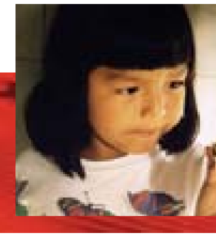
UNIT 5 HOW DID HUMANS EVOLVE?



Evolution TV Show
"The Mind's Big Bang"

AT A GLANCE

Learning Goals

Know the major characteristics selected for in early hominid evolution — bipedalism and big brains — and the advantages of each

Understand how scientific process is used in paleontology

Know hypotheses about evolution of bipedalism

Understand migration patterns of early hominids

QUICK CLICKS

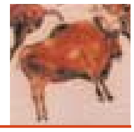
Teacher's Guide Web Resources

Access the Web resources referenced in this guide — from handouts to video segments to Web features — by going to **pbs.org/evolution** and clicking on Teachers and Students, and then going to the *Evolution Teacher's Guide,* where the material is presented by unit.

"We had been working really hard that day and were heading back toward camp when one of our teams decided to liven things up by slinging elephant dung at the rest of us," remembered Andrew Hill, a paleontologist on Mary Leakey's team at Laetoli, Tanzania in 1976. "He aimed one at me, and I had to dive out of the way. I ended up flat on my face. I started to rise and saw marks in the ground. I realized they were fossilized raindrops. Then I looked around and saw ancient animal footprints all over the place. We had passed over that ground so many times before that evening, but none of us had noticed a thing. But once we saw the first prints, we could see them everywhere: fossilized tracks of rhino, elephants, antelopes, all sorts of animals." (From Robin McKie, *Dawn of Man,* pp. 10–11.)

Two years later while excavating a set of animal tracks at Laetoli to bring to a nearby museum, more prints were uncovered in the ash — **hominid** footprints that looked incredibly similar to those that people today make as they walk barefoot along a beach. But, these tracks were at least 3.6 million years old.

It was the first time paleontologists had actually found behavioral evidence of bipedalism, the ability to walk upright on two feet, in early hominids. As Ian Tattersall, curator of physical anthropology at the American Museum of Natural History said, "Usually behavior has to be inferred indirectly from the evidence of bones and teeth, and there is almost always argument over inferences of this kind. But at Laetoli, through these footprints, behavior itself is fossilized."



Background

The footprints at Laetoli are just part of the fossil evidence that depicts human evolution. In 1974, paleontologist Don Johanson's team discovered the skeleton of Lucy, now known as ***Australopithecus afarensis***. Lucy's skeleton was clearly different from other primates. Her knees could lock, her femur slanted inward, and her large toe was in line with her other toes, allowing her to walk upright. The discovery of Lucy surprised paleontologists because although she was unquestionably bipedal, she was remarkably apelike—with a brain about the size of a chimpanzee's.

Bipedalism is a tremendous adaptation for humans and a distinguishing characteristic between humans and other primates. There are many hypotheses about the advantages of bipedalism, including the ability to carry food from place to place, to walk long distances efficiently, the freeing of hands for tool use, and the ability to see further or more clearly during travel. Any or all of these hypotheses may be correct and are being explored by anthropologists today.

A second major adaptive advantage that appeared later in human evolution was an increase in brain size. Fossil evidence allows us to trace the development of the brain as it increased threefold over the last 3 million years. Early hominids such as the **australopithecines** had brains the size of modern apes (400 to 500cc). ***Homo habilis,*** with a brain of about 650cc, was probably the first hominid to make and use stone tools. As brain size increased new capabilities evolved, improving the ability of hominids to adapt to and modify their environments.

Another earlier hominid, ***Homo erectus*** (with an approximate brain size of 900cc), was the first to develop humanlike culture. They used tools, including handaxes, made fires, and were the first hominid species believed to have spread from Africa into Asia. Modern humans, ***Homo sapiens*** (with brains ranging from 1200–1600cc), have even more sophisticated capabilities, probably due to neurological developments within the brain rather than sheer size alone.

