwinian evolution, human biology, and contemporary evolutionary theory via the extended evolutionary synthesis.
- Chapter 5 is a uniquely fascinating introduction to primate behavioral ecology, written from the point of view of a working primatologist.
- Chapters 6 through 9 survey human evolution from the earliest mammals through *Homo sapiens*.
- Chapter 10 surveys human variation and tackles the complex yet critically important topics of race and racism.
- Chapter 11 puts it all together by speculating on how humans are continuing to evolve.

Biological anthropology is a dynamic, fast-changing field, and its discoveries about genetics, human evolution, and human variation are vitally relevant to students' lives. I hope that students reading this book will come to understand the relevance of these concepts and become as excited to learn about biological anthropology as I am to teach it.

Supplements

The 3rd edition of Biological Anthropology: Concepts and Connections, is now available online with Connect, McGraw-Hill Education's integrated assignment and assessment platform. Connect also offers SmartBook for the new edition, which is the first adaptive reading experience proven to improve grades and help students study more effectively. All of the title's website and ancillary content is also available through Connect, including:

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About the Author

Agustín Fuentes completed a BA in Zoology and Anthropology and an MA and PhD in Anthropology at the University of California, Berkeley. He conducted his dissertation fieldwork in the remote Mentaiwai islands of Indonesia and has worked throughout Southeast Asia, North Africa, and the Southern Iberian Peninsula. Dr. Fuentes first taught Introduction to Biological Anthropology in the fall of 1995 at UC Berkeley. In 1996 he joined the department of Anthropology at Central Washington University (CWU), where he founded and directed the interdisciplinary undergraduate Primate Behavior and Ecology program. Dr. Fuentes began working intensively with undergraduate students on original research, and between 1998 and 2009 he collaborated with colleagues in Indonesia and Gibraltar to run field projects in Bali and Gibraltar which involved more than 100 undergraduate students from 12 different countries.

Since 2002 Dr. Fuentes has been in the Department of Anthropology at the University of Notre Dame, where he is currently The Edmund P. Joyce C.S.C. Professor of Anthropology. Dr. Fuentes is interested in both the big questions and the small details of what makes humans and our closest relatives tick. His current research includes cooperation and community in human evolution, ethnoprimatology and multispecies anthropology, evolutionary theory, and interdisciplinary approaches to human nature(s). He is also interested in issues of disease, inequity, and resilience. Dr. Fuentes is committed to an integrative anthropological approach. He has published over 150 articles and book chapters, 14 edited volumes, and 4 single-authored books.

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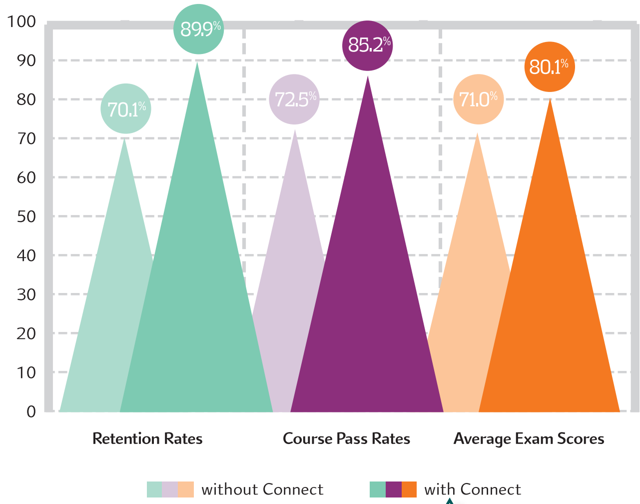

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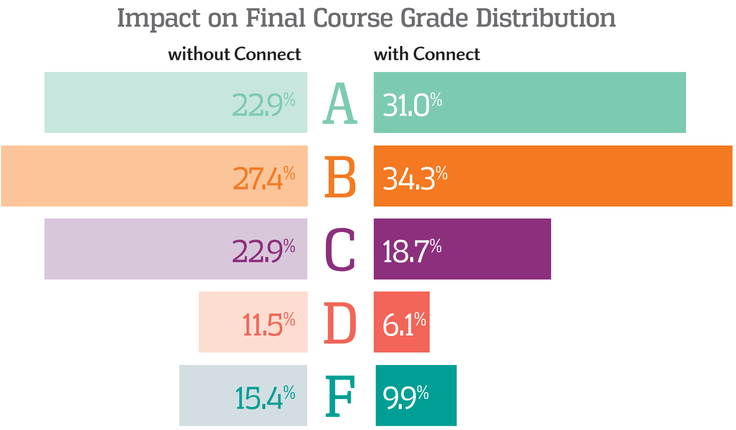

