**Unit 2: Evolution – How Evolution - Macro** Date: \_\_\_\_\_\_\_\_\_\_\_\_\_

****Objectives - By the end of the lesson you should be able to:

* Describe how macro-evolution (speciation) is different from micro-evolution
* Describe 3 patterns of speciation
* Compare and contrast Gradualism with Punctuated Equilibrium

**Macro-evolution: AKA Speciation**

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Recall:

* **Species**: population of organisms that are able to **breed** and produce **viable**, **fertile** offspring
* When a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (by a geographic barrier for example), speciation can occur over a long period of time as all of the small changes in the gene pool due to micro-evolution add up over time.
* Eventually the differences in the two populations are so great that the two populations can \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to make viable, fertile offspring. We now have two different species. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is said to have occurred.

**Patterns of Speciation**

**1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ AKA Adaptive Radiation**

* + Occurs when small fragments of a population \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ … they adapt (evolve) to their new habitats
	+ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	+ EX. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

* Occurs when \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and adapt (evolve) so will display similar characteristics

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ so DNA is not closely related
* EX. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

* Occurs when organisms are closely connected to one another by biological interactions (symbiosis) and \_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ . A change in one organism may be followed by a corresponding change in the other organism.
* EX. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Rate of Evolution**

* There is no defined speed that evolution happens in, but there are two trends that can be clearly observed in the fossil record: Gradualism and Punctuated Equilibrium

 **Gradualism – Modern theory based on the principles of Charles Darwin**

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ evolution of a species over time
* Small changes (micro evolution) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ over time
* **Fossils are direct evidence that show speciation over time**
* The fossil record demonstrates clear examples of slow and steady changes over millions of years preserved in progressively younger layers of rock



 **Punctuated Equilibrium - Eldredge and Gould in 1972**

* Long periods of stasis (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_) with short, rapid periods of change (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)
* Associated with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* The fossil record also demonstrates clear examples of periods of little change followed by rapid changes



Punctuated equilibrium predicts that a lot of evolutionary change takes place in short periods of time tied to speciation events. Here's an example of how the model works:

Ex: Mollusk Evolution by Punctuated Equilibrium

* **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** A population of mollusks is experiencing stasis, living, dying, and getting fossilized every few hundred thousand years. Little observable evolution seems to be occurring judging from these fossils
* **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_:** A drop in sea level \_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of mollusks from the rest of the population.
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: The small, isolated population experiences strong selection and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because of the novel environment and small population size: The environment in the newly formed lake exerts new selection pressures on the isolated mollusks. Also, their small population size means that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ influences their evolution. The isolated population undergoes rapid evolutionary change.
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: Few fossils representing transitional forms are preserved because of their relatively \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ size, the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of change, and their \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_: Sea levels rise, reuniting the isolated mollusks with their sister lineage.
* **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ :** The isolated population \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Larger population size and a stable environment make evolutionary change less likely. The formerly isolated branch of the mollusk lineage may \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ their ancestral population, causing it to go extinct.



* **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** : Larger population size and a larger range move us back to step 1: stasis with occasional fossil preservation.
* This process would produce the following pattern in the fossil record:
* We observe similar patterns in the fossil records of many organisms. For example, the fossil records of certain foraminiferans (single-celled protists with shells) are consistent with a punctuated pattern.
*  

* In the fossil record we can observe examples of gradual, non-punctuated, evolution in some species and long periods of stasis followed by rapid change in other species. **There is fossil evidence for both theories!**
* The question that needs answering is not which one is correct, but what are the relative frequencies of punctuated and gradual change?

**Comparison**

Which graphs/diagrams are showing Gradualism? Punctuated Equilibrium? Why?

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\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Scientist(s)) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(Scientist(s))

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Theory) \_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Theory)

Can you …

… describe how macro-evolution (speciation) is different from micro-evolution?

… explain 3 patterns of speciation?

… compare and contrast Gradualism with Punctuated Equilibrium?