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Introduction

Biological Anthropology & Archaeology
at
Indian River State College

Welcome to ANT 2140 at Indian River State College. This course will introduce you to the fascinating fields of Biological Anthropology and Archaeology, which study the story of human evolution, including the entire span of human history and prehistory. In this course, you will be introduced to what anthropologists have discovered about the biological and cultural evolution of the human species.

ANT 2140 fulfills General Education requirements in the Social Sciences for both the Associate of Arts and the Associate of Science degrees at Indian River State College. This course is directly comparable to other introductory courses in physical anthropology taught at hundreds of colleges and universities around the country, so you can be confident that the credits you earn in this course will automatically transfer to any institution.

This Study Guide has been designed to accompany both the classroom and internet sections of ANT 2140, Introduction to Biological Anthropology & Archaeology. The eight chapters in this Study Guide correspond to the eight units in the course; in each case, the chapters provide detailed guidance about what you’re required to know from each unit. If you follow the suggestions contained in this Study Guide, and if you are conscientious in your approach to your studies, you are sure to do well in this course. You are not on your own, however. As your instructor, I am willing and eager to help you with whatever difficulties you might experience. If you encounter any problems that might prevent you from succeeding in the course, please contact me immediately. You are invited to stop by at any time during my office hours, or you can give me a call to make an appointment at a time that is convenient for you. You also have the option of leaving a telephone message on my voice mail or communicating with me via e-mail (see your syllabus for details).

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LEARNING OBJECTIVES

At the completion of this unit, you will be able to provide a fairly detailed definition of the field of *anthropology*. You will be able to describe the four principal *sub-fields* of anthropology—*cultural anthropology*, *linguistics*, *biological anthropology*, and *archaeology*—and you will be able to describe the *research methods* used in *paleoanthropology*, including *osteology*, *molecular biology*, *excavation procedures*, and several specific *dating techniques*, both relative and chronometric.
LECTURE OUTLINES

I. Anthropology

the scientific study of human beings, including human culture and evolutionary aspects of human biology

II. The Sub-Fields of Anthropology

A. Cultural Anthropology

the comparative study of contemporary societies, which seeks to explain the reasons for the similarities and differences among the world’s cultures—i.e., the study of all aspects of human behavior

B. Linguistics

the scientific study of human language, which includes the study of human speech as well as the nature, origins, and role of language

C. Biological Anthropology

the scientific study of human evolution and human variation within an evolutionary framework (also called Physical Anthropology)

1. Research Specializations in Biological Anthropology

a. Genetics

the study of the biological inheritance of traits from parents to offspring
a. Primatology

the study of non-human primates (the order of mammals that includes humans, apes, monkeys, tarsiers, and prosimians)

b. Forensic Anthropology

the application of anthropological techniques to legal issues—e.g., identifying personal characteristics from human remains

c. Paleoanthropology

the study of human evolution that includes contributions from other fields such as archaeology, cultural anthropology, primatology, and geology

1. Research Methods in Paleoanthropology

a. Osteology

the study of the skeleton, including bone composition, growth, and response to disease & trauma; bones and teeth can reveal body size, form of locomotion, diet, sex, and age at death of the individual

b. Molecular Biology

the direct study of the genetic code (DNA) through a variety of techniques involving laboratory analysis
D. Archaeology

the study of non-living cultures through the excavation of their material remains

1. Research Specializations in Archaeology

a. Historic Archaeology

the study of extinct literate cultures through the excavation of their material remains combined with the analysis of their written records; historic archaeology is applicable only to some societies less than 5,000 years old

b. Prehistoric Archaeology

the study of extinct non-literate cultures through the excavation of their material remains alone; prehistoric archaeology is the only archaeological approach applicable to the study of 99% of the human story

2. Research Methods in Archaeology

a. Excavation Procedures

   i. Site

       a location of human activity that is the focus of an archaeological excavation

   ii. Grid

       a framework of square units imposed on a site using surveying equipment that is used to identify the precise location of every find
iii. Datum Point

A permanent feature at a site used as the basis for establishing the grid based on compass headings; the datum point allows for the subsequent re-creation of the original grid once the excavation has been concluded.

iv. Strata (singular: stratum)

Overlying vertical levels of deposits at a site; each stratum represents a different time period or cultural/geological event.

v. Assemblage

The sum total of all material collected at a site during an excavation—includes artifacts, ecofacts, and features.

vi. Artifact

Objects or materials made or modified by humans that can be removed from the site (e.g., tools, pottery, ornaments, etc.).

vii. Ecofact

Natural objects collected and used by humans (e.g., bones, seeds, etc.).
viii. **Feature**

objects or materials made or modified by humans that cannot be removed from the site (e.g., postholes, hearths, cisterns, etc.)

ix. **Context**

the spatial and temporal associations between and among all elements of the assemblage at a site (the context must be carefully noted and recorded during excavation to preserve crucial information)

x. **Laboratory Analysis**

the stage of archaeological research that follows excavation; it includes measuring, cataloging, preserving, identifying, and dating finds

b. **Dating Methods (Relative)**

dating techniques that tell whether something is older or younger than something else, without telling exactly how old either thing is

i. **Stratigraphy**

a technique that describes the sequential layering of deposits based on the usually valid assumption that deeper layers were deposited earlier

ii. **Fluorine Analysis**

a technique for comparing the age of bones recovered at the same site, which is based on the fact that the longer bones are in the ground, the more fluorine they absorb from groundwater
c. **Dating Methods (Chronometric)**

dating techniques that give an estimate of age in actual number of years (various techniques are applied to various materials using various principles)

i. **Potassium Argon**

technique applied to volcanic rock in the 1 to 5 million-year-old range (potassium decays to argon with a half life of 1.25 billion years)

ii. **Fission-Track**

   technique applied to minerals containing uranium-238, which decays regularly by spontaneous fission, leaving microscopic tracks; applicable range of many millions of years

iii. **Carbon 14**

   technique applied to organic material, useful to about 75,000 years ago (C-14 is absorbed by plants and animals during life, and begins to decay at death with a half-life of 5,730 years)

iv. **Paleomagnetism**

   technique applied to sediments with magnetically-charged particles; sediments act as a fossil compass pointing to the shifting direction of the magnetic pole; paleomagnetism is used especially to cross check Potassium-Argon
v. **Biostratigraphy**

A technique involving faunal correlations; the assemblage is matched with animal species of known dates that were deposited in the same stratum.

vi. **Thermoluminescence**

A technique used primarily for dating ceramics, based on the fact that clay absorbs environmental radiation at a known rate which can be driven off and measured in the laboratory; useful to several thousand years.

d. **Experimental Archaeology**

The study of extinct cultures that attempts to replicate former procedures and processes under controlled conditions.

i. **Lithic Technology**

Techniques for the manufacture of stone tools, used by humans and human ancestors for the past 2.5 million years.

ii. **Flake**

A smaller piece of stone, generally having a thin edge, that has been struck off the original larger piece and that could be either a waste chip or a tool.
iii. Core

a stone that has been reduced by flake removal and that may or may not be a tool

iv. Direct Percussion

a technique for making stone tools by striking a core or flake with a hammerstone

v. Pressure Flaking

a technique for making stone tools by pressing a pointed implement (generally made of bone, antler, or hard wood) against the stone to remove a flake

The following additional lecture notes are intended especially for internet students (although they may also be helpful to classroom students who were absent from the lecture presentation).

This first unit introduces the field of anthropology and focuses on the research methods used in the areas of the discipline that will be the subject of this course. While this course will focus on only two of the four main subfields of anthropology (namely biological anthropology and archaeology), in my lectures I emphasize the fact that anthropology is an integrated, four-field discipline, and that any anthropological investigation of any topic is likely to incorporate insights and/or methods from all four divisions of the field. (Indeed, while most anthropologists tend to specialize in only one subfield, such as archaeology or linguistics, virtually all anthropologists receive graduate training in all four subfields, and some anthropologists, such as myself, consider themselves to be general anthropologists without a single subfield specialty.)
**Buried in Ice**

The content of this Supplemental Reading is derived from the following film:


Unfortunately, this particular film is not available for viewing online; however, the essential content of the film is summarized below.

*Buried in Ice* describes the exhumation of three bodies that were buried in marked graves in the Canadian Arctic for 140 years. In 1845, the British Navy sent an expedition of two ships commanded by Sir John Franklin in search of the Northwest Passage from the Atlantic to the Pacific. The expedition ended in disaster when the ships were trapped in ice and destroyed; all of the crew members died. In the 1980’s, anthropologists opened the graves of three of the sailors and found the bodies to be remarkably well preserved. *Buried in Ice* tells the story of the failed Franklin expedition, and offers excellent illustrations of the research methods used in archaeology (specifically historical archaeology) and biological anthropology (specifically forensic anthropology).

The three members of the Franklin Expedition whose bodies were buried in marked graves on Beechey Island died early in the voyage, soon after the ships became packed in pack ice. Within a couple of years, however, all of the men aboard both ships were dead, and their bodies were never recovered. After many months of encampment, with their food supplies running low, the survivors decided to try to march hundreds of miles to the south where they hoped to find whaling ships; strangely, however, the men attempted to bring with them several cumbersome and useless objects, including an ornate desk from one of the ships.
Forensic anthropologists and archaeologists were able to piece together the clues to explain the bizarre behavior of the expedition’s members: the men were suffering from lead poisoning caused by lead contamination in their food supply. The ships were provisioned with canned food that had been provided by an inexperienced company on the basis of its low bid. The tin cans were soldered with lead which came into prolonged contact with the food inside. The symptoms of lead poisoning include malnourishment, emaciation, and cognitive problems that include irrational thought processes and hallucinations. Biological anthropologists found that the bones of the Franklin crew contained lead levels many times higher than normal, and many times higher than the bones of Inuit people from the same period; archaeologists discovered numerous remains of the tin cans with large lead seals on them at the site of the Franklin encampment.
Return of the Iceman

The content of this Supplemental Reading is derived from the following film:


If you’d like to learn more about the Iceman, you might enjoy visiting the PBS Companion Website for the Ice Mummies Series at http://www.pbs.org/wgbh/nova/icemummies/.

The mummy itself is currently housed in the South Tyrol Museum of Archeology in Italy; you can visit its website at http://www.archaeologiemuseum.it/f01_ice_uk.html.

Unfortunately, this particular film is not available for viewing online; however, the essential content of the film is summarized below.

Return of the Iceman describes one of the most remarkable archaeological finds of the 20th century. In 1991, hikers in the Alps on the border between Austria and Italy discovered the well-preserved body of an ancient European frozen in a rock outcropping beside a melting glacier. The film offers an outstanding illustration of the value of careful archaeological excavation; it also provides an excellent example of unusual research in biological anthropology, given the extraordinary nature of the find. The depiction of the radiocarbon dating technique is especially good in this film. Return of the Iceman vividly illustrates the multidisciplinary nature of anthropological research, and demonstrates the remarkable ability of archaeologists and biological anthropologists to glean large quantities of information from seemingly few clues.
The film opens with the narrator describing the discovery of the Iceman’s mummified body in 1991: “More than 5,000 years ago a man set out on a journey into the Alps. In these harsh reaches, fair turns to foul in the blink of an eye. Beneath a mantle of snow and ice, the man perished. His travels interrupted, his story lost. But in 1991 his journey suddenly resumed. It had been the warmest summer in recent memory, and the Alps were unusually bare. On the border between Austria and Italy, two hikers came across an unsettling sight: a body melting out of the ice. Suspecting a hiking accident, they alerted the owner of a nearby lodge...A forensic team did not reach the site until days later. Ill-equipped to dig a body out of the ice, they used a ski-pole and an ice-axe borrowed from passing hikers. It appeared to be a routine assignment, until a few curious objects surfaced: a knife with a flint blade, and clumps of fur and grass...The body was rushed to the University of Innsbruck in Austria. By the time he arrived, the Iceman had become a sensation—a mute celebrity with an amazing story to tell. Judging from a primitive metal-bladed axe found with the body, archaeologist Konrad Spindler estimated the mummy was about 4,000 years old—the oldest frozen body ever discovered. News of the find swept the globe.”

As it turned out, however, Spindler’s initial estimation of the Iceman’s age was incorrect, because it was based on an erroneous assumption: the Iceman’s ax did indeed look like a 4,000-year-old bronze ax, but it was not bronze, as later investigation would reveal. Bronze is an alloy composed of copper and tin, but the Iceman’s ax was almost pure copper—it had been made many centuries before Europeans discovered how to produce bronze.

As the film continues, the narrator provides more details about the remarkable find: “Miraculously, ice had preserved not only the body, but the equipment the Iceman had with him when he died—ordinary possessions rendered priceless by time: a bead with rawhide strings...two dried mushrooms on leather straps...finely stitched clothing made from animal skins...an unfinished bow taller than the Iceman himself...and remnants of a boot stuffed with grass still tied to one foot. Excavation of the site a few days later turned up more archaeological treasure: a cape made of grass...and a nearly intact quiver still full of arrows... The first question scientists had to tackle was the Iceman’s age. Could he really be 4,000 years old? To find out, small samples of bone were removed for radiocarbon dating. Like all living things, bone contains a form of carbon called carbon-14. When an organism dies, that carbon begins to decay at a precise rate like a clock ticking away into eternity. By measuring the amount of carbon-14 that remains in the body, scientists can calculate when the organism died. Amazingly, the original age estimate was off by more than a thousand years. The Iceman was a staggering 5,300 years old...he had lived at the end of the Neolithic, just as metal was beginning to replace stone for tools and weapons.”

The Iceman was nicknamed Otzi for the region of the Alps where he had been found, but he became the subject of an international custody battle. It was only resolved when a team of surveyors determined that the body had not been found in Austria, but about 300 feet inside the Italian border. After much negotiation, Austria agreed to return the body to Italy in three years. [The Iceman is now permanently housed in a museum in Italy.]

The film’s narrator goes on to describe the painstaking scientific research that was undertaken following the initial accidental discovery of the body: “In search of more clues, scientists returned a year later to the site where the Iceman was found. They melted all the snow in the area, filtering out more than 800 pounds of material...Scientists at Innsbruck University’s botanical department have been meticulously sifting and sorting this ancient debris. From even the tiniest scraps, the botanists have been able to draw startling conclusions about the Iceman.” Botanical researcher Klaus Oeggl explains: “This grain came out from the washing residues from his clothes. They most probably stuck to his clothing and you can see that they are perfectly preserved. These wheat spikelets derive from einkorn, which is a primitive wheat which was commonly grown during Neolithic
within the region. He used it for unleavened bread or cooking porridge or a soup. This einkorn comes from an agricultural community because these spikelets, these two spikelets, show that they were processed. You can see that here this spikelet here is broken... and the spikelets don’t stick together if they are separated from each other and this cultivated species is only separated by threshing, so this is a processed corn.”

The evidence indicated that the Iceman had clearly been in contact with an agricultural community. One archaeological site in the region suggested a strong possibility—Castle Juval, an area that had been continuously populated since the Middle Stone Age. It was located only five miles from where the Iceman’s body was found—close enough to have been his home.

The Iceman’s body was covered with tattoos, as one researcher explains in the film: “If you look at his right lower leg, at the ankle, there were three tattooed lines. Looking further up here there are three lines—being here—and actually these lines were discovered by using infrared photography. If you look at his back there are some tattoos that were found on the left side on the back, and these tattoos were at locations where he could not see them himself, so somebody else must have applied them.”

The film offers an inventory of the Iceman’s possessions: “The Iceman’s equipment completes the picture of a man highly adapted to mountain living. His waterproof grass cape—leather utility belt full of tools—even a lightweight frame backpack… Equally unexpected was the great variety of wood the Iceman used to make his equipment—each kind still found in the Alps today. Yew for the bow and axe handle, hazel for the backpack frame, larch for its supports, and ash for the dagger handle.”

The artifacts associated with the body provided many clues about the Iceman’s life, but still more information could be gleaned from the body itself: “More evidence of the Iceman’s skills was detected in strands of his hair found near the body. By analyzing the different elements in the hair researchers are uncovering tantalizing details about the Iceman’s life.” One of the researchers interviewed in the film explains: “The first thing that we did with the hair was to look at it lengthwise to look at the surface of the hair. After that, we scanned across these slices of hair, and you can distinguish between surface contamination and metabolized elements which tend to concentrate more along the center of the hair. We found copper particles on the surface and when we sliced the hair we found that the copper was indeed localized quite strongly on the surface of the hair, and we also found arsenic which is equally unusual—arsenic is not found in normal human hair to the detection limits of our instrument.”

In other words, the Iceman’s hair was covered in copper on the outside, and on the inside it contained arsenic levels today found only in people with chronic arsenic poisoning. Research indicated that the contamination had not come from trace elements in the soil where the Iceman’s body had been resting, so it must mean that when the Iceman was alive, he had been exposed over a long period to arsenic vapor or arsenic dust. Since arsenic is a common contaminant of copper ores, it raises the question of whether he was involved in actually melting copper ores and breathing arsenic vapor.

The film show experimental archaeologists attempting to duplicate the ancient process that was used to make the Iceman’s ax—and it turns out to be a surprisingly difficult procedure. So, working in a metallurgical laboratory, scientists use modern techniques to make a replica of the ax so that they can test its properties. It turns out that the copper ax is superior to a stone ax for cutting wood, but only for a short time, because copper is a soft metal, and the ax quickly gets dull and becomes deformed when it is used.

“From the moment the Iceman was found,” as the film’s narrator explains, “the most enduring mystery has been what he was doing on top of a mountain. The most plausible clues come from an ancient tradition still
practiced today. The Iceman was discovered at the end of a long valley that pushes north from the plains of Italy. Every spring local shepherds drive their flocks up this valley and over the high pass to summer pastures in the north… The route the sheep take today passes far from where the Iceman was found, but this path was only carved in the last century with dynamite. The ancient route would have taken them right past his body. The Iceman could well have been a shepherd who perished tending his flock.”

This does not explain how the Iceman died, however, as the narrator explains: “In search of the answer to this question, scientists have poked and prodded every inch of the Iceman’s body; inside and out. This team is making a small incision in the torso to insert an endoscope. With this instrument, they extract tiny samples from his gut. And learn that his last meal was meat and einkorn, the ancient form of wheat.”

In the end, the film suggests that the Iceman may have become disoriented in a snowstorm, and, unable to find his way to shelter, had frozen to death. [We now know that’s not what happened—additional research conducted after the film was made revealed a stone arrowhead embedded in the Iceman’s back, along with clear evidence of blunt force trauma to his skull and defensive parry wounds to his hands and arms. Otzi was a homicide victim.]

The film concludes with these remarks from the narrator: “Five thousand three hundred years after the Iceman took his last breath, he was on the move again. In early 1998, Austria turned the body over to Italy. In keeping with his celebrity, the Iceman had an armored truck and military escort for his final trip over the Alps. The Iceman’s long journey finally ended in the Northern Italian town of Bolzano, just a few miles from where scientists think he once lived. The Italians have waited years for the Iceman to come home. They spent 10 million dollars on a special museum and gave him a hero’s welcome. And it is here in this museum that the Iceman has found his final resting place. In a custom-built, climate-controlled freezer, he will be preserved for science and displayed to the curious public.”
TEST OBJECTIVES

The multiple-choice test questions for Unit Test #1 will refer directly to the test objectives listed below; if you can meet all of the test objectives described here, you should have no trouble earning a score of 100% on the Unit Test. (These test objectives will also apply directly to the Midterm Exam, which will cover nothing more and nothing less than all of the test objectives for Units 1 through 4.)