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Biological Anthropology: Concepts and Connections

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Introduction

FAQs for biological anthropology

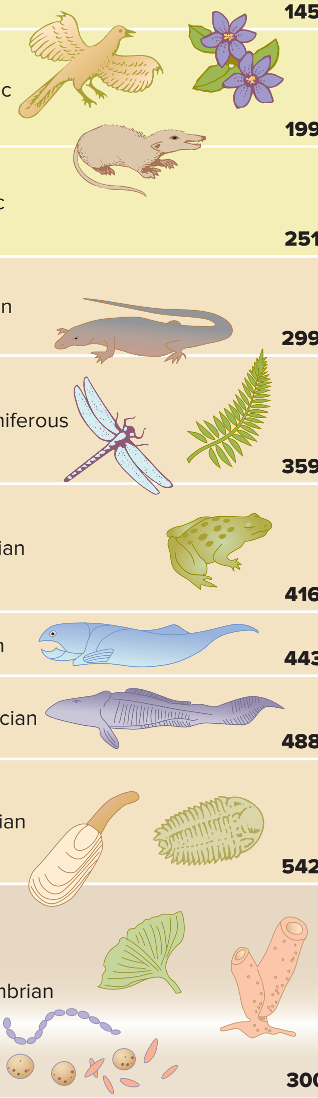
Many students take a course in biological anthropology without much background in science. As a result, they have a lot of questions. So, we'll start this book by introducing a bit of scientific context and history. This information, along with the illustrations in this section, will be useful to set the stage for the rest of the book.

How Old Is the Planet and What Organisms Have Lived on It over That Time?

Before we begin discussion about human biological evolution, we need to review the evolution of the planet and life on it. Let's quickly run through the last 4.5 billion years of the planet's geological and biological history to give us a little perspective on the relative context of humankind. The history of this planet is divided into *eras*, which are divided into *periods*, which are further divided into *epochs* (Figure I.1). The majority of the earth's history is in the Proterozoic era. The Proterozoic began with the formation of the earth, approximately 4.5 billion years ago, and ended with the first major diversification of life-forms, approximately 600 million years ago. It is in this era that we find the first hints of life on this planet: tiny fossilized impressions suggesting clusters or chains of linked cells resembling today's blue-green algae and bacteria (*prokaryotic cells*, or cells that do not contain a nucleus). From about 3.5 to 1.5 billion years ago, these are the only kinds of fossils we find. So, prokaryotes were the only organisms on the planet for the first 2 billion years of the evolution of life.

Starting around 1.2–1.5 billion years ago, life-forms became slightly more diverse. We begin to find evidence of *eukaryotic cells* (cells that have a nucleus, like those of all animals and plants). By 1 billion years ago, we find indirect evidence (fossilized burrowing tracks and fecal pellets) of multicellular organisms. Between 1 billion and 570 million years ago, we see a diversification of types of fossil organisms; however, all life is still very small and confined to limited habitats in the oceans.

Era	Period (epochs)	Beginning of period (millions of years ago)	Biological features
Cenozoic	Pleistogene (Pleistocene and Holocene)	1.8	The genus *Homo* evolved toward the end of period
	Neogene (Miocene and Pliocene)	23.0	
	Paleogene (Paleocene and Oligiocene)	65.5	First hominoids First anthropoids Early prosimians at beginning of period
Mesozoic	Cretaceous	145.5	First placental mammals
	Jurassic	199.6	First flowering plants; first mammals and birds
	Triassic	251.0	
Paleozoic	Permian	299.0	
	Carboniferous	359.2	First coniferous trees; first reptiles and insects
	Devonian	416.0	First amphibians and land plants; first bony fish
	Silurian	443.7	First fish with jaws
	Ordovician	488.3	First vertebrates, armored fish without jaws
	Cambrian	542.0	Invertebrate fossils, molluscs, crustaceans, Echinodermata
Proterozoic	Precambrian		First fossilized animals and plants; protozoa, sponges, corals, and algae
		3000	First fossil bacteria



