Date ___________

AIM: What are the different ways evolution can occur?

1. LOCAL (micro) v. GLOBAL (macro) EVOLUTION

LOCAL - microevolution	GLOBAL - macroevolution
small changes in the genetic makeup of a population ex: change in genetic pool of the peppered moth	large changes ex: global climate change - bye bye dinos, hello mammals

2. COEVOLUTION

- two species interact with each other to help one another evolve
- can be mutualistic, predator/prey or host/parasite relationships

Ex: leaf-cutting ants and fungus gardens – mutualistic coevolution – ants help fungus gardens grow by bringing leaf fragments that can be dissolved and used by fungus – fungus provides a large amount of nutrition for ant colony

In an ongoing coevolutionary relationship, the common **garter snake** continually evolves new levels of immunity to the toxins of one of its prey, the **newt**, while the newt continually evolves new toxins for defense from the attacks of its predator.

The predator-prey relationship between **crabs** and **marine snails** is a great example of coevolution. Indo-Pacific crabs have stronger claws than Caribbean crabs, and Indo-Pacific snails have thicker shells than Caribbean snails. It is presumed that the Indo-Pacific crabs and snails have evolved together. To avoid predation, the snails developed thicker shells. To become better predators, the crabs developed stronger claws.

Cabbage butterfly caterpillars have the ability to break down the chemical defense of **plants** that defend themselves with mustard oils that are toxic to other insects. The caterpillars can break down the mustard oils into simpler non-toxic compounds. So in this case, the plants evolved by developing a chemical defense against plant-eating insects, and in response, the caterpillar evolved a method to deal with that chemical defense.

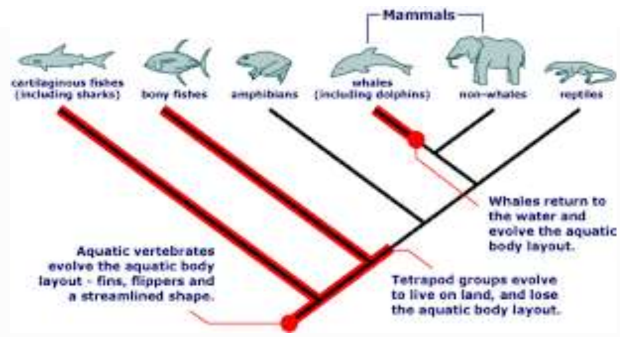
Many **fruit-eating birds**, especially in tropical rain forests are coevolving with the **plants** whose fruits they eat. The birds get nourishment, and in the process the plants get their digestion-resistant seeds dispersed by regurgitation or along with the birds' droppings. Many characteristics of the plants have evolved to facilitate dispersal, and the behavior and diets of the birds have responded to those changes. In particular, the plants have evolved conspicuously colored, relatively odorless fleshy fruits to attract the avian dispersers of their seeds. They are coevolving in response to the finely honed visual systems of the birds; plant species coevolving with color-blind mammalian seed-dispersers have, in contrast, dull-colored but smelly fruits. The bird-dispersed plants often have evolved fruits with giant seeds covered by a thin, highly nutritious layer of flesh. This forces the bird to swallow the fruit whole, since it is difficult or impossible just to nip off the flesh. In response, some birds have evolved both bills with wide gapes (so they can swallow the fruit whole) and digestive tracts that can rapidly dissolve the flesh from the large impervious seed, which then can be regurgitated.

https://web.stanford.edu/group/stanfordbirds/text/essays/Coevolution.html

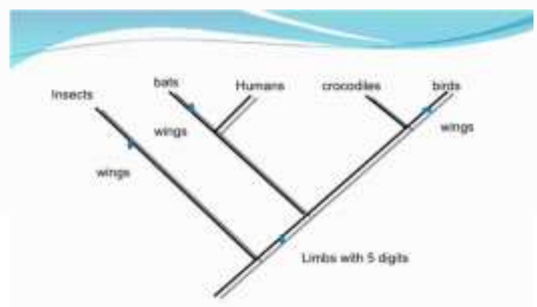
3. CONVERGENT EVOLUTION

organisms that are not closely related evolve similar traits independently as a result of having to adapt to similar environments or ecological niches

Both **sharks** and **dolphins** have similar body forms, yet are only distantly related: sharks are fish and dolphins are mammals. Such similarities are a result of both populations being exposed to the same selective pressures. Within both groups, changes that aid swimming have been favored. Thus, over time, they developed similar appearances (morphology), even though they are not closely related.



