American Museum *of* Natural History

EDUCATOR'S GUIDE

Anne and Bernard SPITZER HALL OF HUMAN ORIGINS

amnh.org/humanorigins-educators

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Key Concepts

Humans, like all species, are a product of **evolution**. The Spitzer Hall of Human Origins presents key and cutting-edge evidence—fossils, genetic data, and artifacts—that scientists use to assemble the evolutionary story of our taxonomic family, the **hominids**. Here are the exhibition's key educational concepts:

Ample scientific evidence documents human evolutionary history.

Neanderthal skull cap

Fossil Evidence: Scientists have long used **fossils** to reconstruct the history of hominids and our larger taxonomic group, the order **Primates**. The fossil record shows that hominids have a past that is long (about 7 million years) and diverse (comprising at least 20 species). New finds continue to clarify what other hominids looked like, and how and when they lived.

Modern human DNA in a test tube

Genetic Evidence: Technology to study **DNA** has emerged in the past few decades, adding to what fossils tell us. Because DNA is passed from generation to generation and can change over time, it can document changes in species and **populations**. Tracking **heredity** geographically explains how modern humans migrated around the Earth. Comparing differences between species' DNA gives measurements of relatedness. By studying how **genes** control body **structure** and **function**, scientists can explore behavior.

Several mechanisms drive evolution.

Except for identical twins, no two individuals share the exact same set of genes and physical features. Because of genetic **variation**, and the fact that some individuals survive to pass traits to future generations, populations of organisms evolve. The evolution of new species involves several processes:

- **Mutation:** Variation can arise from random changes, or mutations, in the DNA an individual has inherited. Mutations may or may not impact the ability to survive and reproduce.
- **Natural Selection:** An individual with heritable features that enable it to cope better with its environment tends to pass them to the next generation. Over time, a population of individuals will exhibit more of the better-adapted features.
- **Genetic Drift:** In small populations, genes and traits will increase in abundance over generations by chance, not because they impact an individual's chance of survival.

Evolutionary trees represent the history of life.

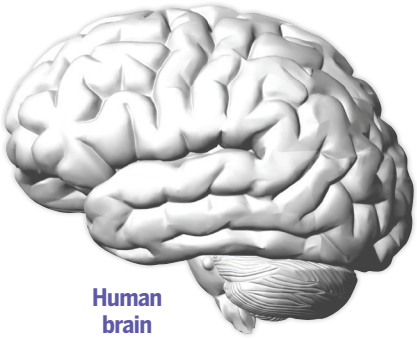
Evolution does not progress toward a goal. It also does not proceed as a single line of sequential species. Rather, new species diverge from common ancestors like branches on a tree. **Trees of life** depict relatedness between species, living and extinct. **Evolutionary trees** show how specific taxonomic groups evolved over time. The hominid evolutionary tree tells us that at many times in the past several hominid species lived on Earth simultaneously. Some survived much longer than the 150,000 years ***Homo sapiens*** has existed. Yet all hominids went extinct—except our species.

Human populations migrated to many environments and diversified.

Early humans emerged in Africa, then spread in waves throughout that continent and the rest of the world. As populations occupied different environments, modern humans continued to change. This is evident in the diversity of features seen across individuals and populations. (See the sidebar "Evolution and Human Diversity.")

The human brain is unique.

Humans have large brains relative to body size, but it isn't the size that sets us apart. Humans are capable of **symbolic thought**: We frame the world in abstract, creative terms. *Homo sapiens*' mental complexity may be what led our species to out-compete all other hominids.

