AMERICAN MUSEUM OF NATURAL HISTORY

Anne and Bernard SPITZER HALL OF HUMAN ORIGINS

EDUCATOR'S GUIDE

amnh.org/education/humanorigins

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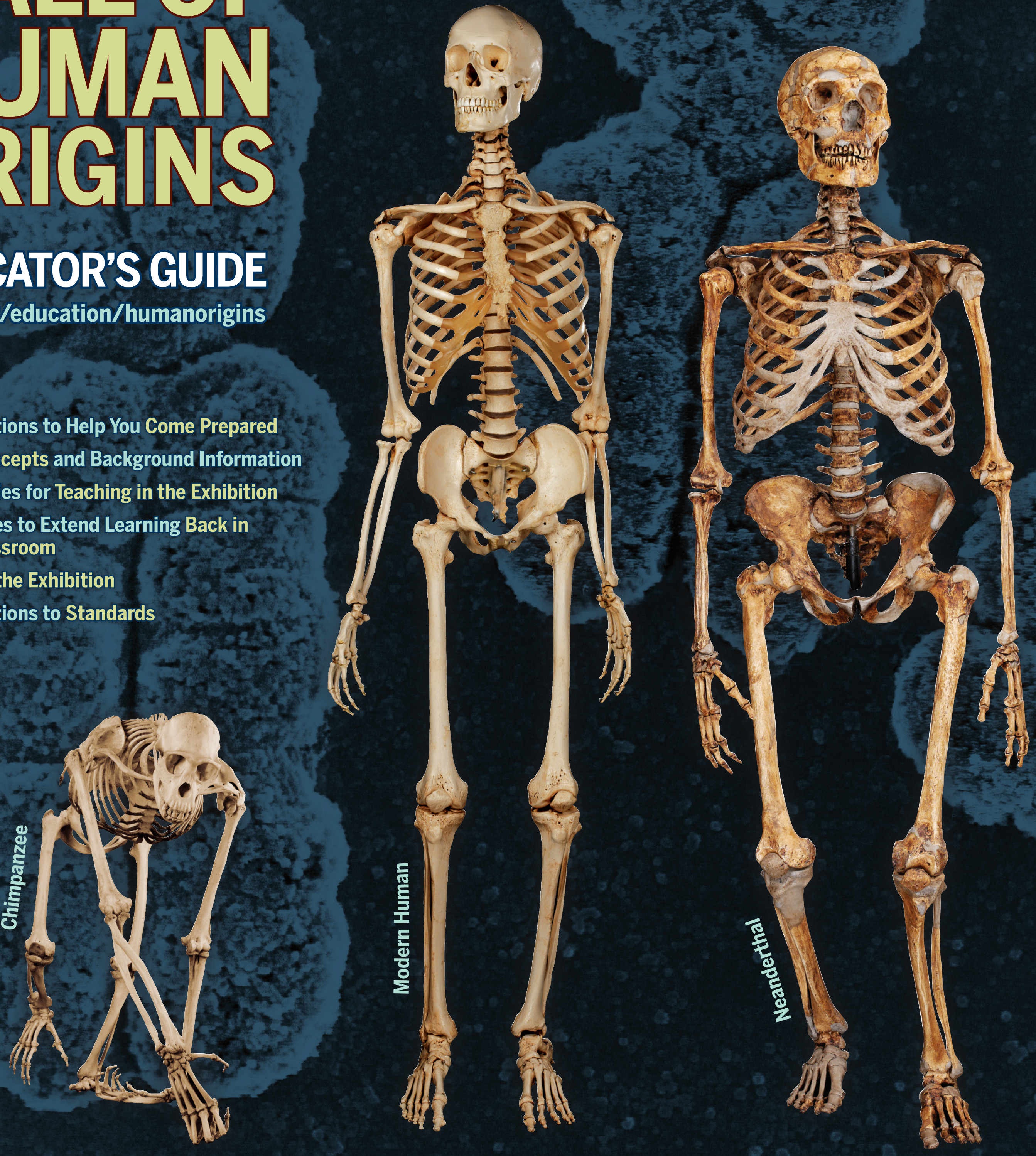


KEY CONCEPTS

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.