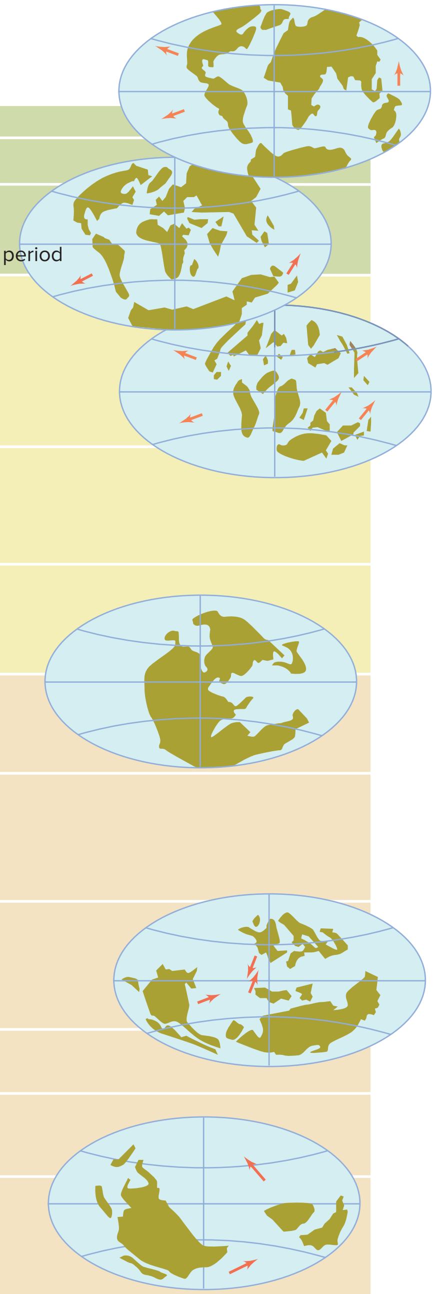


FIGURE I.1
The geological timescale shows the sequence of appearance of the major forms of life on earth.

The next geologic era, the Paleozoic, began around 540 million years ago. The first period of the Paleozoic era, the Cambrian, shows the first major example of an **adaptive radiation** (expansion by a single group of organisms into a diverse array of forms) that we see in the fossil record. At the start of this period there was an explosion of forms moving into a wide array of new niches, or habitats and lifeways, in the oceans. From the basic structures of organisms in the late Precambrian, we see a multitude of variants arise as organisms exploit new oceanic environments and ways of making a living. By the end of the Cambrian period, we have the first precursors for many modern animal lineages.

FIGURE I.2
An artist's conception of an early mammal from 195 million years ago.

Throughout the rest of the Paleozoic we see an array of new forms arising from existing varieties. In the Ordovician we see a great expansion in complex multicellular organisms, including the first fishes (jawless fishes). By the beginning of the Silurian we find fossils of jawed fishes, which suggests a radical change in the cycle of life (that is, the appearance of active chewing). These are the first serious vertebrate predators. These earliest jawed fish have no bones, only cartilage, and at least one lineage of these early Silurian fish is ancestral to modern sharks and rays.

adaptive radiation
expansion by a single group of organisms into a diverse array of forms

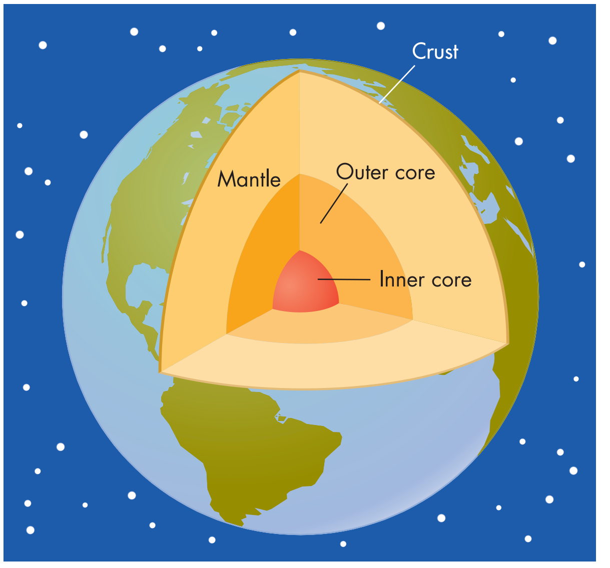
By the middle of the Silurian, bony fish show up in the fossil record and diversify into at least two main groups: the lobe-finned and the ray-finned fishes. The currently favored hypothesis is that one or more lineages of lobe-finned fishes gave rise to the first land vertebrates (the amphibians). The first fossils of land plants show up during this period. By the end of the Devonian, we have evidence of land animals (insects), complex land plant formations (like swamps), and a huge array of life-forms in the seas.