Brain size gives only limited information about the internal structure and capabilities of the brain. One later hominid species, ***Homo neanderthalensis,*** had a brain size of over 1300cc, but is considered to have been much less sophisticated than, and possibly even driven to extinction by, modern humans.

The story of human evolution began in Africa, but what was once a minor species, *Homo sapiens,* has now migrated to inhabit all continents. Patterns of hominid migration are inferred from fossils, which are quite rare, and molecular evidence, which is even more limited. New technologies are allowing paleontologists to reexamine earlier fossil finds. Recently scientists recovered **mitochondrial DNA** from **Neanderthal** skeletons. That molecular evidence differed significantly from modern human DNA and suggests that Neanderthals and modern humans probably did not interbreed.

There are still many questions concerning the shape of the hominid family tree, especially given the ongoing growth in the number of known species as new finds are discovered and added to our already bushy evolutionary tree. In paleontology, as in any scientific field, new evidence continually requires reexamination and revision of old hypotheses.

Know More

Web Sites

cgi.pbs.org/wgbh/aso/tryit/evolution/ (*Science Odyssey* site on human evolution)

anthro.palomar.edu/tutorials/ (A very comprehensive, up-to-date resource with 23 tutorials, complete with photos and illustrations, on both physical and cultural anthropology from Palomar College)

www.becominghuman.org/ (Institute for Human Origins site with many resources including skull photos and information on anatomy, lineages, culture, and theories of human migration)

cogweb.english.ucsb.edu/EP/Paleoanthropology.html#GenusLine (Site includes photos of comparative skulls)

www.talkorigins.org/faqs/homs/ (Site contains current information about hominid evolution and the fossil evidence)

Books

Boyd, Robert, and Joan Silk. *How Humans Evolved, Second Edition.* New York: W.W. Norton and Company, Inc., 2000.

Jones, Steve (ed.), David Pilbeam (ed.), and Robert Martin (ed.). *The Cambridge Encyclopedia of Human Evolution.* Cambridge University Press, 1995.

Klein, Richard. *The Human Career: Human Biological and Cultural Origins, Second Edition.* Chicago: University of Chicago Press, 1999.

Larsen, Clark Spencer. *Human Origins: The Fossil Record.* Waveland Press, 1998.

Lewin, Roger. *Human Evolution: An Illustrated Introduction, Fourth Edition.* Malden, MA: Blackwell Science, 1999.

McKie, Robin. *Dawn of Man: The Story of Human Evolution.* New York: Dorling Kindersley Publishing, Inc., 2000.

Zihlman, Adrienne. *The Human Evolution Coloring Book, Second Edition.* New York: HarperCollins Publishers Inc., 2000.

Articles

Leakey, Mary. "Footprints in the Ashes of Time." *National Geographic* (April, 1979).

Lovejoy, Owen. "Evolution of Human Walking." *Scientific American*/259 (1988): 118-125.

Tattersall, Ian. "Once We Were Not Alone." *Scientific American* (January 2000): 56–62.

Wade, Nicholas. "Neanderthal DNA Sheds New Light on Human Origins." *The Science Times Book of Fossils and Evolution.* New York: The Lyons Press, 1988: 235-238.

Wilford, John Noble. "The Transforming Leap, from Four Legs to Two." *The Science Times Book of Fossils and Evolution.* New York: The Lyons Press, 1998: 196-203.

Videos

"In Search of Human Origins" *NOVA,* 1994.

pbs.org/evolution

SCILINKS **www.scilinks.org**

Topic	Keyword
human evolution	EG23A

Activities

Online Student Lesson 5: ***How Did Humans Evolve?***
Students find out where humans fit in the larger scope of evolution.

Watch Your Step

(adapted with permission from a Steve Randak lesson)

Teacher's Guide Web Resources

Video Resources
"Laetoli Footprints"

Handouts
"Choosing the Best Explanation"
"Laetoli Trackways"
"Teacher Background on Laetoli Trackways"

1. Prepare an overhead transparency of the Laetoli trackways (see **Teacher's Guide Web Resources**) and/or hand out one trackway copy (on paper) per team of four students.

