Lesson 7.2 Evidence for Evolution: Change Over Time

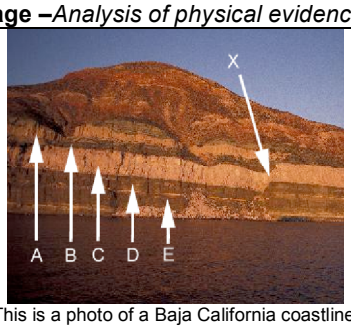
Name

Date

Period

Key Terms		
Adaptive radiation	Molecular Record	Vestigial organ
Homologous structure	Strata	Divergent evolution
Evolution	Fossil	

Engage –*Analysis of physical evidence.*

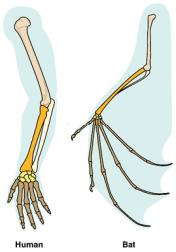


This is a photo of a Baja California coastline.

1. Fossils are found in each of the rock layers shown above. Which layer would contain the oldest fossils? How do you know?

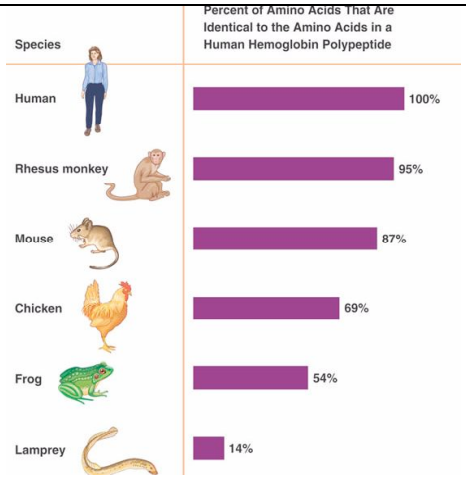
Blind Cave Fish naturally reside in underground caves in Mexico, they have had no eyes and no color, so they are just a pale pink with a slight hint of red on the fins and a shiny sheen. The eyes are completely covered with a layer of skin, but juveniles have small, black, useless eyes which soon grow over.

2. Why would the blind cavefish develop eyes at any stage in its life?



This is a drawing of the bones in the hand of a person and the wing of a bat.

3. Hypothesize why humans and bats have the same number of finger bones in their hands.

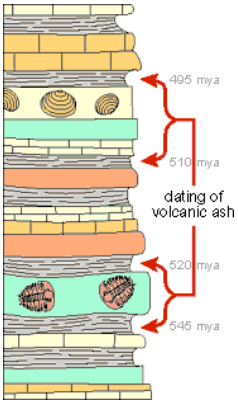


4. Based on this biochemical evidence, which organism is most closely related to humans? Explain in your own words.

Explore- Read the following passages and answer the questions based on your reading.

FOSSILS

Fossils are the remains of creatures that existed long ago. Fossils range from thousands of years to many millions of years in age. The earliest fossils date from around 600 million years ago, however recent reports suggest bacteria may have existed up to 3 billion years earlier. To put this in context, the dinosaurs became extinct just 65 million years ago. Not all former life was preserved as fossils, in fact the vast majority simply vanished without trace. The most likely materials to survive fossilization are the hard parts such as shells and Coral. In order for softer materials to survive, the conditions must be extremely favorable. Fossils come in a variety of sizes, from minute traces to large skeletons. Trace fossils are clues to former life, they result from the activities or presence of creatures and plants. Examples of these traces include footprints, burrows and root tunnels. At the larger end of the scale, fossils also include bones, the largest of which belong to the dinosaurs, which existed between the Triassic and Cretaceous periods.



Fossil Dating

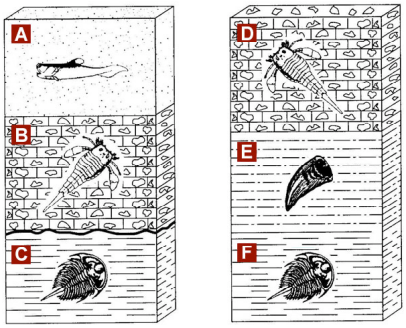
Fossils are generally found in sedimentary rock—not igneous rock. Sedimentary rocks can be dated using radioactive carbon, but because carbon decays relatively quickly, this only works for rocks younger than about 50 thousand years.