♦ Define *anthropology*, and describe the methods, goals, and components of the four main subfields of anthropology (i.e., cultural anthropology, linguistics, biological anthropology, and archaeology); describe as well other natural and social sciences that overlap with or contribute to anthropology.

♦ Describe four principal research specializations within biological anthropology (i.e., genetics, primatology, forensic anthropology, and paleoanthropology).

♦ Describe the two principal research methods used in paleoanthropology (i.e., osteology and molecular biology).

♦ Describe the two principal research specializations within archaeology (i.e., historic and prehistoric archaeology).

♦ Describe the basic elements of excavation procedures (i.e., site, grid, datum point, strata, assemblage, artifact, ecofact, feature, context, laboratory analysis).

♦ Describe the differences between relative dating methods and chronometric dating methods.

♦ Describe the following relative dating methods: stratigraphy and fluorine analysis.

♦ Describe the following chronometric dating methods: potassium argon, fission-track, carbon 14, paleomagnetism, biostratigraphy, and thermoluminescence.

♦ Define *experimental archaeology*, and describe the example of lithic technology (to include distinguishing between flakes and cores as well as describing the techniques of direct percussion and pressure flaking).

♦ Describe the procedures and findings of the modern anthropological research regarding the fate of the 19th-century Franklin Expedition (as presented in the film *Buried in Ice*).

♦ Describe the procedures and findings of the modern anthropological research regarding Otzi the Iceman (as presented in the film *Return of the Iceman*).
Chapter 2

The Theory of Evolution

LEARNING OBJECTIVES

At the completion of this unit, you will be able to describe both the **historical background** and the **modern synthesis** of the **theory of evolution**. You will be able to describe several key concepts from the contemporary science of **genetics**, including **chromosome**, **DNA**, **gene**, **population**, **gene pool**, and **species**. In addition, you will be able to describe the fundamental mechanisms of evolution: **mutation**, **gene flow**, **genetic drift**, and **natural selection**. Finally, you will be able to describe the essential features of the scientific method and to describe the differences between scientific and non-scientific approaches to knowledge (in particular, you will be able to describe the differences between the **science of evolution** and the **pseudoscience of creationism**).
I. The Theory of Evolution

Evolution is a change in the genetic structure of a population, which may result in the appearance of a new species; stated in the simplest terms, the “theory of evolution” means the “explanation of change over time.”

A. Historical Background to The Theory of Evolution

1. Carolus Linnaeus (1707-1778)

Swedish naturalist who developed the basis for the biological taxonomy (system of classification) still used today, called binomial nomenclature (Genus & species: e.g., Homo sapiens).

2. Charles Lyell (1797-1875)

Scottish geologist, considered the founder of the modern science of geology, who developed the theory of uniformitarianism (geological processes that shape the earth—wind, erosion, flooding, volcanism, etc.—are uniform over time); Lyell helped establish the great age of the earth.

3. Alfred Russell Wallace (1823-1913)

British scientist who, along with Darwin, independently discovered the principle of natural selection; Wallace’s discovery inspired Darwin to publish his own theory in much greater detail.
4. **Charles Darwin (1809-1882)**

   British scientist who independently discovered the principle of natural selection and articulated the theory of evolution in *The Origin of Species*; Darwin recognized that natural selection acted on variation within a population to produce new species, but he couldn’t explain the source of the variation.

5. **Gregor Mendel (1822-1884)**

   Austrian monk who founded the science of genetics; the science of genetics would eventually solve the problem that eluded Darwin—namely, the mystery of the source of variation within a population.

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### B. **Darwin’s Principle of Natural Selection**

The principal mechanism of evolutionary change: changes in frequency of certain traits in a population are due to differential reproductive success between individuals—natural selection operates on individuals, but it is the population that evolves. “Adaptation” refers to physiological and/or behavioral adjustments made by organisms in response to environmental circumstances (in other words, adaptation is the result of natural selection). There are six basic principles of Natural Selection:

1. **Biological Variation**

   within a population, no two individuals (other than identical twins) are ever exactly alike

2. **Individual Competition**

   because all resources are finite, only a limited number of individuals can survive; hence individuals are always in competition with each other for access to essential resources
3. **Favorable Variation**

   some individuals have variations that give them advantages over others (e.g., speed, protective coloration, disease resistance, etc.); those individuals are more likely to survive and to produce more offspring.

4. **Environmental Context**

   the environment determines which individual traits are beneficial and which are detrimental (the same trait may be advantageous in one environment but disadvantageous in another).

5. **Selective Pressure**

   forces in the environment that influence reproductive success in individuals (as populations become geographically separated, they respond to different selective pressures; eventually, they may become different species, descended from a common ancestor).

6. **Reproductive Success**

   a measure of the number of offspring an individual produces and rears to reproductive age—i.e., the individual’s genetic contribution to the next generation (over time, more favorable traits are passed on and become more common; eventually, later generations may be a new species).

   “fitness” is a measure of the relative reproductive success of individuals; it is defined as the extent of an individual’s genetic contribution to the next generation (natural selection is “survival of the fittest” in this sense only).

C. **The Modern Synthesis**

   *Combines the principle of natural selection (discovered by Charles Darwin) with the science of genetics (founded by Gregor Mendel)*

1. **The Contemporary Science of Genetics**

   Mendel founded the science that studies the inheritance of biological traits, but major advances have occurred since Mendel (including the discovery of the structure of DNA and the mapping of the human genome).
a. **Chromosome**

discrete structures composed of DNA and protein, and found in the nucleus of every cell in the body; the number of chromosomes is particular to each species (humans have 46 chromosomes, arranged in 23 pairs)

b. **DNA**
deoxyribonucleic acid—a double-stranded molecule that contains the genetic code (DNA is the main component of chromosomes)

c. **Gene**
a sequence of DNA that contains “instructions” for building proteins; a gene is a locus (i.e., position) on a chromosome

d. **Population**
a group of interbreeding individuals within a species; i.e., the group within the species from which individuals are likely to find mates

e. **Gene Pool**
the total complement of genes shared by the reproductive members of a population

f. **Species**
a group of organisms that can interbreed to produce fertile offspring
2. The Modern Synthetic Definition of Evolution

evolution is a two-stage process:

(1) production and redistribution of variation

(2) natural selection operates to give some individuals higher reproductive success, resulting in a change in frequency of genes within the gene pool, and ultimately resulting in speciation

("variation proposes and selection disposes")

3. The Mechanisms of Evolution

a. Mutation

a change in DNA that may involve changes in genes or changes in the number and/or structure of chromosomes (a potential source of completely new variation)

b. Gene Flow

the exchange of genes between populations (accomplished when individuals from one population breed with individuals from another)

c. Genetic Drift

changes in gene frequencies produced by random factors (genetic drift is a result of small population size—the founder effect results when a small number of individuals contribute genes to the next generation, creating a genetic bottleneck)

d. Natural Selection

the mechanism that plays the major role in macroevolutionary (large scale) changes (i.e., speciation); however, all four mechanisms interact to produce evolutionary change
II. Science and Creationism

A. The Nature of Science

Science is a particular way of knowing about the world. In science, explanations are limited to those based on observations and experiments that can be substantiated by other scientists. Explanations that cannot be based on empirical evidence are not part of science. The following four key terms each have a special meaning for scientists:

Fact: An observation that has been repeatedly confirmed and for all practical purposes is accepted as “true.” Truth in science, however, is never final, and what is accepted as a fact today may be modified or even discarded tomorrow in the light of new evidence.

Hypothesis: A tentative statement about the natural world which leads to deductions that can be tested. If the deductions are verified, the hypothesis is provisionally corroborated. If the deductions are incorrect, the original hypothesis is proved false and must be abandoned or modified.

Law: A descriptive generalization about how some aspect of the natural world behaves under stated circumstances.

Theory: A well-substantiated explanation of some aspect of the natural world. In science, theories do not turn into facts through the accumulation of evidence. Rather, theories are the end points of science. They are understandings that develop from extensive observation, experimentation, and creative reflection, and they incorporate a large body of scientific facts, laws, tested hypotheses, and logical inferences.

B. The Nature of Creationism

The arguments of creationists are not driven by evidence that can be observed in the natural world (instead, their arguments are driven by faith, revelation, and the “authority” of “sacred” books). Special creation or supernatural intervention is not subjectable to meaningful tests, which require predicting plausible results and then checking those results through observation and experimentation. Indeed, claims of “special creation” reverse the scientific process. The explanation is seen as unalterable, and evidence is sought only to support a particular conclusion by whatever means possible (including using illogical reasoning and ignoring known facts).

In 1987, the U.S. Supreme Court ruled that creationism is religion, not science, and cannot be advocated in public school classrooms. As it happens, most religious groups have concluded that the concept of evolution is not at odds with their understanding of human origins.
C. The Fact of Evolution

The concept of biological evolution is one of the most important ideas ever generated by the application of scientific methods to the natural world. The evolution of all the organisms that live on Earth today from ancestors that lived in the past is at the core of genetics, biochemistry, neurobiology, physiology, ecology, and other biological disciplines. Evolution helps to explain the emergence of new infectious diseases, the development of antibiotic resistance in bacteria, the agricultural relationships among wild and domestic plants and animals, the composition of the Earth’s atmosphere, the molecular machinery of the cell, the similarities between humans and other primates, and countless other features of the biological and physical world. In the words of the great geneticist and evolutionist Theodosius Dobzhansky, “Nothing in biology makes sense except in the light of evolution.”

D. The Fiction of Creationism

The belief that the Earth was created just a few thousand years ago is decisively contradicted by a vast amount of evidence from astronomy, astrophysics, nuclear physics, geology, geochemistry, and geophysics. That evidence establishes the great age of the universe, our galaxy, the solar system, and our planet: the Earth and the solar system are about 5 billion years old, and the universe is about three times older than that.

Nor is there any evidence that the entire geological record, with its orderly succession of fossils, is the product of a single universal flood that occurred a few thousand years ago, lasted a little longer than a year, and covered the highest mountains to a depth of several meters. On the contrary, intertidal and terrestrial deposits demonstrate that at no recorded time in the past has the entire planet been under water. Moreover, a universal flood of sufficient magnitude to form the sedimentary rocks seen today, which together are many kilometers thick, would require a volume of water far greater than has ever existed on and in Earth.

For more information, see the full text of Science, Evolution, and Creationism, which is available online free of charge at http://www.nap.edu/catalog.php?record_id=11876
Darwin’s Darkest Hour

The content of this Supplemental Reading is derived from the following film:

Darwin’s Darkest Hour. 2009. A co-production of NOVA and National Geographic Television.

Watch the film on the PBS website at http://video.pbs.org/video/1286437550

Darwin’s Darkest Hour is a dramatic presentation (starring noted actors Henry Ian Cusick and Frances O’Connor) that tells the story of the professional and personal trauma Charles Darwin endured the year before the publication of On the Origin of Species. Darwin had been working on the book for years, but he suddenly discovered that he was in danger of being scooped by Alfred Russell Wallace; at the same time, one of his children is stricken by scarlet fever, and another with diphtheria. In the midst of these crises, Darwin’s wife Emma is his greatest source of support, even though his scientific work poses a major challenge to her Christian faith. The film brings to life the human circumstances surrounding the production of one of the single most important publications in the history of science.

Watch the program by following the link above to the PBS website (at the site, you’ll also find a link to the complete transcript of the program that you can download free of charge if you’d like to have a written version of the content).
The content of this Supplemental Reading is derived from the following film:

The Ultimate Journey. 1996. NOVA episode. PBS Television.

Unfortunately, this particular film is not available for viewing online; however, the essential content of the film is summarized below.

**Odyssey of Life: The Ultimate Journey** is a truly remarkable film. It features stunning microphotography that shows how the developing human embryo reveals evolutionary links to other species, demonstrating the shared ancestry of all life on the planet. This film is one of the most vivid illustrations ever produced of the aphorism that “ontogeny recapitulates phylogeny.”

The following comments are from Joe Levine, a biologist, educator, and science journalist; they were originally posted on the website for the *Odyssey of Life* PBS television series, and they provide an excellent summary of this episode of the program.

“The history of man for the nine months preceding his birth would probably be far more interesting, and contain events of greater moment, than all the three score and ten years that follow it.” -- Samuel T. Coleridge

When Coleridge penned those words more than a hundred and fifty years ago, neither he nor scientists of his day knew just how right he was. Why? Because they didn’t know, as we do now, that every living being carries within it evidence of more than 3.5 billion years of evolutionary change and adaptation by its ancestors [the earth itself is about 4.5 to 5 billion years old--the original single-celled organisms appeared about 3.5 billion years ago, and the first multi-celled organisms appeared just under 1 billion years ago]. And it just so happens that much of the evidence we humans carry is most obvious -- to the eye, at least -- during the stages of life that take place inside the womb. So if you watch developing embryos through the lens of evolutionary biology, they can carry you on even more amazing journeys -- outward to the odyssey of life’s history, and inward, into the invisible world of genes.
Ernst von Haeckel, an early champion of evolutionary theory, was the best-known scientist to propose that similarities among embryos contain important information. Specifically, Haeckel proposed that “ontogeny recapitulates phylogeny.” This pithy bit of jargon, when translated into English, asserts that as an embryo develops, it passes through stages that are equivalent to the adult forms of its ancestors. For example, according to Haeckel, a human embryo would pass through a stage in which it has features of an adult fish, then features of an adult amphibian, and so forth.

That would be a mighty tall order, of course, for at least two reasons. First, many adult animals (including extinct species) are highly specialized, and carry scores of complicated structures that would have to be assembled and disassembled as an embryo progresses from one stage to another. Second, any species alive today has an awful lot of ancestors that stretch back over billions of years. To pass through the adult stages of all of them would make for a long, tortuous (and wasteful) embryonic life!

Biologists have known for decades that ontogeny doesn’t strictly recapitulate phylogeny -- at least not in the precise way that Haeckel thought it did. Haeckel was wrong in his insistence that embryos resemble ancestral adults. But many embryos do pass through stages during which they look a lot like embryos of their ancestors -- and therefore, embryos of related species. And many scientists agree that events during development are vitally important in evolution. Leigh von Valen, a prominent modern evolutionary thinker, went so far as to suggest that “...evolution is the control of development by ecology.” The subject is fascinating, complicated, and not at all easy to summarize. (Stephen Jay Gould devoted several years and a lengthy book to the topic.) But here are a few important points to think about.

The embryos (fishes, birds, pigs and humans) in NOVA’s *Odyssey of Life - The Ultimate Journey* resemble each other because they all belong to animals that biologists call vertebrates. Any textbook can tell you that, but what does grouping us together that way actually mean? The simple answer is that we all share common ancestors who evolved a successful body plan based on a backbone, two pairs of limbs, and body systems set up in a certain basic manner. But what does that mean? And what does it have to do with the importance of embryos in evolution?
Think about it this way. Each major animal group has evolved a unique combination of particular body-parts that perform essential functions. Take, for example, the fact that all animals must breathe. Many land animals use lungs like ours, but insects and spiders use quite different devices. Some aquatic animals use various styles of gills, while others just let oxygen and carbon dioxide pass across soft, wet skin. You can think of lungs, gills, and other body parts that help animals breathe as the “breathing tool” component of their body-part kits. There are similar “tools” for feeding, movement, defense, reproduction, and so on. [A major event in the evolution of breathing took place about 400 million years ago when ancient relatives of the lungfish first developed the ability to breathe air, thus beginning the colonization of the land.]

The intriguing point is that among all the millions of animal species alive today, there are only a couple of dozen really different body-part tool kits. Each is the hallmark of a major animal group -- a collection of related species that biologists usually call a Phylum. Mollusks -- snails, clams, octopi and their kin -- are one such group. Insects and their relatives are another. But with only two dozen or so basic body plans, where do the many thousands of species within each group come from? You can think of each group’s basic body plan as the biological equivalent of a major musical theme. The slightly different body plans of species within each group are like variations on that theme. Just where do these themes and variations come from? Here’s where things get interesting.

An embryo grows and develops under the control of its genes. Some genes work fairly simply, directing cells to churn out products and assemble those products into structures. But these relatively simple genes couldn’t produce a complex organism by themselves. Their actions are coordinated by master control genes that act like orchestra conductors -- determining which genes are turned on and which are turned off, in what cells, at what stages in development, and for what lengths of time. Of course, the task of orchestrating the entire process of constructing a fish, pig, or human makes directing the most complex musical score look like playing with nursery rhymes! [The amazingly complex process of embryonic development begins at the moment of conception--for humans, cell division begins one day after fertilization has occurred.]

This is one reason why entirely new basic body plans don’t evolve very often. Each body-part is assembled by a group of genes acting under the direction of particular control genes. Those control genes are themselves controlled by higher level control genes. And those genes are controlled by still higher-level control genes. (In some ways, these controls-within-controls are set up almost like a military chain of command.) The long and the short of it is that making major changes in body-part tool kits requires wholesale shakeups in these complex genetic programs. And in order to survive the test of natural selection, these shake ups need to happen in ways that don’t introduce any fatal flaws.

So it isn’t surprising that completely new body plans haven’t evolved very often. In fact, these sorts of shakeups have occurred only a few times in the entire 3.5 billion year history of life. The best-known was the “Cambrian Explosion” -- a period roughly 600 million years ago during which the basic body plans of most major groups of living organisms (and those of many extinct groups) arose. Of course, those original body plans were controlled by genetic programs that have been passed down over time to species alive today.

How does all this explain why vertebrates pass through an early stage that resembles a fish embryo? As Nietzsche once wrote, “Ye have made your way from the worm to man, and much within you is still worm.” Our “fish-like” early stages are directed by parts of the same genetic program that built early fishes -- some of the first members of our branch of the animal kingdom. By the time fishes evolved, genetic control of development was already a very complicated business, because fishes are complex animals. And once a genetic program passes a certain level of complexity, it becomes difficult for major changes early on not to have
“domino effects” that knock things out of kilter down the line. [That’s why, for example, all six classes of vertebrates have at least the precursors of gill slits at some stage during embryonic development.]

So, over millions of years, evolution operated mainly by adding on to and fiddling around with later stages in development, rather than by making radical changes in genetic programs that substituted one type of body part for another. The result is that some aspects of the earliest stages in the human developmental program remain rather similar to those found in living fishes. [For example, the limbs of terrestrial vertebrates evolved from the fins of fish, probably similar to the fins of the coelacanth, an ancient fish found today in the Indian Ocean that’s often described as a living fossil.]

It is even more fascinating, however, to realize that minor modifications in the timing and ordering of events during embryonic life can produce enormous differences in adults. In fact, nearly all the sorts of evolutionary changes most of us usually think about -- ancient fishes giving rise to amphibians, amphibians to reptiles, dinosaurs to birds, and so on -- have occurred through relatively small changes in timing and orchestration of genetic controls during development. That’s how ancient limbs evolved into wings, or feet into flippers. [These sorts of changes, of course, have happened many different times--for example, ancient land mammals resembling dogs began to evolve into dolphins and whales about 50 million years ago.] It is also how ape-like ancestors evolved into humans. Why do humans share an astonishing 98% of our genes with chimpanzees? Because, when it comes to differences between such closely related species, timing is everything!
Judgment Day: Intelligent Design on Trial

The content of this Supplemental Reading is derived from the following film:


Watch the film on the PBS website at
http://video.pbs.org/video/980040807/

Judgment Day: Intelligent Design on Trial tells the story of a famous (or infamous) court case in Dover, Pennsylvania in 2005 that pitted the scientific theory of evolution against the religious theory of creationism (the Dover School Board had required that religious ideas be introduced into the science classroom, and several parents sued, claiming that their constitutional rights had been violated). In the course of the trial, vividly recreated for this NOVA episode, the attorneys for the plaintiffs present an excellent explanation of the nature of evolutionary theory, and show how it is fundamentally different from creationism (also called, deceptively, “intelligent design”).