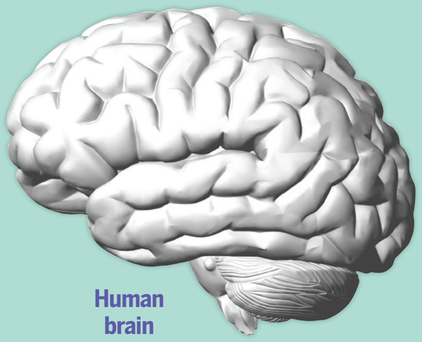
Evolutionary trees represent the history of life.

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.



Human brain

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.

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.

Words in green are defined in our online glossary found at: amnh.org/education/humanorigins

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.

Teaching Evolution

The exhibition, this guide, and the Museum’s professional development programs are designed to support you and make the critical science of evolution accessible and engaging. The following resources offer additional strategies for teaching and responding to concerns from students or community members:

- **American Association for the Advancement of Science**
  aaas.org/news/press_room/evolution/
- **American Association of Anthropologists: RACE Exhibit Resources**
  understandingrace.org/resources
- **Evolution and the Nature of Science Institutes**
  baesi.org/ensi-evolution-and-the-nature-of-science-institutes/
- **Howard Hughes Medical Institute**
  Biointeractive.org
- **National Center for Science Education**
  ncseweb.org/
- **PBS *Evolution* series educator resources**
  pbs.org/wgbh/evolution/educators/
- **Seminars on Science—*Evolution* Course for Teachers**
  amnh.org/learn-teach/seminars-on-science/courses/evolution
- **University of California Museum of Paleontology**
  evolution.berkeley.edu/evosite/evohome.html

Come Prepared

Review this guide prior to your visit to the exhibition. On the inserts you’ll find grade-specific classroom activities and worksheets to prepare your students and guide them during your visit. Go to amnh.org/education/humanorigins for an in-depth description of the exhibition, glossary, reference lists, and information about planning your visit.

Before you visit, become familiar with the education standards listed below that this exhibition can help you teach. Additional correlations to New York State and City standards can be found at amnh.org/education/humanorigins.

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

TEACHING IN THE EXHIBITION

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."

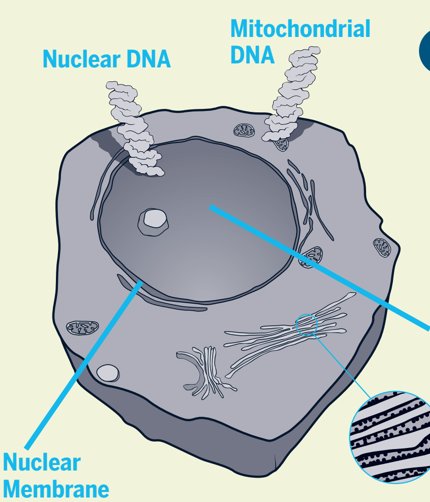
Key Concept: Ample scientific evidence documents evolutionary history.

3 Evolutionary Trees

3a. Our Hominid "Family Tree": Use the sidebar at right to help students read this evolutionary tree, which shows how the hominid family changed over time. Ask: What do the orange bars indicate? Have students find *Homo sapiens*. What does its position on the tree tell you? Which hominids are extinct? Which lived longer than *Homo sapiens*? Which lived on Earth at the same time?

3b. Tree of Life: Find the tree of life across the room. It shows how species are related to one another. Can students find *Homo sapiens*? Have students use the interactive to explore the tree.

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 Two *Australopithecus* Figures/Laetoli Footprints

Have students compare themselves to the figures, then walk on the fossilized footprints behind the figures. Ask: How do the prints compare to your feet and stride? What do your observations suggest about the individuals who left them?

Key Concept: Ample scientific evidence documents evolutionary history.