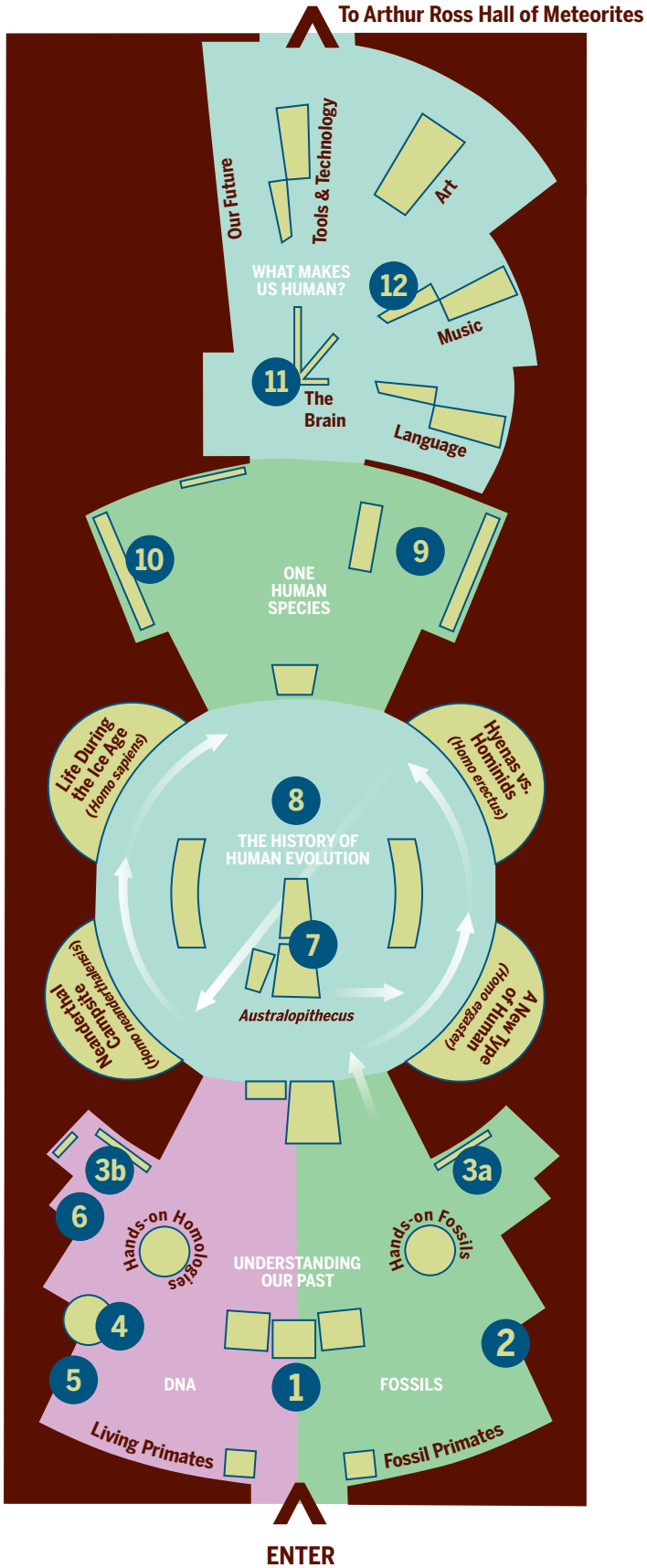


Human brain

Only modern humans create complex culture.

Our mental capacities enable us to produce increasingly complex tools and a vast range of symbolic expression, such as art, language, and music. Both innate talent as well as skills nurtured in society create the cultural complexity of humans. Our diversity of cultures is a hallmark of our humanity.

Map of the Hall



The numbered locations correspond to the Teaching in the Hall explorations.

1. **Chimpanzee, Modern Human, and Neanderthal Skeletons**
2. **Fossils: A Record of the Past**
3. **Evolutionary Trees (3a. Our Family Tree and 3b. Tree of Life)**
4. **Cell Model**
5. **DNA: Comparing Humans and Chimps**
6. **Evolution: How It Works**
7. **Little Foot**
8. **Scenes of Hominin Life**
9. **Video and Kiosks**
10. **Our Own Species**
11. **The Brain**
12. **Language, Music, Art, Tools & Technology**

Teaching in the Hall

The explorations below support your teaching of the Key Concepts. Refer to the Map of the Exhibition to find locations.

1 Chimpanzee, Modern Human, and Neanderthal Skeletons

Ask students: Why do these skeletons introduce the exhibition? Have students compare the skeletal structures of the three species. What biological structures do you recognize in the video above? Students can explore the interactive "Meet Your Relatives" behind the skeletons.

Key Concept: Ample scientific evidence documents evolutionary history.

2 Fossils: A Record of the Past

Have students find an example of a **trace fossil** and a **body fossil** here and later as they explore the exhibition. Ask: What can fossils reveal about extinct species? Examine the column of earth layers. What can the position of earth layers reveal about the age of fossils inside them? Students can deepen their investigation with the interactive "Fossil Detectives."

Key Concept: Ample scientific evidence documents evolutionary history.

3 Evolutionary Trees

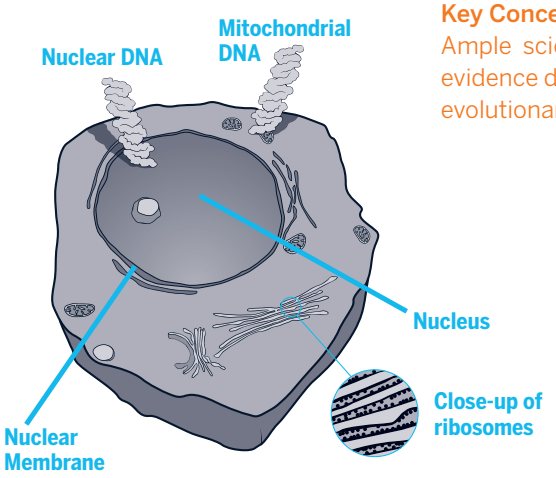
3a. Our Family Tree: The casts of fossil skulls, along with the dots, represent different species on our family tree. They are arranged on a timeline, with earlier species to the left of later species. Solid lines under each skull or dot indicate how long scientists think that species existed on Earth. Dotted lines indicate how scientists think species are related, based on current evidence. Ask: Can you find the earliest species? The most recent? The species that existed for the most time? Our own species? Our closest relative? Students can then compare the skulls of our own species and our closest relative to note similarities and differences.