From the rest of the Paleozoic we find a growing number of fossils of land animals, especially in coastal areas, where the early amphibians (which looked very much like slightly modified lobe-finned fish) gradually changed into a wide array of amphibian forms and early reptiles. During the last period of the Paleozoic (the Permian), there was a broad radiation of reptilian forms, including a group called the therapsids, or mammal-like reptiles (the reptile group that mammals are hypothesized to be most closely related to).

The Mesozoic era began around 250 million years ago. By the early Mesozoic, reptiles had undergone a broad and dramatic adaptive radiation. Freed from the water by two crucial adaptations—self-contained eggs and skin that resists drying out—reptiles spread across the land environments and adapted to a broad spectrum of habitats. During this era the best-known reptile group, the dinosaurs, make up a large portion of the fossil remains. It is also during the Mesozoic that the first mammals show up (Figure I.2). These mostly small, probably nocturnal, insect-eating mammals are found throughout the era, but do not make their grand adaptive radiation until the Cenozoic.

The Mesozoic was the age of reptiles. The Cenozoic, which began around 65 million years ago, is the age of mammals and birds. After an enormous extinction event at the Mesozoic-Cenozoic boundary, mammals and birds began to diversify, filling many of the niches left vacant by the extinctions of reptiles and other types of animals. The Cenozoic period is very important in the history of primates (and therefore humans) and is covered in detail in chapter 6.

FIGURE I.3
Model of the earth's interior, showing the layers. This demonstrates the earth's crust "floating" on the liquid mantle.



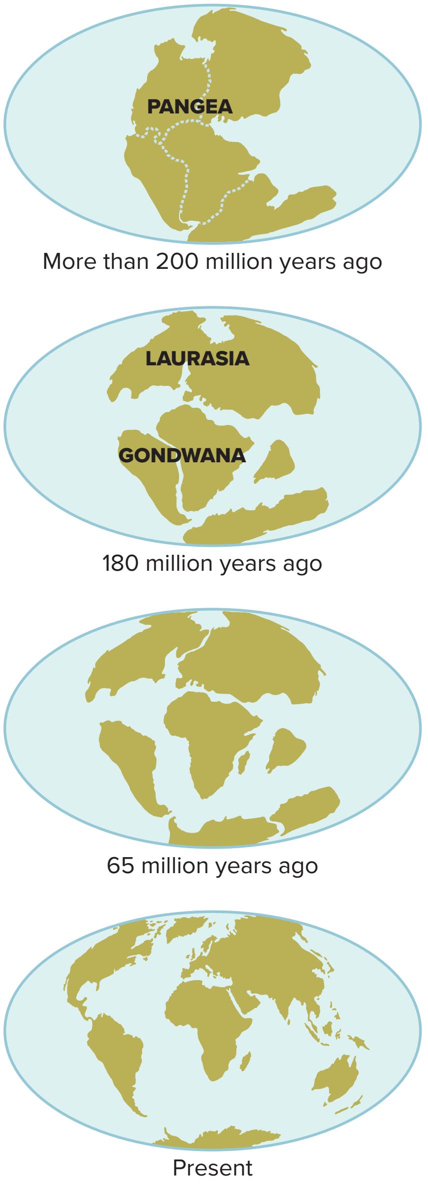


FIGURE I.4
Continental drift. The continents took on their present relative positions only about 35 million years ago. The forces of plate tectonics continue to reshape the crust.

If Life on Our Planet Has Changed So Much Over Time, What About the Planet Itself?

During the time that life on earth has been changing, so has the surface of the planet. The process of **plate tectonics** drives the phenomenon of **continental drift.** Plate tectonics results from the continental plates floating on a layer of mantle (magma, or molten rock, like lava) (Figure I.3). Currents in the magma move the plates in a number of different ways. Sometimes magma pushes up between plates and solidifies, pushing them apart (spreading). When plates meet, one can overlap the other, driving it down into the magma (subduction). Plates can move against one another, pushing the earth up and creating mountain ranges (collision). If we look at the model of continental movement over just the last 200 million years, we can see that the earth's surface has changed dramatically over time (Figure I.4).