So in order to date older fossils, scientists look for layers of igneous rock or volcanic ash above and below the fossil. Scientists date igneous rock using elements that are slow to decay, such as uranium and potassium. By dating these surrounding layers, they can figure out the youngest and oldest that the fossil might be; this is known as "bracketing" the age of the sedimentary layer in which the fossils occur.

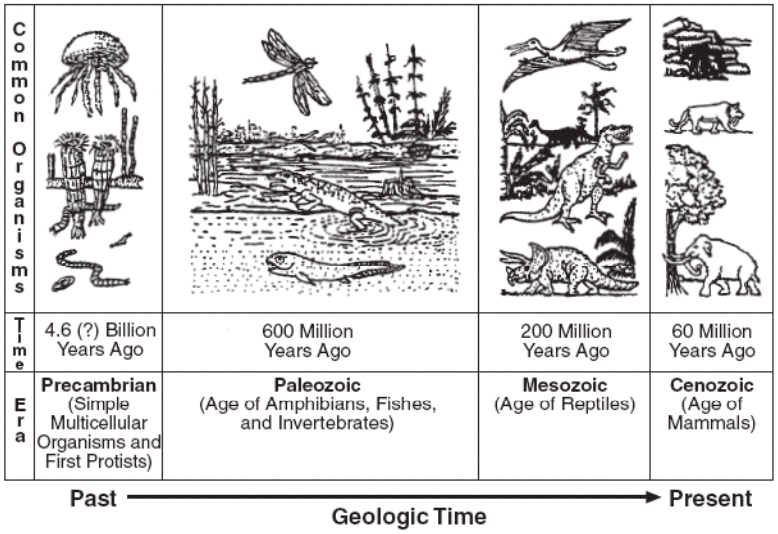
Fossils can be dated relative to one another by noting their positions in layers of rocks, known as strata. By studying and comparing strata from all over the world, we can date rocks relative to one another. Using numerical dating techniques, such as those based on the radioactive decay of atoms, we can assign probable ages to these layers and the fossils they contain.

5. Summarize the process of determining the age of a fossil in your own words.

6. In the picture to your left, which layer was the first to be deposited? Explain your reasoning.



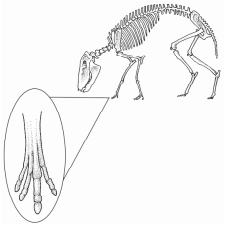
7. Sequence these fossils from <u>oldest to most recent</u>. In your own words describe the reason for your sequencing. The rock core sample with layers A, B, and C was taken from a stream in North America and the rock core sample with layers D, E, and F was taken from a mountain in South America. **Hint: Combine the letters of both columns in one column. Some "layers" may have more than one letter.**



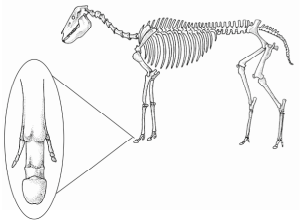
8. Which statement concerning the first appearance of the organisms over the time period represented in this chart is most likely correct?

a) Life on Earth has remained the same.
b) Life on Earth has changed from primitive organisms to more complex organisms.
c) Life on Earth began with complex organisms and changed to more complex organisms.
d) Life on Earth has changed rapidly.

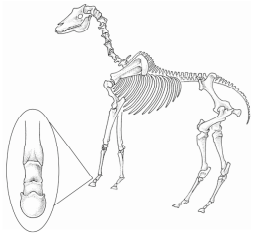
Fossils and Evolution



Hyracotherium – found in the fossil record

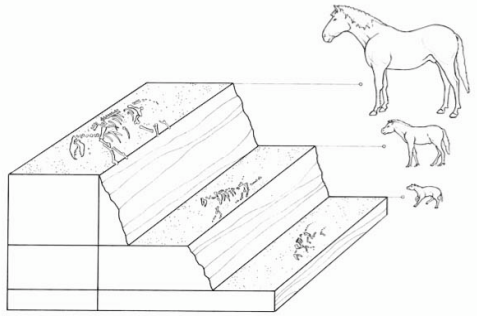


Merychippus – found in the fossil record



Equus – Modern Horse

These fossils were found in the fossil record as shown below:



9. Draw what you think the foot would look like in the strata level between Hyracotherium and Merychippus.

10. In your own words explain what happened to the foot of the horse from Hyracotherium to Equus.

11. What may have happened to the environment that made the new form more advantageous?

For #12 – 14 (*attached color plate*), use different colored pencils, color the bones and corresponding bone names.
12. Locate the bones listed in the **bird wing** diagram. To color 'B' simply color the letter B and the bracket.
13. Locate the bones listed in the **human hand**. Use the same color-coding to color these bones.
14. Locate the bones in the **bat wing**. Use the same color-coding to color these bones.
15. In your own words describe the similarities between these three limbs.