3b. Tree of Life: Find the tree of life across the room, which was constructed using genetic rather than structural evidence. It shows how species are related to one another. Can students find *Homo sapiens*? Have them watch the nearby video to gain a better understanding of how scientists use DNA to determine common ancestry.

Key Concept: Evolutionary trees represent the history of life.

4 Cell Model

Have students identify and describe cell structures they know. Ask: Which structures contain DNA?



Key Concept: Ample scientific evidence documents evolutionary history.

5 DNA: Comparing Humans and Chimps

Students can compare the human, chimp, and mouse chromosomes. Which two chromosomes are most alike? How are humans and chimps similar? Different?

Key Concept: Ample scientific evidence documents evolutionary history.

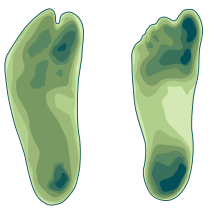
6 Evolution: How It Works

Have students read the sections on variation and selection. Ask: What mechanisms produce variation? Have students describe variation between individuals in our species.

Key Concept: Several mechanisms drive evolution.

7 Little Foot

It took scientists two decades to chisel this fossil, a member of an *Australopithecus* species, from its rock matrix and to determine how to arrange the bones. Two casts of the same specimen show the work in progress (floor case) and completed (standing skeleton). After students examine the casts of foot bones in the floor case, have them look behind them for the round table. There they can touch models of chimpanzee, *Homo sapiens*, and Neanderthal foot bones for a tactile comparison of ancient and modern hominid feet.



Laetoli hominid footprint

Modern human footprint

Key Concept: Ample scientific evidence documents evolutionary history.

8 Scenes of Hominin Life

Each of these four sections includes:

- a scene that shows members of a hominin species interacting with, or using parts of, other animal species;
- a model of that hominin's skeleton, along with other fossil evidence;
- a panel that provides information about time, geography, and DNA evidence.

Have students compare the hominins' environments, their bodies, and their relationships with the other species depicted in the scene.

Key Concepts: Ample scientific evidence documents evolutionary history; Human populations migrated to many environments and diversified.

Neanderthal Campsite

9 Science Bulletins Video and Kiosks

Have students watch the media in this section. Ask them to note the dates associated with each story. Encourage them to recognize that science is an ongoing process.

Key Concepts: All.

10 Our Own Species

So far, in stops 1–9, we have explored many different species related to us. This section focuses on just one species: *Homo sapiens*. As members of this species, we all share the same biology and evolutionary history, yet we also perceive differences. Ask: What are the consequences of categorizing members of the human species by race?

Key Concept: Human populations migrated to many environments and diversified.

11 The Brain

Have students explore this area and compare the human brain to that of other species. Have them identify the parts of the brain that they think make humans unique.

Key Concept: The human brain is unique.

12 Language, Music, Art, Tools & Technology

In this section, students can read about different forms of cultural expression and consider their own abilities. Ask: What skills were you born with? What have you learned from others? What do you think makes us "human"? Explore the interactives to deepen understanding.

Key Concept: Only modern humans create complex culture.

Paleolithic tools (L-R): small hand axe, scraper, awl

Evolution and Human Diversity

All species consist of individuals that differ at some level. In *Homo sapiens*, population diversity arose as small groups occupied varied environments around the world. Localized populations changed due to genetic drift and natural selection. For example, some populations eventually showed more susceptibility to certain diseases, or more ability to digest certain foods. Superficial differences in stature and hair, eye, and skin color also arose among individuals and populations.

Although these *population* changes take place at a genetic level, it does not mean that genes define *race*. Race is cultural and social, not biological.

Small, isolated groups are less and less prevalent in the human population. Our population is now abundant, consisting of larger varied groups that intermingle and overlap. Since humans reproduce both within and between groups, we constantly mix genetic information. Genetic differences between people of the same "racial group" can be greater than the those between people of two different groups. Furthermore, influences other than genes—such as hormones and environmental factors—also contribute to individual variation.

What Is a Theory?

Scientific theories explain facts and laws, have predictive power, and so can be tested. Most people would rate facts and laws as more important than theories, thinking of theories as "guesses" or "hypotheses." But for scientists, theories are the highest level of understanding. They are not just stepping-stones to more knowledge, but the goal of science. Examples of theories that justify great confidence because they work so well to explain nature include gravity, plate tectonics, atomic theory, and evolution.

