EXPLORATIONS: AN OPEN INVITATION TO BIOLOGICAL ANTHROPOLOGY, 2ND EDITION

BETH SHOOK, PH.D.; KATIE NELSON, PH.D.; KELSIE AGUILERA, M.A.; AND LARA BRAFF, PH.D.

American Anthropological Association
Arlington

1.

INTRODUCTION TO BIOLOGICAL ANTHROPOLOGY

Katie Nelson, Ph.D., Inver Hills Community College

Lara Braff, Ph.D., Grossmont College

Beth Shook, Ph.D., California State University, Chico

Kelsie Aguilera, M.A., University of Hawai'i: Leeward Community College

Learning Objectives

- Describe anthropology and the four subdisciplines.
- Explain the main anthropological approaches.
- Define biological anthropology, describe its key questions, and identify major subfields.
- Explain key components of the scientific method.
- Differentiate between hypotheses, theories, and laws.
- Differentiate science from other ways of knowing.

Diving in caves along the Caribbean coast of Mexico, archaeologist Octavio del Rio and his team spotted something unusual in the sand 26 feet below the ocean surface. As they swam closer, they suspected it could be a bone—and likely a very ancient one, as this cave system is inaccessible today without modern diving equipment. However, in the distant past, these caves were dry land formations high above the ocean. The divers ended up recovering not just one but many bones from the site. Eventually they were able to reconstruct an 80% complete human skeleton that they named "Eve of Naharon." Dated to 13,600 years ago, she is (as of today) the oldest known North American skeleton (TANN 2018).

Who was Eve? What was her life like? How did she end up in the cave? What can we learn about her from the bones she left behind? Anthropologists have determined that Eve was 4.6 feet tall, had a broken back, and died in her early 20s. Although it is rare to find an ancient, nearly complete skeleton in the ocean depths, Eve is not the only such find. In underwater caves along Mexico's Yucatan Peninsula, archaeologists have found eight well-preserved skeletons dated between 9,000 to 13,000 years old. With each new discovery—whether it is a skeleton in North America, fossil footprints in Tanzania, or a mandible with teeth in China—we come another step closer to understanding the evolution of our species.

Biological anthropologists study when and how human beings evolved; their intriguing findings are the focus of this book. Biological anthropology is one of four **subdisciplines** within anthropology; the others are cultural anthropology, archaeology, and linguistic anthropology. All anthropological subdisciplines seek to better understand what it means to be human.

What is Anthropology?

Why are people so diverse (Figure 1.1)? Some people live in the frigid Arctic tundra, others in the arid deserts of sub-Saharan Africa, and still others in the dense forests of Papua New Guinea. Human beings speak more than 6,000 distinct languages. Some people are barely five feet tall while others stoop to fit through a standard door frame. What makes people, around the world, look, speak, and behave differently from one another? And what do all humans share in common?

Figure 1.1: Despite superficial differences among individuals, humans are 99.9% genetically similar to one another. Credit: Humans (Figure 1.1) original to Explorations: An Open Invitation to Biological Anthropology is a collective work under a CC BY-NC-SA 4.0 License. [Includes Untitled by Mission de l'ONU au Mali – UN Mission in Mali/Gema Cortes, CC BY-NC-SA 2.0; Untitled in Middle East by Mark Fischer, CC-BY-SA 2.0; Smiling Blonde Girl by Egor Gribanov, CC BY 2.0; UNDP Supports Mongolian Herders by United Nations Photo, CC BY-NC-ND].

Anthropology is a discipline that explores human differences and similarities by investigating our biological and cultural complexity, past and present. Derived from Greek, the word –*anthropos* means "human" and –*logy* refers to the "study of." Therefore, anthropology is, by definition, the study of humans. Anthropologists are not the only scholars to focus on the human condition; biologists, sociologists, psychologists, and others also examine human nature and societies. However, anthropology is a uniquely dynamic, multifaceted discipline that emerged from a deep-seated curiosity about who we are as a species.

The Subdisciplines

In the United States, the discipline of anthropology includes four subdisciplines: cultural anthropology, biological anthropology, archaeology, and linguistic anthropology. In addition, applied anthropology is sometimes called the fifth subdiscipline (Figure 1.2). Each of the subdisciplines provides a distinct perspective on the human experience. Some (like biological anthropology) use the scientific method to develop theories about human origins, evolution, material remains, or behaviors. Others (like cultural anthropology) use humanistic and interpretive approaches to understand human beliefs, languages, behaviors, cultures, and societies. Findings from all subdisciplines, together, contribute to a multifaceted appreciation of human biocultural experiences, past and present.

Cultural Anthropology

Cultural anthropologists focus on similarities and differences among living persons and societies. They suspend their sense of what is expected in their own culture in order to understand other perspectives without judging them (**cultural relativism**). They learn these perspectives through **participant-observation** fieldwork. Beyond describing another way of life, cultural anthropologists ask broader questions about humankind: Are human emotions universal or culturally distinct? Is maternal behavior learned or innate? How and why do groups migrate to new places? For cultural anthropologists, no aspect of human life is outside their purview: They study art, religion, medicine, migration, natural disasters, even video gaming. While many cultural anthropologists are intrigued by human diversity, they recognize that people around the world share much in common.

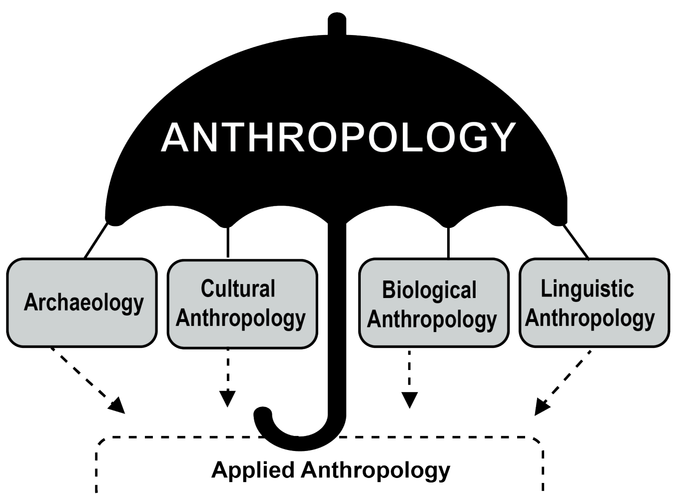

Figure 1.2: The discipline of anthropology has four subdisciplines: archaeology, cultural anthropology, biological anthropology, and linguistic anthropology, as well as an applied dimension. Credit: Subdisciplines of anthropology (Figure 1.8) original to Explorations: An Open Invitation to Biological Anthropology by Mary Nelson is under a CC BY-NC 4.0 License.

One famous U.S. cultural anthropologist, Margaret Mead (1901–1978, Figure 1.3), conducted cross-cultural studies of gender and socialization. In the early twentieth century, people in the U.S. wondered if the emotional turbulence exhibited by American adolescents was caused by the biology of puberty, and thus natural and universal. To find out, Mead went to the Samoan Islands, where she lived for several months getting to know Samoan teenagers. She learned that Samoan adolescence was relatively tranquil and happy. Based on her fieldwork, Mead wrote *Coming of Age in Samoa*, a best-selling book that was both sensational and scandalous (Mead 1928). In it, she critiqued U.S. parenting as restrictive in contrast to Samoan parenting, which allowed teenagers to freely explore their community and even their sexuality. Ultimately, she argued that nurture (i.e., socialization) more than nature (i.e., biology) shaped adolescent development. Despite her expressed relativism, she has been critiqued recently for exploiting the people she studied.