Homology

Comparative study of the anatomy of groups of animals or plants reveals that certain structural features are basically similar. For example, the basic structure of all flowers is the same; yet the size, color, number of parts and specific structure are different for each individual species. Homology forms the basis of organization for comparative biology.

Homologous structures and divergent (adaptive) evolution

If widely separated groups of organisms are originated from a common ancestry, they are expected to have certain basic features in common. The degree of resemblance between two organisms should indicate how closely they are related. Groups with little in common are assumed to have diverged from a common ancestor much earlier in geological history than groups that have a lot in common; in deciding how closely related two animals are, a comparative anatomist looks for structures that, though they may serve quite different functions in the adult, are fundamentally similar, suggesting a common origin. Such structures are described as homologous. Homologous structures are structures that are derived from a common ancestor i.e. they have a common evolutionary ancestry. This is not to say that homologous structures have the same function e.g. a whale's flipper is homologous to a human arm. These two limbs are superficially different, but their internal skeletal structure is essentially the same. Similarly, the wings of a bird and the wings of a bat are homologous structures. Homologous structures in modern organisms may show even less similarity in form, but it's still possible to trace their development and use them as a measure of evolutionary relatedness.

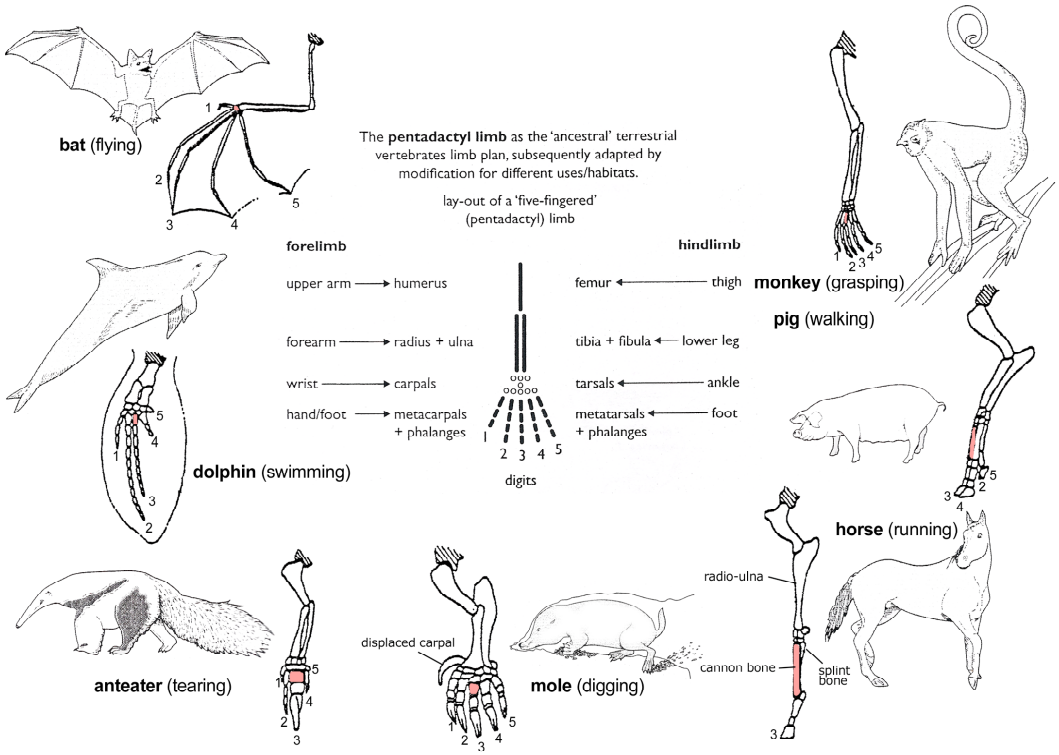
Adaptive radiation is where species all deriving from a common ancestor have over time successfully adapted to their environment. Adaptive radiation is one example of divergent evolution. **Divergent evolution** is the process of two or more related species becoming more and more dissimilar. The red fox and the kit fox provide and example of two species that have undergone divergent evolution. The red fox lives in forests, where its red color helps it blend in with surrounding trees. The kit fox lives in the desert, where its sandy color helps conceal it from prey and predators. The ears of the kit fox are larger than those of the red fox. The kit fox's large ears are an adaptation to its desert environment. The enlarged surface area of its ears helps the fox get rid of excess body heat. Similarities in structure indicate that the red fox and the kit fox had a common ancestor. As they adapted to different environments, the appearance of the two species diverged.