Flight has evolved in **bats, birds,** and **insects**. They all have wings, which are adaptations to flight. However, the wings of all three have evolved from very different original structures. This is an example of convergent evolution, because they all have a similar trait that evolved independently.



The gliding capabilities of **gliding lemurs** (Philippines), **flying squirrels** (North America and Europe), and **sugar gliders** (Australia) are also examples of convergent evolution. Gliding is an adaptation thought to have developed in forest environments as a way for animals to travel or evade predators, but to use less energy. An argument made is that many gliding animals eat low energy foods such as leaves and are restricted to gliding because of this, whereas flying animals eat more high energy foods such as fruits, nectar, and insects. Again, all three animals developed this trait independently to be able to live in their established niches.

The prehensile (gripping) tails of **monkeys** and **opossums** are yet another example of convergent evolution. Animals with prehensile tails use their tails to hold on to objects. They can curl their tail around objects such as branches and hold on to those objects for balance. Tails can be prehensile or partially prehensile. More often than not, this feature helps arboreal animals (animals who spend most of their time on trees) to grab and eat food. In case of partially prehensile tails, the tail helps them climb or dangle from branches.

4. DIVERGENT EVOLUTION

the accumulation of differences between groups which can lead to the formation of new species, usually a result of separation of the same species to different and isolated environments

speciation – two species arise from one

2 phases:
1. geographic isolation (mountain barriers, separated on different islands, valleys carved by rivers, human construction)
2. reproductive isolation

When Charles Darwin stepped ashore on the Galapagos Islands in September 1835, it was the start of five weeks that would change the world of science, although he did not know it at the time. Among other finds, he observed and collected the variety of **finches** that inhabited the islands, but he did not realize their significance, and failed to keep good records of his specimens and where they were collected. It was not until he was back in London, puzzling over the birds, that the realization that they were all different, but closely related, species of finch led him toward formulating the principle of natural selection.

In his memoir, *The Voyage of the Beagle,* Darwin noted, almost as if in awe, "One might really fancy that, from an original paucity of birds in this archipelago, one species had been taken and modified for different ends." Indeed, the Galapagos have been called a living laboratory where speciation can be seen at work. A few million years ago, one species of finch migrated to the rocky Galapagos from the mainland of Central or South America. From this one migrant species would come many -- at least 13 species of finch evolving from the single ancestor. This process in which one species gives rise to multiple species that exploit different niches is called adaptive radiation. The ecological niches exert the selection pressures that push the populations in various directions. On various islands, finch species have become adapted for different diets: seeds, insects, flowers, the blood of seabirds, and leaves.

The ancestral finch was a ground-dwelling, seed-eating finch. After the burst of speciation in the Galapagos, a total of 14 species would exist: three species of ground-dwelling seed-eaters; three others living on cactuses and eating seeds; one living in trees and eating seeds; and 7 species of tree-dwelling insect-eaters. Scientists long after Darwin spent years trying to understand the process that had created so many types of finches that differed mainly in the size and shape of their beaks. http://www.pbs.org/wgbh/evolution/library/01/6/l_016_02.html

The divergent evolution of **wolves** and **domesticated dogs** from a common ancestor provides another example. Scientists once thought that dogs descended from gray wolves. Now, through genetic studies, researchers know that dogs and wolves share a common ancestor instead of a direct lineage.

Their common ancestor was a prehistoric wolf that lived in Europe or Asia anywhere between 9,000 to 34,000 years ago, according to various studies. (Several subgroups of prehistoric wolves went extinct about 10,000 years ago, at the same time as the mammoths, giant sloths and saber-toothed tigers.) https://www.livescience.com/