Figure 1.3: Margaret Mead, circa 1948. Credit: Margaret Mead by Internet Archive Book Images has been designated to the public domain (CC0). [Image from page 47 of "A brief expedition into science at the American Museum of Natural History" (1969).]

Cultural anthropologists do not always travel far to learn about human experiences. In the 1980s, American anthropologist Philippe Bourgois (1956–) asked how pockets of extreme poverty persist in the United States, a country widely perceived as wealthy with an overall high quality of life compared to other countries. To answer this question, he lived with Puerto Rican drug dealers in East Harlem, contextualizing their experiences both historically and presently, in terms of ongoing social marginalization and institutional racism. Rather than blame drug dealers for their choices, Bourgois argued that both individual choices and social inequality can trap people in the overlapping worlds of drugs and poverty (Bourgois 2003).

Linguistic Anthropology

The study of people is incomplete without attending to language, a defining trait of human beings. While other animals have communication systems, only humans have complex symbolic languages—and more than 6,000 of them! Human language makes it possible to teach and learn, plan and think abstractly, coordinate our efforts, and contemplate our own demise. Linguistic anthropologists ask questions like: How did language first emerge? How has it evolved and diversified over time? How has language helped our species? How can linguistic style convey social identity? How does language influence our worldview? Some linguistic anthropologists track the emergence and diversification of languages, while others focus on language use in social context. Still others explore how language is crucial to socialization: children learn their culture and identities through language and nonverbal forms of communication (Ochs and Schieffelin 2017; Figure 1.4).

One line of linguistic anthropological research focuses on the relationships among language, thought, and culture. For example, Benjamin Whorf (1897–1941) observed that whereas the English language has grammatical tenses to indicate past, present, and future, the Hopi language does not; instead, it indicates whether or not something has "manifested." Whorf argued that this grammatical difference causes English and Hopi speakers to think about time in distinct ways: English speakers think about time in a linear way, while Hopi think about time in terms of a cycle of things or events that have manifested or are manifesting (Whorf 1956). Based on his research, Whorf developed a strong version of the **Sapir-Whorf hypothesis** (also known as linguistic relativity), which states that language shapes thought. Some critics, like German American linguist Ekkehart Malotki (1938–), recognized that English and Hopi tenses differ but argued against Whorf by claiming that the Hopi language does, in fact, have linguistic terms for time and that a linear sense of time may be universal (Malotki 1983). Nevertheless, anthropological linguists tend to see human languages as a unique form of communication, linked to our ability to think and process our world.

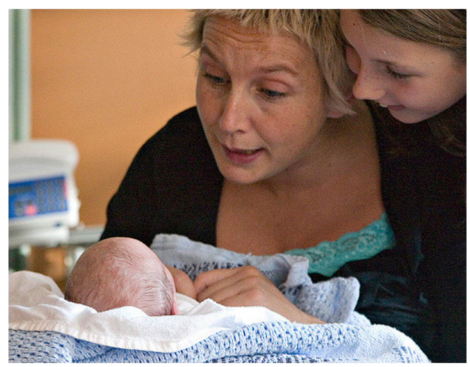

Figure 1.4: From the moment they are born, children learn through language and nonverbal forms of communication. Credit: Babytalk by Torbein Rønning is under a CC BY-NC-ND 2.0 License.

Archaeology

Archaeologists focus on material remains—tools, pottery, rock art, shelters, seeds, bones, and other objects—to better understand people and societies. Archaeologists ask specific questions like: How did people in a particular area live? How did they utilize their environment? What happened to their society? They also ask general questions about humankind: When did our ancestors begin to walk on two legs? How and why did they leave Africa? Why did humans first develop agriculture? How did the first cities develop?

One critical method that archaeologists use to answer these questions is excavation, which involves carefully digging and removing sediment to uncover material remains while recording their context. Take the example of Kathleen Kenyon (1906–1978), a British archaeologist and one of few female archaeologists in the 1940s. While excavating at Jericho, which dates back to 10,000 BCE (Figure 1.5), she discovered city structures and cemeteries built during the Early Bronze Age (3,200 YBP in Europe). Based on her findings, she argued that Jericho is the oldest city continuously occupied by different groups of people for thousands of years (Kenyon 1979).

Figure 1.5: Archaeologists, including Kathleen Kenyon, have helped unearth the foundations of ancient dwellings at Jericho. Credit: Jerycho8 by Abraham Sobkowski has been designated to the public domain (CC0).

While most archaeologists study the past, some excavate at contemporary sites to gain new perspectives on present-day societies. For example, participants in the Garbage Project, which began in the 1970s in Tucson, Arizona, excavate modern landfills as if they were a conventional dig site. They have found that what people say they throw out differs from what is actually in the trash. The landfill holds large amounts of paper products (that people claim to recycle) as well as construction debris (Rathje and Murphy 1992). This finding indicates the need to create more environmentally conscious waste-disposal practices.

Biological Anthropology

Biological anthropology—the focus of this book—is the study of human evolution and biological variation. Some biological anthropologists study our closest living relatives—monkeys and apes—to learn how nonhuman and human primates are alike and how they differ both biologically and behaviorally (Figure 1.6). Other biological anthropologists focus on extinct human species and subspecies, asking questions like: What did they look like? What did they eat? When did they start to speak? How did they adapt to new environments? Still other biological anthropologists focus on modern human diversity, asking questions about the evolution of traits, like lactose tolerance or skin color, that differ between populations. Throughout this book, we will learn about biological anthropological research that explores our nonhuman primate cousins, the origins of **hominins** (i.e. humans and fossil human relatives), how they adapted over time, and how we – modern humans – continue to change.

Figure 1.6: Chimpanzees are the nonhuman primate that is most closely related to humans. Credit: Chimpanzees by Klaus Post is under a CC BY 2.0 License.

Applied Anthropology

Sometimes considered the fifth subdiscipline, applied anthropology involves the practical application of anthropological theories, methods, and findings to solve real-world problems. Applied anthropologists span the subdisciplines. An applied archaeologist might work in cultural resource management to assess a potentially significant archaeological site unearthed during a construction project. An applied cultural anthropologist could work for a technology company that seeks to understand how people interact with their products in order to design them better. Applied anthropologists are employed outside of academic settings, in public and private sectors, including business firms, advertising companies, city government, law enforcement, hospitals, nongovernmental organizations, and even the military.

Figure 1.7: Paul Farmer in Haiti. Credit: PEF-with-mom-and-baby—Quy-Ton-12-2003 1-1-310 by Cjmadson is under a CC BY 3.0 License.

Trained as both a physician and anthropologist, Paul Farmer (1959–2022, Figure 1.7) demonstrated the potential of applied anthropology to improve lives. As a college student in North Carolina, Farmer became interested in the Haitian migrants working on nearby farms. This led him to visit Haiti, the most resource-poor country in the Western Hemisphere, where he was struck by the deprived state of its health care facilities. Years later, he would return to Haiti, as a physician, to treat diseases that had been largely eradicated in the United States, such as tuberculosis and cholera. Drawing on his anthropological training, he also did fieldwork and wrote books that contextualize the suffering of Haitians in relation to historical, social, and political conditions (Farmer 2006). Finally, as an applied anthropologist, he took action by co-founding Partners in Health, a nonprofit organization that establishes health clinics in resource-poor countries and trains local staff to administer care.

