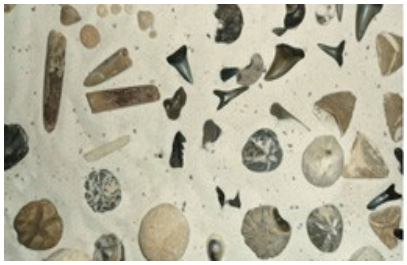
Evidence of Common Ancestry

Reflect

Are birds related to dinosaurs? Years ago, this question spawned heated debates and controversy among many scientists. Today, the scientific community generally accepts the idea that birds and dinosaurs share a common **ancestor**. What changed? Did scientists find evidence to support this theory? If so, what sort of evidence did they find?

ancestor: an organism from which other organisms evolved

The Fossil Record



Many pieces of evidence support the theory that birds and dinosaurs are related. One such piece of evidence, the *fossil record*, is the accumulation of all fossilized remains that scientists have collected around the world. However, while the fossil record provides evidence to support the theory of common ancestors among different organisms, it does not give a complete picture of this shared ancestry.

From fossils, scientists can identify the habitats and ecosystems that extinct organisms once occupied. They can also group similar extinct organisms together and arrange them in the order in which they lived, from oldest to youngest. The relative age of a fossil can be determined by comparing its location to other fossils within the same rock layers. Older fossils appear in rock layers below younger fossils. Scientists also use **radioactive dating** to determine the age of fossils. Radioactive materials have a fixed rate at which they decay. By measuring how much radioactive material is left in a fossil, scientists know how much has decayed and can then determine how long it took to decay. Working back this way, scientists can calculate the age of the fossil.

Fossils also give clues about how organisms changed over time. Scientists study the similarities and differences in the bones, shell shapes, or other features of organisms over time. For example, scientists discovered melanosomes in an ancient bird feather. Melanosomes are structures that contain melanin, which helps determine a creature's coloring. Scientists also found melanosomes in the feathery areas of a dinosaur fossil, which suggests an ancestral link between birds and dinosaurs.

Reflect

Sometimes the fossil record reveals a shift from one entire species to another. After comparing the skeletons of birds to those of *Coelurosaurian* dinosaurs, **paleontologists** concluded that many birds are likely direct descendants of the group of dinosaurs called coelurosaurs (especially the *Velociraptors*). Paleontologists point to characteristics such as the S-shaped neck, hollow bones, large eye sockets, five or more vertebrae in the hip, and many other similarities between birds and dinosaurs.

paleontologist: a scientist who studies prehistoric life

What Do You Think?

Take a look at the photographs below. Do you think the elephant on the left is a direct descendant of the woolly mammoth on the right? Explain your reasoning.

Studying Homologies of Different Organisms

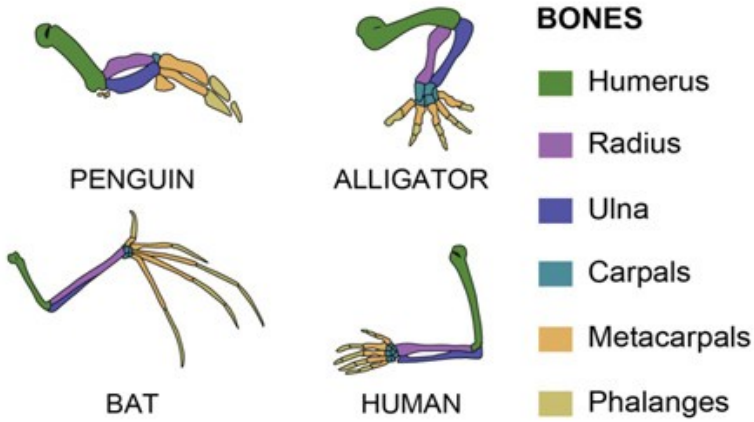
A 2005 study of mitochondrial DNA confirmed that woolly mammoths and African and Asian elephants share a **common ancestor.** Scientists compared the mitochondrial DNA sequences of both animals and found strong similarities. Mitochondrial DNA is particularly valuable in making these determinations because only the mother passes mitochondrial DNA down to her offspring. Scientists looked at the DNA sequences of each organism and compared their similarities and differences. Similarities in anatomical structure, gene sequences, developmental stages, or any other criteria that point to a common ancestor are called **homologies**.

