

# ***Understanding Computers and Data Processing: Today and Tomorrow***

***Second Edition***



***Charles S. Parker***



***Understanding  
Computers and  
Data Processing:  
Today and Tomorrow***

***Second Edition***

To our children

*Lydia, Peter, and Alexander*

*Christopher and Emily*



# Preface

This book has been a long time in the making. It represents not only what we hope will be a useful approach to the teaching of human evolution at the introductory college and university level, but also a new restatement of the coherency and fundamental compatibility of all the many and varied subdisciplines in which biological anthropologists have become specialized. In all, there is the uniting thread of evolution by natural selection, which forms the basic paradigm of our discipline. The subtitle of the volume underlines this concept by using the term “synthetic” to define our approach. Our hope is that our exposition does justice to the elegant theoretical framework of modern biological anthropology and that we have succeeded in communicating the exciting diversity so apparent in this rapidly developing field.

This book is a narrative treatment of human evolution, organized along lines of increasing organismal complexity, leading from prebiotic replicating molecules through to modern *Homo sapiens*. Following this organization, the text proceeds generally from very early time to the present, and from broad taxonomic categories that include human beings to progressively more specific categories, ending with *Homo sapiens sapiens*. We have used available paleoecological data to set the stage and provide the context of the morphological and behavioral adaptations characterizing our ancestors at each major time period. We believe that this organization serves to build students’ understanding of the biological, genetic, and anatomical basics of biological anthropology so that the complex questions of hominid phylogeny, human sociocultural behavior, human variability, and modern-day adaptation to our increasingly demanding environment can be approached in more meaningful ways. The table provides an overview of the text’s organization.

Many individuals have shaped this book. Sherwood Washburn and Jane Lancaster were instrumental in developing our ideas of a text that brought together fossils and behavior. Joe Birdsell was an important influence in our incorporation of ecology and population perspectives. Jack Cronin deserves credit for contributing the concept of a textbook that fully integrated molecular and fossil approaches. We are indebted to the authors of the text’s Frontiers boxes who agreed to share their perspectives and insights, Eugenie C. Scott, Vincent Sarich, Lloyd H.



Time (Years)	Taxonomic Level	Taxa	Structural Complexity	Behavior/ Adaptation	Chapters
10 <sup>4</sup> –Present	Populations and “Races”	<i>Homo sapiens sapiens</i>		Adaptability and Disequilibrium	11,12, 13,14,15
10 <sup>5</sup>	Subspecies	<i>Homo sapiens sapiens</i>		Culture	11, 12, 13,14,15
	Species	<i>Homo sapiens</i>	Cerebral Expansion	Language	10
10 <sup>6</sup>		<i>Homo erectus</i>	Body Size Increase	Fire Use	10
	Genus	<i>Homo</i>	Cerebral Expansion	Stone Tool Use	10
	Family	Hominidae	Thick-Enamelled Molars	Bipedalism/ Omnivorous	9
10 <sup>7</sup>	Superfamily	Hominoidea	Body Size Increase	Climbing/ Hanging	8
	Order	Primates	Vision	Social/Arboreal	6, 7
10 <sup>8</sup>	Class	Mammalia	Limbic System; High Metabolism	Nocturnal/ Insectivorous	5
		Reptilia	R-Complex/ Kidney	Terrestrial	5
		Amphibia	Hand/Foot	Semi-Terrestrial	5
		Pisces	Limb Elements	Aquatic	4
10 <sup>9</sup>	Phylum	Chordata	Multi-cellular	Instinct	3
	Kingdom	Animalia	Cellular/Multi-cellular	Active Movement	2,3
2–3 × 10 <sup>9</sup>			RNA/DNA		1,2

Burckle, Glenn C. Conroy, Matt Cartmill, Linda D. Wolfe, David R. Begun, Craig B. Stanford, Alan Walker, Milford Wolpoff, John D. Speth, Kenneth K. Kidd, Judith R. Kidd, Michael Little, and S. Boyd Eaton.

In the book's long history our editors and publishers, Peter Dougherty, Jerry Lyons, Nancy Roberts, Fred Whittingham, and Barbara Reilly have all believed in the book and have uniquely contributed to the outline, structure, and content in their own ways. Readers and reviewers have helped us immensely in refining passages and editing muddled text. We particularly thank Marc Feldesman, John Fleagle, Paris Pavlakakis, Sue Parker, and many anonymous reviewers. Our students have contributed tremendously to the development of the book by their many questions and careful reading, particularly Margaret Streloff, Leslie Khayatpoor, Jean Henderson, Heather Harlan, and Levon DerMikaelian. A special thanks goes to Sabina Johnson for the long hours of copyediting she put in. Finally, the forbearance, support, and encouragement of Meleisa McDonell and Barbara Almquist ensured that this book did not take a second decade to complete. For that we are all grateful.