Anthropological Approaches

Each of the four main anthropological subdisciplines contributes to our understanding of humankind by exploring cultures, languages, material remains, and biological adaptations. To study these phenomena, anthropologists draw upon distinct research approaches, including **holism**, comparison, dynamism, and fieldwork.

Holism

Anthropologists are interested in the *whole* of humanity. We look at the interactions among several aspects of our complex bodies or societies, rather than focusing on a singular aspect (Figure 1.8). For example, a biological anthropologist studying the social behaviors of a monkey species in South America may not only observe how they interact with one another, but also how physical adaptations, foraging patterns, ecological conditions, and habitat changes also affect their behaviors. By focusing on only one factor, the anthropologist would attain an incomplete understanding of the species' social life. A cultural anthropologist studying marriage in a small village in India would not only consider local gender norms but also family networks, laws regarding marriage, religious rules, and economic factors. All of these aspects can influence marital practices in a given context. In both examples, the anthropologist is using a holistic approach by considering the multiple interrelated and intersecting factors that comprise a given phenomena.

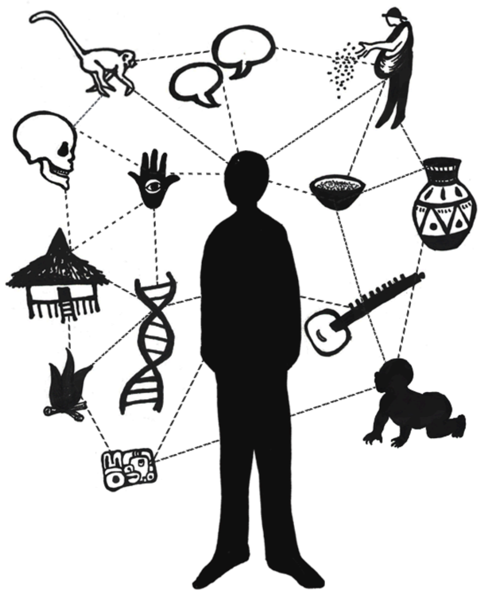

Figure 1.8: By using a holistic approach, anthropologists learn how different aspects of humanity interact with and influence one another. Credit: Holism (Figure 1.2) original to Explorations: An Open Invitation to Biological Anthropology by Mary Nelson is under a CC BY-NC 4.0 License.

Comparison

Anthropologists use comparative approaches to compare and contrast data from different populations, from groups within a population, or from the same group over time. For example: How do humans today differ from prior *Homo sapiens* populations? How does Egyptian society today compare to ancient Egyptian society? How do male and female behaviors differ within a given human society or a particular primate group? Comparative analyses help us understand commonalities and differences within or across species, groups, or time.

Dynamism

Comparative analysis is facilitated by the fact that humans are extremely dynamic. Our ability to change, both biologically and culturally, has enabled us to persist over millions of years and to thrive in different environments. Anthropologists ask about all kinds of changes: short-term and long-term, temporary and permanent, cultural and biological. For example, a cultural anthropologist might look at how people in a relatively isolated society are affected by globalization. A linguistic anthropologist might explore how a hybrid form of language, like Spanglish, emerged. An archaeologist might study how climate change influenced the emergence of agriculture. A biological anthropologist might consider how diseases affecting our ancestors led to physical changes that persist today. All of these examples highlight the dynamic nature of human bodies and societies.

Fieldwork

Throughout this book, you will read examples of anthropological research from around the world. Anthropologists do not only work in laboratories, libraries, or offices. To collect data, they travel to where their data lives, whether it is a city, village, cave, tropical forest, or desert. At their field sites, anthropologists collect data that, depending on subdiscipline, may include interviews with local peoples (Figure 1.9), examples of language in use, skeletal features, or cultural remains like stone tools. While anthropologists ask an array of questions and use diverse methods to answer their research questions, they share this commitment to conducting research in the field.

Figure 1.9: Anthropologist Katie Nelson conducting fieldwork with undocumented Mexican immigrant college students. Credit: Ethnographic interview by Luke Berhow is under a CC BY-NC 4.0 License.

What is Biological Anthropology?

Biological anthropology uses a scientific and evolutionary approach to answer many of the same questions that all anthropologists are concerned with: What does it mean to be human? Where do we come from? Who are we today? Biological anthropologists are concerned with exploring how humans vary biologically, how humans adapt to their changing environments, and how humans have evolved over time and continue to evolve today. Some biological anthropologists also study what humans and nonhuman primates have in common and how we differ.

You may have heard biological anthropology referred to by another name—physical anthropology. Physical anthropology is a discipline that dates to as far back as the eighteenth century, when it focused mostly on physical variation among humans. Some early physical anthropologists were also physicians or anatomists interested in comparing and contrasting the human form. These researchers dedicated themselves to measuring bodies and skulls (anthropometry and craniometry) in great detail (Figure 1.10). Many also acted under the misguided racist belief that human biological races existed and that it was possible to differentiate between, or even rank, such races by measuring differences in human anatomy. Anthropologists today agree that there are no biological human races and that all humans alive today are members of the same species, *Homo sapiens*, and subspecies, *Homo sapiens sapiens*. We recognize that the differences we can see between peoples' bodies are due to a wide variety of factors, including environment, diet, activities, and genetic makeup.

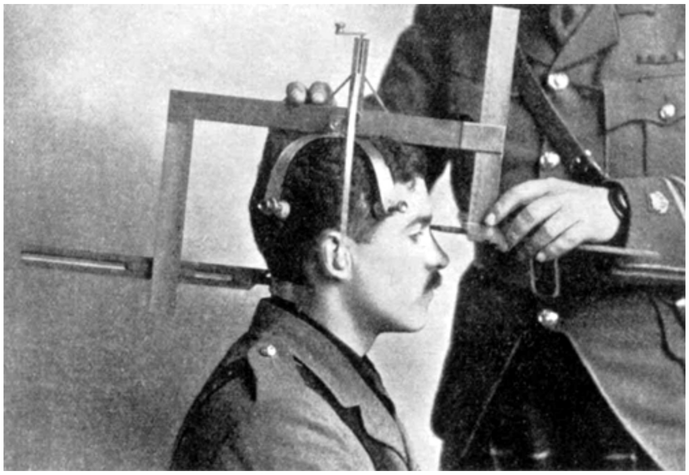

Figure 1.10: An anthropometric device used to measure a subject's head, circa 1913. Credit: Head-Measurer of Tremearne (side view) by A.J.N. Tremearne, Man 15 (1914): 87–88 is in the public domain.

The subdiscipline has changed a great deal since these early years. Biological anthropologists no longer identify human differences in order to assign people to groups, like races. The focus is instead on understanding how and why human and primate variation developed through evolutionary processes. The name for the subdiscipline has transitioned in recent years (from *physical anthropology* to *biological anthropology*) to reflect these changes. Many believe the term *biological anthropology* better reflects the subdiscipline's focus today, which includes genetic and molecular research.

The Scope of Biological Anthropology

Just as anthropology as a discipline is wide ranging and holistic, so too is the subdiscipline of biological anthropology. There are at least six **subfields** within biological anthropology (Figure 1.11): primatology, paleoanthropology, molecular anthropology, bioarchaeology, forensic anthropology, and human biology. Each subfield focuses on a different dimension of what it means to be human from a biological perspective. Through their varied research in these subfields, biological anthropologists try to answer the following key questions:

- What is our place in nature? How are we related to other organisms? What makes us unique?
- What are our origins? What influenced our evolution?
- How and when did we move/migrate across the globe?
- How are humans around the world today different from and similar to each other? What influences these patterns of variation? What are the patterns of our recent evolution and how do we continue to evolve?