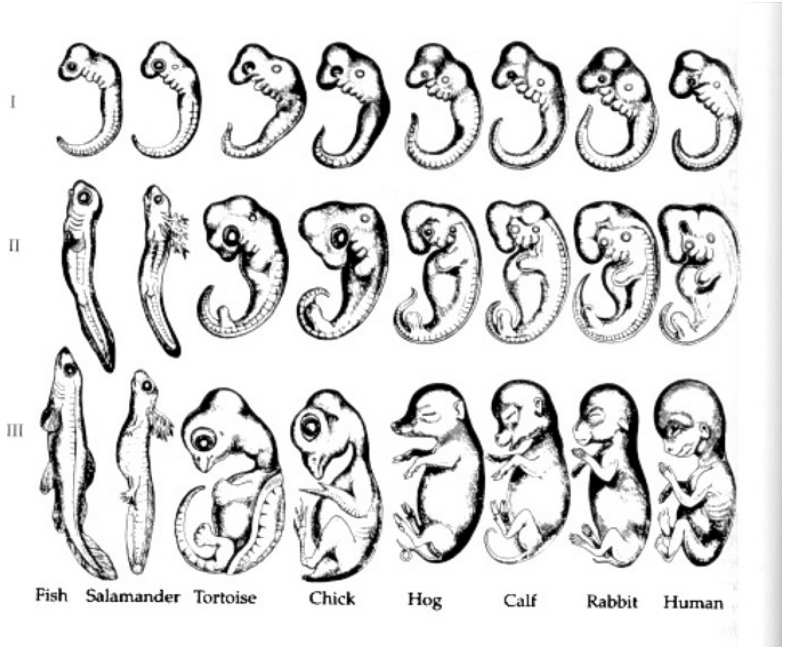
common ancestor: an organism or creature that is the shared predecessor of two or more decendant groups of organisms or creatures

What Do You Think?

Paleontologists compare bone structures in organisms to determine their common ancestry. A likeness between the bone structures of two creatures may indicate a common ancestor. Mammals, birds, and reptiles all show similar anatomical patterns.

This diagram shows similarities in the anatomical structure of forelimbs in mammals (bat and human), birds (penguin), and reptiles (alligator). Although they look similar, these forelimbs function differently in each of the organisms.





Species with similar origins also show similar embryonic development patterns. Paleontologists can learn a lot about a species by studying the embryo and patterns of its development. For example, certain snake embryos have small buds that look like limbs. The buds disappear in later developmental stages. This suggests that snakes evolved from an ancestor that had limbs.

Look Out!

Although evidence may support a certain hypothesis, that hypothesis may not be readily accepted. One hypothesis that has received mixed reactions is the idea that *Tyrannosaurus rex* is a predecessor of the chicken. Paleontologists found protein (collagen) in a 68-million-year-old *T. rex* bone. In 2007, they reported that five of the seven collagen fragments closely matched the collagen of chickens.

Look Out!

Other researchers questioned this conclusion and the research process. No other scientist had ever found protein that had survived even one million years, let alone 68 million. Could the proteins have come from contamination? Also, the match between the protein in the *T. rex* bone and chickens was determined by a computerized process. Some scientists wondered if different results might have emerged with differently written instructions. Acceptance of this shared ancestry hypothesis will take more research and evidence.

Biogeography

Biogeography is another type of evidence that supports the theory of evolution by natural selection. Biogeography is the study of past and present geographical distribution of species.