Laetoli hominid footprint

Modern human footprint

8 The History of Human Evolution

- Ask: What evidence was used to reconstruct how these hominids might have looked and lived?
- Have students compare the faces, bodies, and environments of the hominid species. Ask: How are they similar? Different? How has the hominid family changed over time?
- Gather in front of the *Homo sapiens* diorama scene. Ask: Do all modern humans look like these people? Why not?

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 Map: Our Earliest Migrations

Have students illuminate the migration pathways. In what continent did modern humans evolve? Where did humans disperse? Did humans really "leave" Africa?

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

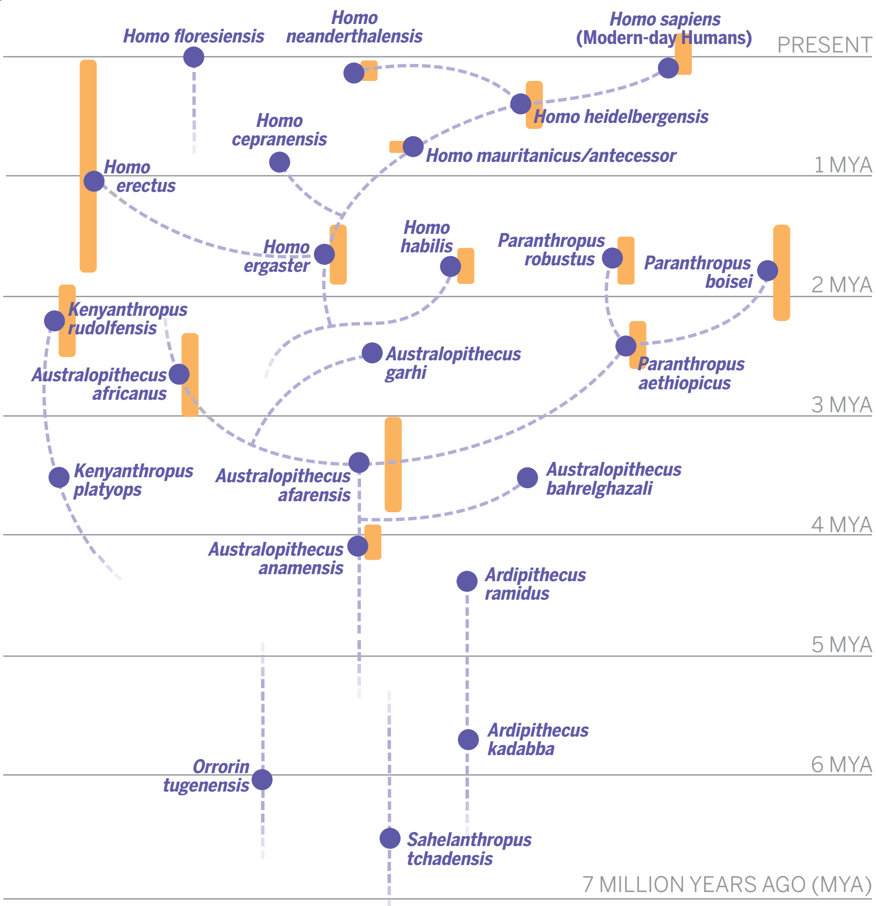
In this section, students can read about different forms of cultural expression and consider their own abilities. Ask: What skills were you born with? What have you learned from others? What do you think makes us "human"? Explore the interactives to deepen understanding.

Key Concept: Only modern humans create complex culture.

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

How to Read an Evolutionary Tree

Hominid "Family Tree": This evolutionary tree depicts lines of possible descent for hominids. In other words, it proposes relationships among species over time. All trees are hypotheses, and are based on comparison of living species, fossils, and genetic data.



Reading This Evolutionary Tree:

1. **Dashed lines** show how related species diverged from each other through a common ancestor.
2. **Faded lines** indicate very unclear origin or descent.
3. **Branch points** are called **nodes**. Nodes indicate a species that once lived, and was the common ancestor of two or more descendants.
4. **Horizontal lines** indicate time.
5. **Orange vertical bars** indicate how long a species is known, from fossils, to have existed.

Common Misconceptions:

• All species on this evolutionary tree are ancestors of *Homo sapiens.*

This is not true. You can follow the dashed lines back through time to learn which species are proposed ancestors.