The terms *subfield* and *subdiscipline* are very similar and are often used interchangeably. In this book we use *subdiscipline* to refer to the four major areas of focus that make up the discipline of anthropology: biological anthropology, cultural anthropology, archaeological anthropology, and linguistic anthropology. When we use the term *subfield* we are referring to the different specializations within biological anthropology.

Primatology

Primatologists study the anatomy, behavior, ecology, and genetics of living and extinct nonhuman primates, including apes, monkeys, tarsiers, lemurs, and lorises. Primatology research gives us insights into how evolution has shaped our species, since nonhuman primates are our closest living biological relatives. Through such studies, we have learned that all primates share a suite of traits. Primates, for instance, have nails instead of claws, possess hands that can grasp and manipulate objects (Figure 1.12), invest great amounts of time and energy in raising a small number of offspring, and employ complex social behaviors. Behavioral studies, such as those by Jane Goodall of wild chimpanzees and others, reveal that great apes are like humans in that they have families and form strong maternal-infant relationships. Gorillas mourn the deaths of their group members, and they exhibit behaviors similar to humans such as playing and tickling. Importantly, the work of Goodall, Karen B. Strier (see Appendix B), and others focus on primate conservation: They have brought attention to the fact that 60% of primates are currently threatened with extinction (Estrada et al. 2017).

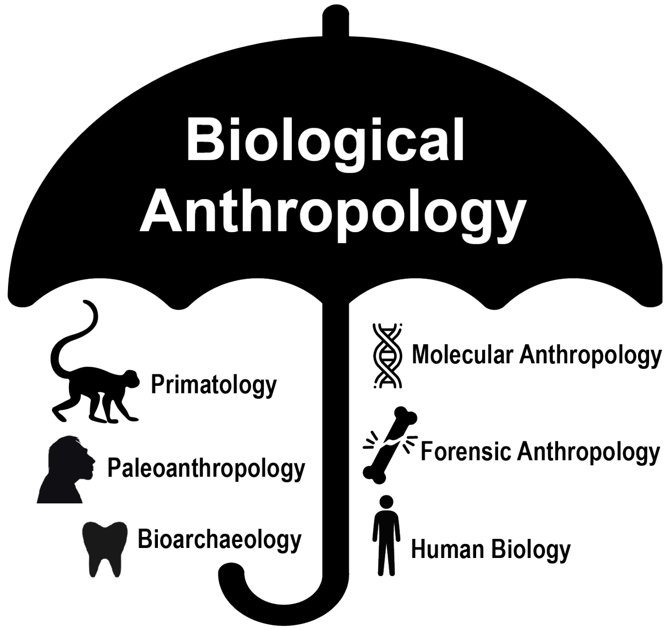

Figure 1.11: Biological anthropology has at least six subfields. Credit: Subfields of biological anthropology (Figure 1.16) original to Explorations: An Open Invitation to Biological Anthropology by Mary Nelson is under a CC BY-NC 4.0 License.

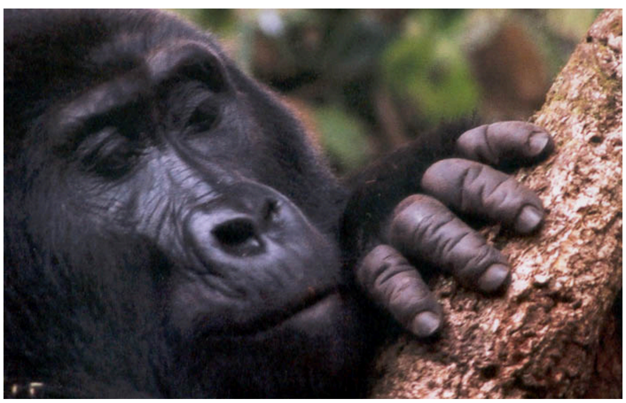

Figure 1.12: A mountain gorillas feeds on insects. Their fingers and fingernails are very similar to that of humans. Credit: Mountain gorilla finger detail.KMRA by Kurt Ackermann (username KMRA) is under a CC BY 2.5 License.

Paleoanthropology

Paleoanthropologists study human ancestors from the distant past to learn how, why, and where they evolved. Because these ancestors lived before there were written records, paleoanthropologists have to rely on various types of physical evidence to come to their conclusions. This evidence includes fossilized remains (particularly fossilized bones; Figure 1.13), DNA, artifacts such as stone tools, and the contexts in which these items are found. In recent years, paleoanthropologists have made some monumental discoveries about hominin evolution.

Figure 1.13: Donald Johanson and an Australopithecus fossil skull. Credit: Donald Johanson 2009 by Julesasu has been designated to the public domain (CC0).

These findings helped us learn that human evolution did not occur in a simple, straight line but, rather, branched out in many directions. Most branches were evolutionary "dead ends." Humans are now the only living hominins left on planet Earth. Paleoanthropologists frequently work together with other scientists such as archaeologists, geologists, and paleontologists to interpret and understand the evidence they find. Paleoanthropology is a dynamic subfield of biological anthropology that contributes to our understanding of human origins and evolution.

Molecular Anthropology

Molecular anthropologists use molecular techniques (primarily genetics) to compare ancient and modern populations as well as to study living populations of humans or nonhuman primates. By examining DNA sequences, molecular anthropologists can estimate how closely related two populations are, as well as identify population events, like a population decline, that explain the observed genetic patterns. This information helps scientists trace patterns of migration and identify how people have adapted to different environments over time.

Several molecular anthropologists have recently attracted international recognition for their groundbreaking work. For instance, in 2022, Svante Pääbo won the Nobel Prize in physiology (medicine) for his work extracting the DNA from 40,000-year-old Neanderthal bones and producing the first complete genome of *Homo neanderthalensis*. This was a challenging task because ancient DNA does not preserve well and older extraction techniques tended to become contaminated by the researcher's and other environmental DNA. Pääbo and his team designed specialized clean rooms for handling ancient DNA and made advances in DNA sequencing. Their research helped scientists identify genetic differences between modern humans and Neanderthals and analyze how those differences influence how diseases, such as COVID-19, affect our bodies. Molecular anthropology is a quickly changing field as new techniques and discoveries shape our understanding of ourselves, our ancestors, and our nonhuman primate relatives.

Bioarchaeology

Bioarchaeologists study human skeletal remains along with the surrounding soils and other materials. They use the research methods of skeletal biology, mortuary studies, osteology, and archaeology to answer questions about the lifeways of past populations. Through studying the bones and burials of past peoples, bioarchaeologists search for answers to how people lived and died, including their health, nutrition, diseases, and/or injuries. Most bioarchaeologists study not just individuals but entire populations to reveal biological and cultural patterns.

People have always been intrigued by the remains of the dead, however historically, human bodies were often studied isolated from the ground and location where they were found. Bioarchaeologists emphasize the context in and around where the remains are found, using a biocultural approach that studies humans through an understanding of the interconnectedness of biology, culture, and environment.

Forensic Anthropology

Forensic anthropologists use many of the same techniques as bioarchaeologists to develop a biological profile for unidentified individuals, including estimating sex, age at death, height, ancestry, or other unique identifying features such as skeletal trauma or diseases. They may also go to a crime or accident scene to assist in the search and recovery of human remains, aiding law enforcement teams (Figure 1.14). The popular television show *Bones* told the fictional story of a forensic anthropologist, Dr. Temperance Brennan, who brilliantly interpreted clues from victims' bones to help solve crimes. While the show includes forensic anthropology techniques and responsibilities, it also includes many inaccuracies. For example, forensic anthropologists do not collect trace evidence like hair or fibers, run DNA tests, carry weapons, or solve criminal cases.