Watch the program by following the link above to the PBS website (at the site, you’ll also find a link to the complete transcript of the program that you can download free of charge if you’d like to have a written version of the content).
Science & Religion

In the federal case of Kitzmiller v. Dover School District (which was decided in December 2005 and described in the film Judgment Day: Intelligent Design on Trial), Judge John E. Jones III made the following comment: “Both defendants and many of the leading proponents of ‘intelligent design’ make a bedrock assumption which is utterly false. Their presupposition is that evolutionary theory is antithetical to a belief in the existence of a supreme being and to religion in general.” Most Christians would agree with him, and so too would some scientists, including the late Stephen Jay Gould, who wrote a book entitled Rocks of Ages (2002, Ballantine) which argued that science and religion can be compatible.

However, other scientists, such as Richard Dawkins, would strongly disagree with both Judge Jones and Stephen Jay Gould. I am firmly in the camp of those scholars who believe that science and religion are fundamentally incompatible, as explained in the article reprinted below. For those interested in further reading on the topic, I recommend the following works:

Boyer, Pascal

Dawkins, Richard

Dennett, Daniel

Harris, Sam

Hitchens, Christopher

Lett, James
**Irreconcilable Differences:**
The Fundamental Incompatibility of Science and Religion

The content of this Supplemental Reading is excerpted from the following publication:

Lett, James 2003 *Think*. Issue Four, Summer: 75-80

**Introduction**

Among many recent arguments for a reconciliation between science and religion, one of the most eloquent is the late Stephen Jay Gould’s appeal for scientists and theologians to embrace what he calls the principle of NOMA, or ‘nonoverlapping magisteria’ (‘magisteria’ is an archaic word he resurrected meaning ‘teaching authority’). According to Gould, the ‘lack of conflict’ between science and religion arises from a lack of overlap between their respective domains of professional expertise.’ As Gould envisions it, science and religion are potentially complementary: ‘The net of science covers the empirical realm: what is the universe made of (fact) and why does it work this way (theory). The net of religion extends over questions of moral meaning and value. These two magisteria do not overlap.’

Besides being an eminent scientist, Gould was a remarkably graceful and intelligent writer, which only strengthens the appeal his argument has for many people. Unfortunately, his argument is founded upon a false premise. In point of fact, the scientific and religious domains do overlap to a considerable extent, as Richard Dawkins made clear in his rebuttal to Gould. A universe that did have a supernatural component would be fundamentally different from one that did not, and whether it did or did not would clearly be a question of great scientific import. Furthermore, as Dawkins points out, religions do make factual claims that are amenable to scientific investigation. For example, Christian claims about the Virgin Birth, the bodily Assumption of the Blessed Virgin Mary, the Resurrection of Jesus, and the survival of human souls after death are all claims of a scientific nature. ‘Either Jesus had a corporeal father or he didn’t,’ Dawkins writes. ‘This is not a question of ‘values’ or ‘morals,’ it is a question of sober fact.’

**The Scientific Approach to Knowledge**

The best system that human beings have ever devised for addressing questions of sober fact is a system of collective rationality called science. Science can be succinctly defined as an objective, logical, and systematic technique for acquiring propositional knowledge, but the key to understanding the essential nature of the scientific method is to recognize that science has a built-in mechanism for correcting its own errors. Science is an open-ended enterprise, erected on the cornerstone of a perpetual search for falsifying evidence; in science, every claim is subject to relentless scrutiny. Nothing—no fact, no idea—is sacrosanct. In contrast to religion, which claims to be in possession of absolute truth, science claims only to possess provisional truth.
Therein lies the virtue of science, however, because the knowledge it produces is continuously being refined and expanded. Science may not be a perfect approach to propositional knowledge, but it is vastly superior—and immeasurably more successful—than any alternative that has ever been proposed or adopted by any group of people anywhere in the world at any time in human history. The biologist E. O. Wilson calls scientific knowledge the ‘signature achievement of humanity;’ that observation is not, as he says, a ‘paean to the god of science’ but rather a salute to ‘human ingenuity.’

The Religious Appeal to Faith

Religious believers know that their beliefs can’t be supported by scientific reason, and that’s why most of them don’t even try. Indeed, most of them rarely reflect upon their beliefs at all. As Steven Pinker notes, religious believers ‘don’t pause to wonder why a God who knows our intentions has to listen to our prayers, or how a God can both see into the future and care about how we choose to act.’ The striking thing about religious beliefs, in fact (striking, that is, to nonbelievers), is just how preposterous those beliefs are. ‘Such shocking nonsense,’ is how H. L. Mencken characterized religious belief; for him (and for many other perceptive thinkers), religious belief ‘is so absurd it comes close to imbecility.’ In Letters from the Earth, Mark Twain applied his inimitable wit to the ludicrous nature of Christian belief, with uproarious results; it is highly recommended reading.

Religious believers generally retreat behind the mask of faith when challenged to defend their beliefs, because they have no real option (if they could successfully defend their beliefs on the basis of reason, they’d do so in an instant). The problem, however, is that the appeal to faith is insupportable on any grounds. The appeal to faith can’t possibly be justified by reason (after all, faith simply means belief without any supporting evidence whatsoever or belief despite abundant contradictory evidence, and neither alternative is remotely reasonable). At the same time, the appeal to faith can’t possibly be justified by faith itself (after all, faith in Christianity tells you that faith in Islam is misplaced, and vice versa, so clearly faith is fallible—at least some of the faithful have to be wrong).

Remarkably, religious believers have persuaded themselves not only of the absurd notion that faith can somehow be used to lend intellectual respectability to their irrational beliefs, but also of the execrable notion that faith is somehow admirable. Religious believers are deluded on both counts. Faith is nothing more than blind, irrational, unreflective prejudice; it is a vice rather than a virtue. The huge irony, of course, is that faith happens to be socially and politically respectable at the moment; nevertheless, faith is both intellectually indefensible and morally reprehensible.

Faith is morally reprehensible for the simple reason that it can be used to justify absolutely any kind of horrific evil humans can imagine or invent. In the history of the world, faith-based religion has inspired countless acts of censorship, imprisonment, torture, mutilation, and murder, all directed against individuals who refused to embrace the particular supernatural beliefs of the faithful. That’s what leads Steven Weinberg to conclude that ‘on
balance the moral influence of religion has been awful, and that’s what leads Daniel Dennet to argue that ‘there are no forces on this planet more dangerous to all of us than the fanaticisms of fundamentalism.’ Richard Dawkins aptly describes the pitfalls of faith in his characteristically trenchant style: ‘[It] is capable of driving people to such dangerous folly that faith seems to me to qualify as a kind of mental illness.’

**Conclusion**

There can be no reconciliation between science and religion because the two approaches are antithetical to one another. It is impossible to conduct a rational dialogue with people who insist upon basing their position upon irrational arguments. Consider the question of moral principles, for example. Those who are religiously inclined believe (incorrectly) that principles of morality derive from divine law and divine revelation; those who are scientifically informed believe (correctly) that principles of morality derive from human nature and human reasoning. It is logically impossible to reconcile these beliefs, and that means there’s no possibility of any genuine progress in a dialogue between science and religion. Steven Weinberg makes this point eloquently: ‘I am all in favor of a dialogue between science and religion, but not a constructive dialogue. One of the great achievements of science has been, if not to make it impossible for intelligent people to be religious, then at least to make it possible for them not to be religious. We should not retreat from this accomplishment.’

Religious belief is always intellectually indefensible, because it is inherently irrational. Religious behavior is often morally reprehensible, as the history of the world has repeatedly shown. There is yet another damning indictment that can be directed against religion, however: it is deeply demeaning to human beings. Religion insults human intelligence, denigrates human courage, and undermines human nobility. The deity envisioned by the world’s major monotheistic religions, for example, is either powerless to stop the abundant evil that occurs in the world, or he is able to stop it but chooses not to. If it’s the former, he’s impotent and worthless; if it’s the latter, he’s monstrous and tyrannical. In either case, the notion that humans should prostrate themselves before such a being, and shower him with worshipful praise, is enormously offensive to anyone with a shred of self-respect. The only appropriate response to such a being, if he indeed existed, would be to oppose him with every last resource of human ingenuity, courage, and resolve.

Those who would like to see a peaceful coexistence between science and religion should remember that, while science has always recognized the right of religion to exist, religion has not always granted science the same right. Instead, religion has often sought to imprison scientists, to squelch scientific discourse, and to outlaw the teaching of scientific truth. Despite that ugly history, few if any scientists or other reasonable people would wish to respond with comparable crimes against religious believers. However, while we should respect people’s right to believe whatever they want to be, that doesn’t mean we have to respect people’s beliefs. Religious belief is intellectually indefensible and morally reprehensible, and religious believers don’t deserve to be sheltered from the announcement of that fact.
Science is a relatively new adversary to religion in the battle for the hearts and minds of humans, but if the past four centuries are any indication, there’s reason to be optimistic about the long-term prospects for science. Religion once enjoyed exclusive dominion over a very wide range of human interests, with no opposing force to challenge its superstitious accounts. Science has steadily and dramatically encroached on that domain, however, offering accounts of vastly greater explanatory power (as well as vastly greater imagination and beauty). Meanwhile science continues to expand the realm of human knowledge with dazzling speed, and religion remains mired in the same old tired irrational silliness. Daniel Dennet believes there’s no future in religion, and his belief is rooted in a conviction about human nature. ‘Whatever we hold precious,’ he writes, including our religious belief, ‘we cannot protect it from our curiosity, because being who we are, one of the things we deem precious is the truth. Our love of truth is surely a central element in the meaning we find in our lives.’ If he’s right, and religious belief eventually succumbs to the human yearning for truth, it will represent the triumph of the best that is in us over the worst that is in us.

Notes


TEST OBJECTIVES

The multiple-choice test questions for Unit Test #2 will refer directly to the test objectives listed below; if you can meet all of the test objectives described here, you should have no trouble earning a score of 100% on the Unit Test. (These test objectives will also apply directly to the Midterm Exam, which will cover nothing more and nothing less than all of the test objectives for Units 1 through 4.)

♦ Define evolution, and describe the principal mechanisms of evolutionary change (i.e., mutation, gene flow, genetic drift, and natural selection).

♦ Identify and describe the principal 18th and 19th century historical figures who were directly or indirectly responsible for the development of the theory of evolution (i.e., Carolus Linnaeus, Charles Lyell, Alfred Russell Wallace, Charles Darwin, and Gregor Mendel); describe the contribution each made to evolutionary theory.

♦ Describe the fundamental principles of natural selection (i.e., biological variation, individual competition, favorable variation, environmental context, selective pressure, and reproductive success); define adaptation.

♦ Describe the fundamental concepts of genetics (i.e., chromosome, DNA, gene, population, gene pool, and species).

♦ Describe the modern syncretic theory of evolution.

♦ Describe the nature of science, and define the terms fact, hypothesis, law, and theory; describe the extent to which evolution should be regarded as fact; describe the scientific facts regarding the age of the earth and universe.

♦ Describe the nature of creationism; describe the extent to which creationism should be regarded as fiction; identify and describe the relevant Supreme Court ruling pertaining to the teaching of creationism in public schools.

♦ Describe the historical circumstances in 1858-1859 surrounding Charles Darwin’s decision to write On the Origin of Species; describe the nature of Darwin’s relationships and interaction with his scientific colleagues, including Alfred Russell Wallace and Charles Lyell; describe the nature of Darwin’s relationships and interaction with his wife and family; describe the nature of Darwin’s earlier experiences prior to that year and their impact on his thinking, including his voyage aboard the Beagle in the 1830’s; identify Charles Darwin’s father and grandfather, and describe their influence on Darwin’s thinking.

♦ Describe basic facts about the evolution of life on earth as summarized in the film The
*Ultimate Journey*, including the timing of major evolutionary changes (e.g. the appearance of the first multi-cellular organisms, the appearance of the first terrestrial animals, and the appearance of the first whales and dolphins) as well as basic biological facts (including the fundamental similarities among all six classes of vertebrates and the fundamental facts regarding human fertilization and embryonic development); describe as well the evolutionary significance of the coelacanth.

♦ Describe the 2005 federal court case concerning the teaching of creationism in public schools in Dover, Pennsylvania; identify and describe the litigants on either side, and describe the arguments they offered to support their positions; identify the judge in the case and describe his ruling.

♦ Describe the evolutionary significance of the fossil Tiktaalik, as summarized in the film *Judgment Day*.

♦ Describe the range of opinion among contemporary scientists regarding the compatibility of science and religion; describe the range of opinion among the general public in the United States regarding the truth of evolution.
Chapter 3

Primate Taxonomy
and
Early Primate Evolution

LEARNING OBJECTIVES

At the completion of this unit, you will be able to list the defining characteristics of primates, and you will be able to describe primate taxonomy with a focus on human phylogeny. In particular, you will be able to describe the phylum, subphylum, class, subclass, order, suborder, infraorder, superfamily, family, subfamily, tribe, and genus to which humans belong. Finally, you will be able to describe the general outline of early primate evolution in the Oligocene and Miocene geological epochs by identifying important genera of early anthropoids and hominoids.
LECTURE OUTLINES

I. Primate Taxonomy
   (focusing on HUMANS in the ANIMAL Kingdom)

   A. Phylum—CHORDATES
      
      animals with a nerve cord supported by a stiff cord (the notochord) along the back; chordates have gill slits during at least part of the life span

   B. Subphylum—VERTEBRATES
      
      animals with bony backbones and sense organs in the head; divided into six classes: bony and cartilaginous fishes, amphibians, reptiles, birds, and mammals; the earliest vertebrates appeared 480 million years ago

   C. Class—MAMMALS
      
      warm-blooded vertebrates with mammary glands, a four-chambered heart, a diaphragm separating the thorax & abdomen, and heterodont dentition; the earliest mammals appeared 160 million years ago

   D. Subclasses of MAMMALS

      1. Prototherian (a.k.a. monotremes)
         
         egg-laying mammals (e.g., duck-billed platypus)
2. **Metatherian (a.k.a. marsupials)**

pouched mammals (e.g., kangaroo, opossum)

3. **EUTHERIAN (a.k.a. PLACENTALS)**

fetus nourished in the uterus by the placenta (eutherians dominate living mammals)’ the earliest eutherian mammals appeared 65 million years ago

E. **Order of Eutherian Mammals—PRIMATES**

the earliest primates appeared about 60 million years ago--there are approximately 200 living species of primates

**Primate Characteristics**

1. **Arboreal Adaptation**

a way of life centered on living in trees and obtaining food in trees

2. **Generalized Limb Structure**

flexible limb structure allows for a range of locomotor behaviors (ways of moving about); primates retain the clavicle (collarbone), a primitive feature lost in many more specialized mammals

3. **Prehensility**

grasping ability, facilitated by the retention of five digits on the hands and feet; many primates have grasping feet as well as grasping hands
4. **Opposable Thumbs**

the thumb can come into contact with the second digit and/or the palm; some primates have opposable big toes; most primates have nails rather than claws on their digits

5. **Generalized Dentition**

teeth are not specialized for processing any one type of food

6. **Stereoscopic Vision**

the ability to perceive objects in three dimensions (depth perception) as a result of having eyes toward the front of the face which sends overlapping visual signals to the brain

7. **Larger Brains**

larger size and greater complexity, especially in regions of the brain associated with vision and the use of the hand

8. **Longer Gestation & Life Span**

longer life span as a result of having larger brains and a greater reliance on flexible, learned behavior--characteristics also associated w/ delayed maturation

9. **Social Adaptation**

most primates live in groups, where adult males remain permanently associated with the group
F. *Suborders of PRIMATES* (traditional classification)

1. **Prosimians (a.k.a. the lower primates)**

   small body size, mostly nocturnal, greater reliance on smell; lemurs (Madagascar) and lorises (Africa, South Asia, and Southeast Asia)

2. **Tarsiers**

   tiny body size, nocturnal insectivores, enormous eyes, heads rotate 180° (insular Southeast Asia—Sumatra, Borneo, Celebes, Mindanao)

3. **ANTHROPOIDS**
   (a.k.a. the higher primates)

   humans, apes, & monkeys; larger body size, larger brains, color vision, one pair of breasts; the earliest anthropoids appeared 35 million years ago

G. *Infraorders of ANTHROPOIDSs*

1. **Platyrrhines**

   New World Anthropoids (New World monkeys)

2. **CATARRHINES**

   Old World Anthropoids (humans, apes & Old World monkeys)
H. Superfamilies of ANTHROPOIDS

1. Ceboids (New World Monkeys)

2 1 3 3 dental formula (incisors, canines, premolars, molars); broad, flaring noses with outward-facing nostrils; some species have prehensile tails

2. Cercopithecoids (Old World Monkeys)

2 1 2 3 dental formula; narrow noses with downward-facing nostrils; no species have prehensile tails

3. HOMINOIDS (humans & apes)

2 1 2 3 dental formula; larger body size, larger, more complex brains; no tails at all; the earliest hominoids appeared approximately 20 million years ago

I. Families of Hominoids

1. Hylobatids (lesser apes)

gibbons and siamangs (Southeast Asia); very long arms for brachiation (swinging from arms); dense, heavy fur
2. **HOMINIDS (humans & great apes)**

humans, orangutans, gorillas, chimpanzees, and bonobos

a. **Subfamilies of Hominids**

i. **Pongines**

Orangutans (Asia); long arms, short legs, U-shaped jaws, four-handed climbers

ii. **Gorillines**

Gorillas (Africa) long arms, short legs, U-shaped jaws, knuckle-walkers

iii. **HOMININES**

humans, chimpanzees, and bonobos

b. **Tribes of HOMININES**

i. **Panins**

chimpanzees and bonobos (long arms, short legs, U-shaped jaws, knuckle-walkers)
ii. HOMININS

humans and human ancestors/relatives with bipedal locomotion; short arms, long legs, lumbar curve, centrally-located foramen magnum, parabolic jaws; the earliest hominins appeared approximately 5 million years ago

J. Genera of HOMININS

1. Sahelanthropus
2. Orrorin
3. Ardipithecus
4. Australopithecus
5. Paranthropus
6. HOMO (“humans”)

modern humans and closely related hominins; large brains, small faces, larger brain cases, reduced brow ridges, little or no sagittal crest; the earliest members of the genus Homo appeared approximately 2.5 million years ago

K. Species of HOMO

1. habilis
2. erectus
3. heidelbergensis
4. neanderthalensis
5. SAPIENS

modern humans (the earliest members of the species sapiens appeared approximately 100,000 years ago)
The following additional lecture notes are intended especially for internet students (although they may also be helpful to classroom students who were absent from the lecture presentation).

The primary goal of this unit is to make you thoroughly familiar with primate taxonomy: thus you should be able to quickly answer such questions as “Is a prosimian an anthropoid?” or “Is a hominin a hominoid?”, and you should be able to define the criteria that distinguish the various taxa (e.g., what are the differences between hominins, hominids, hominoids, and anthropoids?).