• Evolution progresses toward a goal.

Evolution does not necessarily follow from simple to more complex, or non-human to human.

• Evolutionary trees are fixed.

Evolutionary trees are not fixed. They are based on interpretations of current data. New evidence or new ways of interpreting existing evidence can revise them.

BACK IN THE CLASSROOM

Try these activities and discussion points to explore and extend the themes in the exhibition.

Grades K–4:

- Have students explore the Tree of Life Cladogram on the Museum's OLogy website (amnh.org/explore/ology/biodiversity/tree-of-life2) to learn how scientists sort species based on shared characteristics.
- Have students reflect on how organisms' distinct structures help them survive by identifying body parts that help humans acquire food. Do the same with a different animal. What are the similarities and differences?
- Students can investigate "fossilization" by cutting out bone shapes from kitchen sponges, then soaking them in a saturated solution of Epsom salts. Have them soak another sponge in water as well. Allow them to dry and then compare the bone shapes with the control sponge. The salts replace spaces in the sponge just as minerals replace materials in a fossilizing bone or shell.
- If a zoo is accessible, take students to observe other primates. Have the class study their appearance, locomotion, and social interactions, and compare these traits to those of humans.

Grades 5–8:

- Invite students to classify organisms: Create a set of images of 24 very different organisms. First, have students separate them into plants and animals. Then have them subdivide the groups into progressively smaller ones based on similar characteristics. On what did they base their decisions? You may wish to present how scientists would classify the organisms.
- Construct a paper strip 500 cm long. Each centimeter represents a million years of Earth's history. Mark "origin of vertebrates" at the beginning. Mark "origin of hominids" between 6 and 7 million years ago. Have students research and add other evolutionary events to the timeline.

Grades 9–12:

- Based on what they saw at the exhibition, have students give examples of the two main lines of evidence for human evolution: fossil and genetic. What can each tell us about our evolutionary history?
- Ask students to further research how scientists other than paleontologists and geneticists contribute to the study of human origins (e.g. geologists, anatomists, botanists, etc.).
- Have students research the evolution of a non-primate, such as the horse. Students should note that, like humans, adaptations appeared over time as species descended from common ancestors.
- Show students drawings of limb bones of various tetrapod organisms, such as humans, birds, and whales. Ask: How is the structure of homologous organs evidence of descent from a common ancestor? Discuss vestigial organs as evidence of common ancestry.
- Ask students to select one of the human abilities from the exhibition: language, music, art, or tools and technology. Ask: Do you think humans are unique in this ability? Have students justify their answer.

For more activities to use in your classroom, visit: amnh.org/education/humanorigins

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.