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# *Evolutionary Perspectives on Human Biology and Behavior*



## **Anthropology**

The Scientific Method  
Paradigms of Biological  
Anthropology

## **Subjects That Biological Anthropologists Study**

Human Differences  
How Human Populations Adapt  
Origins  
The Role of Molecular Biology  
Behavior

## **The Language of Biological Anthropology**

Species  
Subspecies

## **Phylogeny: Reconstructing the Evolutionary History of Species**

Phylogenetic Systematics  
Gene Lineages and Organismal  
Lineages  
Ecology and Evolution  
Evolution Versus Creationism

## **The Perspective of Human Evolution**

## **Summary**

**Critical-Thinking Questions**  
**Suggested Readings**



*Biological Anthropology* is about humankind's place in nature, how we came to be, how and why our bodies and brains are built the way they are, and why we behave as we do. Portions of these subjects are studied by scientists in many diverse disciplines, but the general, or holistic, study of them is the domain of **biological anthropology**. This broad-based understanding of the human organism is the strength of biological anthropology, and in today's increasingly specialized world of science, it is an important perspective.

The basic scientific framework of modern biological anthropology is *evolution by natural selection*, Charles Darwin's theory to explain the origin and diversity of species on earth. This theory provides scientists with a way to make predictions about human evolution, biology, and behavior, and to test their predictions against observations made in nature. For example, these observations result from laboratory experiments, field studies of our living primate relatives in remote rain forests, or excavations of fossils millions of years old. To give our readers an overall appreciation of human adaptation, anatomy, behavior, and evolution, this book integrates the advances that biological anthropologists have made in understanding human evolution and biology. We draw upon many different lines of evidence to demonstrate both the uniqueness of the human condition and those continuities that make humans part of nature.

Human beings evolved out of and are still today intimately connected with the natural world. The "natural world" does not connote only the "forest primeval" or the African savanna homeland of our early ancestors. Our ancestors lived as gatherers and hunters for the last several million years. We have been "civilized"—living in permanent structures packed into villages, towns and cities, growing food plants, tending domesticated animals, and using metal tools—only for the last few thousand years. This period is less than one-half of one percent of our evolutionary history, which began approximately 2.5 million years ago when we became stone tool-using early humans. But regardless of the diversity of our modern habitats, our biology is still that of hunter-gatherers, quick-witted opportunists who can eat almost anything and who can survive under conditions of great hardship as well as prosperity.

**biological anthropology**—the study of human evolution, biology, variation, and adaptation (also known as physical anthropology).



## ANTHROPOLOGY STUDIES HUMANKIND

**Anthropology** is the science that studies humans, their biology, adaptations, behavior, and variation within the context of a specialized adaptation of learned social behavior called **culture**. Anthropologists study such broad ranging phenomena as physical and cultural differences among human groups, the structure of the many human languages, the adaptability of human groups to different environmental conditions, the patterns of growth, and the changing patterns of culture over time. This broad scientific agenda makes anthropology a discipline with many specialists and many subdisciplines. For this reason, anthropological research is frequently described as “multidisciplinary.” One characteristic of all anthropologists is a commitment to understanding humanity in its entirety, as a functioning whole. For this reason anthropology is also termed holistic.

Anthropology grew out of the Enlightenment, the period of European intellectual discovery in the eighteenth century when interest arose in the diversity of the natural world and scientists became committed to the empirical method. As foreign lands became better known, the perspective of Europeans became more global. People with different customs, living in environments that seemed strange to Europeans, speaking unknown and unwritten languages, and lacking historical records, required explanations. Where did they come from? Why did they live where they lived? How did their customs and languages develop? Anthropology arose as a means to answer these questions.

Although many of the earliest contributors to anthropology were European, today scientists throughout the world contribute to the anthropological data base. For example, Japanese researchers have offered new, ground-breaking insights into the behavior of the non-human primates, the monkeys and apes; and African biological anthropologists have made some of the most important fossil discoveries, leading us closer to an understanding of our origins.

Anthropology in the United States is generally made up of four fields: biological or physical anthropology, cultural anthropology or ethnology, archaeology, and linguistics. Biological anthropologists, also referred to as **physical anthropologists**, study the physical makeup, evolution, and variations of human populations, the relationships of humanity with the natural world, and the biological bases of human behavior. **Cultural anthropologists** study living societies of people, their customs, their myths, their kinship systems, their rituals, and all aspects of their social behavior within the uniquely human adaptation of culture. **Archaeologists** look at how human culture has adapted and evolved over time through the study of artifacts and sites. **Linguists** study language: its many varieties, the forces governing how languages change, the relationships between language and the



**anthropology**—the study of humankind.

**culture**—learned aspects of behavior passed on from one generation to the next in human societies.

**physical anthropology**—the study of human evolution, biology, variation, and adaptation (also known as biological anthropology).

**cultural anthropology**—the anthropological study of human societies, their belief systems, their cultural adaptations, and their social behavior.

**archaeology**—the anthropological study of past cultures, their social adaptations, and their lifestyles by use of preserved artifacts and features.

