Examining the Fossil Record

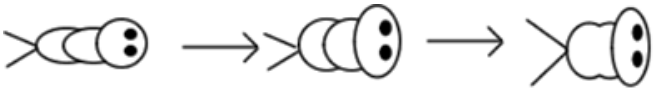
Objectives:

- analyze characteristics of fossils
- compare placement of fossils and determine relative ages
- develop a model evolutionary tree based on the morphology and age of fossils

Background:
Fossils are traces of organisms that lived in the past. When fossils are found, they are analyzed to determine the age of the fossil. The absolute age of the fossil can be determined though **radioactive dating** and the relative age of the fossil can be determined by using the layer of rock in which the fossil was found. Older layers are found deeper within the earth than newer layers.

The age and morphologies of fossils can be used to place fossils in sequences that often show patterns of changes that have occurred over time. This relationship can be depicted in an evolutionary tree, also known as a **phylogenetic** tree.

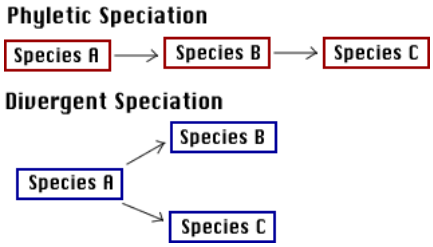
There are two major hypotheses on how evolution takes place: **gradualism** and **punctuated equilibrium**. Gradualism suggests that organisms evolve through a process of slow and constant change. For instance, an organism that shows a fossil record of gradually increased size in small steps, or an organism that shows a gradual loss of a structure. Punctuated equilibrium suggests that species evolve very rapidly and then stay the same for a long period of time. This rapid change is attributed to a mutation in a few essential genes. The sudden appearance of new structures could be explained by punctuated equilibrium. **Stasis** refers to the time when changes are *not* being made to an organism. In other words, the fossil record shows no significant differences between the fossils found in two consecutive time periods. Both hypotheses are evident in the fossil record.



Gradualism: creature became larger, segments fused

Punctuated equilibrium: head changed shape, loss of segment

Speciation:
Speciation is simply the formation of a new species. The fossil record cannot accurately determine when one species becomes another species. However, two hypotheses regarding speciation also exist. **Phyletic speciation** suggests that abrupt mutations in a few regulatory genes occur after a species has existed for a long period of time. This mutation results in the entire species shifting to a new species. Phyletic speciation would also relate to the Punctuated Equilibrium hypothesis regarding evolution. **Divergent speciation** suggests that a gradual accumulation of small genetic changes within two (or more) subpopulation of a single species eventually accumulate so the two (or more) subpopulations become distinctly different species. This hypothesis would coincide with the gradualism model of evolution. Most evolutionary biologists accept that a combination of the two models has affected the evolution of species over time.

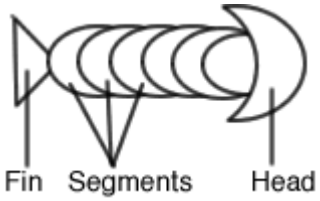


Procedure:

1. The Geologic time periods for this experiment can be seen in the following table. The time periods will be used to place your fossils in order from the oldest to the most recent. These are imaginary time periods.

Time Period	**Began (years ago)**
Idahoan (the present)	30,000
Californian	80,000
Montanian	170,000
Coloradian	320,000
Oregonian	395,000
Texian	445,000
Nevadian	545,000
Ohioian	745, 000
Wyomingian (oldest)	995,000

2. The group of "fossils" you will work with includes fictitious animals. Each fossil is marked with a time period.
3. Arrange the fossils by age. Place each fossil in order according to the period from which the fossil came. The term "upper" means more recent and should be placed higher in the time period. The term "lower" means an earlier time period; fossils from a "lower" time period should be place toward the older time periods. In each fossil column, you may have 3 specimens, one from the main time period, one from the upper and one from the lower. **Not all fossils are represented**, illustrating the incompleteness of the real fossil record.
4. While keeping the fossils in the proper age order, arrange them by morphology. To help you understand the morphology of the specimen, view the diagram below.



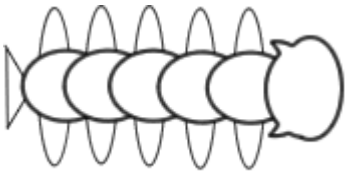
Arrange the fossils using the following steps.

a. Center the oldest fossil at the bottom of the fossil column (toward the oldest layer).

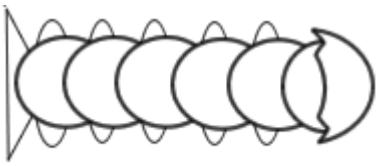
b. Throughout the chart, those fossils that appear to be the same (or close to the same) as the fossils preceding them should be placed in a vertical line.

c. During a certain period, the fossils will split into two branches. When this happens, place the fossils side by side in the appropriate time period. From this point on, you will have two lineages. Keep the “holes” in the fossil record. Do not align fossils from different time period next to each other.