Understanding that the earth and life on it have changed over the last 4.5 billion years is an important basic concept. You will notice throughout this book that change over time is a recurring notion in biological anthropology.

Have Humans Changed?

Yes, absolutely, humans have changed. Change over time in humans is pretty much the core of biological anthropology. So, thinking about change on a slightly smaller scale than 4.5 billion years, let's turn to another basic set of information that we'll be expanding upon throughout this book—the history of humans and their immediate ancestors over the last 6 million years or so.

Figure I.5 is a simplified time line of human history over the last 6 million years. This time line is just a brief outline to get you to start thinking about names, places, and dates in human evolution. We'll be discussing each of the names and types of human and humanlike organisms in detail in chapters 6 through 11. Notice, however, that during most of the time that our species has been evolving, more than one humanlike species existed side by side. While trends and patterns are evident in the history of human evolution,

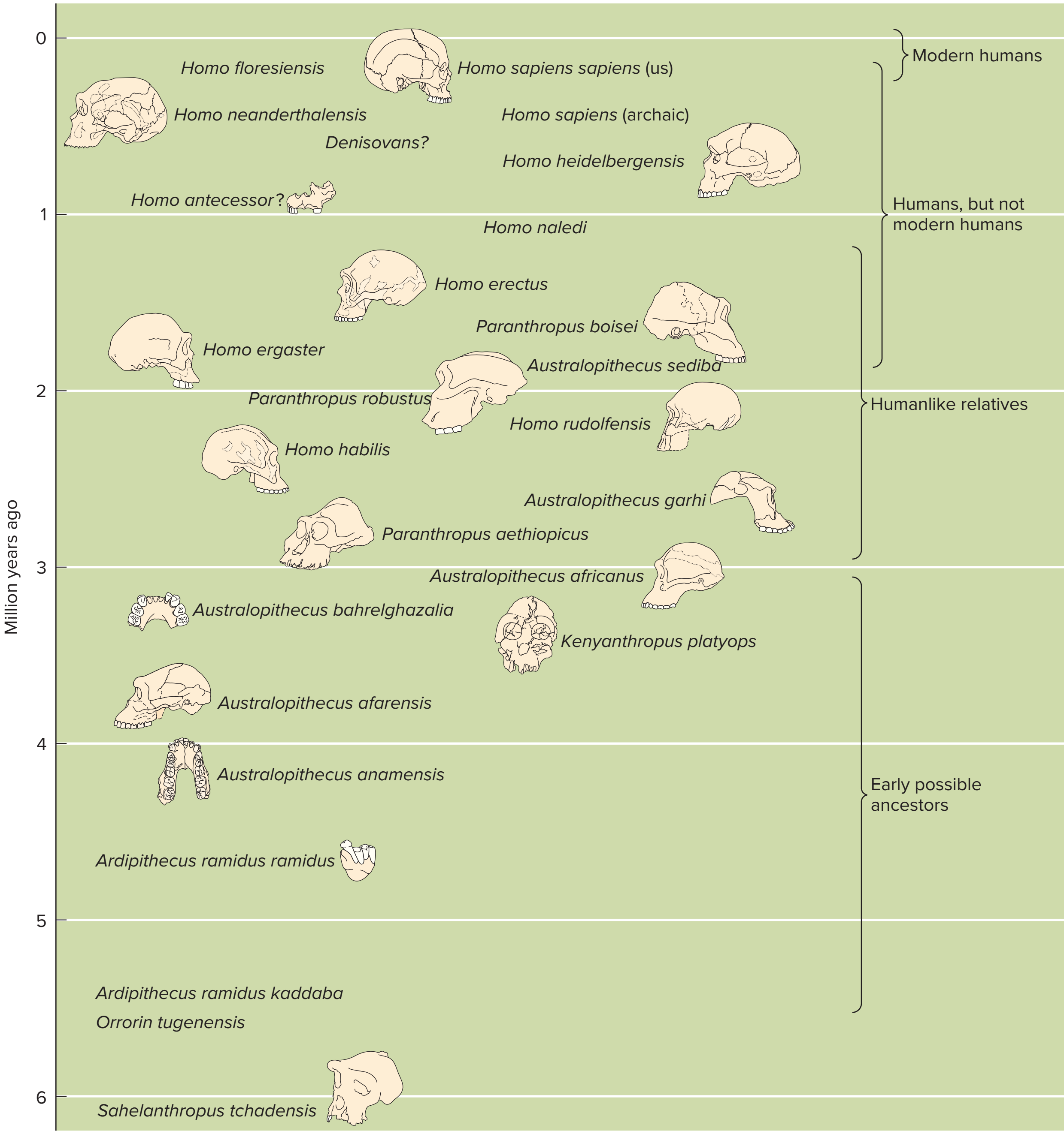


FIGURE I.5

An evolutionary time line of human history. In this book we will explain what these different organisms are and how they might be related to us.