You should find it helpful to pay close attention to the chart on the following page. Notice that humans belong to all of the yellow-shaded taxa* in the chart, all of which extend to the extreme right of each row (thus humans are Animals, Chordates, Vertebrates, Mammals, Eutherians, Primates, Anthropoids, Catarrhines, Hominoids, Hominids, Hominines, Hominins, members of the genus *Homo*, and members of the species *sapiens*). Remember when using binomial nomenclature (in which every organism is identified by its genus and species), the genus term is always capitalized, the species term is always in lower case, and the entire term is always italicized (or underlined if you’re writing by hand)--for example: *Homo sapiens*.

*The word “taxa” is the plural of “taxon,” which means any single unit in a taxonomy (such as class, order, or family); on the chart on the following page, each box is a distinct taxon, and all the boxes (i.e., taxa) to which humans belong are shaded yellow.
**Primate Taxonomy & the Classification of Humans**

(Humans belong to each of the yellow-shaded taxa.)

<table>
<thead>
<tr>
<th><strong>Animals</strong></th>
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<th>Tarsiiformes</th>
<th>Platyrhines (Platyrrhini)</th>
<th>Ceboids (Cebidae)</th>
<th>Cercopithecoids (Cercopithecoidae)</th>
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<td>Tarsiers</td>
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<td>Old World Monkeys</td>
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**Hominoids (Hominoida)**

(Humans & apes)

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<td>Ardipithecus</td>
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<tr>
<td>Australopithecus</td>
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</tr>
<tr>
<td>heidelbergensis</td>
<td>neanderthalensis</td>
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<tr>
<td>sapiens</td>
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Ape Genius

The content of this Supplemental Reading is derived from the following film:


Watch the film online on the PBS website at http://video.pbs.org/video/1200128615

Ape Genius examines the similarities and differences between the mental capacities of the great apes (chimpanzees, bonobos, orangutans, and gorillas) and the mental capacities of humans. It has long been recognized that some of the great apes make and use simple tools in the wild, and that some of them can be taught to communicate via sign language in captivity. Recent research, however, has demonstrated that the mental abilities of apes are much closer to our own than previously expected, and many cognitive functions that were once thought to be uniquely human are now known to be shared with our closest living relatives.

Watch the program by following the link above to the PBS website (at the site, you’ll also find a link to the complete transcript of the program that you can download free of charge if you’d like to have a written version of the content).
<table>
<thead>
<tr>
<th>Bonobo</th>
<th>Orangutan</th>
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- Bonobo
- Orangutan
TEST OBJECTIVES

The multiple-choice test questions for Unit Test #3 will refer directly to the test objectives listed below; if you can meet all of the test objectives described here, you should have no trouble earning a score of 100% on the Unit Test. (These test objectives will also apply directly to the Midterm Exam, which will cover nothing more and nothing less than all of the test objectives for Units 1 through 4.)

♦ Define taxonomy.

♦ Describe the essential characteristics of the phylum of chordates.

♦ Describe the essential characteristics of the subphylum of vertebrates, and identify the date when the earliest vertebrates appeared.

♦ Describe the essential characteristics of the class of mammals, and identify the date when the earliest mammals appeared.

♦ Describe the essential characteristics of the three subclasses of mammals (i.e. prototherians, metatherians, and eutherians), and identify the date when the earliest eutherians appeared.

♦ Describe the essential characteristics of the order of primates, and identify the date when the earliest primates appeared.

♦ Describe the essential characteristics of the three suborders of primates (i.e., prosimians, tarsiers, and anthropoids), and identify the date when the earliest anthropoids appeared.

♦ Describe the essential characteristics of the two infraorders of anthropoids (i.e., platyrhines and catarrhines).

♦ Describe the essential characteristics of the three superfamilies of anthropoids (i.e., ceboids, cercopithecoids, and hominoids), and identify the date when the earliest hominoids appeared.

♦ Describe the essential characteristics of the two families of hominoids (i.e., hylobatids and hominids).

♦ Describe the essential characteristics of the two subfamilies of hominids (i.e., gorillines and hominines).

♦ Describe the essential characteristics of the two tribes of hominines (i.e., panins and hominins), and identify the date when the earliest hominins appeared.
♦ Identify the six principal genera of hominins (i.e., *Sahelanthropus, Orrorin, Ardipithecus, Australopithecus, Paranthropus*, and *Homo*); describe the essential characteristics of the genus *Homo* and identify the date when the earliest member of the genus *Homo* appeared.

♦ Identify the five principal species of *Homo* (i.e., *habilis, erectus, heidelbergensis, neanderthalensis*, and *sapiens*) and identify the date when the earliest *Homo sapiens* appeared.

♦ Describe the similarities and differences between humans and the great apes as summarized in the film *Ape Genius*; describe the linguistic abilities of the bonobo Kanzi; identify prominent contemporary primatologists who are active in field research, and describe their findings.

♦ Describe the time ranges for the geological epochs of the Oligocene and Miocene.

♦ Identify and describe the earliest genera of anthropoids from the Oligocene (i.e., *Apidium* and *Aegyptopithecus*) and the earliest genera of hominoids from the Miocene (i.e., *Sivapithecus, Dryopithecus*, and *Proconsul*).
LEARNING OBJECTIVES

At the completion of this unit, you will be able to trace the outline of *hominin evolution* in the *Pliocene* and *Pleistocene* geological epochs. You will be able to identify the probable date of the *panin-hominin divergence*, and you will be able to describe the essential characteristics of several early hominins, including *Sahelanthropus tchadensis, Orrorin tugenensis, Ardipithecus ramidus, Australopithecus anamensis, Australopithecus afarensis, Australopithecus africanus, Paranthropus robustus, Paranthropus boisei*, and *Homo habilis*. Finally, you will be able to describe what is known and what is not known at the moment about the earlier stages of the *human phylogeny*.
LECTURE OUTLINES

I. Plio-Pleistocene Hominins

Pliocene: 5 – 1.8 million years ago (m.y.a.)

Pleistocene: 1.8 m.y.a. – 10,000 y.a

Hominin: humans & human ancestors with bipedal locomotion, centrally-located foramen magnum, and (generally) lumbar curve & parabolic jaws

A. Pre-australopiths

the earliest hominins at the base of the tribal tree, following the panin-hominin divergence, which occurred between 5 and 8 million years ago

1. *Sahelanthropus tchadensis*

Chad, 7 m.y.a. (estimate based on biostratigraphy, surprisingly old) cranial capacity estimated 320 to 380 cm$^3$ (chimpanzee size) mixture of panin-like and hominin-like features: huge browridges, sagittal crest, large muscle attachments, yet smallish vertical face with front teeth that are very un-apelike…no postcranial remains, so bipedal status unknown (hominin status inferred from face and teeth)

2. *Orrorin tugenensis*

Ethiopia, 6 m.y.a.
mostly dental fragments, cranial capacity unknown; some lower leg bones that apparently indicate bipedalism

3. *Ardipithecus ramidus*

Ethiopia (Aramis), 4.4 m.y.a.; fragmentary cranial remains, but cranial capacity probably between 300 and 350 cc; thin molar enamel (unusual for early hominins); bipedal pelvis, forward position of foramen magnum, forelimb not weight bearing—all indicating bipedalism, but divergent big toe
B. Australopiths

widely dispersed throughout Africa from 4.2 to 1 million years ago—the longest enduring hominin group yet documented, consisting of two closely related genera; all australopiths are clearly bipedal, with relatively small brains, large teeth (especially the back teeth), and thick enamel on the molars

1. Australopithecus

a. Australopithecus anamensis

northern Kenya (Kanapoi), 4.2 – 3.9 m.y.a. cranium capacity unknown primitive features including large canines; the most primitive Australopithecine discovered so far, but still clearly a small-brained biped with thick molar enamel

b. Australopithecus afarensis

Ethiopia (Hadar), Chad, Laetoli (Tanzania) ranging from 3.9 – 3.0 m.y.a. cranial capacity averaging 420 cm³ based on extensive specimens (more than 60 individuals) very primitive: large canines, parallel teeth rows, but definitely bipedal high degree of sexual dimorphism (males 5’, females 3.5’) “Lucy,” Laetoli footprints; a strong candidate for the ancestor of all later hominins, based on currently available evidence
c. *Australopithecus africanus*

southern Africa, 2.5 – 2.0 m.y.a. (no Australopithecine fossils have been found in East Africa after 3.0 m.y.a.)
cranial capacity averaging 440 cm$^3$; small-bodied, large-toothed bipeds
the “Taung child”

2. *Paranthropus*

later australopiths showing a number of peculiarly evolved (“derived”) features—
largest teeth of all australopiths, with large, deep jaws and prominent attachments
for chewing muscles, including a sagittal crest; flat faces with broad, flaring cheekbones

a. *Paranthropus robustus*

South Africa, 2.0 – 1.3 m.y.a.
cranial capacity averaging 520 cm$^3$
massive jaws and teeth, large broad faces,
large sagittal crest
specialized diet (seeds, nuts, and roots)

b. *Paranthropus boisei*

East Africa (Olduvai Gorge, Tanzania), 2.3 – 1.0 m.y.a.
cranial capacity averaging 520 cm$^3$
massive jaws and teeth, large broad faces,
large sagittal crest
specialized diet (seeds, nuts, and roots)

C. *Early Homo*

earliest members of the genus *Homo* yet discovered, 2.4 – 1.4 m.y.a.; larger brains than other hominins; several species may have coexisted in the earliest stages

*Homo habilis* (“handy man”)

Olduvai Gorge, Tanzania, East Africa, 1.8 m.y.a.
average cranial capacity 630 cm$^3$
smaller and narrower teeth, slightly larger body size
compared to the Australopithecines
II. The Human Phylogeny

“phylogeny” refers to a schematic representation showing ancestor-descendant relationships, usually in a chronological framework (i.e., a “family tree”)

A. Currently Unresolved Questions

regarding the Human Phylogeny from the Plio-Pleistocene (the fragmentary nature of the fossil record: approximately 500 individuals have been recovered for the period 4.4 – 1.0 m.y.a.—that’s a sample of one individual for every 6,800 years!)

1. Were Sahelanthropus and Orrorin both unquestionably bipedal? Were they in fact hominins?

2. Are Australopithecus anamensis and Australopithecus afarensis in fact separate species? Is there more than one species of afarensis?

3. Are Australopithecus anamensis, Australopithecus afarensis, and/or Australopithecus africanus direct human ancestors?

4. How many species of early Homo existed?

B. Currently Accepted Conclusions

regarding the Human Phylogeny from the Plio-Pleistocene

1. the panin-hominin divergence occurred between 5 and 8 million years ago

2. Africa is the location of the earliest hominin evolution (Charles Darwin was right!)

3. the African fossils that have been designated as Ardipithecus, Australopithecus, or Homo are unquestionably hominins

4. among anthropologists, there is general agreement on genus level designations for Plio-Pleistocene hominins

5. Paranthropus robustus and Paranthropus boisei are definitely not direct human ancestors (instead, they represent a side branch that became extinct)
The models below were created by the paleo-artist John Gurche for an exhibit on human origins at the Smithsonian Institution’s National Museum of Natural History.

| Australopithecus afarensis | Paranthropus boisei |
First Steps

The content of this Supplemental Reading is derived from the following film:

First Steps. 2009. NOVA episode. PBS Television.

Watch the film online on the PBS website at http://video.pbs.org/video/1312522241

Where did we come from? What makes us human? An explosion of recent discoveries sheds light on these questions, and NOVA’s special series on Becoming Human examines what the latest scientific research reveals about our hominin relatives. Part I of the series, entitled First Steps, examines the factors that led us to split from our ape-like ancestors. This episode examines the fossil of “Selam,” also known as “Lucy’s Child.” Paleoanthropologist Zeray Alemseged spent five years carefully excavating the sandstone-embedded fossil. NOVA’s cameras are there to capture the unveiling of the face, spine, and shoulder blades of this 3.3 million-year-old fossil child. NOVA takes viewers “inside the skull” to show how our ancestors’ brains had begun to change from those of the apes.

Watch the program by following the link above to the PBS website (at the site, you’ll also find a link to the complete transcript of the program that you can download free of charge if you’d like to have a written version of the content).
Birth of Humanity

The content of this Supplemental Reading is derived from the following film:


Watch the film online on the PBS website at [http://video.pbs.org/video/1319997127](http://video.pbs.org/video/1319997127)

_Birth of Humanity_ is the second episode in the *Becoming Human* series. In this episode, NOVA investigates the first skeleton that really looks like us, namely Turkana Boy (also known as Nariokotome Boy), an astonishingly complete specimen of *Homo erectus* found by the famous Leakey team in Kenya. These early humans are thought to have developed key innovations that helped them thrive, including hunting large prey, the use of fire, and extensive social bonds. The program examines an intriguing theory that long-distance running—our ability to jog—was crucial for the survival of these early hominins. Not only did running help them escape from vicious predators roaming the grasslands, but it also gave them a unique hunting strategy: chasing down prey animals such as deer and antelope to the point of exhaustion. *Birth of Humanity* also probes how, why, and when humans’ uniquely long period of childhood and parenting began.

Watch the program by following the link above to the PBS website (at the site, you’ll also find a link to the complete transcript of the program that you can download free of charge if you’d like to have a written version of the content).
TEST OBJECTIVES

The multiple-choice test questions for Unit Test #4 will refer directly to the test objectives listed below; if you can meet all of the test objectives described here, you should have no trouble earning a score of 100% on the Unit Test. (These test objectives will also apply directly to the Midterm Exam, which will cover nothing more and nothing less than all of the test objectives for Units 1 through 4.)

♦ Define the time ranges for the Pliocene and Pleistocene geological epochs, and define hominin.

♦ Identify and describe the three principal species of Pre-Australopiths (i.e., *Sahelanthropus tchadensis*, *Orrorin tugenensis*, and *Ardipithecus ramidus*).

♦ Identify and describe the two principal genera of Australopiths (i.e., *Australopithecus* and *Paranthropus*).

♦ Identify and describe the three principal species of *Australopithecus* (i.e., *A. anamensis*, *A. afarensis*, and *A. africanus*).

♦ Identify and describe the two principal species of *Paranthropus* (i.e., *boisei* and *robustus*).

♦ Identify and describe an important early species of the genus *Homo* (i.e., *habilis*).

♦ Define the term phylogeny, and describe what anthropologists do and do not know for certain about the phylogeny of hominins in the Pliocene and early Pleistocene, based on currently available evidence.

♦ Identify and describe the technique that geneticists use in order to find out how long ago closely related species split from a common ancestor (as explained in the film *First Steps*).

♦ Describe the percentage of the body’s energy that modern human brains consume (as explained in the film *Birth of Humanity*).

♦ Describe the ways in which the evolution of human pubic lice provides evidence for dating the reduction in human body hair.

♦ Identify and describe the earliest stone tool industry from the Lower Paleolithic.

♦ Describe the significance that cooking may have had for human biocultural evolution.
Identify the researcher who discovered the first Australopithecine fossil in South Africa in the 1920’s; identify and describe the fossil, and identify the exact location where it was found.

Identify and describe the fossil specimen that’s been nicknamed “Toumai.”

Identify and describe the fossil specimen that’s been nicknamed “the black skull.”

Identify and describe the fossil specimen that’s been nicknamed “Selam.”

Identify and describe the fossil specimen that’s been nicknamed “Lucy.”

Identify and describe the fossil specimen that’s been nicknamed “Turkana Boy.”
Chapter 5

The Evolution of the Genus Homo

LEARNING OBJECTIVES

At the completion of this unit, you will be able to trace the outline of the evolution of the genus *Homo* by describing the essential biological and cultural characteristics of *Homo erectus, Homo heidelbergensis, Homo neanderthalensis*, and early *Homo sapiens*. In addition, you will be able to describe the contemporary competing theories to account for the origins of *Homo sapiens sapiens*. 
LECTURE OUTLINES

I. Homo erectus

a species of Homo that evolved in Africa from some earlier species of Homo and that eventually evolved into Homo sapiens; if not the first hominin to disperse out of Africa, certainly the first hominin to have a wide geographic dispersion

A. Dating/Geography

Homo erectus lived from 1,800,000 to 200,000 (or even later) years ago, during the Pleistocene (“Ice Age”)
East Africa 1.8 m.y.a.
Georgia (Dmanisi) 1.75 m.y.a. (possibly an earlier form of Homo)
Java 1.6 m.y.a. (possibly surviving to 25,000 y.a.)
China as early as 670,000 y.a.
European presence of Homo (in Spain) as early as 1.2 m.y.a. years ago was probably not Homo erectus, but another species (perhaps Homo antecessor)

B. Biological Characteristics

average cranial capacity 900 cm$^3$ (with a range from 700 cm$^3$ to 1,250 cm$^3$)
large brow ridges (supraorbital tori), heavy cranial bones
postorbital constriction
receding forehead and chin, first prominent hominin nose
long, low skull vault, with maximum breadth low on the skull
pentagonal skull shape from rear, shovel-shaped incisors
larger body than early Homo (average 5’6”, > 100 lbs), with considerable sexual dimorphism (males average 6’ tall)
Nariokotome Boy (a.k.a. Turkana Boy, Lake Turkana, Kenya, 1984), 1.6 m.y.a., 8-12 years old
C. Cultural Characteristics

tools made of stone, bone, horn, and antler
first biface stone tools—hand axes most common
(Acheulian tool kit)
remarkably uniform technology for 1.5 + million years
clear evidence of butchering, but debatable whether
hunters or scavengers—probably both
debatable whether controlled fire (absence of hearths,
which would be the best evidence); clothing assumed
because of temperate climate
unlikely to have used language (fully articulate
speech)—but not known for certain; no deliberate
burials, no evidence of symbolic life

II. Homo heidelbergensis

premodern humans from the Middle Pleistocene that differ from Homo erectus but lack the
full set of characteristics diagnostic of Homo sapiens (a transitional species that is ancestral
to both Neandertals and modern humans)

A. Dating/Geography

Africa, Asia, & Europe
850,000 years ago – 200,000 years ago

B. Biological Characteristics

average cranial capacity 1,200 cm³
increased parietal breadth
skull no longer pentagonal
occipital bun
pronounced brow ridges (compared to Homo sapiens)
decreased cranial and postcranial robusticity
(compared to Homo erectus)
C. Cultural Characteristics

slightly more sophisticated stone tools than Homo erectus (although there is considerable regional diversity)
may have increased the use of caves as shelters, but also built temporary shelters
greater probability of being able to control fire
greater probability of extensive big game hunting

III. Homo neanderthalensis (“Neandertals”)

a particular descendant of Homo heidelbergensis with distinctive characteristics and limited geographical distribution

A. Dating/Geography

Europe and southwest Asia only; 130,000 – 30,000 years ago

B. Biological Characteristics

average cranial capacity 1,520 cm³
(largest brain of any hominin that’s ever lived; possible adaptation to extreme cold)
large, long, low cranium, bulging at the sides
prominent brow ridges, projecting face, large nasal aperture
very robust postcranially—barrel-chested, heavily muscled

C. Cultural Characteristics

fairly sophisticated flake tools
lived in open sites, caves, and rock shelters
used fire for cooking, warmth, light, and predator protection; big-game hunters, but limited to close-proximity spearing; high injury rate, short longevity
clothing of simple design, not sewn
first deliberate burials, but not as elaborate as Homo sapiens sapiens (few grave goods)
IV. *Homo sapiens sapiens*

anatomically modern human beings that share a particular set of derived characteristics

A. **Origins**

there are three principal competing hypotheses—each has some merit, and the truth may lie in a combination of elements from all three

1. **Complete Replacement Model**

anatomically modern populations emerged in Africa as early as 200,000 years ago and then migrated to replace populations elsewhere in the Old World through an abrupt process that involved little or no gene flow

2. **Partial Replacement Model**

anatomically modern populations emerged in Africa more than 100,000 years ago and migrated to replace populations elsewhere in the Old World through a gradual process involving some gene flow

3. **Regional Continuity Model**

anatomically modern populations emerged in various places in the Old World and evolved along parallel lines in a process that involved some gene flow and that exhibited some regional variation

B. **Dating/Geography**

Africa 195,000 y.a.
Southwest Asia 130,000 y.a., East Asia 40,000 y.a.,
Southeast Asia 45,000
Australia ~50,000 y.a., Europe 35,000 y.a.