16. Which of the following best demonstrate homologous structures?
    a. a human arm and a starfish arm
    b. a human leg and an octopus tentacle
    c. a human arm and a whale flipper
    d. a human leg and a spider leg

17. Some homologous structures like a human leg or a horse leg do not look the same. Explain what makes them homologous?

18. Darwin discovered thirteen types of finches spread out on the different Galapagos Islands. Since all had a common ancestor, the finches demonstrate a perfect example of: _____ (*think vocabulary word*)

19. You just learned that the red fox and kit fox are two species that recently underwent divergent evolution. Pick two other animals that you think show divergent evolution AND explain why.

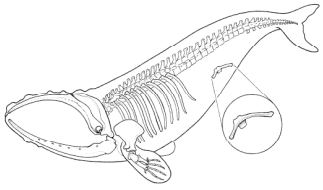
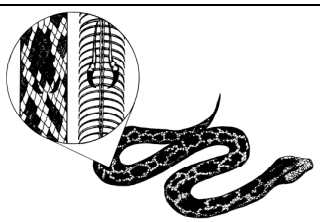
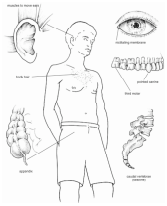


20. Consider the structure of the bones in the hand. These bones are shared between bats, monkeys, anteaters, moles, pigs, horses, etc. According to evolutionary theory, did these structures evolve independently, or were they inherited from a common ancestor? Explain your reasoning.

Vestigial organs

A further aspect of comparative anatomy is the presence of vestigial organs. Organs that are smaller and simpler in structure than corresponding parts in the ancestral species are called vestigial organs. They are usually degenerated or underdeveloped. The existence of vestigial organs can be explained in terms of changes in the environment or modes of life of the species. Those organs are thought to be functional in the ancestral species but have now become unnecessary and non-functional. Examples are the vestigial hind limbs of whales, the haltere (vestigial hind wings) of flies and mosquitoes, vestigial wings of flightless birds such as ostriches, and the vestigial leaves of some xerophytes (e.g. cactus) and parasitic plants (e.g. dodder). Although the structures most commonly referred to as "vestigial" tend to be functionless, a vestigial structure need not necessarily be without use or function for the organism. Vestigial structures have lost their original main purpose, but they may retain lesser functionalities, or develop entirely new ones. Thus, a "vestigial wing" need only be useless for flight to be vestigial; it may still serve some other purpose than that of a wing.

Vestigial Structures

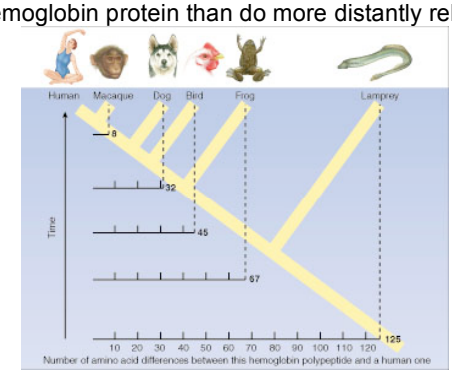
		
Hind limb bones in a whale.	Hind limb bones in a snake.	Muscles attached to ear Semilunar fold in eye Appendix Coccyx