Organisms have characteristics that allow them to survive in their environment. If the environment changes, some species may evolve over time to cope with the differences. Sometimes, part of a population is geographically separated from the main group. The isolated population is forced to adapt to different conditions and evolve separately. The lemur is one example. Some scientists believe lemurs crossed from Africa to the island of Madagascar millions of years ago by floating on vegetation. By 20 million years ago, the continents had drifted so far apart that the lemurs became permanently isolated on Madagascar. *Continental drift*, the fragmentation and movement of continents from one massive landform named “Pangaea,” explains why many species evolved into new species. As the land masses of Pangaea drifted apart, newly isolated species developed characteristics that distinguish them from their common ancestor.

The lemur is an example of an animal whose ancestors were geographically separated from their native population.

Crocodiles have not changed from their original forms in 200 million years. They are an example of stasis.

Try Now

Read each example in the left column of the chart. Then, choose a term from the list below the chart that BEST matches each example. Each term may be used more than once.

Example	Matching Term
Humans and chimpanzees share some DNA and protein sequences.	
Whales, bats, and birds have the same bone that connects their limbs to the middle of their bodies.	
Used to determine the age of fossils.	
A predecessor that a creature shares with another creature.	
A scientist is studying the distribution of extinct and modern ferns in North America.	
Chicken, pig, and fish embryos all have pharyngeal folds.	
If the environment changes, some species may evolve over time to cope with the differences.	
Alligators and humans show similar bone components.	
Two species said to arise from the same species.	

List of Terms:

- Biogeography
- Structural Homology
- Molecular Homology
- Developmental Homology
- Common Ancestor
- Radioactive Dating

What Do You Think?

How does learning about animal structure, fossil records, and DNA sequencing from species that no longer exist help us care for the species that exist today? Write a paragraph answering this question. Include the following terms in your answer: homology, common ancestor, and embryonic development.

Connecting With Your Child

Evolutionary Trees

According to Darwin's theory of evolution by natural selection, all species share a common ancestor. To help your child learn more about common ancestry, work together to create an evolutionary tree. Also called a **phylogenetic** tree or ***t*ree of life***,* this diagram shows how species that share similar physical characteristics, genetics, or character traits may be related to each other.

First, have your child choose 12 organisms for the evolutionary tree, including three aquatic animals, three land mammals, three insects, and three reptiles. Search for photographs of these creatures on the Internet or in old magazines. Gather a large poster board, ruler, glue, and pencil. This evolutionary tree will focus on the physical characteristics of organisms. Brainstorm with your child different characteristics to put on the tree. Some ideas include:

- presence or absence of a backbone
- presence of hair, fur, or scales
- warm- or cold-bloodedness
- lungs or gills
- external structures such as fins, claws, or hooves
- food preference (omnivore, carnivore, or herbivore)

With the poster board in landscape orientation, write "Common Ancestor" at the bottom and draw a large "Y" above the term. Leave plenty of room above the Y to draw your tree's "branches." Now choose a characteristic for each side of the Y (e.g., presence or absence of a backbone). Separate the 12 organisms into two piles according to this characteristic.

Now, look at the organisms in each group and choose a characteristic to separate each of the two groups into smaller groups. You might find that one group, such as the organisms without backbones, cannot be further separated. If this is the case, glue these organisms onto the correct side of the Y at the top. For any group that can be further separated, draw a "V" on the correct side of the Y at the top. Place the organisms on either side of the V. For characteristics such as hair, fur, or scales, you will need to draw an extra line or two on the V, one line for each form of the characteristic.

Continue this process until only one organism is left. Glue the picture of that organism to the end of the branch. For ideas about how evolutionary trees are drawn and organized, you may want to do an Internet search prior to this activity using the keyword, **evolutionary tree**.

Here are some questions to discuss with your child:

- What surprised you the most about the relationships of the organisms in the evolutionary tree?
- What surprised you the least?
- Do you think an evolutionary tree based on genetic information might look different from the tree based on physical characteristics? Explain your reasoning.