C. **Biological Characteristics**

average cranial capacity 1,400 cm$^3$
high, rounded cranial vault; vertical forehead; distinct chin; small brow ridges; less robust post-cranially little or no prognathism (the extent to which the lower face protrudes in front of the upper face in profile)
smaller teeth evolved because of specialized tools; chin evolved to buttress lower jaw (good example of biocultural evolution)
D. Cultural Characteristics: The Upper Paleolithic

a cultural period associated with early modern humans, primarily in Europe 40,000 to 10,000 years ago, that is distinguished by technological and artistic innovation

1. Technology

tailored, sewn clothing (eyed needles made of bone)
harpoons (composite tools consisting of a detachable stone point connected to a wooden shaft by a cord made of leather, sinew, or fiber)
atlatl (spearthrower—allowed spears to be thrown greater distances with greater force)
burin (stone chisel) used to engrave bone, antler, ivory, wood, and stone
burials with elaborate grave goods

2. Art

perhaps better called visual and material imagery—the term “art” assumes aesthetic intent, and it’s not known for certain if that assumption is warranted for Upper Paleolithic peoples

Sculpture: bone and ivory carving, figures made from fired clay (including “Venuses,” female figurines with exaggerated sexual characteristics and blank faces)

Cave Painting: game animals such as bison and horses, but almost never reindeer, and rarely carnivores; outlines of human hands, but rarely human figures, and never realistic drawings of humans
V. The Human Phylogeny

A. Currently Unresolved Questions

1. Did *Homo erectus* have language?

2. Did *Homo erectus* have complete control of fire?

3. Were the various species of the genus *Homo* that have been identified from the Pleistocene (including *erectus, ergaster, antecessor, heidelbergensis, neanderthalensis, sapiens, floresiensis*) in fact separate biological species that would not have been capable of interbreeding, or were some or all of them simply different sub-species that would have been capable of interbreeding? (In other words, does the taxonomy accurately reflect the phylogeny of the genus? For example, recent evidence indicates that *H. sapiens* and *H. neanderthalensis* did interbreed to a small extent, but what about the other species?)

B. Currently Accepted Conclusions

1. *Homo heidelbergensis* definitely descended from *Homo erectus* (although some regional populations of *Homo erectus* may have become extinct)

2. Modern humans definitely descended from *Homo heidelbergensis* (although some regional populations of *Homo heidelbergensis* may have become extinct)
The models below were created by the paleo-artist John Gurche for an exhibit on human origins at the Smithsonian Institution’s National Museum of Natural History.

<table>
<thead>
<tr>
<th>Homo erectus</th>
<th>Homo heidelbergensis</th>
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<tbody>
<tr>
<td><img src="image1" alt="Homo erectus" /></td>
<td><img src="image2" alt="Homo heidelbergensis" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Homo neanderthalensis</th>
<th>Homo floresiensis</th>
</tr>
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<tbody>
<tr>
<td><img src="image3" alt="Homo neanderthalensis" /></td>
<td><img src="image4" alt="Homo floresiensis" /></td>
</tr>
</tbody>
</table>
Decoding Neanderthals

The content of this Supplemental Reading is derived from the following film:

Decoding Neanderthals. 2013. NOVA episode. PBS Television.

Watch the film on the PBS website at http://video.pbs.org/video/2323758207

Over 60,000 years ago, the first modern humans—people physically identical to us today—left their African homeland and entered Europe, then a bleak and inhospitable continent in the grip of the Ice Age. But when they arrived, they were not alone: the stocky, powerfully built Neanderthals had already been living there for hundreds of thousands of years. So what happened when the first modern humans encountered the Neanderthals? Did we make love or war? That question has tantalized generations of scholars and seized the popular imagination. Then, in 2010, a team led by geneticist Svante Paabo announced stunning news. Not only had they reconstructed much of the Neanderthal genome—an extraordinary technical feat that would have seemed impossible only a decade ago—but their analysis showed that “we” modern humans had interbred with Neanderthals, leaving a small but consistent signature of Neanderthal genes behind in everyone outside Africa today. In Decoding Neanderthals, NOVA explores the implications of this exciting discovery. In the traditional view, Neanderthals differed from “us” in behavior and capabilities as well as anatomy. But were they really mentally inferior, as inexpressive and clumsy as the cartoon caveman they inspired? NOVA explores a range of intriguing new evidence for Neanderthal self-expression and language, all pointing to the fact that we may have seriously underestimated our mysterious, long-vanished human cousins.

Watch the program by following the link above to the PBS website (at the site, you’ll also find a link to the complete transcript of the program that you can download free of charge if you’d like to have a written version of the content).
Alien from Earth

The content of this Supplemental Reading is derived from the following film:

Alien from Earth. 2008. NOVA episode. PBS Television.

Watch the film online on the PBS website at http://video.pbs.org/video/1051895972

Alien from Earth tells the story of the discovery, analysis, and startling implications of a 2003 archeological find on the island of Flores in the Indonesia archipelago—a diminutive hominin, classified as a member of the genus Homo, that’s been nicknamed “the hobbit”. Flores is known for its strange fauna, but Homo floresiensis may be the strangest yet. The hobbit was an adult female no larger than a three-year-old child, with a skull less than one-third the size of a modern human’s. The discovery created a media sensation. But only now are researchers beginning to make sense of this archeological oddity. Definitive proof of its place in the human lineage awaits future finds, especially DNA evidence, but the implications of the work so far are intriguing and quite possibly revolutionary.

Watch the program by following the link above to the PBS website (at the site, you’ll also find a link to the complete transcript of the program that you can download free of charge if you’d like to have a written version of the content)
TEST OBJECTIVES

The multiple-choice test questions for Unit Test #5 will refer directly to the test objectives listed below; if you can meet all of the test objectives described here, you should have no trouble earning a score of 100% on the Unit Test. (These test objectives will also apply directly to the Final Exam, which will cover nothing more and nothing less than all of the test objectives for Units 5 through 8.)

♦ Describe the essential characteristics of *Homo erectus* (i.e., describe the biological and cultural characteristics of the species as well as its geographic distribution and time range).

♦ Describe the essential characteristics of *Homo heidelbergensis* (i.e., describe the biological and cultural characteristics of the species as well as its geographic distribution and time range).

♦ Describe the essential characteristics of *Homo neanderthalensis* (i.e., describe the biological and cultural characteristics of the species as well as its geographic distribution and time range).

♦ Describe the essential characteristics of *Homo sapiens sapiens* (i.e., describe the biological and cultural characteristics of the species as well as its geographic distribution and time range).

♦ Describe the three contemporary hypotheses in anthropology that attempt to account for the origins of *Homo sapiens sapiens*.

♦ Describe the Upper Paleolithic, and describe the innovative forms of technology and art that first appeared during that cultural period.

♦ Describe what anthropologists do and do not know for certain about the phylogeny of the genus *Homo* based on presently available evidence.

♦ Define the terms *grade* and *clade* in the context of taxonomy.

♦ Identify and describe the fossil specimen that’s been nicknamed the “Nariokotome boy.”

♦ Describe the biological and cultural characteristics of *Homo floresiensis*, as well as the geographic location and dating for the species; describe the circumstances of its discovery, and describe the controversy in anthropology over the taxonomic status of this surprising hominin.

♦ Describe the fossil specimens found in Dmanisi, Georgia, and describe their implications for the course of hominin evolution.
♦ Describe the interaction that took place between the Neandertals and modern humans when *Homo sapiens* first entered Europe about 40,000 years ago.

♦ Describe the technology for making stone tools used by the Neandertals (i.e., the Levallois technology).

♦ Describe the similarities and differences between the genomes of *Homo sapiens* and *Homo neanderthalensis*.

♦ Describe the presently-available evidence that is relevant to the question of the ultimate fate of the Neandertals.
LEARNING OBJECTIVES

At the completion of this unit, you will be able to describe the evidence for the earliest human habitation of the New World, and you will be able to identify the strengths and weakness of the three competing hypotheses for the origins of the earliest Americans. You will be able to identify the principal archaeological sites associated with the earliest Americans, and you will be able to describe both the biological characteristics of the earliest Americans as well as the essential features of Paleo-Indian culture. Finally, you will be able to describe the Mesolithic as a cultural adaptation to environmental change at the end of the Pleistocene.
LECTURE OUTLINES

I. Holocene Archaeology

The Holocene is the geological epoch from 10,000 years ago to the present, also known as the Post-Pleistocene or Recent Period. *Homo sapiens sapiens* is the only hominin living during the Holocene—a time during which humans became very numerous, occupied most of the earth, left an extensive archaeological record, and developed highly complex technologies and societies.

II. The First Americans

Who were the first Americans? When and how did they arrive? The *precise* answers are still an unsolved problem (there are three principal hypotheses at the moment)

A. Origins of the Earliest Americans

1. Bering Land Bridge

Upper Paleolithic hunters were in northeastern Siberia by 30,000 years ago, culturally and geographically poised to become the first Americans.

The Bering Land Bridge (located where the Bering Strait is today), existed most recently from 25,000 to 11,000 years ago; at maximum glaciation, sea levels fell 330 feet, creating a 1,300-mile-wide (north-south) landmass called Beringia with a tundra environment (a treeless plain with permafrost that supports shallow-rooted vegetation such as grasses and mosses—a cold, dry arctic climate).

Once they reached present-day Alaska, however, the earliest Americans would have been blocked from entry into the rest of the Americas by massive ice sheets; an ice-free corridor finally opened in the late Pleistocene around 13,500 years ago, but that was *after* the earliest archaeological evidence of humans in the Americas south of the glaciers.
2. **Pacific Coastal Route**

The earliest Americans may have used some form of water transport (such as canoes or rafts) to travel from Asia to the Americas, hugging the coasts along the way and exploiting rich marine resources; feasible in principle, most of the archaeological evidence is submerged 300’ below sea level—however, there is some supporting archaeological evidence, including 13,000-year-old human skeletal remains on California’s Santa Rosa Island, and the site at Monte Verde in Chile, near the coast.

3. **North Atlantic Ice-Edge Corridor**

The Upper Paleolithic *Solutrean* culture of Europe is very similar, technologically, to the *Clovis* culture of North America, suggesting a possible European origin of early Americans; early immigrants may have traveled along the North Atlantic sea-ice bridge that linked Europe and North America during the Last Glacial Maximum.

However, the Solutrean ended 5,000 years before Clovis began, there is no archaeological evidence to link the Solutrean with the precursors of Clovis, and the genetic evidence points clearly to an Asian (not European) origin for native Americans.

**B. Early Archaeological Sites in the Americas**

the earliest sites were probably erased by silt and gravel from glacial melting and rising sea levels, but there are some significant sites that are claimed to be very early, including:

- **Pedra Furada**, Brazil: charcoal dated to 40,000 + B.P. (hearths or natural fires?); stone “tools” (cores and flakes worked by humans, or natural chips?)

- **Meadowcroft Rock Shelter**, Pennsylvania: many levels, dated to as early as 19,000 years ago; variety of carefully-crafted stone tools (dating now generally accepted)

- **Monte Verde**, Chile: dated to 14,800 years ago; foundations of huts, stone tools, animal bone including mastodon; dating now generally accepted (this site has important implications for the Pacific Coastal Route hypothesis)
C. Biological & Cultural Characteristics of Earliest Americans

1. Biological Characteristics

There are very few New World skeletons from the period prior to 9,500 years ago; among the oldest human remains are the partial skeleton of a young woman from a cave near the near Buhl, Idaho dated to 12,800 years ago, and a mummified man in his early 40’s from Spirit Cave, Nevada, dated to 10,600 years ago.

New World skeletons before 7,000 years ago lack the craniofacial morphological traits associated with modern Asians and Native Americans; instead, the earliest Americans had small, narrow faces and long skulls (similar to the modern Ainu).

Amerindians from the past 7,000 years have the Sinodont (“Chinese tooth”) dental complex, which is shared by Amerindians and northern Chinese: shovel-shaped incisors, distinctive molar roots.

Amerindians have a high frequency of blood groups rarely found in other populations (strongly suggesting a founder effect); superficial features shared with Asian populations include straight black hair, little body hair, epicanthic fold.

2. Paleo-Indian Culture

ancient hunting culture, sometimes focused on megafauna, from 13,500 to 8,000 years ago; rapid spread indicated by cultural consistency in weaponry and hunting behavior.

**Clovis points** (13,200 – 12,800 y.a.) long, heavy, with small flute (fluting may have been an American invention); widespread throughout North America; associated with mammoths and other extinct species.

**Folsom points** (12,500 y.a.) western United States; shorter, thinner, with proportionally longer flute; associated exclusively with extinct long-horned bison.

**Plano points** (11,000 – 9,000 y.a.) Great Plains; unfluted points associated only with modern fauna, including bison.
III. The Middle Stone Age

the Mesolithic (Old World) or the Archaic (New World)—a cultural period characterized by broad spectrum foraging

A. Environmental Changes

the end of the Pleistocene brought major changes in climate, landscape, flora, and fauna; warmer weather, retreating glaciers, rising sea level, coastal flooding

tundra replaced by grasslands, then spruce forests, followed by deciduous forests; tundra grazers (moss & grass) such as reindeer, mammoth, horse, musk ox, and bison were replaced by forest browsers (leaves & twigs) such as red deer, elk, moose, white-tailed deer, auroch, and boar

B. Cultural Adaptations

wide range of animal foods, including fish, shellfish, birds, and small mammals; decreased importance of big game animals, increased importance of plant foods

new technologies: composite tools (multiple parts) such as the bow and arrow; weirs (fish dams) made of brush and stone; tool materials besides stone (bone, antler, leather, wood)

new division of labor: greater economic role for women, children, and the aged

IV. Kennewick Man & the Concept of “Race”

In the film Mystery of the First Americans, archaeologist Jim Chatters describes Kennewick Man as “Caucasoid” in appearance. However, the term simply indicates that the features of Kennewick Man’s skull resemble the American cultural stereotype of someone who is of predominantly European ancestry more than they resemble the stereotypes of someone who is of predominantly Asian ancestry (“Mongoloid”) or someone who is of predominantly African ancestry (“Negroid”).
**There is no such thing, biologically, as race.** Race is a cultural concept, not a scientific concept.

There is polytypic variation within the human species (i.e., local populations differ in the expression of one or more traits), but that variation is **continuous** across the human species for any genotypic or phenotypic trait (e.g., skin color), and that variation cannot be neatly divided into clearly defined categories with distinct boundaries.

Different cultures define racial categories differently—but no matter how the categories are defined, there is more genotypic and phenotypic variation **within** each category than there is **between** any two categories.

It is true that forensic anthropologists attempt to identify the “race” of an individual from skeletal remains, but that’s because “race” is an important identifying element to the forensic anthropologist’s clients (e.g., law enforcement officials). Forensic anthropologists know that “race” is not a valid scientific concept (which means they realize that there’s no scientific test that could possibly identify a person’s “race,” because “race” is not something that actually exists). When forensic anthropologists try to identify an individual’s “race,” they are trying to predict how that individual would have been classified in life by members of his or her culture using that culture’s definition of “race.”

Forensic anthropologists generally use the term “ancestry” rather than “race” (i.e., they try to identify the geographic population that most of an individual’s ancestors would have come from over the past few thousand years). Typically, forensic anthropologists identify three stereotypical ancestral groups based on features of the skull, and then attempt to determine which of the three stereotypes any given skull most closely resembles:

<table>
<thead>
<tr>
<th>European</th>
<th>Asian</th>
<th>African</th>
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<tbody>
<tr>
<td>narrow nasal aperture</td>
<td>medium nasal aperture</td>
<td>wide nasal aperture</td>
</tr>
<tr>
<td>sloping eye orbits</td>
<td>round eye orbits</td>
<td>rectangular eye orbits</td>
</tr>
<tr>
<td>little prognathism</td>
<td>moderate prognathism</td>
<td>strong prognathism</td>
</tr>
<tr>
<td>projecting chin</td>
<td>median chin</td>
<td>retreating chin</td>
</tr>
<tr>
<td>z-shaped palatal suture</td>
<td>straight palatal suture</td>
<td>arched palatal suture</td>
</tr>
</tbody>
</table>

Worldwide, however, **very few** individual skulls fit **any** of these three categories **exactly**, and **many, many** skulls fit **none** of these three categories. (For example, it would be impossible to classify the skull of Tiger Woods as either European, Asian, or African, because his father was of predominantly African and European ancestry while his mother was of predominantly Asian ancestry—thus, like most people, his skull exhibits a mixture of ancestral features.)
Finally, with the gene flow that goes on between various human populations (gene flow that has considerably increased in the modern age), the phenotypic features of any population are constantly changing. Thus, just because some individual might have predominantly “European” features in their skull (such as Kennewick Man), it doesn’t mean that they necessarily came from Europe. “European” features are simply a particular set of phenotypic traits that may have appeared and disappeared many times in many places in the history of the human species (the same is true of “Asian” or “African” features—and it’s also true that the overall pattern of phenotypic traits in most populations in the history of the human species did not conform to any of those three stereotypes).

The following additional lecture notes are intended especially for internet students (although they may also be helpful to classroom students who were absent from the lecture presentation).

The Lecture Outlines that appear above for Unit 6 are largely self-explanatory, and they are entirely so when read in conjunction with the assigned chapter in the textbook. As explained there, the terms “Mesolithic” and “Archaic” are synonyms (they both mean Middle Stone Age) but archaeologists typically reserve the term Archaic for New World cultures, and use the term Mesolithic for Old World cultures.

In the classroom, I discuss three archaeological sites that have been claimed to show human habitation prior to the Paleo-Indians: Pedra Furada, Meadowcroft, and Monte Verde. All three sites are discussed in some detail in the textbook. As explained there (and as I discuss in the classroom) most archaeologists are highly skeptical of the claims from the excavators of the Brazilian site, but most are inclined to accept the claims of the excavators of the Pennsylvanian site. The site in Chile has won virtually unanimous acceptance among archaeologists as proof of a pre-Clovis human presence in the New World.
**Mystery of the First Americans**

The content of this Supplemental Reading is derived from the following film:


You’ll find more information on the PBS Companion Website for *Mystery of the First Americans* at [http://www.pbs.org/wgbh/nova/first/](http://www.pbs.org/wgbh/nova/first/)

Unfortunately, this particular film is not available for viewing online; however, the essential content of the film is summarized below.

*Mystery of the First Americans* examines the recent discovery of Kennewick Man and its impact on archaeological theories about the original inhabitants of the New World. The film explains why the Clovis Culture is no longer regarded as the earliest culture in the New World, and describes the leading anthropological theories that attempt to explain the origins of American Indians. *Mystery of the First Americans* features excellent illustrations of the research methods used in both forensic anthropology and archaeology.