**linguistics**—the anthropological study of languages, their diversity and connections, and the interaction of language and culture in society.



**Figure 1-1** • Paleoanthropologist at work.

brain, and the interactions between language and cultural concepts. The four disciplines are joined, sometimes loosely, by their shared focus on human adaptation within culture, that set of learned behaviors which, shared by each member of a society, mediates all social interactions.

Culture has not been such a uniting theme in continental Europe. There “anthropology” is generally regarded as synonymous with American “biological anthropology.” In Europe ethnology, archaeology, and linguistics are treated as related but separate sciences.

Biological anthropology, the subject of this book, is closely related to the branch of biology known as **human biology**. Biological anthropologists strive to accurately describe human physical structure both in the present and in the past. They seek to understand how human structure functions in real life and how human individuals with that structure “behave.” In addition, biological anthropologists investigate how function and behavior are integrated into the environment in which human beings live. Because they want to understand the origins of structures, biological anthropologists also explore human genetics, growth and development, and evolutionary history.

There are some strong connections between biological anthropology and other anthropological subdisciplines. Biological anthropologists may come into close contact with archaeologists in the cross-disciplinary area of **paleoanthropology**, the study of human evolution through fossils and artifacts (Figure 1-1). Archaeologists may find a fossilized human skull, but the job of describing and studying the specimen falls to the biological anthropologist. Or biological anthropologists may find it essential to put together their knowledge of skeletal biology with that of the cultural and living contexts that the archaeologist has discovered in order to better understand the adaptations of a past human population. Biological anthropologists who study the behavior of the nonhuman primates may have close intellectual ties to psychologists. Specialists on human growth and adaptation may feel particularly at home among a group of biologists who specialize in human biology. And biological anthropologists who investigate molecular biology and the genetics of human populations may work closely with geneticists and molecular biologists. Because biological anthropology is an interdisciplinary field, there are many areas of cross-communication and cross-fertilization, limited only by the scientific ingenuity of individual researchers.

Many of the subject areas relevant to understanding human evolution and biology discussed in this book are taught not only in Anthropology departments but within departments of biology, genetics, biochemistry, anatomy, geology, geography, environmental sciences, and psychology. Researchers in human evolution may call themselves biological anthropologists, biologists, geneticists, biochemists, geologists,

**human biology**—the branch of biology that studies human physiology and adaptation; closely related to biological anthropological study of the same topics.

**paleoanthropology**—the study of the physical characteristics, evolution, and behavior of fossil humans and their relatives, incorporating parts of biological anthropology and archaeology.





anatomists, paleontologists, or psychologists, depending on their research specialty. We will use “biological anthropology” and “biological anthropologists” as the most inclusive terms to refer to this broad, interdisciplinary field and to those scientists studying human evolution.

Most biological anthropologists work in university departments of anthropology, where they teach courses in human evolution, human biology, and related subjects. The second largest number of biological anthropologists work in medical schools as instructors and researchers in departments of anatomy or in other research departments. The third largest number work in natural history museums or research institutes where their responsibilities include care of collections of specimens and basic research. A smaller number of biological anthropologists are found in departments of biology, psychology, genetics, biochemistry, forensic studies, and in industry.

## The Scientific Method

Anthropology, biology, and other branches of science use a “hypothetico-deductive” scientific method that requires the framing of ideas in the form of **hypotheses**. A hypothesis is a preliminary explanation of observations phrased as a proposition: if “x” is true, then “y” is true. The most significant characteristic of a hypothesis is that it must be *falsifiable*; that is, we must be able to disprove it. Testing and experimentation determine if a given hypothesis explains or conforms with what is observed. If it does not it is rejected or modified. A **theory** is a hypothesis or a series of hypotheses that has stood the test of time and has withstood numerous attempts at falsification. This methodology of hypothesis testing distinguishes science from the humanities.

The most widely understood application of the scientific method is the experiment. Scientists formulate a question that they want to answer, devise a test in which the variables are all held constant except those being tested, run the experiment while varying the conditions of interest, and compare the results to a “control” in which all the variables are held constant. This is the standard mode of operation in experimental sciences such as physics and chemistry.

Biological anthropology also is an experimental science. In the 1950s Sherwood Washburn advanced the approach of “experimental anthropology,” later termed the “new physical (biological) anthropology.”<sup>1</sup> Thereafter the testing of specific hypotheses in biological anthropology

**hypothesis**—an explanation of a set of observations that can be disproved or falsified by additional observations or facts.

**theory**—usually a set of hypotheses that withstands attempts at disproof and continues to successfully explain observations as they are made, thus gaining scientific support over time.

<sup>1</sup>Some anthropologists make a distinction between the older term, “physical anthropology,” and the newer term, “biological anthropology.” In this book and in most common usage the two terms are synonymous and interchangeable. When a distinction is made it refers to “physical anthropology” being a more specialized field within biological anthropology dedicated to studying human anatomical structures and variation.