2. Ask each team to study and discuss the trackways and record group's answers to the following questions:

What creatures probably made the tracks?

How were these creatures moving (walking, running, etc.)?

What interactions, if any, do the tracks suggest?

What is the evidence for your answers?

3. Conduct a class-wide discussion, sharing different scenarios from each team, and pointing out the evidence for each.

4. Direct students to the seven criteria for "Choosing the Best Explanation" (see **Teacher's Guide Web Resources**) to reach a class-wide consensus for the most likely explanation for these trackways.

5. Then, using the Teacher Background information, share with the class what scientists do know about the Laetoli footprints and what inferences they have made.

6. Engage students in a discussion about what footprints can tell us. Do individuals with longer feet also have longer legs? Are people with longer legs taller? Are the number of strides a person takes in a given distance different when he/she is running or walking? Does the person's stride length change with speed? Would the same hold true for early hominids? Can patterns of the present give you clues to patterns in the past?

Chromosome Clues

(adapted with permission from a Larry Flammer lesson)

Teacher's Guide Web Resources

Handouts
"Chromosome Clues"
"Chromosome Clues Worksheet"

1. Display an overhead copy of the "Chromosome Clues" diagram. Explain that this diagram shows real chromosomes from a comparison study of three different species. In each set the first chromosome is species A, the second is species B, and the third is species C. Point out that only some of the species C chromosomes have been matched.

2. Model how to compare chromosomes with **inversions**. Use an enlarged overhead copy of chromosomes #4AB and #4C (which is the third chromosome from the left, top row of the box). Show how when #4C is inverted, the region just above and below the **centromere** (constricted region) of #4C matches the same region in #4A.

3. Hand out the "Chromosome Clues" worksheet (one per pair of students) and scissors (one per student). Have students work in pairs to cut apart the 12 chromosomes in the box on the right, then place each in the "C" space where it most closely matches the others.

4. When done, students are to answer the questions on the worksheet. After all teams have completed the discussion questions, reveal the species names on the board or overhead:

Species A is *Homo sapiens* (modern human)
Species B is *Pan troglodytes* (common chimpanzee)
Species C is *Gorilla gorilla* (gorilla)

5. Ask if this new knowledge causes them to reconsider their answers to #6 and #7, and if so, why. Also, ask if anyone correctly predicted the names, and why. Have students discuss their replies to these questions.

6. Explain that analysis of all the chromosomes from these three species reveals that the chromosomes of species A and B are most alike (13 chromosomes are virtually identical); and 9 chromosomes of species A and C are virtually identical. Because of this, scientists recommend that all three species, along with orangutans, be classified in the same family (Hominidae).

Video 5 for Students

Did Humans Evolve?
Fossil and molecular evidence support the evolution of humans from earlier primate ancestors. This video demonstrates some of the evidence for that relationship.

Discussion questions:

What are the occasional mistakes in copying of DNA called and why are they significant for evolutionary change?

How does DNA evidence support the close evolutionary relationship between chimps and humans?

What is the difference between relatedness and descendancy?

What is the relationship between common ancestry and degree of DNA similarities?

What kinds of evidence support the fact that humans have evolved?

Take It Further

Online Course for Teachers
Session 5: "How Did Humans Evolve?"

Evolution Web Features
"Riddle of the Bones"
"Origins of Humankind"
"Is Intelligent Life Inevitable?"

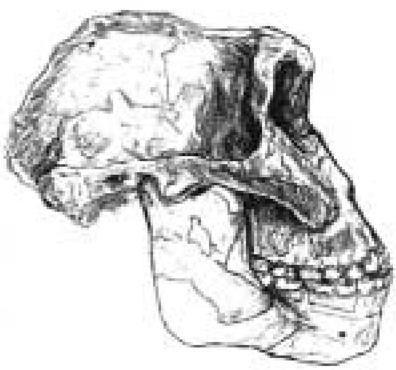
Extensions
Link to **www.nap.edu/readingroom/books/evolution98/** *Teaching about Evolution and the Nature of Science:* Activity 4, "Investigating Common Descent: Formulating Explanations and Models."