The nearly complete skeleton of Kennewick Man was discovered along the banks of the Columbia River in Kennewick, Washington, in 1996. Archaeologist and forensic investigator Jim Chatters was the first scientist to see the skeleton, which he determined to be that of a man in his mid-forties. Chatters observed that the skull was long and narrow with fairly prominent brow ridges and an extensive nose—all features that are generally characteristic today of people of
European ancestry. At first Chatters thought he was dealing with a contemporary forensic case, but then he noticed a strange object embedded in Kennewick Man’s hip: a stone projectile point. The skeleton was subjected to radiocarbon dating, and it turned out to be nearly 9,000 years old.

Appearing on camera in the film, Chatters describes his analysis of the pathologies evident in the skeleton of Kennewick Man: “This fellow told more of a story than most people I’ve ever dealt with. I mean, he not only had the spear point stuck in him - and it was healed there, he’d had it for quite a long time - but he had a whole series of other injuries too. If you sort of start from his youth, he broke his left elbow and appears to have gotten an infection or some serious bone damage. He had his chest crushed with a massive blunt blow, breaking the ribs off on either side and leaving them separate. That’s an often fatal wound. It healed. He has a little skull fracture on the front left side, the kind that’s consistent with being struck by a right-handed person wielding a club, and that had healed. In a few words, the man led a perilous existence.”

But the most striking thing about the Kennewick Man was the shape of his face and skull. In a skeleton this old Chatters would have expected to see the wide, flaring cheekbones and rounder skull of an American Indian. But Kennewick Man had a long cranium and narrow face, features more typical of people from Europe, the Near East, or India. It was an exceptional find, and one that raised important questions for anthropological research — but then Chatters was forced to halt his analysis when it was just getting underway.

A coalition of five northwest Indian tribes, led by the Umatilla, had claimed the skeleton under NAGPRA - a federal law that provides for the return of Native American remains to their living descendants. The Umatilla believe they have lived in the Pacific Northwest since the beginning of time. If Kennewick Man was 9,000 years old, they said, he must be their ancestor, whatever he looked like. It’s a feeling shared by many Native Americans. The Umatilla demanded a halt to all scientific study and the immediate return of the Kennewick Man for burial in a secret location. With the coroner on his way over to impound the bones, Chatters made a hasty record on videotape, thinking they might never be seen again. Then anthropologist Douglas Owsley of the Smithsonian Institution and seven other scientists filed suit in federal court to stop the return of the bones [the lawsuit was eventually resolved in the scientists’ favor, and the study of Kennewick Man’s skeleton is ongoing]. The scientists’ contention was not that Kennewick Man was definitely not Native American, but that study was necessary to determine whether he was or not. The scientists recognized, of course, that it would be extremely difficult to prove a direct lineal relationship between any 9,000 year old skeleton and any modern population (after all, there have been about 400 human generations between the end of the Pleistocene and the present, and with such a large number of links, many ancestral connections would be possible).

As the film explains, the “Clovis First” theory that once dominated anthropology was seriously undermined in the late 20th century. One of the biggest challenges to the Clovis story comes from the southern hemisphere. In the mid-1990’s, a group of prominent archaeologists met in southern Chile at a place called Monte Verde. They’d come to look at evidence of a human habitation site that was reputedly, 1,000 years older than Clovis. Everyone was convinced. Clovis was not first after all. More evidence comes from southern Brazil. In prehistoric rock shelters, archaeologists have found some of the oldest human remains in the
New World. As in North America, these early skulls don’t look anything like present day Indians. One skeleton, called Luzia, is more than 11,000 years old.

The date of 11,000 makes her potentially the oldest skeleton in the New World, and the fact that Luzia looks so very different may imply that she was part of a different population. The question of how she got there is another one altogether because her early age, combined with data from Monte Verde, certainly means that people must have been migrating into South America much earlier than we previously thought.

When the “Clovis First” hypothesis dominated anthropology, conventional wisdom held that the entire northwest coast of North America was covered by glacial ice all the way out to the continental shelf until nearly the end of the Pleistocene. If true, there would have been no opportunity for plants or animals, much less humans, to exist along that coastline during the last Ice Age. But archaeologists Jim Dixon and Tim Heaton have been taking a closer look at the environment of Alaska’s coastline during the last Ice Age. Their work is changing our view of how and when the first Americans could have moved into the New World. They’ve found evidence of abundant plants and animals at a time when the coast was thought to be a lifeless, frozen wasteland.

Archaeology in this terrain is difficult. Most of the Ice Age coastline is underwater now, submerged by the rising sea level as the glaciers melted. The forest is a tangle of roots and vegetation that makes excavation nearly impossible. But scattered along this coast there are places where evidence of ancient life has accumulated undisturbed for tens of thousands of years. This is where Heaton and Dixon do their work—in ancient bear caves, deep underground.

They’ve made significant discoveries that provide substantial support for the Pacific Coastal Route hypothesis, including a human jawbone that turned out to be more than 9,000 years old. In the film, Dixon appears on camera to discuss the find: “This is a cast of the mandible that provides a lot of evidence about the individual and the individual’s diet. As you can tell from looking at the teeth, they’re rather heavily worn for an individual of this age. It’s a young man about 23 years of age. And the reason we can tell that is the wisdom teeth, or these last molars to erupt, one has erupted and it’s actually made contact with the upper teeth and is worn. The other has erupted but not made contact with the upper teeth. So this suggests he’s in his early 20s. There are some slight indentations or nicks or notches in his front teeth here, the teeth that are still preserved, and this suggests he did some kind of repetitive task with a line or sinew in his teeth, either holding line or tying line. We’ve also done isotope analysis on the bone. And this suggests that the individual’s diet was largely marine foods. In fact, his isotopic signature is so strong that it’s equal to marine mammals such as ring seal and oceangoing fish. So this is incredible. This clearly shows that this young man was raised on a diet of marine foods.”

If the first Americans migrated along the coast from Asia, they could have reached the New World long before the ice melted away. The problem now is to discover the identity of those early people. The only direct evidence comes from human skeletons.

Researchers have compiled measurement data on dozens of populations from around the world. With a large enough sample size, a statistical analysis can show the range of variability in a given population, and whether an individual falls inside or outside the range. This technique
has helped the museum identify and repatriate more than 100 ancestors of western Nevada Paiute Indians. But it’s also turned up yet another mystery skeleton, like Kennewick Man, that cannot be connected with any modern tribe. It was discovered in the western Nevada desert 60 years ago, and has been in the museum collection ever since. The Spirit Cave Man was so well preserved, it was not thought to be very old. But recently, the museum decided to have it radio carbon dated. In the past, extracting enough carbon from bone to obtain a date would destroy a large piece of the skeleton, so it was rarely done. But today it takes less than half a gram of bone, and the dates are accurate to within 60 or 70 years. The Spirit Cave Man turned out to be 9,400 years old.

The Spirit Cave Man’s skeleton is off limits to NOVA’s camera. But it’s still possible to get a sense of what he looked like. A reconstruction of his living face begins with a 3-D CAT scan of the skull. At a medical imaging laboratory, the data is projected by laser into a tank of liquid resin, which hardens at the focal point of the beam. The result is an accurate replica of the Spirit Cave Man’s skull. In the hands of forensic sculptor Sharon Long, it’s the basis for a reconstruction of his face. She starts with depth markers that will determine the thickness of the facial tissue. Then she builds the face, using techniques developed and tested in criminal forensic cases. The contours of the skull and specific muscle attachment points determine things like the shape of the mouth, the length and width of the nose, and the opening for the eye.

Gradually, the face of the 9,400-year-old Spirit Cave Man is revealed. But is it the face of an American Indian—or someone else? The Spirit Cave Man seems more “Caucasoid” in appearance, like the people of Europe, the Near East, or India, especially when compared with two other American Indian faces from the Nevada State collection, including Wizard’s Beach Man and an 850-year-old Native American from Nevada.

Anthropologist Amy Dansie appears on camera to describe the reconstructed faces: “We’ve noticed that in the overall profiles of the three faces the degree of facial forwardness, or prognathism, varies quite a bit. Spirit Cave Man has virtually none, and that’s one of the traits that has been referred to as Caucasoid. Wizard’s Beach Man is kind of in between the two of them in that respect, and you can see the difference when you look at the later Native American, where his face sticks out from an up and down plane. Another characteristic that is surprising about the Spirit Cave Man is his small bilobed or bifurcate chin. It’s really quite pointed, and this is usually considered a Caucasoid trait. This is one of the traits that forensic anthropologists look for. It’s also fairly small, the jaw is fairly small compared to the Native American, where it comes way down, very strong and square. This square jaw is one of the traits that is used to identify Native Americans.”

When Jim Chatters did his own facial reconstruction of Kennewick Man, based on a cast he had made of the skull, the result bore a striking resemblance to British actor Patrick Stewart. That caused a great deal of confusion, at least when the information was shared with the news media. Were the first Americans really Europeans? Chatters had described the face of Kennewick Man as having “Caucasoid” traits, but he knew that did not necessarily mean that Kennewick Man had come from Europe (in fact, all available evidence indicates that Kennewick Man descended from a population that came from Asia).

Douglas Owsley and his colleague Richard Jantz completed a statistical analysis of the half dozen American skulls more than 8,000 years old to see where they fall in relation to modern
people. The results clearly demonstrate that the oldest American skulls are distinctly different from any modern skulls—and the one grouping those early skulls are very far from in terms of their morphology is contemporary Native Americans. At the same time, however, those ancient skulls don’t fall in the range of Europeans or any other modern people, either.

Instead, the closest modern match for people like Spirit Cave Man or Kennewick Man is found among the Ainu of Japan. The Ainu are the indigenous people of Japan. Their ancestry reaches back deep into prehistory, long before the ethnic Japanese arrived some 2000 years ago. Today there are fewer than 100 full-blooded Ainu left. But in the 19th century, there were many more. Anthropologists called them Asiatic Caucasoids, because they had facial features and body hair that seemed more European than Asian. In fact, the Ainu are thought to be a remnant of a very ancient population that was once widespread in the Old World. The first anatomically modern humans are thought to have come out of Africa about 100,000 years ago, and spread throughout Europe and Asia. So the key to understanding the first Americans is not that they looked like Europeans, but that they looked like Asians—at least, the way some Asians looked 20,000 years ago, when people were on their way to the New World.

Further complicating the picture, however, the oldest skeletons found in South America appear to be related to a different group of early Asians. Spirit Cave Man, for example, doesn’t look a whole lot like these 9,000-year-old skeletons from Brazil. And in many ways, the South American samples look much more like Australian aborigines or people from Melanesia. The 11,400-year-old skeleton called Luzia is one of those early South Americans who resembles Australian aborigines. But that doesn’t mean that she came from Australia. What may be going on is that Luzia represents a group of people who started from a central place in Asia, some of whom migrated south into Australia, others who came into the New World.

The old Clovis story said that a single founding population from Asia gave rise to most of the native people in the Americas—and that their doorway to the New World did not open until the end of the Ice Age. But the human fossil record, and the archaeology from Alaska, tell a different story. Parts of the coast were ice-free, even when glaciers covered half of North America. So a coastal migration route would have been open to the early people of Asia—like the ancestors of the Ainu and the Australians—people who resemble the first inhabitants of the New World. Then, as the glaciers began to recede between 11 and 12,000 years ago, the interior route opened up—a natural pathway, perhaps, for nomadic hunters from northeast Asia. So these could be very, very different populations, coming into the New World literally thousands of years apart from one another, possibly from different sources in northeastern Asia, we don’t really know that. But certainly we are looking at the possibility of multiple migrations into the New World, possibly going on different routes.
America’s Stone Age Explorers

The content of this Supplemental Reading is derived from the following film:


You’ll find more information on the PBS Companion Website for America’s Stone Age Explorers at http://www.pbs.org/wgbh/nova/stoneage/

Unfortunately, this particular film is not available for viewing online; however, the essential content of the film is summarized below.

America’s Stone Age Explorers explores the central questions surrounding the earliest Americans: who were they and where did they come from? For much of the 20th century, based on the only evidence that was available at the time, archaeologists believed that the first people to inhabit the New World arrived around 13,500 years ago; recent archaeological discoveries, however, suggest that the original date of entry into the Americas may have been substantially earlier. The film explores a variety of recent hypotheses—some highly probable, some much less so—that attempt to account for the peopling of the New World.

The following account is derived from the film description on the PBS website, along with the transcript of the film itself (the entire transcript is available as a free download on the PBS website).

Ever since unusually ancient and deadly spear points were found near Clovis, New Mexico in the 1930s, many archeologists have believed that this type of weapon originated with the first settlers of the New World, who supposedly migrated from Asia at the end of the last ice age. The timing of the land bridge, the ice-free corridor and the Clovis dates all seemed to fit together in a simple elegant theory: 13,500 years ago, Clovis people, big game hunters from Asia, armed with their lethal Clovis spear point, walked across the land bridge to the Americas, followed the ice-free corridor down into the lower continent and spread across the land, killing all the great beasts. As ice age glaciers melted, the seas rose, submerging the land bridge. The
descendants of the Clovis people, the Native Americans, remained isolated until their first contact with Columbus. The theory became known as Clovis First. It was written into the textbooks and taught for the better part of a century. The Clovis spear point became the icon of the first Americans.

The distinctive design of a Clovis point is perfect for killing big game, making it a Stone Age weapon of mass destruction. The Clovis point may even have been behind the extinction of large ice age mammals such as the mammoth. Clovis points have been found at archeological sites throughout North America (including all 48 of the contiguous United States), and for decades these sites represented the oldest accepted evidence of human presence in the New World. Many Clovis points have been found in caches, bundles of spear points, hidden away for later use by Clovis hunters—nearly two dozen such caches have been found in the United States.

Thus for much of the 20th century, archeologists believed that hunters equipped with Clovis technology were the first settlers of the Americas and that they probably arrived from Asia at the end of the Ice Age about 13,500 years ago, when lower sea level allowed hunters to cross a land bridge connecting Siberia and Alaska. But by the last couple of decades of the 20th century, however, there was growing evidence that humans were in the Americas long before the Clovis hunters.

One of the best known of the pre-Clovis sites is called Meadowcroft, near Pittsburgh, Pennsylvania. There, Jim Adovasio of Mercyhurst Archeological Institute has been excavating artifacts well below the geological layer that corresponds to the Clovis period. Many archeologists disputed his evidence at first, but the validity of the Meadowcroft site has gained wide acceptance in the field, and it is now generally regarded as providing proof of human habitation dating back to 18,000 years ago.

Another convincing pre-Clovis dig is Monte Verde in southern Chile, where archeologist Tom Dillehay, formerly of the University of Kentucky, has made an unusually rich find half a world away from the Asian land bridge route. In 1997, a group of highly regarded archaeologists went to examine the evidence with their own eyes. They saw weapons, tools and other objects, the result of two decades of excavation. After intensely scrutinizing the dating, they confirmed the artifacts were older than Clovis by over a thousand years (they dated to 14,800 years ago).

Together with the evidence from Monte Verde, Meadowcroft and other sites, it now seemed as if Clovis people could not be the first Americans. The Pacific coast route offered a possible alternative to the Bering land bridge and the ice-free corridor, but that still left the question of where the Clovis point itself had come from. Archaeologist Dennis Stanford decided to search for its origins along the route from Asia to America. But as he worked back from Alaska to Siberia, the trail went cold. The weapons and tools he found in Asia were quite different. The Clovis spear point is a single stone, bifacial, or shaped on both sides, with a flute, or groove, at its base. The spear points in Asia are made from lots of small razor-like flints called micro-blades embedded in a bone handle. Microblade technology involves making a projectile point or a knife blade out of bone and then cutting a slot in it and then putting the microblades in the slot. It’s a totally different philosophy from using the bifacial projectile point.
With this in mind, Stanford and his colleague, archaeologist Bruce Bradley, proposed the idea that the first Americans might have come from Europe, not Asia, based on the similarity of Clovis points to the weapons of the Solutreans, who lived about 20,000 years ago in what is now southern France and northern Spain. If the Solutreans ever crossed the Atlantic, they may have traveled like today's Eskimos, who make long journeys skirting ice floes in watertight skin boats, hunting arctic game as they go.

The possibility of a European connection was suggested by the fact that Clovis and Solutrean spear points not only look alike, they are made the same unusual way. To Stanford and Bradley, this was a powerful clue that prehistoric explorers had come from Europe and brought with them the technology that transformed Stone Age America: the Clovis Spear Point.

It was an outlandish idea with a few big problems. The Solutrean culture ended in Europe around 18,000 years ago, and the Clovis point would not arrive in America for another 5,000 years. If the Solutreans brought the Clovis point to America, where had they been? There’s also the difficulty, of course, of getting from Europe to North America across a 3,000-mile-wide ocean barrier. Stanford and Bradley believe Solutrean hunters could have made the journey in boats similar to those built today by the Inupiat in Alaska. The Inupiat build umiaks, whaling boats that use sealskin and caribou sinew stretched on wood frames and waterproofed with oil applied directly from seal blubber. These same techniques and materials would have been available to prehistoric people. However, even if it’s just possible that prehistoric people could have made such an arduous journey, relying upon marine resources along the way, the probability of such a trip seems highly remote—especially in the absence of any positive evidence that such a thing actually happened.

Stanford and Bradley needed to find some artifact in the Americas to bridge the 5,000-year time gap between the last Solutrean point and the first Clovis point. They scoured Clovis sites across the continent, places where other archaeologists had been digging for years. Then, from a site called Cactus Hill, in Virginia, a possibility, a point that resembled the Solutrean style, and it dated far earlier than the Clovis. The spear point, however, is not exactly like either the Solutrean or the Clovis point, and it’s the only such point that’s ever been found in the Americas; as a result, few archaeologists think the evidence that’s presently available supports the Solutrean hypothesis.

The archaeological evidence isn’t the only source of information about early migrations into the New World, however. Geneticist Douglas Wallace uses DNA to reveal traces of ancient migrations. Stored in his lab are DNA samples of indigenous people collected from all corners of the globe. DNA is the molecule of our genetic endowment expressed in a code of four letters representing four different chemical bases. Every cell in these samples contains DNA. But Wallace studies a specific kind of DNA, not from the nucleus, which is a random mix of genes from both parents, but from the mitochondria, the cell’s energy factories outside the nucleus.

This kind of DNA is inherited only from the mother and is passed intact from generation to generation as lineages diverge. But at a steady and predictable rate, tiny mutations creep, like
spelling mistakes, into specific stretches of DNA. The amount of genetic variation between any two lineages can reveal how far back in time they shared a common ancestor. Using genetic variation and comparing the genetic variation of aboriginal populations from all the major continents of the world, Wallace and his team have been able to reconstruct the history of migration. They found four distinctive lineages that they labeled A, B, C and D. All four turned out to share common ancestors back in Siberia and northeast Asia.

Then they turned their attention to a surprising group of American Indians, the Ojibwa. When they studied the mitochondrial DNA of the Ojibwa they found the four primary lineages—A, B, C and D—but there was about a quarter of the mitochondrial DNAs that was not A, B, C or D: there was a fifth source of DNA of mysterious origin. They called it X, and unlike A, B, C and D, they couldn’t find it anywhere in Siberia or eastern Asia, although it was similar to an uncommon lineage in European populations today. When they looked at the amount of variation in the X lineage, it pointed to an origin long before Columbus—in fact, to at least 15,000 years ago.

At first, it seemed that the mysterious X lineage might be genetic evidence of Ice Age Europeans in America, but further investigation raised another possibility. The ancient X lineage may have existed in Siberia, but died out, though not before coming over to America with Ancient migrations. Thus the X lineage could be either from Europe or from Siberia, from a population that is now lost.