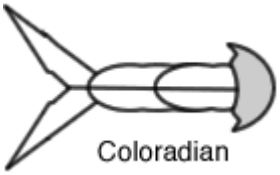
5. Once all the fossils have been placed correctly according to relative age and morphology, get approval from your teacher and then answer the Analysis Questions.



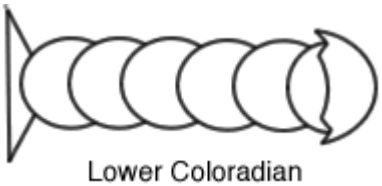
Californian



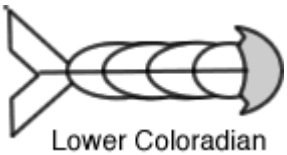
Coloradian



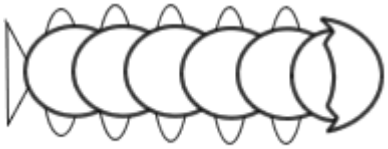
Coloradian



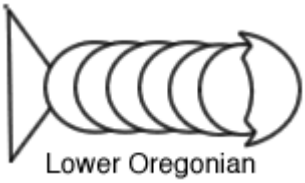
Lower Coloradian



Lower Coloradian

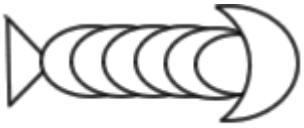


Lower Montanian

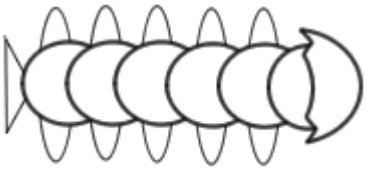


Lower Oregonian

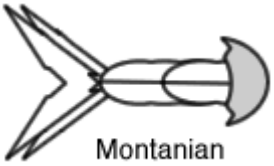
Lower Oregonian



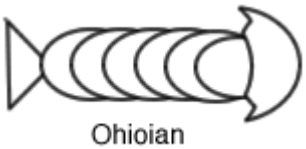
Lower Wyomingian



Montanian



Montanian

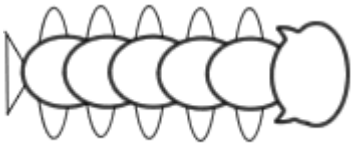


Ohioian

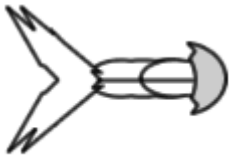
Oregonian

Texian

Texian



Upper Montanian

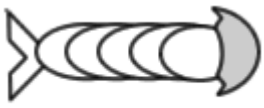


Upper Montanian

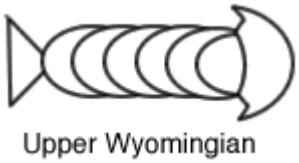
Upper Nevadian

Upper Nevadian

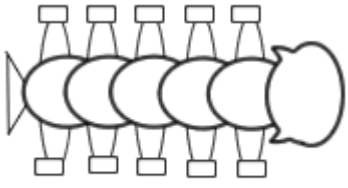
Upper Texian



Upper Texian



Upper Wyomingian



Idahoan

Name: _____ Date: _____ Period: _____

Examining the Fossil Record

Analysis:

1. Which scientist introduced the idea of "Older layers are found deeper within the earth than newer layers."
   _____

2. Give a brief description of the evolutionary morphological changes that occurred in the organism. You must include descriptions of 4 major morphological trends in the fossils.
   _____
   _____
   _____
   _____

3. During which time period did the fossils diverge into two branches? _____

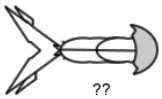
4. Explain how the phylogenetic tree you created illustrates punctuated equilibrium in at least two examples. Use specific fossils from the chart to support your answer. Be sure to identify which branch of organisms to which you are referring.
   _____
   _____
   _____
   _____

5. Explain how the phylogenetic tree you created illustrates gradualism in at least two examples. Use specific fossils from the chart to support your answer. Be sure to identify which branch of organisms to which you are referring.
   _____
   _____
   _____
   _____

6. During which time periods was stasis apparent? _____

7. Define the following terms:
   a. morphology –
   b. physiology
   c. fossil -
   d. phylogenetic tree –

8. Examine the fossil that was unearthed in a museum, apparently the labels and other information were lost. Using your fossil record, determine the time period this fossil is likely from.



_____

9. Of the two major species that arose from the parent species, which appeared to survive longer? Would this be considered to be a successful species? Explain your answer.

_____
_____
_____

10. Why might one lineage have ended thousands of years ago?

_____
_____

11. Based on both lineages, between what two time periods might you hypothesize that a major environmental change occurred? Use evidence from your fossils to defend your answer.

_____
_____
_____
___

12. What causes the new structures to appear in the lineages?

_____

13. What are some examples of animals that have been in relative stasis for millions of years?

_____

14. Distinguish between relative dating and radioactive dating. Which did you use?

_____
_____
__

15. Why are there holes in the fossil record?

_____
_____
__