Figure 1.14: A remembrance of the victims of El Mozote Massacre in El Salvador. Forensic anthropologists played an important role in identifying the victims of this massacre during the Salvadoran Civil War. Credit: Untitled by Presidencia El Salvador has been designated to the public domain (CC0).

Forensic anthropology is considered an applied area of biological anthropology, because it involves a practical application of anthropological theories, methods, and findings to solve real-world problems. While some forensic anthropologists are academics that work for colleges and universities, others are employed by public safety and law agencies.

Human Biology

Many biological anthropologists do work that falls under the label of "human biology." This type of research explores how the human body is affected by different physical environments, cultural influences, and nutrition. These include studies of **human variation** or the physiological differences among humans around the world. Some of these anthropologists study **human adaptations** to extreme environments, which includes physiological responses and genetic advantages to help them survive. Others are interested in how nutrition and disease affect human growth and development. Biological anthropologists engage in a wide range of research that spans the breadth of human biological diversity.

The six subfields of biological anthropology—primatology, paleoanthropology, molecular anthropology, bioarchaeology, forensic anthropology, and human biology—all help us to understand what it means to be biologically human. From molecular analyses of our cells to studies of our changing skeleton, to research on our nonhuman primate cousins, biological anthropology assists in answering the central question of anthropology: What does it mean to be human? Despite their different foci, all biological anthropologists share a commitment to using a scientific approach to study how we became the complex, adaptable species we are today.

Anthropologists as Scientists

Biological anthropologists use the scientific method as a way of learning about the world around them. Many people think of science as taking place in a sterile laboratory, but in biological anthropology it is just as likely to occur somewhere else, such as at a research station in Ethiopia, a field site in Tanzania, or a town in El Salvador. To understand how information in this field is established, it is important to recognize what science is and is not, as well as to understand how the scientific method actually works.

Recognizing Science

Science combines our natural curiosity with our ability to experiment so we can understand the world around us and address needs in our communities. Thanks to science, meteorologists can predict the weather, it takes a relatively small number of farmers to grow enough food to feed our large population, our medicine continues to improve, and over half of the world's population owns a cell phone.

Anyone can participate in science—not just academics. In fact, children are often some of the best scientists (Figure 1.15). An early, well-known psychologist, Jean Piaget (1896–1980), argued that a child is a "little scientist," internally motivated to experiment and explore their world. This can be seen when an infant repeatedly drops a toy to see if the parent will pick it up, or when a four-year-old sincerely asks "why" again and again. Maria Montessori (1870–1952), an Italian doctor and educator, was interested in how children learn. Through her research, she also recognized that children have natural scientific tendencies. Children have a desire to explore their environment, ask questions, use their imaginations, and learn by doing. In 1907, Montessori opened a school to foster children's natural desire to learn this way. This developed a child-centered teaching method that has spread around the world and is being used in over 22,000 schools today. In anthropology and other scientific fields, the process of learning is more formalized, but scientists still benefit from the curiosity that motivates children and still experience the thrill of discovery.

Science represents both a body of knowledge and the process for learning that knowledge (the scientific method). Scientific claims can, at times, be difficult to distinguish from other information. Science also incorporates a broad range of methods to collect data, adding to the difficulty of knowing what science really is. This section will address four key characteristics that help us define and recognize science: (1) science studies the physical and natural world and how it works, (2) scientific explanations must be testable and refutable, (3) science relies on **empirical** (observable) evidence, and (4) science involves the scientific community.

Figure 1.15: Children are true scientists as they explore and test the world around them through sight and touch. Credit: Child Scientist at Window original to Explorations: An Open Invitation to Biological Anthropology (2nd ed.) by Beth Shook is under a CC BY-NC 4.0 License.

Science Studies the Physical and Natural World and How It Works

Our physical and natural universe ranges from very small (e.g., electrons) to very large (e.g., Earth itself and the galaxies beyond it). Scientists often design their research to address how and why natural forces influence our physical and natural world. In biological anthropology, we focus our questions on humans as well as other primate species, both living and extinct. We ask questions like: What influences a primate's diet? Why do humans walk on two legs? And did Neanderthals and modern humans interbreed?

There are very few questions that are considered off-limits in science. That being said, the scope of scientific investigation is generally focused on *natural* phenomena and *natural* processes and excludes the supernatural. People often regard the supernatural, whether it be a ghost, luck, or god, as working outside the laws of the universe, which makes it difficult to study with a scientific approach. Science neither supports nor contradicts the existence of supernatural powers—it simply does not include the supernatural in its explanations.

Scientific Explanations Must Be Testable and Refutable

The goal of scientists is to identify a research question and then identify the best answer(s) to that question. For example, an excavation of a cemetery may reveal that many people buried there had unhealed fractures when they died, leading the anthropologist to ask: "Why did this population experience more broken bones than their neighbors?" There might be multiple explanations to address this question, such as a lack of calcium in their diets, participation in dangerous work, or violent conflict with neighbors; these explanations are considered hypotheses. In the past, you might have learned that a **hypothesis** is an "educated guess," but in science, hypotheses are much more than that. A scientific hypothesis reflects a scientist's knowledge-based experiences and background research. A hypothesis is better defined as an explanation of observed facts; hypotheses explain how and why observed phenomena are the way they are.

Scientific hypotheses should generate expectations that are *testable.* For example, if the best explanation regarding our cemetery population was that they were experiencing violent conflict with their neighbors, we should expect to find clues, like weapons or protective walls around their homes, in the anthropological record to support this. Alternatively, if this population did not experience violent conflict with their neighbors, we may eventually be able to gather enough evidence to rule out (refute) this explanation. An important part of science is rigorous testing. Science *does not prove* any hypothesis. However, a strong hypothesis is one that has strong supporting evidence and has not yet been disproven.

Science Relies on Empirical Evidence

The word *empirical* refers to experience that is verified by observation (rather than evidence that derives primarily from logic or theory). In anthropology, much evidence about our world is collected by observation through fieldwork or in a laboratory. The most reliable studies are based on accurately and precisely recorded observations. Scientists value studies that explain exactly what methods were used so that their data collection and analysis processes are reproducible. This allows for other scientists to expand the study or provide new insights into the observations.

Science Involves the Scientific Community

Contrary to many Hollywood science fiction films, good science is not carried out in isolation in a secret basement laboratory; rather, it is done as part of a community. Scientists pay attention to what others have done before them, present new ideas to each other, and publish in scientific journals. Most scientific research is collaborative, bringing together researchers with different types of specialized knowledge to work on a shared project. Today, thanks to technology, scientific projects can bring together researchers from different backgrounds, experiences, locations, and perspectives. Most big anthropological questions such as "Where did modern humans develop?," "What genetic changes make us uniquely human?," and "How did cooperative behavior evolve?" cannot be addressed with one simple study but are tested with different lines of evidence and by different scientists over time.

Working within a scientific community supports one of the most valuable aspects of science: that *science is self-correcting*. Science that is openly communicated with others allows for a system with checks and balances: competing explanations can be proposed and questionable studies can be reevaluated. Ultimately, the goal is that through science the best explanations will stand the test of time.