Archeologist Michael Collins of the University of Texas at Austin has been excavating a Paleo-Indian site at Gault, Texas, which shows evidence of a more complex Clovis culture than ever imagined, including a diet that spans the food chain, evidence of a sophisticated trade network, hundreds of types of tools, and possibly the earliest example of art in the Americas.

“Where did Clovis come from?” asks Collins. “The longstanding notion of the rapid spread of Clovis across the continent has been taken to mean the spread of a people across the continent. An alternative might be that the spread of Clovis is actually the expansion of a technology across existing populations—analogous to the fact you can go anywhere in the world and find people driving John Deere tractors.”

In other words, the Clovis point could be the first technological breakthrough in the Americas, invented by people who had long been resident here—and then adopted by their neighbors, who knew a good thing when they saw it.
TEST OBJECTIVES

The multiple-choice test questions for Unit Test #6 will refer directly to the test objectives listed below; if you can meet all of the test objectives described here, you should have no trouble earning a score of 100% on the Unit Test. (These test objectives will also apply directly to the Final Exam, which will cover nothing more and nothing less than all of the test objectives for Units 5 through 8.)

♦ Describe the extent of the archaeological record in the Holocene.

♦ Describe the three contemporary hypothesis for the origins of the earliest Americans (i.e., Bering Land Bridge, Pacific Coastal Route, North Atlantic Ice-Edge Corridor), and describe the merits and demerits of each.

♦ Describe the evidence from the earliest archaeological sites of human habitation in the New World in the Late Pleistocene.

♦ Describe the biological and cultural characteristics of the earliest Americans.

♦ Describe the technologies and cultures associated with Clovis, Folsom, and Plano points.

♦ Define Middle Stone Age, and identify the synonyms used to refer to the Middle Stone Age in the Old and New Worlds.

♦ Describe the environmental changes that inspired the Middle Stone Age, and describe the technological and social adaptations that characterized the Middle Stone Age.

♦ Describe the anthropological perspective on the concept of “race.”

♦ Describe the biological characteristics of Kennewick Man, and describe the similarities and differences between Kennewick Man, contemporary American Indians, and other contemporary populations around the world.

♦ Describe the difficulties involved in determining the ancestral group or groups from which contemporary Native Americans descend.

♦ Describe the technology of the Clovis Point, and describe the competing hypotheses for its origin; describe as well the geographic distribution of the Clovis Point in the archaeological record.
Chapter 7

The Neolithic Revolution

LEARNING OBJECTIVES

At the completion of this unit, you will be able to describe the essential elements of the *Neolithic Revolution* and to describe the *origins of plant and animal domestication* in both the Old and New World. You will also be able to identify the social, technological, economic, environmental, and biological *consequences of domestication*. 
I. The Neolithic Revolution

the “New Stone Age”—two profound and far-reaching developments of later prehistory:

(1) shift from food collection to food production (i.e., plant & animal domestication)

(2) emergence of large-scale, complex societies

A. Domestication

the mutually dependent relationship between humans (the domesticators) and selected plants and animals (the domesticates)

domesticators remove undesirable flora and fauna from the domesticates’ environment, control domesticates’ access to space, sunlight, water, & nutrients, and regulate the domesticates’ reproductive processes

humans regulate the reproductive processes of plants and animals in order to deliberately select for desirable characteristics in a process called artificial selection

the result of artificial selection is evolution (a change in the frequency of genes within the gene pool of a wild species), which ultimately results in speciation (the appearance of a new [domesticated] species)

domestication was independently underway in the Old World by 10,000 years ago and in the New World by 7,000 years ago

B. Plant Domestication

plant domestication occurred independently in several parts of the world, using locally available wild plant species, frequently cereal grasses, which have several advantages:

(1) grow in dense concentrations

(2) respond readily to human manipulation

(3) provide storable nutrients
1. Old World Plant Domestication

southwest Asia: wheat, barley, lentils, peas

east & southeast Asia: rice, soy beans, citrus, bananas

Africa: millet, sorghum, yams, coffee

2. New World Plant Domestication

three plants were domesticated independently in both the Old World and New World: cotton, sweet potatoes, gourds
MesoAmerica: maize, squash, common bean, tomato, chili pepper

South America: potato, manioc (a.k.a. cassava), peanut, pineapple, tobacco

C. Animal Domestication

The dog was the first animal to be domesticated, probably by Upper Paleolithic cultures during the late Pleistocene; all others were domesticated by Neolithic cultures during the Holocene.

dogs provide protection, companionship, and assistance in hunting & herding; other animals can provide meat, dairy products, transportation, traction, and by-products (bone, horn, leather, fleece, fertilizer, fuel)

the best candidates for domestication are animals that (1) form hierarchical herds, (2) do not readily flee, (3) are not especially territorial (there were few good candidates in the New World)

1. Old World Animal Domestication

southwest Asia: sheep, goats, pigs, cattle, horses  
east & southeast Asia: water buffalo  
Africa: camels  
Europe: reindeer

2. New World Animal Domestication

MesoAmerica: turkeys  
South America: llama (from guanaco), alpaca (from vicunya), muscovy duck, guinea pig
D. Consequences of Domestication

1. New Settlement Patterns

permanent villages & towns surrounded by fields & pastures; dramatic increase in population size and density:

- 10,000 B.P. - 5 million
- 5,000 B.P. - 10 million
- 2,000 B.P. - 200 million

2. New Technologies

ground & polished stone tools; pottery (ceramic vessels made from fired clay), replacing leather and basketry (sacrificed portability for superior liquid & dry storage); weaving (plant and animal fibers made into cloth on looms)

3. New Environmental Relations

deforestation, terracing, and irrigation altered the landscape and increased soil erosion;

reduction in biodiversity means humans rely on a small number of plant and animal species, whose genetic homogeneity makes them highly vulnerable to disease, drought, and pests


the emergence of full-time religious specialists and the construction of impressive religious monuments; precursors of botany, zoology, astronomy, meteorology, math (i.e., systematic knowledge that is communal and cumulative)

5. New Impacts on Human Health

Neolithic diets tended to be starchy and lacking in proteins and essential minerals, resulting in: decreased stature, increased dental disease, increased nutritional deficiency (e.g., anemia), increased infectious diseases and parasites
Secrets of Stonehenge

The content of this Supplemental Reading is derived from the following film:


Watch the film on the PBS website at:
http://video.pbs.org/video/1636852466

Dated to the late Stone Age (specifically, the Neolithic), Stonehenge may be the best-known and most mysterious relic of prehistory. Every year, a million visitors are drawn to England to gaze upon the famous circle of stones, but the monument's meaning has continued to elude us. Now investigations inside and around Stonehenge have kicked off a dramatic new era of discovery and debate over who built Stonehenge and for what purpose.

How did prehistoric people quarry, transport, sculpt, and erect these giant stones? Granted exclusive access to the dig site at Bluestonehenge, a prehistoric stone-circle monument recently discovered about a mile from Stonehenge, NOVA cameras join a new generation of researchers finding important clues to this enduring mystery.

Watch the program by following the link above to the PBS website (at the site, you’ll also find a link to the complete transcript of the program that you can download free of charge if you’d like to have a written version of the content).
TEST OBJECTIVES

The multiple-choice test questions for Unit Test #7 will refer directly to the test objectives listed below; if you can meet all of the test objectives described here, you should have no trouble earning a score of 100% on the Unit Test. (These test objectives will also apply directly to the Final Exam, which will cover nothing more and nothing less than all of the test objectives for Units 5 through 8.)

♦ Define the term Neolithic, and describe the reasons anthropologists refer to the Neolithic as the Neolithic Revolution.

♦ Define the terms domestication, domesicator, and domesticate, and describe the biological consequences of domestication for the domesticates.

♦ Describe the advantages that wild cereal grasses possess as candidates for domestication.

♦ Describe the characteristics that wild animal species would possess to be ideal candidates for domestication.

♦ Describe the plants and animals that were originally domesticated in Southwest Asia, East and Southeast Asia, Africa, Europe, MesoAmerica, and South America.

♦ Describe the consequences of plant and animal domestication in terms of new settlement patterns, new technologies, new environmental relations, new roles for science and religion, and new impacts on human health.

♦ Describe the materials, tools, and techniques used in the construction of Stonehenge.

♦ Describe the sequential stages in the construction of Stonehenge, along with the dates for each stage.

♦ Describe the culture and lifestyle of the people who built Stonehenge.

♦ Describe the nature of the cremated remains found buried at Stonehenge.

♦ Describe current scientific thinking regarding the number and type of astronomical alignments at Stonehenge.

♦ Describe recent archaeological discoveries about other sites in the wider landscape surrounding the monument at Stonehenge.
Chapter 8

Ancient Civilizations of the Old & New Worlds

LEARNING OBJECTIVES

At the completion of this unit, you will be able to define civilization and to describe the essential characteristics of ten ancient civilizations—five in the Old World (Sumeria, Egypt, Indus Valley, Shang China, Minoa)—and five in the New World (Olmec, Teotihuacán, Maya, Aztec, Inca).
LECTURE OUTLINES

I. Civilization

large-scale, complex, *stratified societies* with urbanism and a *state* level of sociopolitical organization

*stratified society*: a society divided into different levels of wealth, power, and standard of living

*state*: a form of sociopolitical organization featuring a government with full authority over a well-defined territory and its population, having the power to collect taxes, enforce laws, and defend or expand its boundaries

civilizations are generally associated with writing, metallurgy, and monumental architecture; they developed independently in several places around the world

II. Old World Civilizations

A. Sumerian Civilization

1. Location

   the plains surrounding the Tigris and Euphrates Rivers (a.k.a. Mesopotamia) in what is today Iraq

2. Dating 5,000 – 4,300 years ago

3. Notable Features

   many practical innovations: wheeled carts, plow, draft animals, sailing boats; first to refine metals (gold, silver, and copper) and to make the alloy bronze;
3. **Notable Features cont’d**

Cuneiform (wedge-shaped) writing made by pressing a reed stylus into damp clay, then baking the tablet; used hundreds of standardized signs; 90% of writing concerned economic, legal, and administrative matters.

Mathematical system using base 6 (source of dozen, time measures);

Ziggurats (mud brick temple pyramids—picture, textbook, page 443);

3 social classes: nobility, commoners, slaves

**B. Egyptian Civilization**

1. **Location**

Nile valley, Egypt

2. **Dating**  5,000 – 2,300 years ago

3. **Notable Features**

Pyramids: immense public works projects, built by farmers, not slaves; Great Pyramid of Khufu had a 765’ base and was 479’ high; pyramid building lasted only 200 years, circa 4,500 years ago.

Hieroglyphic writing, probably inspired by Mesopotamia; combined signs that represent ideas with signs that represent sounds;

Faience: glassy blue-green glaze made from powdered quartz and copper, applied to objects such as ceramics and sometimes shaped into beads and figurines.
C. **Indus Valley Civilization**

1. **Location**
   
   valley of the Indus River, Pakistan

2. **Dating** 4,600 – 3,900 years ago

3. **Notable Features**
   
   half-a-dozen urban centers and more than 1,000 agricultural villages, all linked by the Indus River which provided a commercial highway several hundred miles long;

   largest port cities of Mohenjo-Daro and Harappa were located more than 400 miles apart; both had a carefully-planned grid layout and standard-sized city blocks, suggesting a high degree of centralized control;

   no picturesque ruins remaining, but achieved the world’s first efficient sewage system;

   small amount of pictographic writing, not yet fully translated

D. **Shang Chinese Civilization**

1. **Location**

   Huang Ho (“Yellow”) River valley, northern China

2. **Dating** 3,750 – 3,300 years ago

3. **Notable Features**

   first dynasty in world’s longest running civilization;

   high level of sophistication in material culture, architecture, art, and writing…obviously a highly-structured, centralized society; widespread use of divination (foretelling the future), especially scapulimancy (reading the heated cracks in the scapula of an animal); sophisticated bronze metallurgy
E. Minoan Civilization

1. Location

Mediterranean island of Crete, modern country of Greece

2. Dating 3,800 – 3,400 years ago

3. Notable Features

- Maritime traders, with a fleet of sailing vessels plying the eastern Mediterranean; they transformed raw materials into luxury goods for trade
- Huge temple-palace in city of Knossos;
- Maintained distinctive art, architecture, and religion despite extensive contact with other societies

III. New World Civilizations

A. Olmec Civilization

1. Location

Gulf coast of Mexico, in the modern states of Vera Cruz & Tabasco

2. Dating 3,200 – 2,400 years ago

3. Notable Features

- Ceremonial centers at San Lorenzo and La Venta (where there are remains of a 100’ tall cone-shaped earthen pyramid);
- Monumental basalt heads, up to 18 tons, individual portraits
B. Teotihuacán Civilization

1. Location

Valley of Mexico (central highlands)

2. Dating 2,150 years ago (150 B.C.E.) to 1,300 years ago (700 C.E.)

3. Notable Features

largest city in the world in 500 C.E.; maximum population of more than 125,000; carefully planned grid pattern, central axis Avenue of the Dead, stone Pyramids of the Sun and Moon

C. Mayan Civilization

1. Location

Yucatan Peninsula (Mexico, Belize, Guatemala, Honduras)

2. Dating 300 – 900 C.E.

3. Notable Features

many urban ceremonial centers with impressive stone architecture: pyramids, temples, ball courts, and reservoirs (cenotes);

Copan (Honduras), Tikal (Guatemala), Palenque (Mexico)

stelae (singular, stela): upright carved stone posts or columns, often bearing inscriptions;

highly sophisticated calendar
D. Aztec Civilization

1. **Location**
   
   Valley of Mexico, present-day Mexico City

2. **Dating** 1200 C.E. to 1521 C.E. (conquered by Hernan Cortes)

3. **Notable Features**
   
   militaristic empire that subjugated neighboring peoples;
   
   capital Tenochtitlan was a huge city, with a population of 600,000;
   
   chinampas: rich garden plots made by dredging mud from the bottom of lakes and canals

E. Inca Civilization

1. **Location**
   
   Andes Mountains of western South America, centered on Peru

2. **Dating** 1475 C.E. to 1538 C.E. (conquered by Francisco Pizarro)

3. **Notable Features**
   
   capital at Cuzco in southern Peru;
   
   stone architecture of carved, close-fitting massive blocks, precisely set without mortar;
   
   far-flung empire with a well-maintained network of roads
   
   no true writing—instead, symbolic record-keeping using knotted strings called quipus
The following additional lecture notes are intended especially for internet students (although they may also be helpful to classroom students who were absent from the lecture presentation).

This unit summarizes the distinctive characteristics of ten ancient civilizations, five from the Old World and five from the New World. In each case, you’re asked to remember a relatively small bit of information about each civilization: its name, where and when it existed, and what notable features make it unique (remember that all civilizations share a relatively long list of traits in common, including stratification, urbanism, state forms of political organization, monumental architecture, metallurgy, writing or some form of symbolic record keeping, etc.). Details and illustrations for all of these civilizations can be found in the assigned chapter in the textbook.

In the classroom, when I discuss writing as a feature of virtually all civilizations, I explain that there are three fundamental types of writing that humans have developed. The first is **pictographic** writing, which, as the name suggests, draws pictures to communicate information. Pictographic writing is simple and obvious, and it has the advantage that it can be used for communication between speakers of different languages, but it is extremely limited: it is really only useful for communicating simple ideas about concrete nouns. It’s difficult or impossible to represent abstract ideas with pictographic writing (you can draw a picture of “two cows,” for example, but imagine trying to draw a picture of “truth” or “justice”).

The second type of writing is called **ideographic** writing, which uses symbols that have been assigned a conventional meaning to represent concepts. In ideographic writing, the same symbol may represent several different ideas, and the meaning of any particular symbol must be interpreted in context. For example, the symbol ☼, which looks something like the sun, might be understood in one context to mean “sun,” but in other contexts it might be used to convey the idea of “heat” or “light” or even “enlightenment.” Ideographic writing can convey more ideas than pictographic writing, but it has the significant disadvantage that it requires a large number of conventional symbols whose meaning must be memorized (and thus only a small number of people, often a priestly class, are likely to be literate in a society that uses ideographic writing).

The third and most efficient form of writing is called **phonetic** writing, which uses symbols to represent the sounds that are used in speech. Phonetic writing has the huge advantage that any idea that can be put into words can be conveyed in written form with a very small number of symbols. Phonetic writing can be either **syllabic**, where the symbols represent entire syllables of words, or it can be **alphabetic**, where the symbols represent phones. The writing we use, of course, is alphabetic.
The Mummy Who Would Be King

The content of this Supplemental Reading is derived from the following film:


Additional information about *The Mummy Who Would Be King* is available on the NOVA website at [http://www.pbs.org/wgbh/nova/mummy/](http://www.pbs.org/wgbh/nova/mummy/)

Unfortunately, this particular film is not available for viewing online; however, the essential content of the film is summarized below.

*The Mummy Who Would Be King* examines the case of a shriveled mummy with crossed arms that had long lain neglected on a dusty museum shelf at Niagara Falls. Could be the remains be those of a long-lost Egyptian king? While a trail of clues hints at how the looted mummy made its way to North America, archeologists, scientists, and even an orthodontist look to the latest genetic testing and imaging techniques in hopes of ascertaining the body’s hidden identity.

This is how the film is described on the NOVA website [with additional comments in brackets]:

*The Mummy Who Would Be King* examines the case of a shriveled mummy with crossed arms that had long lain neglected on a dusty museum shelf at Niagara Falls. Could be the remains be those of a long-lost Egyptian king? While a trail of clues hints at how the looted mummy made its way to North America, archeologists, scientists, and even an orthodontist look to the latest genetic testing and imaging techniques in hopes of ascertaining the body’s hidden identity. *The Mummy Who Would Be King* reveals an astounding story filled with historical intrigue and the wonders of forensic science.

Suspicions about the mummy's noble past first arose decades ago. Speaking with avid collectors and top scholars involved in the investigation, NOVA discovers just how complicated it can be to unravel ancient truths. By the late 20th century, the Niagara Falls mummy had
journeyed across an ocean. It had been stolen, sold, bought, and neglected. It had languished in obscurity and had been “discovered” in the 1960s only to be declared a fraud. Yet Egyptologist Gayle Gibson tells NOVA that as soon as she laid eyes on the body, she was convinced it was someone special. This documentary is about how one mummy finally convinced the world.

The Mummy Who Would Be King examines Westerners’ long-standing fascination with all things Egyptian, an attraction that brought the likes of Abraham Lincoln, Ulysses S. Grant, and P.T. Barnum to see the mummies displayed at Niagara Falls. And like any good story, this one is rich with colorful characters, such as Dr. James Douglas, the 19th century physician who originally acquired the mummies for the Niagara Falls Museum and himself displayed collected mummies on his own front porch. [At the time, it was entirely legal to purchase mummies and transport them out of Egypt; that has since changed.] NOVA also interviews Meinhard Hoffman, the man who first suspected royal connections and even had his attorney draw up an affidavit regarding his prescient hunch 20 years before it would be proven. [Hoffman was indeed somewhat prescient—the mummy did indeed turn out to be royal—but Hoffman’s originally believed that the mummy’s head exactly matched the bust of Queen Nefertiti and said “it could only be that face” (given that the mummy was male, Hoffman couldn’t possibly have been more wrong).]