Glossary

adaptation: a change in an organism that improves its ability, and the ability of its offspring, to survive in an environment.

base: biological compounds that pair up on a strand of DNA and make up genes. The bases are adenine, thymine, cytosine, and guanine, and are denoted with the letters A, T, C, and G.

common ancestor: an ancestor shared by two or more descendant species

body fossil: a fossil of a body or body part of an organism.

DNA (deoxyribonucleic acid): the molecule that encodes genetic information. It is shaped like a double helix held together by bonds between base pairs.

evolution: the scientific theory for how groups of living things change over time.

evolutionary tree: a representation of how a specific taxonomic group evolved new species over time. All trees are hypotheses, and are based on comparison of living species, fossils, and genetic data.

fossil: remains or traces of an organism turned to stone by geochemical processes.

function: the activity of a body part.

gene: a specific sequence of DNA base pairs that controls the expression of one or more traits.

genetic drift: an evolutionary mechanism in which genes and traits in small populations increase in abundance over generations by chance, not because they impact an individual's ability to survive.

heredity: the passing on of genetic traits from parent to offspring.

hominids: the family of primates that includes humans, their ancestors, and great apes (including the living chimpanzees, gorillas, and orangutans).

hominins: a subgroup of hominids which includes humans and close relatives s such as *Australopithecus* and *Ardipithecus.*

Homo sapiens: the taxonomic name for our species: modern humans.

mutation: a change in a gene's structure that may be passed on to future generations.

natural selection: an evolutionary mechanism whereby individuals tend to pass on heritable features that enable them to cope better with their environment to future generations. Over time, populations of individuals will exhibit more of the better-adapted features.

node: a point on evolutionary trees from which two or more lines branch. A node represents a common ancestor.

population: a group of organisms of one species, occupying a defined area and usually isolated from other groups of the same species.

primate: a member of the order Primates, which includes lemurs, monkeys, apes, and hominids.

structure: the shape and organization of a body part.

symbolic thought: the ability to interpret and re-create the world mentally using symbols. Evidence of symbolic thought includes language, music, art, and complex tools and technology.

trace fossil: indirect evidence of an ancient organism and/or its behavior. Examples are footprints, skin impressions, and nests.

trait: any genetically determined characteristic.

tree of life: a representation of evolutionary relationships among species. Scientists call trees of life "cladograms."

variation: genetic variation represents differences between individual members of a species. Variation comes from both recombination of parental DNA and genetic mutation.

Come Prepared Checklist

- ☐ **Plan your visit.** For information and videos about reservations, transportation, lunchrooms, and everything else you need to prepare for your day at the museum, visit **amnh.org/feld-trips**.
- ☐ **Read the Key Concepts** in this guide to see how themes in the hall connect to your curriculum. Identify the key points that you'd like students to learn.

  Review the Map and the Teaching in the Hall section for an advance look at what your class will encounter.
- ☐ **Decide how your class will explore the hall:**
  - You and your chaperones can facilitate the visit using the Teaching in the Hall section.
  - Students can use the Map to explore the hall on their own or in small groups.

Correlations to Standards

National Science Education Standards

All grades: A1: Abilities necessary to do scientific inquiry; A2: Understanding about scientific inquiry; E2: Understanding about science and technology; G1: Science as a human endeavor

K-4: C1: Characteristics of organisms; C2: Life cycles of organisms; C3: Organisms and their environments; E3: Abilities to distinguish between natural objects and objects made by humans; F2: Characteristics and changes in populations

5-8: C1: Structure and function in living systems; C2: Reproduction and heredity; C4: Populations and ecosystems; C5: Diversity and adaptations of organisms; F2: Populations, resources, and environments

9-12: C1: The cell; C2: Molecular basis of heredity; C3: Biological evolution; C4: Interdependence of organisms; C5: Matter, energy, and organization in living systems; C5: Behavior of organisms; F2: Population growth; G2: Nature of scientific knowledge; G3: Historical perspectives

National Curriculum Standards for Social Studies

Thematic Strands I: Culture; II: Time, continuity, and change; III: People, places, and environment; IV: Individual development and identity; VIII: Science, technology, and society; IX: Global connections

National Standards in the Arts

Understanding the visual arts in relation to history and cultures

Credits

The Museum is deeply grateful to the Hall's lead benefactors Anne and Bernard Spitzer, whose marvelous generosity inspired and made possible the new Spitzer Hall of Human Origins.

The Museum also extends its gratitude to The Mortimer D. Sackler Foundation, Inc., Katheryn P. and Thomas L. Kempner, Jr., Arlene and Arnold Goldstein, the Honorable Lucy Wilson Benson, and the Stout Family for their generous support.

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