How Science Works: The Scientific Method

Most students have learned the scientific method as a simple linear, or perhaps circular, process (see, e.g., Figure 1.16). Typically, the process is said to begin with making observations about the natural world. This leads to the development of a scientific hypothesis. From the hypothesis a set of predictions can be made, which are then tested by experimentation or by making additional observations. Scientific predictions are often phrased as "if… then…" statements, such as "If hypothesis A is true, then this experiment will show outcome B." The results of a scientific study should then either support or reject the hypothesis.

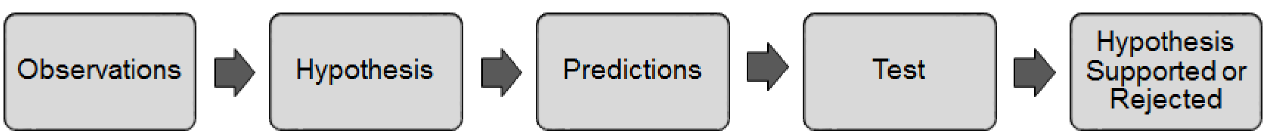

Figure 1.16: Simple depiction of the scientific method. Credit: Simple depiction of the scientific method (Figure 1.23) original to Explorations: An Open Invitation to Biological Anthropology is under a CC BY-NC 4.0 License.

This simple version of the scientific method is valuable because it highlights the key aspects that should be present in any scientific research experiment or scientific paper. However, this simplistic view does not accurately represent the dynamic and creative side of science, nor does it identify the complex steps that are incorporated into a scientist's routine.

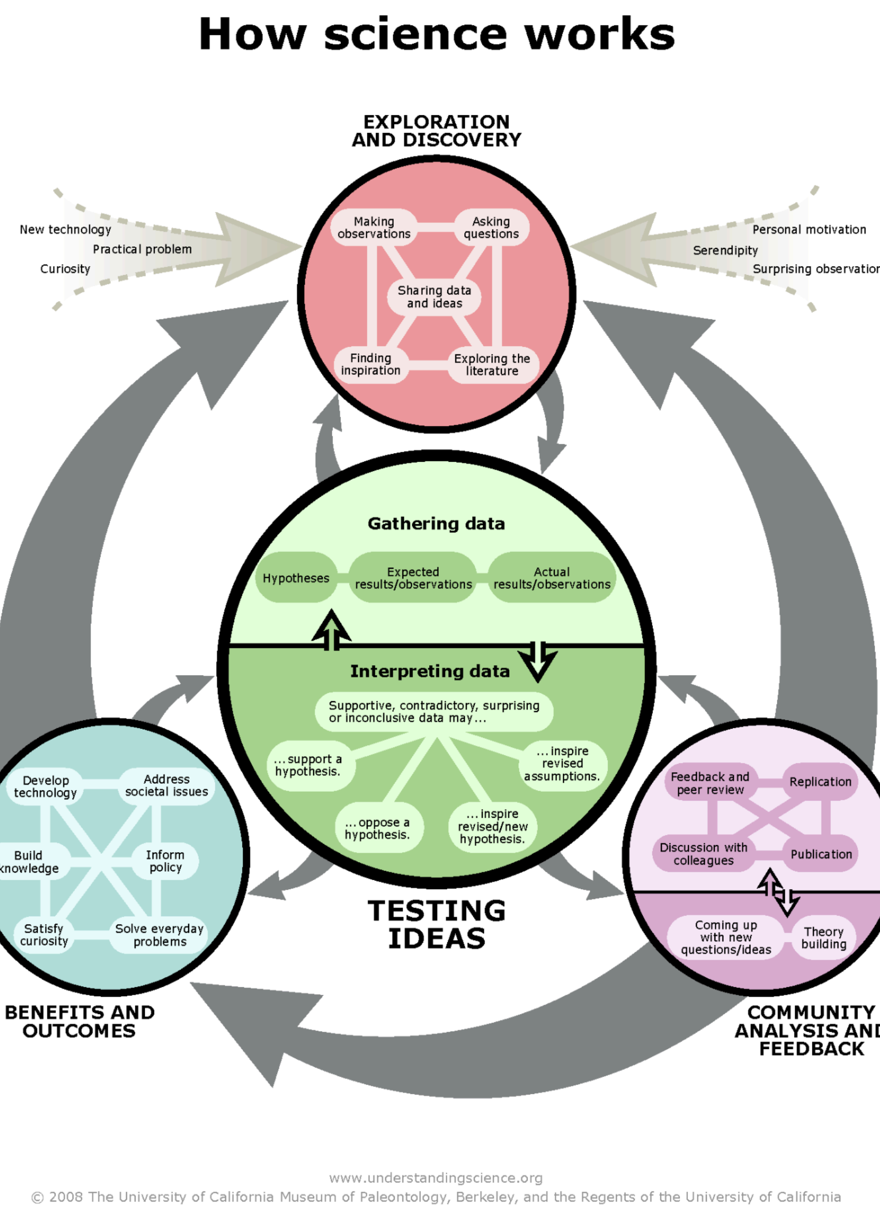

Figure 1.17: Complex flow of the scientific method. A full text description is available from Understanding Science. Credit: Complex Science Flowchart (2022) by Understanding Science, University of California Museum of Paleontology is used by permission and available here under a CC BY-NC 4.0 License.

Figure 1.17 provides an alternative representation of the scientific method that emphasizes the many paths to scientific discovery. While still incorporating the key components of making observations, testing ideas, and interpreting results, this chart shows that scientific ideas have many possible starting points and influences, and scientists often repeat steps and circle back around. Gathering evidence does not always rest on experiments in the laboratory. Evaluating data is not always clear-cut, and results are sometimes surprising or inconclusive. Many important discoveries were in fact made by mistake. For example, engineer Percy Spencer accidentally melted a chocolate bar in his pocket with a magnetron, which became the first microwave, and Spencer Silver invented the adhesive for 3M Post-it ® notes while trying to develop a strong glue. The real scientific process is more similar to the philosophy of the animated television character Ms. Frizzle from *The Magic School Bus*, “Take chances, make mistakes, get messy.”

Two key components lacking in the simple version of the scientific method are exploration and discovery. There are many reasons that a scientist might choose a particular research question: they may be motivated by personal experience, struck by something they read, or inspired by a student's question in class. Often scientific research reveals more questions than answers, so experienced researchers rarely lack problems to solve. But identifying a research question is just part of the process; most scientists spend more time exploring the literature, sharing ideas, asking questions, and planning their research project than conducting the test itself.

Science itself is a social enterprise that is influenced by cultural issues and values, as well as funding priorities. For example, corporations are the biggest funders of scientific research, followed by government agencies such as the National Science Foundation (which also fund many research projects done at colleges and universities). Those organizations have great influence on what is considered valuable research at any given time. For example, the World Health Organization (WHO) has classified many diseases as "neglected tropical diseases," including dengue, leprosy, rabies, and hookworm. Together these diseases affect an estimated one billion people, mostly in impoverished areas. While these debilitating tropical diseases can be as deadly as diseases that receive more attention, like AIDS and tuberculosis, they receive comparatively little funding due to political priorities (Farmer et al. 2013).

Also important to the scientific process are interactions within the scientific community. Scientific collaboration can take place through informal discussion over a cup of coffee as well as more formal interactions, such as presenting at conferences and engaging in **scholarly peer review**. Scholarly peer review describes the process whereby an author's work must pass the scrutiny of other experts in the field before being accepted for publication in a journal or book. This helps keep scientists accountable for ethically responsible research projects and papers. Additionally, presenting data at conferences and in articles and books allows researchers to receive critical feedback from academic peers and others to test these ideas and further the field of science toward identifying the best explanations. It is important that the scientific field include researchers with diverse identities, backgrounds, and experiences so that researchers ask new questions, innovate, and problem solve more effectively.