there is not an inevitable trajectory. Knowing this may help you realize that our species is just one of many on this planet that evolved by filling, modifying, and being modified by different niches.

plate tectonics
process by which the earth's crustal plates move independently of one another, resulting in continental drift

continental drift
theory that the present configuration of continents results from the movement of the earth's crust

Where Did Modern Science Come From?

All of the information we've just reviewed and much of what we will be introducing in this book is the product of a process we call *science*. The methods and philosophy of what we call "science" today have deep roots but developed their modern form over the last 5 or 6 centuries and is largely what Francis Bacon called for in 1605: a collaboration between inductive methodologies (drawing conclusions from extant facts) and experimental methodologies (testing hypotheses and making observations). This contrasts with the *a priori* methods wherein investigators go from cause to effect, basing their reasoning on beliefs or assumptions rather than experience or testable observations. The hallmark of modern scientific knowledge is its *falsifiability*, not its verifiability; that is, science can prove things 100% false but not 100% true. To be falsifiable, statements must be capable of being subjected to tests that might result in their refutation. So scientific information emerges from series of observations, refutations, and hypotheses supported by rigorous testing.

In this book we focus on scientific information and processes that relate to understanding our bodies and our biological history. It is important to realize that all our current knowledge rests on past discoveries and collaborations. For example, our understanding of the cells that make up our bodies has developed over 350 years. It began in 1665, when Robert Hooke first described cells. In 1683, Anton van Leeuwenhoek used his early microscopes to examine blood and sperm cells. In 1883, August Weismann recognized the role of gametes (germ-cells, or egg and sperm). In 1902, Emil Fischer proposed that proteins (the building blocks of our cells) are made up of naturally occurring amino acids, and in 1926, J. Haldane described the complex internal structures of cells and their permeable membranes. All of these elements laid the groundwork for Erwin Chargaff's 1950 discovery of the composition of DNA, for Rosalind Franklin's images of DNA via X-ray crystallography, and finally James Watson and Francis Crick's 1953 model of the structure of DNA.

Similarly, our understandings of the basic patterns in our solar system and galaxy started with Johannes Kepler's and Galileo Galilei's observations and proposals in the early 1600s. These in turn supported Nicolaus Copernicus's notions about the motion of planets and the sun as the center of the solar system. By 1704, Isaac Newton had published accounts of his ideas on gravity, optics, and particulate light; and approximately 200 years later, Albert Einstein began publishing his ideas about the energy source of the sun and the relationships among matter, mass, and light. In 1929, Edwin Hubble published his observations that all galaxies were moving away from each other. Today all of their proposals, plus many others, are integrated in our understanding of the motion of the earth and all other celestial bodies.

Even such seemingly minor scientific events as the discoveries that resulted in the production of the first electric refrigerator and the invention of the television tube (both in 1923) have had a great impact on our ability to conduct laboratory work and write it up. (Freezers and computers are now ubiquitous in laboratories worldwide.) Modern science comes from a specific set of methodologies and a continuous history of investigation, collaboration, and refutation. Understanding that our knowledge is based on prior knowledge, and is subject to change, is important for assessing the information presented in this book. In chapter 1, you will see how the theory of evolution developed out of investigations carried out over several centuries by numerous scientists in a number of different fields.

Where Is Uzbekistan?

A major piece of any college student's baseline education (regardless of your major) is a grasp of the geography of the planet. You are 1 of over 7 billion humans currently residing on earth; as a citizen of this planet you need to know where you and your neighbors live. Also, in this book you will be learning about discoveries that have taken place all over the world. Figure I.6 shows a current (as of the time this book was written) world map identifying the various countries. Figure I.7, however, is a map that looks a bit different. It is a more accurate projection of the actual size of the landmasses. You will note that it does not look like the maps you are used to seeing: they all overstate the size of the north and downplay the size of the south. Having accurate information is critical as we seek to unravel human evolutionary history.

With these few basic bits of information under your belt, you are now ready to move on to the study of biological anthropology.