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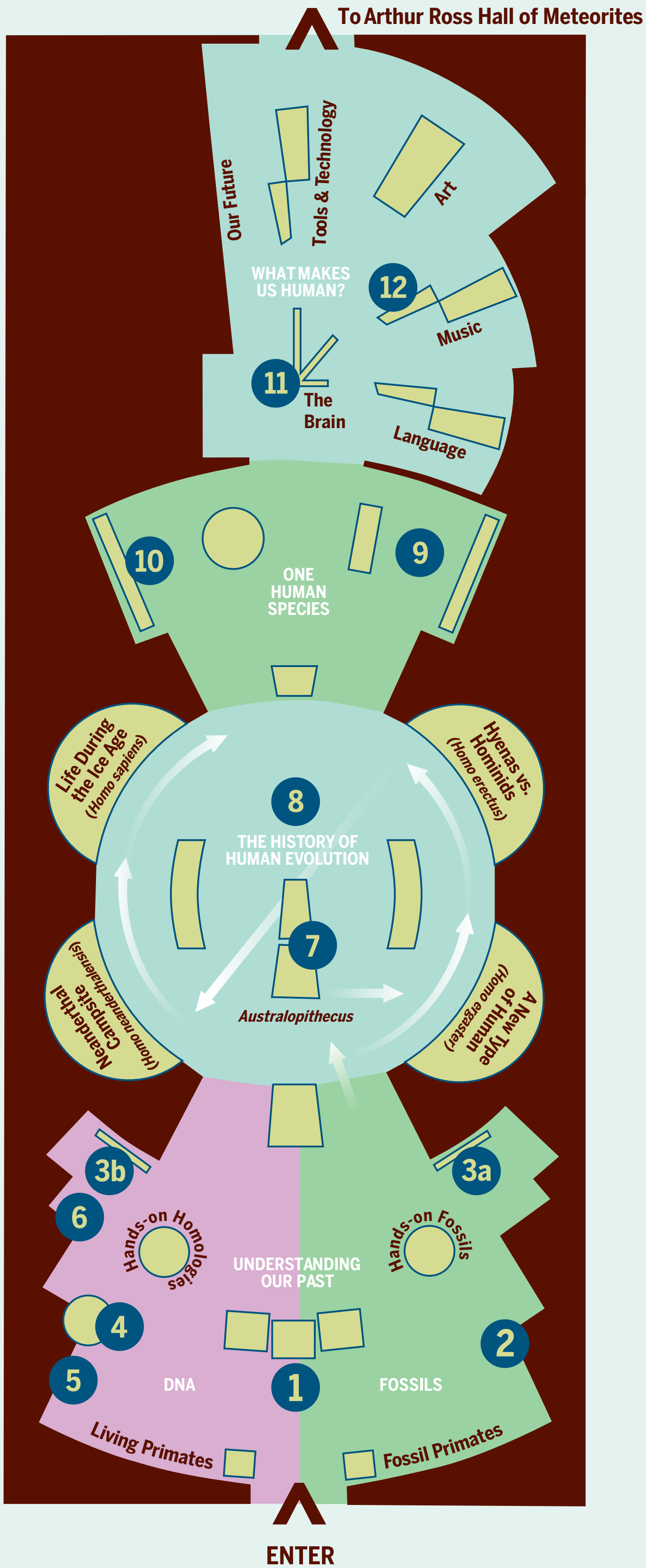
PHOTO CREDITS: Cover – human chromosomes, Getty; chimpanzee, modern human, and Neanderthal skeletons, AMNH / Roderick Mickens. **Key Concepts** – all images, AMNH Teaching Evolution – Chauvet lions © Jean Clottes. **Teaching in the Exhibition** – cell illustration, AMNH; Laetoli hominid footprint and modern human footprint, AMNH; Neanderthal campsite, AMNH / Roderick Mickens; Mozart: Motet Manuscript, The Granger Collection, NY; Paleolithic tools, AMNH. **Connections to Other Museum Halls** – Hall of Biodiversity, AMNH / Craig Chesek; all other photos, AMNH / Roderick Mickens. **Pre-Visit Activities Grades K–4** – human and woolly monkey hand comparison, AMNH

Spitzer Hall of Human Origins

MAP OF THE EXHIBITION



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

1. **Chimpanzee, Modern Human, and Neanderthal Skeletons**
2. **Fossils: A Record of the Past**
3. **Evolutionary Trees (3a. Our Hominid "Family Tree" and 3b. Tree of Life)**
4. **Cell Model**
5. **DNA: Comparing Humans and Chimps**
6. **Evolution: How It Works**
7. **Two *Australopithecus* Figures/ Laetoli Footprints**
8. **The History of Human Evolution**
9. **Science Bulletins Video and Kiosks**
10. **Map: Our Earliest Migrations**
11. **The Brain**
12. **Language, Music, Art, Tools & Technology**

COMPARE PRIMATES

Humans belong to a group called primates. Below are photographs of a human and two other primates. In what ways do these primates look alike? In what ways are they different?

Using these pictures, select a particular body part from two primates and draw them for comparison. Then label the differences and similarities of the body part.

Modern Human

Crowned Lemur

Chimpanzee

COMPARE SKELETONS

Below are photographs of three pairs of skeletons—of a chimpanzee, a modern human, and a Neanderthal. What differences do you see between the skeletons? What similarities? How are the skeletons adapted for walking on either two or four legs?

Chimpanzee

Modern Human

Neanderthal