21. What is a ***vestigial*** structure?

22. Are the eyes of a blind cave fish vestigial structures? Support your answer in your own words.

The Molecular Record

Traces of our evolutionary past are also evident at the molecular level. If you think about it, the fact that organisms have evolved successively from relatively simple ancestors implies that a record of evolutionary change is present in the cells of each of us, in our DNA. When an ancestral species gives rise to two or more descendants, those descendants will initially exhibit fairly high overall similarity in their DNA. However, as the descendants evolve independently, they will accumulate more and more differences in their DNA. Consequently, organisms that are more distantly related would be expected to accumulate a greater number of evolutionary differences, whereas two species that are more closely related should share a greater portion of their DNA. To examine this hypothesis, we need an estimate of evolutionary relationships that has been developed from data other than DNA. Such an hypothesis of evolutionary relationships is provided by the fossil record, which indicates when particular types of organisms evolved. In addition, by examining the anatomical structures of fossils and of modern species, we can infer how closely species are related to each other. When degree of genetic similarity is compared with our ideas of evolutionary relationships based on fossils, a close match is evident. For example, when the human hemoglobin protein is compared to the corresponding molecule in other species, closely related species are found to be more similar. Chimpanzees, gorillas, orangutans, and macaques, vertebrates thought to be more closely related to humans, have fewer differences from humans in the hemoglobin protein than do more distantly related mammals, like dogs.



DNA molecules reflect evolutionary divergence. You can see that the greater the evolutionary distance from humans the greater the number of amino acid differences in the vertebrate hemoglobin polypeptide (protein). Why should closely related species be similar in DNA? Because DNA is the genetic code that produces the structure of living organisms, one might expect species that are similar in overall appearance and structure, such as humans and chimpanzees, to be more similar in DNA than are more dissimilar species, such as humans and frogs. Comparison of the DNA of different species provides strong evidence for evolution.

23. According to evolutionary theory, if organisms of two separate species share a great deal of DNA, are these organisms closely or distantly related? Explain your answer.

The following sequences of letters stand for the DNA bases from portions of the genes that code for hemoglobin proteins.

Lemur	GGG CCT AAG TCT TCT ATC TTC ACC TGT TCC TGT CTG CTT CCT CTT CCT GGA CAT CTA TCA
Human	GGC CCT AGG TCC CCT ATC TCC ACC TGC TCC AGT CAG CTA CCT CTA CCT GAA CAT CTA TCA

Deoxyribonucleic acid (DNA) codes for proteins that your body needs to live. Two of those proteins are the alpha and beta hemoglobin proteins that occur in your blood. These proteins carry oxygen and carbon dioxide as they circulate in your bloodstream. Other animals blood also contains alpha and beta hemoglobin proteins. However, not all of these proteins are identical. The differences are caused by differences in the DNA that codes for them. One reason why developmental biologists are interested in comparing the DNA and proteins of organisms is to learn about relatedness. The more similar two organisms' DNA are, the more likely it is that the organisms are closely related.

24. Compare the DNA sequences from the hemoglobin for the two different primates. What is the percent similarity between lemur and human? Hint: percent similarity=(number of DNA bases the same/total number of DNA bases) X100

Comparisons between portions of the genetic code for hemoglobin in four primates

Chimpanzee	TAT AAA TCT GTT CCT GCA AAT AGT CAA AGA TGC CAC TTC TTT TTC TTC ATA TCA TCG ACG
Gorilla	TAA AAA TCT CTT CCT GCA AAT AGT CAA AGA TGC CAC TTC TTT TTC TTC ATA TCA TCG ACG
Human	TAT AAA TGT GTT CCT GCA TAT AGT CAA AGT TGC CAC TTC TTT TTC TTC ATA TCA TCG ACG
Orangutan	TAA AAA TCT GTC CCT GCA AAT AGT CAA AGT TCC CAC TTC TTT CCC TTC CTA TCA TCG ACG

25. Calculate the percent similarity between
-Humans and chimpanzees

-Humans and gorillas

-Humans and orangutans

26. Based on these percent differences, which organisms are most closely related to humans?

27. Compare your initial thinking (from the Engage) to what you think now. What have you learned that will improve each of your answers from the Engage at the very beginning of the lesson? Complete the following thoughts.

#1 I now know the oldest fossils are ……. because……..

#2 I now know **blind** cavefish have eyes because ….

#3 I now know humans and bats have the same number of finger bones because ….

#4 I now know organisms the most closely related to humans are ……. because……