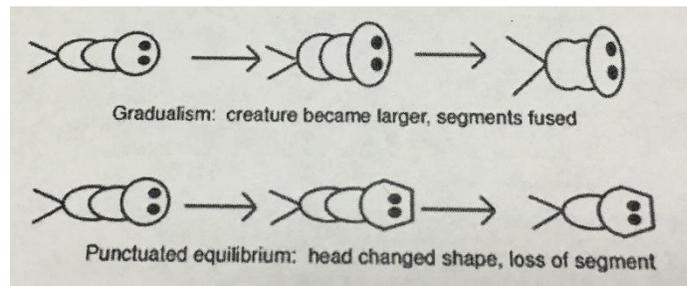


## Lab: Marine Fossils and the Phylogenic Tree (MAKEUP VERSION)

**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 relative age of the fossil can be determined by the Law of Superposition (Steno) which states that undeformed sedimentary rock layers are older than layers above them. This means that older layers are found deeper within the earth than newer layers. The absolute age of the fossil can be determined through methods such as radiometric dating, amino acid racemization or fission track dating.

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 phylogenic tree.

There are two major ways in which evolution proceeds through time: gradualism (Darwin) and punctuated equilibrium (Gould & Eldredge). 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, often exploiting a newly opened niche, and then stay relatively the same for a large period of time. This rapid change is attributed to a mutation in a few essential genes. The sudden appearance of new structures can be explained by punctuated equilibrium.



There are two ways that speciation occurs. 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 is generally associated only with punctuated equilibrium. Divergent speciation occurs with the gradual accumulation of small genetic changes results in a subpopulation of a species becoming so different from the parent population that reproduction between subpopulations no longer occurs. Divergent speciation is generally associated with gradualism.

### Prelab Questions:

1. How does the Law of Superposition allow us to identify when fossil organisms lived in the past?
2. Why are phylogenic trees useful?
3. Compare and contrast gradualism with punctuated equilibrium.
4. Compare and contrast phyletic speciation with divergent speciation.
5. Give two ways in which subpopulations might be separated prior to divergence? (not given in text)

**What We Did in Class:** Students organized a group of fictitious fish by age, then identified changing phylogeny to analyze evolutionary patterns over time. You will look at how fish populations have evolved by visiting the website below.

Visit the website [http://evolution.berkeley.edu/evolibrary/article/fishtree\\_01](http://evolution.berkeley.edu/evolibrary/article/fishtree_01) to answer the following questions as you look from left to right (oldest to youngest evolutionarily) across the phylogenetic tree.

6. (green bar: Craniata) All fish are craniates. What are the six features that define a craniate?
  7. (green bar: Chondrichthyes) Chondrichthyans include sharks and rays. What differentiates them from other fish?
  8. (red circle: From Water To Land) Sarcopterygians gave rise to all tetrapods. Describe the evidence that supports this.
  9. (red circle: From Water To Land) Explain the relationship between gills, lungs and swim bladders.
  10. (green bar: Actinopterygii) Actinopterygii are the ray-finned fishes. What are the four features that define them.
  11. (red circle: Fish on Equal Footing) Explain the concept of rotation around a node in a phylogenetic tree.
  12. (red circle: A Light in the Darkness) How is bioluminescence achieved in fish?
  13. (red circle: A Light in the Darkness) Name the five lineages that have evolved bioluminescence.
  14. (red circle: Gender-Bending Fish) Explain the two types of hermaphroditism: protandrous and protogynous.
  15. (red circle: Gender-Bending Fish) Name the eight lineages of fish that are hermaphroditic.
  16. (red circle: Oh Fish, Where is Thy Sting?) Venom has evolved many times independently in fish. Why is this?
  17. (red circle: Oh Fish, Where is Thy Sting?) Name the four lineages that have evolved venom.
- Click on “see the full tree” in the upper right corner of the page to show more detail among the Actinopterygians.
18. The order Perciformes is the largest order of vertebrates in the world, and include 41% of all bony fish. How many species are in the order?
  19. (green bar: Smegmamorpharia) Smegmamorpharians have a weird name, don't you think? Name a fish in this taxonomic group.

Watch the video <https://youtu.be/2yRN6bdOb8c> and answer the following questions

20. How can fossils be used to determine ancient temperatures?
21. What is paleothermometry?
22. What is paleobathymetry?
23. Explain the connection between tides, marine organisms and length of day as described in the video.
24. What did you learn from this makeup lab?