Link to **www.indiana.edu/~ensiweb/lessons/hom.cran.html** for a hominid skull lab.

In-depth Investigation

Fossils and Migration Patterns of Early Hominids

(adapted with permission from a John Banister-Marx lesson)



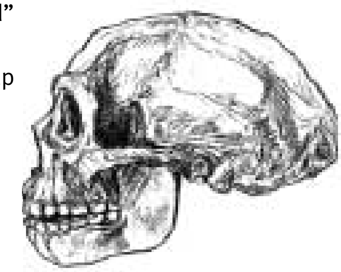
Paranthropus boisei

Discoveries of fossil hominids around the world have helped scientists determine not only the likely place of origin for the human species, but also a migration path throughout the world. In this activity, student teams will use representative hominid fossil evidence to determine the possible pattern of migration for early hominids.

Objective:
Students use actual data from fossil evidence to determine patterns and to develop/examine hypotheses that explain the data.

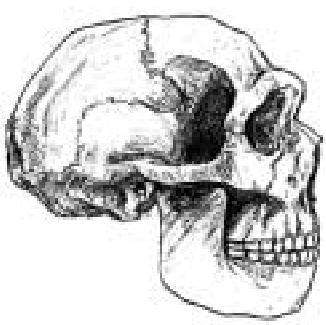
Materials:

- *Evolution* Web features: "Riddle of the Bones" and "Origins of Humankind"
- Small (8.5" x 11") black and white world maps with numerical latitude and longitude axes (see **Teacher's Guide Web Resources**) and large world map (approximately 4 x 6 feet or larger)
- Copies of the "Hominid Fossil Skull Drawings" and the "Hominid Fossil Data" handout (see **Teacher's Guide Web Resources**), cut into five sections (so that everyone in team will have a copy of their team's data)
- Copies of the "Hominid Migration Discussion Questions" (see **Teacher's Guide Web Resources**)
- Colored pencil sets and colored push pins (same 4 colors for pencils and pins; box of at least 100 pins)
- Optional: a set of hominid skull casts



Homo erectus

Procedures
Preparation: Copy and cut the fossil data sheets into five pieces (by ***taxon****), one set of taxa for each team. Students need knowledge of latitude and longitude to plot the locations of the fossils sampled. If time allows, prior to this activity, have students do the related Web features.*



Neanderthal

1. Group students into five teams: Australopithecine, *Homo erectus, Homo neanderthalensis,* and two *Homo sapiens* teams.

2. Introduce the activity by explaining that discoveries of fossil hominids around the world have helped scientists to determine not only a likely origin for the human species, but also a migration path throughout the world. The type, dates, and distribution of these representative fossil specimens offer an indication of where humankind's earliest ancestors had originated and migrated. Tell students their assignment is to map this distribution.

3. Give each team one part of the fossil evidence from the "Hominid Fossil Data" sheet and colored pencils to match their taxon code (Australopithecines—red, *Homo erectus*—blue, etc.). Point out that the early modern *Homo sapiens* data is divided between two teams because there is more of it. Post the color code key on the board.

4. Tell students that each team will plot its data points by number on a small world map, using its assigned color. Later each team will add their data to the class world map. (Plotting of the 56 points as a class may take 20–30 minutes.) Demonstrate one example of how to plot each coordinate site.

5. Have teams transfer their data to a large world map using colored and/or numbered push pins. Have students check off the fossils on their data sheets as each pin is placed to prevent repeats.

6. Tell students to work in teams to analyze the distribution of fossils on the world map and answer the Hominid Migration Discussion Questions. Have teams discuss their answers.

See Assessment Rubric on p. 35.