In 1998, when the Niagara Falls Museum closed down and its mummies were sold to the Carlos Museum at Emory University, the mysterious cross-armed body finally received the attention and resources needed for a thorough background check. [Bodies were mummified with their arms crossed over their chests at two different points in ancient Egyptian history: during the New Kingdom, around 3,500 years ago, when the practice was reserved for royalty, and during the Roman Era, around 2,000 years ago, when the practice was applied to commoners. The mummification techniques for royalty were far superior to those used for commoners, so the fact that the Niagara Falls mummy was in excellent shape and had crossed arms strongly suggested that it could be a New Kingdom pharaoh. Yet another clue to the mummy’s identity was the fact that embalmers during the New Kingdom did not pack the chest cavities of the mummies with organ packets, as later embalmers did—and the Niagara Falls mummy did not have organ packets in its chest.] NOVA is there as esteemed Egyptologist Salima Ikram, an expert with intimate knowledge of the era and its rituals, examines the mummy. She looks for onions placed in the eyes and resin used to seal the body. Three-dimensional CT scans provide a truly “inside” look as to how the organs were removed and what fills the chest cavity [both the skull and the chest cavity were filled with large amounts of resin, a rare and precious commodity in ancient Egypt]. Radiocarbon dating confirmed that the Niagara Falls mummy had lived sometime between 1,085 and 790 B.C.E., placing it within the time frame of the New Kingdom and well before the Roman Era. In the final analysis, X-ray images allow for familial skull comparison with royal mummies from the Cairo Museum. Ultimately, one candidate is confirmed: Rameses I.

Making the case for a 3,000-year-old monarch is a task set as much in the past as the present. NOVA takes viewers on a fascinating visual journey through modern laboratories at Emory, and back in time into ancient tombs dotting the Nile River Valley. Reenactments bring to
life the mummification rites that marked the heyday of ancient Egypt's illustrious New Kingdom, when Rameses I ruled as founder of the 19th dynasty.

*The Mummy Who Would Be King* captures an in-depth and truly international investigation that requires the best of modern science and old-fashioned archeological analysis. After exhausting the evidence, there is one last crucial test: the opinion of the man who speaks for Egypt, Director of Antiquities Zahi Hawass. Declaring the body to be that of an ancient pharaoh, Hawass accepts the donation of the mummy to the Cairo Museum, and brings Rameses I home to rest alongside his family, a fitting solution to a 3,000-year-old puzzle.
Lost King of the Maya

The content of this Supplemental Reading is derived from the following film:

Lost King of the Maya. 2001. NOVA episode. PBS Television.

You’ll find more information on the PBS Companion Website for Lost King of the Maya at http://www.pbs.org/wgbh/nova/maya/

Unfortunately, this particular film is not available for viewing online; however, the essential content of the film is summarized below.

Lost King of the Maya follows archaeologist Bill Fash and his team as they excavate the possible burial site of a legendary Mayan king who founded the Copán dynasty. The film explains how researchers are using techniques from linguistic analysis and biological anthropology in addition to archaeology to discover new information about Copán.
His name is Yax K’uk Mo’. His spirit haunts this valley, deep in the rainforest of Honduras. He is the legendary founder of Copan, a Maya city mysteriously abandoned over 1000 years ago. For 400 years, his dynasty of Holy Lords rules a kingdom through hallucinogenic visions, ritual warfare and human sacrifice.

If the legend of Yax K’uk Mo’ is true, then scientists believe he must be buried here, beneath this massive temple pyramid. One-hundred-thirty feet down and 1600 years back in time, anthropologist Robert Sharer burrows deep into the pyramid, searching for the bones of Yax K’uk Mo’.

After 10 years of excavating and tunneling, following lines left from plaster floors long ago buried, Sharer uncovers an immense underground temple. On a vibrantly colored stucco panel, carved with symbols only recently decoded, is the name of the legendary first king of Copan, Yax K’uk Mo’.

In the depths of this sacred monument a modern scientist rediscovers a 1600-year-old tomb. Beneath the stone slab, Sharer finds the disintegrating, jade-studded skeleton. This will prove to be the bones of Yax K’uk Mo’.

On November 17th, 1839, in the jungles of Honduras, a small expedition is about to make a momentous discovery. Two young explorers, American John Lloyd Stephens and Englishman Frederick Catherwood, stumble upon a vine-strangled ruin. They are entering the ancient Maya city of Copan.

Catherwood, an excellent draftsman, brings the exotic world of Copan back to life through his drawings of temples and monuments. Their best-selling book, Incidents of Travel in Central America, captivates the public with stories of a lost civilization, newly found.

Stephens and Catherwood explore a world that stretches from the highlands of Chiapas, in Mexico, to the lowlands of the Yucatan peninsula and into the tropical rain forests of Central America. They discover 44 Maya cities, remains of a culture that flourished for more than 700 years, from roughly 200 to 900 of the Common Era.

But beyond their sheer beauty and size, the towering temple pyramids conceal something even more amazing—many are astronomically aligned to the sun and Venus. And the strange markings that cover the buildings are more than decorative, they are evidence of Maya picture writing, the most comprehensive ancient script of the Americas and one of only five original writing systems in the world.

Throughout Copan’s nearly 10 square miles (about half the size of Manhattan), beautifully carved monuments and temple pyramids rise from the jungle. At the center of the ruined city, Catherwood and Stevens find a key piece of the puzzle, that will eventually explain the rise and fall of the great Maya civilization—the Acropolis, a massive stone complex of temples and pyramids.

Close to its center is a four-foot square monument that archaeologists call Altar Q. Carved on its sides are 16 enigmatic figures. As he looks out over Copan, John Lloyd Stephens
ponders the mysteries of the Maya. “One thing I believe,” he writes, “the history of Copan is graven on its monuments. Who shall read them?”

One-hundred-fifty years later, Stephens finally got an answer to his question—David Stuart. Stuart, the son of Maya experts, took his first trip to Central America when he was three years old. He began deciphering glyphs at age eight, and by the time he was 18 he became the youngest person ever awarded a MacArthur Genius Grant.

Today David Stuart is working at Copan with Barbara Fash, director of the Hieroglyphic Stairway Project. Each of the stairway’s 2200 blocks displays a carved glyph. Unfortunately, many of the glyphs are wearing away.

In the film, Stuart speaks on camera: “When John Lloyd Stevens came here about 160 years ago, he speculated that the history was written in stone—that the inscriptions contained historical records. And it turns out he was absolutely right. He had good instincts. Behind me here is the great hieroglyphic stairway of Copan, which is one of the longest texts in the world, certainly the longest text from pre-Columbian America, and written in it are the dates and names of the royal history of Copan. And we’ve really only been able to read the details of this in the last, oh, 15 to 20 years.”

To resurrect the voice of the Maya, scholars must overcome one of the most tragic losses in history—that of the Maya code. For centuries, the Maya created thousands of books made of bark and covered with hieroglyphs. But in the 1500s when the Spanish conquer Central America, the Spanish priests declare the strange books to be the work of the devil and burn them. A thousand years of knowledge and the key to understanding the Maya writing go up in smoke.

Fortunately the Maya wrote on other surfaces that couldn’t be burned; and miraculously, four of the Maya books, or codices, escape the Spanish bonfires. One of those books leads to the first major breakthrough in deciphering Maya writing and understanding the Maya’s reverence for time.

David Stuart: “One of the first things that was deciphered about 100 years ago was the calendar system. And I have an example of it here from an ancient Maya book, a facsimile of one, where we have an example of a date written with five numbers using bars and dots. That’s the way Maya represented numbers between one and 19. A bar was a five, and a single dot was a one. So, if we look at this column for example, right here, we have five numbers, the top one being an eight, the next down is an eleven, then after that an eight, and a seven. And then this football-shaped sign is the way the ancient Maya wrote a zero sometimes.”

Their knowledge of the number system helped early scholars discover that the Maya books were celestial almanacs. The Maya could chart the 365-day solar cycle, predict solar and lunar eclipses, and even track the complex orbit of Venus. Amazingly, their Venus almanac is accurate to within two hours every 500 years.

This incredible astronomical ability and the apparent lack of any fortifications around Maya cities led early scholars to see the Maya as not only the most advanced civilization in the Americas, but also a peaceful people. When these scholars looked at Altar Q they believed they
were seeing a conference of peaceful astronomer-priests. But a shocking discovery in 1946 would forever change the image of the peaceful Maya.

Bonampak, a ruined Maya palace in the jungles of southern Mexico, unveiled a series of startling murals depicting torture, warfare and bloodshed. Yet it took another 40 years for scholars to accept that the Maya, for all their heavenly concerns, practiced the earthly tradition of warfare, torture and human sacrifice. To the Maya, Venus was not the planet of love, but the god of ritual warfare and bloody sacrifice. But if the figures on Altar Q are not peaceful astronomer-priests, who are they?

David Stuart: “In the early days of Maya archeology, really before the glyphs could be deciphered, it was thought that the inscriptions contained a lot of information about the calendar, about the planets, astronomy—a lot of kind of esoteric information for the priests to read and contemplate. And, about 1960 or so, things really changed. There was a woman working at the Peabody museum at Harvard named Tatiana Proskouriakoff. And she noticed that she could divide up the inscriptions into segments of time that corresponded more or less to a human lifetime. And using those texts, she identified a glyph that she thought was a glyph for birth, another glyph for death and then for a very important event that occurred in between these two dates that was, she surmised, the inauguration of someone to kingship. It turned out she was absolutely right.”

After 150 years of slow progress, the pace of decipherment suddenly explodes. In the 1970s, scholars could only identify perhaps 10 percent of the glyphs. Thirty years later, they can read 80 percent of Maya writing. And by studying the language the Maya people use today, Stuart and other scholars learn the sounds and meanings of the ancient Maya glyphs. Now when David Stuart looks at Altar Q, he’s reading the history of real people.

David Stuart: “When we were able to actually decipher Maya hieroglyphs, these anonymous characters were suddenly transformed into real people. We now know that they are kings, and that on the altar they are all sitting at...on their name glyphs. When we can read those names we can actually read the names of ancient Maya kings.”

All the figures sit on name glyphs, with one prominent exception. The first figure, the one who anoints the 16th king with the baton of office, sits on the glyph that represents the Maya word “lord.” Years after the other kings were identified the first figure on Altar Q remained a mystery. Dressed differently from the others and wearing the eye-goggles of the Central American rain god, many Maya scholars believed this figure must surely be a god.

Then David Stuart found his name hidden in plain sight. “Ever since we realized this was a king list of Copan, the first figure in the list was always mysterious. We always wondered, ‘Where is his name? Who is this guy?’ And I was here back in 1986, and I realized that he’s not actually sitting on his name glyph, but rather has his name up in his headdress. And if you look closely you’ll see that he’s got a quetzal feather device back here, he has a macaw head on—a bird, he has a sun symbol, and the symbol yax for green or blue. And I realized they’re...that there are all four elements of the name K’Inich Yax K’uk Mo’. That was the name of the founder.”

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After 150 years of trying to crack the Maya code, the most prominent figure on Altar Q now has a name—K’Inich Yax K’uk Mo’—Great Sun Green Quetzal Macaw.

Archaeologists finally locate the tomb that they believe to be the final resting place of Yax K’uk Mo’. The tomb is rich with grave goods, including a jade bead carved with the woven mat motif, which, to the Maya, represented rulership. The teeth of the individual in the tomb are filed and inlaid with jade, also a symbol of Maya aristocracy.

As Sharer and his associate, Ellen Bell, remove the precious contents of the tomb, they still face the question, “Are these the remains of Yax K’uk Mo’?” Once again, Sharer turns to a familiar source—Altar Q. The image of Yax K’uk Mo’ on the side of Altar Q is one of the most detailed in all of Copan, right down to his jewelry. It depicts him wearing ear-flares and a single jade bar, jewelry identical to ones found by Sharer in the tomb. The image of Yax K’uk Mo’ on Altar Q also depicts him holding a shield on his right arm, making him a left-handed warrior. That corresponds intriguingly to evidence from the bones.

Archaeologist Robert Sharer: “The bones in the tomb tell us many things about the man buried here. They tell us his age—he was an elderly individual, probably over 50 years old at death. They tell us, of course, that he was male. They also tell us about a series of injuries, combat-style injuries, that he suffered during life. Perhaps most dramatic, a severe blow to the right forearm, of the type that’s usually called a parry-fracture, the kind of fracture that one gets in warding off a blow with the forearm—in this case probably with a shield on that forearm. This also gives us added information about the individual’s identity, because on Altar Q, that individual is depicted wearing a shield on his right arm. This is one more case where the myth of Copan’s dynastic founder is becoming real through archaeological evidence.”

David Stuart: “The inscription on the top of Altar Q really tells the story about Yax K’uk Mo’ and how he came to Copan. It begins with a reference to a day in the early 400s, when it says that he took the emblems of office at a place that we think is connected somehow to Teotihuacan or with Central Mexico somewhere. Three days later, it says, he comes from that place. He leaves that very spot. And then the inscription goes on to say something really remarkable. A hundred and fifty three days after he leaves, apparently Central Mexico, he rests his legs. And then it says he is a West Lord, and that’s a title that he has throughout the Copan inscriptions throughout history. And then finally, the last two glyphs of the passage read ‘Hu’li Uxwitikî,’ ‘he arrived at Copan.’ So there’s no question in my mind that K’Inich Yax K’uk Mo’ became a king at a very far away spot in Central Mexico and brought those emblems of office back here to Copan to found the dynasty.”

Based on the evidence—the location of the tomb in the Acropolis, matching the jewelry and fractured bones from the tomb with the image of Yax K’uk Mo’ on Altar Q, and the origin of the bones confirming the text on Altar Q—archaeologists are now sure Yax K’uk Mo’ was a real king, and that they have discovered his tomb.

After the arrival of Yax K’uk Mo’ in AD 426, he decides to make a clean break with the past and the old dynasty. The old Acropolis and center for performances is abandoned, and instead he creates his own regal ritual center about 200 yards south of the old Acropolis. And for this magnificent historic occasion, he dedicates a whole series of new monuments in his new
center, including a new ball court, new palaces, new temples, and essentially puts a new stamp and a new seal on the kingdom of Copan, saying this is a new place now. This is a new dynasty, and we’re going to start afresh, with a new vision and a new regal ritual center.

Yax K’uk Mo’ builds bigger than any Maya lord before him. For the first time in Copan, the temples and monuments are inscribed with Maya writing. In these inscriptions the legend of Yax K’uk Mo’ is born. But also hidden on the carved stones of Copan is evidence of Yax K’uk Mo’s most powerful weapon—the perfect timing of his arrival.

The year 426 corresponds to a powerful milestone in the Maya calendar—the Baktun. The Maya Baktun is a recurring 400-year period. Like our own millennium, its onset was both an auspicious and fearful occasion. Yax K’uk Mo’s arrival ushers in the Ninth Baktun and elevates him to the realm of the supernatural.

David Stuart: “Stela 63 is probably the earliest dated stela we have from Copan, and it commemorates an extremely important time period in the Maya calendar. It has a date on the front of it that reads nine, zero, zero, zero, zero. In other words, it was the beginning of the Ninth Baktun. This was a period that would only occur every 400 years or so, and the scribes and kings of Copan decided to commemorate that time period using this stela, and associating it with K’inch Yax K’uk Mo’, the first king of the dynasty. And it can’t be a coincidence that the beginning of the Baktun was also the beginning of history at Copan.”

Yax K’uk Mo’, Lord of the West, the outsider, accomplishes what had never been done before—he consolidates power into a single dynasty and sparks a period of unprecedented growth and artistic achievement. Copan’s Holy Lords, the successors of Yax K’uk Mo’, rule for the next 400 years, an entire Maya Baktun.

David Stuart: “Altar Q, with its 16 portraits of the rulers of Copan, is much more than just a visual king list. All of the kings are shown in a remarkable symmetry that reflects cosmology and its combination with history in the Maya sense of the world. There are four kings on each of the four sides. And I think the lord who dedicated this stone certainly was aware of the fact that he could construct a monument that would show all of his ancestors in such a remarkable pattern of symmetry that reflected the cosmos, the cardinal directions and the four points. And one gets a sense from this stone also that there is a sense of destiny, a profound sense of destiny in Maya history—a beginning and an end point. Yax K’uk Mo’ is the founder. Yax Pasah is the closing ruler who receives the emblem from the ancestor on this side of the stone. And so we can conceive, I think, of Copan’s history as coming to an end almost automatically with the 16th ruler. What came afterwards was essentially the collapse of the dynasty. And anything that would have come afterwards would not have fit into this perfect scheme.”

The last carved monument at Copan is this stone, Altar L. Dated 822, it shows Yax Pasah passing power to a king who never rules, on an altar that is never completed. Within a hundred-year period, many of the great Maya cities fall by invasion. Others, like Copan, collapse from within. The regal ritual centers are empty and the stones of their mighty temples lie scattered around a ghost town. The people of Copan and many Maya centers abandon the cities and retreat into the jungle.
Yet the legacy of Yax K’uk Mo’ lives on—in the carved stones of the great city of Copan, where archaeologists piece together the history of his dynasty; in the millions of Maya living in Central America, speaking Maya dialects, and performing ceremonies that echo the distant glory of Copan and its Holy Lords. The spirits of Yax K’uk Mo’ and the mighty Maya, one of the greatest civilizations of ancient times, continue to haunt the Copan Valley and all of the Americas forever.
The Great Inca Rebellion

The content of this Supplemental Reading is derived from the following film:


Watch the film online on the PBS website at [http://video.pbs.org/video/2205823703](http://video.pbs.org/video/2205823703)

*The Great Inca Rebellion* explores questions that have puzzled researchers for nearly 500 years: how was Francisco Pizarro able to conquer the huge militaristic empire of the Inca with only 200 Spanish conquistadors? Was it the superiority of the Spanish weapons, the European diseases to which the Inca had no resistance, or something else? Recent research on Inca skeletons is revealing a new perspective on the conquest.

Watch the program by following the link above to the PBS website (at the site, you’ll also find a link to the complete transcript of the program that you can download free of charge if you’d like to have a written version of the content).
TEST OBJECTIVES

The multiple-choice test questions for Unit Test #8 will refer directly to the test objectives listed below; if you can meet all of the test objectives described here, you should have no trouble earning a score of 100% on the Unit Test. (These test objectives will also apply directly to the Final Exam, which will cover nothing more and nothing less than all of the test objectives for Units 5 through 8.)

♦ Define the terms civilization, stratification, and state, and describe the characteristics that all civilizations possess.

♦ Describe the locations, dates, and notable features of the following ten ancient civilizations: Sumerian, Egyptian, Indus Valley, Shang Chinese, Minoan, Olmec, Teotihuacan, Mayan, Aztec, and Inca.

♦ Describe the various forms of writing developed by different cultures (i.e., pictographic, ideographic, and phonetic).

♦ Describe the mummification and burial procedures used for Egyptian royalty and commoners during the New Kingdom and the Roman Era, and identify the time frames for each period.

♦ Describe the characteristics of the mummy from the Niagara Falls Museum, and describe the conclusions researchers were able to reach about its identity; describe as well the ultimate disposition of the mummy.

♦ Describe the historical developments in the scientific decipherment of Mayan glyphs.

♦ Identify and describe the first Mayan King of Copan, and describe the biological characteristics of the individual found in the royal tomb at Copan.

♦ Describe the history of Yax K’uk Mo’s ascension to kingship in Copan.

♦ Describe the Mayan calendar and the units that the ancient Maya used to demarcate important intervals of time.

♦ Describe the reasons for the defeat of the Inca army at the siege of Lima in 1536.

♦ Describe the tactical advantages that the Spanish conquistadors possessed over the Incan army, and describe the weapons possessed by each side.

♦ Describe the weapons that were used to kill most of the Indians at the siege of Lima in 1536, based on the analysis of the skeletons in the cemetery at Puruchuco.