Hypotheses, Theories, and Laws

Scientific investigation occurs at many levels, from investigating individual cases (e.g., "What is causing this child's mysterious illness?") to understanding processes that affect most of us ("What is the ideal amount of sleep for an adult?"). All of these questions are important and will generate different types of testable scientific explanations. So far, we have used the term *hypothesis* to describe these scientific ideas about why observed phenomena are the way they are. Hypotheses are typically explanations that address a narrow set of phenomena, such as (in anthropology) a particular human population or primate species.

In science, a **theory** is an explanation of observations that addresses a wide range of phenomena. Like hypotheses, theories also explain how or why something occurs, rely on empirical evidence, and are testable and able to be refuted. Because the term *theory* is often used casually outside of science, you may hear people try to dismiss a scientific claim as "just a theory." In science there are often multiple competing theories, but over time some are eliminated, leaving standing the theory or theories that best explain the most evidence. Scientific theories that have stood the test of time are thus supported by many lines of evidence and are usually reliable. Some well-tested theories accepted by most scientists include the theory of general relativity, which explains the law of gravitation and its relation to other forces, and evolutionary theory, which describes how heritable traits can change in a population over time.

While scientific hypotheses and theories share many characteristics, laws are quite different. A **law** is a *prediction* about what will happen given certain conditions, *not* an explanation for how or why it happens. A law is not a "mature" version of a theory. For example, Newton's universal law of gravity allows us to predict the gravitational force (F) between any two objects using the equation $F=G(m_1m_2)/r^2$, but it does not explain *why* gravity works. Laws are often mathematical, and some well-known laws include Newton's three laws of motion and Mendel's laws of genetic inheritance. Laws are important, and their discovery often promotes the development of theories.

To demonstrate how important laws can be—and to show how unusual things can inspire scientific discoveries—we can use the story of the ancient Greek mathematician and inventor Archimedes (Figure 1.18). Archimedes's buoyancy principle is a law that is useful for many things, including density calculations and designing ships. Purportedly, he made this discovery when he noticed the water level rise in the bathtub when he climbed in it. Realizing its importance, he is said to have shouted "Eureka" and proceeded to run naked through the city of Syracuse. While this fun story may or may not be true, it does remain that scientific laws, alongside scientific hypotheses and theories, have a very important role in the scientific process and in generating scientific explanations about our natural world.

Figure 1.18: Archimedes is portrayed here having just discovered his Principle of Buoyancy. The vignette is by Count Giammaria Mazzuchelli (1707–1765). Credit: Eureka! Archimede by Science and Society Piture Library Prints is in the public domain. [This image is a faithful photographic reproduction of "Archimedes' Principle" vignette from "Historical and Critical Information about the Life, Inventions and Writings of Archimedes of Syracuse" by Count Giammaria Mazzuchelli (1707–1765), published in Brescia, Italy in 1737.]

Ways of Knowing: Science, Faith, and Anthropology

In anthropology, we recognize that there are many ways of knowing things. For instance, you might know that fingernails are softer than metal because as a child you accidentally stapled through your fingernail while doing an art project (a coauthor of this textbook once experienced this). This would be an example of knowledge you gained through experience. You might also know that inserting a knife into an electrical outlet is dangerous and could greatly harm you. Hopefully you learned this not from personal experience but through instruction from parents, teachers, and others in your social group. The degree to which humans rely on and benefit from the experiential knowledge of others is an important characteristic of what makes us human.

A unified way of knowing that is shared by a group of people and used to explain and predict phenomena is called a **knowledge system**. Human knowledge systems are diverse and reflect the wide range of cultures and societies throughout the world and through time.

Science and religion are both knowledge systems. Yet they differ in important ways. The type of knowledge gained from science is often called **scientific understanding**. As we have explored in the previous section, scientific understanding can change and relies on evidence and rigorous, repeated testing. Religious or spiritual ways of knowing are called **belief**, which is different from scientific understanding because they do not require repeated testing or validation (although they can rely on observations and experiences). Instead, belief relies on trust and **faith**.

Different individuals, cultures, and societies may place more value on one type of knowing than another, although most use a combination that includes science, empiricism, and religion. In fact, Bronisław Malinowski (1884–1942), an important anthropologist of the early twentieth century, concluded that all societies use both religion *and* science in some way or another, because they are both common ways that humans experience the world.

In contemporary societies such as the United States, science and (some) religions conflict on the topic of human origins. Nearly every culture and society has a unique origin story that explains where they came from and how they came to be who they are today. These stories are often integrated into the culture's religious belief system. Many anthropologists are interested in faith-based origin stories and other beliefs because they show us how a particular group of people explain the world and their place in it. Anthropologists also value scientific understanding as the basis for how humans vary biologically and change over time. In other words, anthropologists value the multiple knowledge systems of different groups and use them to understand the human condition in a broad and inclusive way.

It is also important to note that scientists often depend on the local knowledge of the people with whom they work to understand elements of the natural or physical world that science has not yet investigated. Many groups, including **Indigenous** peoples, know about the world through prolonged relationships with the environment. Indigenous knowledge systems—specific to an Indigenous community or group—are informed by their own empirical observation of a specific environment and passed down over generations.

While religion and Indigenous knowledge systems may play a complementary role in helping anthropologists understand the human condition, they are distinct from science. The anthropological subdiscipline of biological anthropology is based on scientific ways of knowing about humans and human origins. In this volume, we will exclusively explore what science tells us about how humans came to be and why we are the way we are today. Therefore, you do not need to *believe* in evolution to master this material, because belief is not a scientific way of knowing. For this textbook, you only need to *understand* the scientific perspectives of evolution.

Throughout our lives, each of us work to reconcile our worldview with the different ways we have of knowing things. This is part of our lifelong intellectual journey. It is also, in our opinion, one of the most exciting parts of learning. We are pleased you have joined us on this journey of knowledge about humanity and yourself!

Review Questions

- What are some key approaches to anthropological research?
- What are some similarities and differences between the subdisciplines? How does the "fifth subdiscipline" of applied anthropology fit within the larger discipline of anthropology?
- What are the subfields of biological anthropology and their unique contributions?
- What is science? What is the scientific method? How does science compare to other ways of knowing?

Key Terms

Belief: A firmly held opinion or conviction typically based on spiritual apprehension rather than empirical proof.

Cultural relativism: The anthropological practice of suspending judgment and seeking to understand another culture on its own terms sympathetically enough so that the culture appears to be a coherent and meaningful design for living.

Empirical: Evidence that is verifiable by observation or experience instead of relying primarily on logic or theory.

Faith: Complete trust or confidence in the doctrines of a religion, typically based on spiritual apprehension rather than empirical proof.

Holism: The idea that the parts of a system interconnect and interact to make up the whole.

Hominins: Species that are regarded as human, directly ancestral to humans, or very closely related to humans.

Human adaptation: The ways in which human bodies, people, or cultures change, often in ways better suited to the environment or social context.

Human variation: The range of forms of any human characteristic, such as body shape or skin color.

Hypothesis: Explanation of observed facts; details how and why observed phenomena are the way they are. Scientific hypotheses rely on empirical evidence, are testable, and are able to be refuted.

Indigenous: Refers to people who are the original settlers of a given region and have deep ties to that place. Also known as First Peoples, Aboriginal Peoples, or Native Peoples, these populations are in contrast to other groups who have settled, occupied, or colonized the area more recently.

Knowledge system: A unified way of knowing that is shared by a group of people and used to explain and predict phenomena.

Law: A prediction about what will happen given certain conditions; typically mathematical.

Participant observation: A research method common in cultural anthropology that involves living with, observing, and participating in the same activities as the people one studies.

Sapir-Whorf hypothesis: The principle that the language you speak allows you to think about some things and not other things. This is also known as the linguistic relativity hypothesis.

Scholarly peer review: The process whereby an author's work must pass the scrutiny of other experts in the field before being published in a journal or book.

Scientific understanding: Knowledge accumulated by systematic scientific study, supported by rigorous testing and organized by general principles.

Subdisciplines: The four major areas that make up the discipline of anthropology: biological anthropology, cultural anthropology, archaeology, and linguistic anthropology. Applied anthropology is sometimes considered to be a fifth subdiscipline.

Subfield: In this textbook, *subfield* refers to the different specializations within biological anthropology, including primatology, paleoanthropology, molecular anthropology, bioarchaeology, forensic anthropology, and human biology.

Theory: An explanation of observations that typically addresses a wide range of phenomena.

About the Authors

Katie Nelson, Ph.D.

Inver Hills Community College, kanelson@inverhills.edu

Katie Nelson is an instructor of anthropology and sociology at Inver Hills Community College. She is the recipient of the 2022 Minnesota State Board of Trustees Educator of the Year award. Her research focuses on migration, identity, belonging, and citizenship(s) in human history and in the contemporary United States, Mexico, and Morocco.

She received her B.A. in anthropology and Latin American studies from Macalester College, her M.A. in anthropology from the University of California, Santa Barbara, an M.A. in education and instructional technology from the University of Saint Thomas, and her Ph.D. from CIESAS Occidente (Centro de Investigaciones y Estudios Superiores en Antropología Social –Center for Research and Higher Education in Social Anthropology), based in Guadalajara, Mexico.

Katie views teaching and learning as central to her practice as an anthropologist and is co-founder and Associate Editor of *Teaching and Learning Anthropology Journal*. She has contributed to several open access textbook projects, both as an author and an editor, and views the affordability of quality learning materials as an important piece of the equity and inclusion puzzle in higher education.

Lara Braff, Ph.D.

Grossmont College, Lara.Braff@gcccd.edu

Lara Braff is a professor of anthropology at Grossmont College, where she teaches courses in cultural and biological anthropology. She received her B.A. in anthropology and Spanish from the University of California at Berkeley, and her M.A. and Ph.D. in comparative human development from the University of Chicago, where she specialized in medical anthropology.

Lara's research, teaching, and involvement in open access projects (like this textbook) are rooted in concerns about social equity. In an effort to make college more accessible to all students, she serves as an Open Educational Resources (OER) coordinator at Grossmont College and Liaison for the Academic Senate for California Community Colleges—Open Educational Resources Initiative.

Beth Shook, Ph.D.

California State University, Chico, bashook@csuchico.edu

Beth Shook is a lecturer in the anthropology department at California State University, Chico. She received her B.A. in anthropology and in molecular biology from Cornell College (in Mount Vernon, Iowa) and her M.A. and Ph.D. in anthropology from the University of California, Davis. While she is broadly trained in anthropology, her research has focused on utilizing DNA in forensic and anthropological contexts.

Beth enjoys teaching a variety of anthropology courses and mentoring graduate students in teaching. Additionally, she leads Chico State's Affordable Learning Solutions (CAL$) program, is committed to programs that prioritize diversity, and serves on the Society for Anthropology in Community Colleges (SACC) Executive Board.

Kelsie Aguilera, M.A.

Leeward Community College, kelsieag@hawaii.edu

Kelsie Aguilera is an associate professor of anthropology at Leeward Community College. Located on the island of O'ahu, Leeward Community College is part of the University of Hawai'i System and holds a special commitment to Native Hawaiian education. At Leeward, Kelsie teaches anthropology courses in all of the subdisciplines.

Kelsie received her B.A. in anthropology from the University of Miami and her M.A. in anthropology from Binghamton University. She is active within the American Anthropological Association and the Society for Anthropology in Community Colleges. She continues to work hard toward making anthropology accessible and relevant for her students.

For Further Exploration

American Anthropological Association website.

American Association of Biological Anthropologists website.

Partners in Health.

Understanding Science website (a project of the University of California Museum of Paleontology.

Anticole, Matt. n.d. "What's the Difference between a Scientific Law and Theory?" TedEd Lesson. Accessed January 28, 2023.

Chan, Keith. 2021. "Icebreaker Science." In *Explorations: Lab and Activities Manual*, edited by Beth Shook, Katie Nelson, Kelsie Aguilera, and Lara Braff. Arlington, VA: American Anthropological Association.

Chizmeshya, Sydney Quinn, and Katherine E. Brent. 2021. "Knowing and Believing." In *Explorations: Lab and Activities Manual*, edited by Beth Shook, Katie Nelson, Kelsie Aguilera, and Lara Braff. Arlington, VA: American Anthropological Association.

Pfister, Anne E. 2021. "Science and Belief: Just Because We Can, Doesn't Always Mean We Should." In *Explorations: Lab and Activities Manual* edited by Beth Shook, Katie Nelson, Kelsie Aguilera, and Lara Braff. Arlington, VA: American Anthropological Association.

References

Binford, Leigh. 2016. *The El Mozote Massacre: Human Rights and Global Implications.* Revised and expanded edition. Tucson: University of Arizona Press.

Estrada, Alejandro, Paul A. Garber, Anthony B. Rylands, Christian Roos, Eduardo Fernandez-Duque, Anthony Di Fiore, K. Anne-Isola Nekaris, et al. 2017. "Impending Extinction Crisis of the World's Primates: Why Primates Matter." *Science Advances* 3(229): 1–16.

Farmer, Paul. 2006. *AIDS and Accusation: Haiti and the Geography of Blame.* Berkeley: University of California Press.

Farmer, Paul, Matthew Basilico, Vanessa Kerry, Madeleine Ballard, Anne Becker, Gene Bukhman, Ophelia Dahl, et al. 2013. "Global Health Priorities for the Early Twenty-first Century." In *Reimagining Global Health: An Introduction,* edited by Paul Farmer, Jim Yong Kim, Arthur Kleinman, and Matthew Basilico, 302–339. Berkeley: University of California Press.

Kenyon, Kathleen. 1979. *Archaeology in the Holy Land.* New York: W.W. Norton.

Malotki, Ekkehart. 1983. *Hopi Time: A Linguistic Analysis of the Temporal Concepts in the Hopi Language.* Berlin: De Gruyter.

Mead, Margaret. 1928. *Coming of Age in Samoa*. Oxford: Morrow.

Ochs, Elinor and Bambi Schieffelin. 2017. "Language Socialization: An Historical Overview." In *Encyclopedia of Language and Education, Volume 8,* edited by Patricia Duff, 3-16. New York: Springer.

Rathje, William and Cullen Murphy. 1992. "Five Major Myths about Garbage, and Why They're Wrong." *Smithsonian* 23, no. 4: 113-122.

TANN. 2018. "Mexican Anthropologists Put Face on Nearly 14,000-Year-Old Woman." *Archaeology News Network*, August 19, 2018. Accessed on November 16, 2022.

Whorf, Benjamin. 1956. *Language, Thought, and Reality.* Cambridge: MIT Press.

Acknowledgment

We are grateful to the anonymous reviewers for their many insightful comments and suggestions.