Other Mechanisms of Evolution

Natural selection is the primary mechanism (process) by which populations of species change over time. Essentially, it states that there are differences between individuals of a species, and some of those differences are beneficial, providing a survival and reproduction advantage to those individuals. Those individuals then pass on those beneficial traits to their offspring. Over time, beneficial traits become more common in the population. Natural selection is **not a random process**. A selective pressure *selects* which individuals are favored and selected for, and *selects* which individuals are disfavored and selected against.

However, there are other mechanisms of evolution that cause changes in the make-up of a population as well. Some of these other mechanisms aren't random, like natural selection, which others are random. Those mechanisms that are random don't act upon an organism's phenotype, as natural selection does, but are rather based on chance or even luck.

In this activity, you will be modeling the effects of some of the other mechanisms of evolution as explained in section 18.2 of your textbook. Throughout the activity, you'll be using small plastic chips to represent individuals within a population. You'll need to complete the tasks

- Define phenotype:

- First, list the four phenotypes (variations) in your population:

Gene Flow

Gene flow is the movement of alleles from one population to another due to migration. Remember, moving **in** to a population is immigration; moving **out** of a population is emigration.

1. Start with 2 populations on your lab bench. Each population should have 20 individuals, 5 of each phenotype. Record your starting populations.
2. Now **randomly** select 7 individuals from each population and move them to the other population. Record the **new** populations that result after the migration.
3. Repeat the random movement two more times.

POPULATION 1: Phenotype	Original Generation	After 1 Move	After 2 Moves	After 3 Moves

POPULATION 2: Phenotype	Original Generation	After 1 Move	After 2 Moves	After 3 Moves

- How do the new populations compare to the original populations?
- How do the new populations compare to each other?
- Compare this to human populations. How does this compare to gene flow between cities?

Genetic Drift

Genetic drift is a change in the proportions of phenotypes (variations) due to chance events. It typically only occurs when populations are small or become small. There are two processes – the bottleneck effect and the founder effect – that commonly cause populations to become small enough for genetic drift to occur.

The Bottleneck Effect

The bottleneck effect occurs after an event greatly reduces the size of a population. Natural disasters, like volcanic eruptions and hurricanes, are common causes of the bottleneck effect.

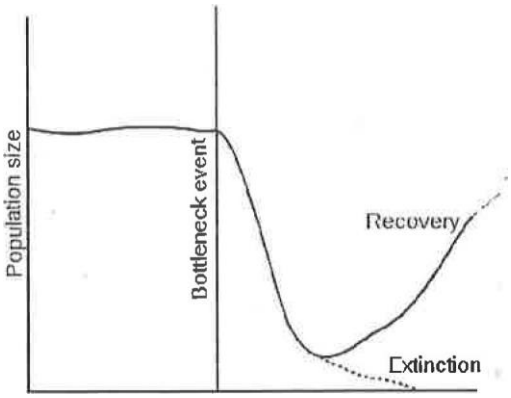
1. Start with 80 individuals in your population, with at least some of each phenotype represented. You do **not** need to have even proportions of each phenotype.
2. After recording the numbers, put the entire population into a bag. You will simulate the result of a bottleneck event by randomly drawing (no peeking) 10 individuals from the bag. The remaining 70 individuals in the bag did not survive the bottleneck event. ☹
3. Record the 10 survivors of the bottleneck event in the data table. They will represent the individuals that will continue reproducing and rebuild the population.
4. Assuming that no other selection occurs, the population phenotypes will remain the same as the population grows. To complete the modeling process and the data table, show this by multiplying the population by 2 until the population has 80 individuals again.

Phenotypes	Original Population	After Bottleneck Event	Generation 2 (after bottleneck event x2)	Generation 3 (Generation 2 x 2)	Generation 4 (Generation 3 x 2)
Total Individuals:	80	10	20	40	80

- How does the final population (Generation 4) compare to the original population?

- Before 1492, there were an estimated 60,000,000 American Bison. Due to hunting, the number fell to approximately 750 individuals in 1890. As of 2000, there were 360,000 American Bison and they continue to recover.

After a bottleneck event, there are two possibilities for the population: it either recovers or goes extinct. (*see figure at right*)



- If the population recovers, what is the impact on the genetic diversity of the population?
- Why does it make sense that the population could go extinct?

<u>Founder Effect</u>

The founder effect occurs after a small number of individuals colonize a new area that wasn't previously inhabited by that species. It can sometimes occur when a storm

1. Start with 80 individuals in your population, with at least some of each phenotype represented.
2. After recording the numbers, determine who your **founders** will be and why. This is your group's decision and there is no wrong way to accomplish this step. Perhaps, if they are humans, maybe they're a group who decided to travel to a "new land." If they are plant seeds or birds, perhaps they were the lightest or caught in a storm and blew to a different island.
3. Determine your 10 founders and record them.
4. Assuming that no other selection occurs, the population phenotypes will remain the same as the population grows. To complete the modeling process and the data table, show this by multiplying the population by 2 until the population has 80 individuals again.

Phenotypes	Original Population	After Founding Event	Generation 2 (after founding event x2)	Generation 3 (Generation 2 x 2)	Generation 4 (Generation 3 x 2)
Total Individuals:	80	10	20	40	80

- How does the final population (Generation 4) compare to the original population?
- Consider the following fictitious case: A population of humans (who were persecuted for their recessive bright green hair) travel across the ocean to start a new colony. They find themselves on an uninhabited island, separated from other humans, and live there for several generations. Explain why, many generations later, the recessive green hair is common in the population while the population at the original location have almost no green haired people.

Sexual Selection

Sexual selection occurs when certain traits increase mating success. Like natural selection, it was an idea first proposed by Charles Darwin. It typically involves the males of a species attempting to "show off" in some way (mating dances or songs, displays of strength, displays of certain body parts like bright feather, etc.) for females, and females selecting which male they are willing to mate with.

The following data were collected during an experiment involving widowbirds in Kenya. The biologist was trying to determine the relationship between tail feather length and reproductive success in males of this species. The average number of nesting sites was used to measure reproductive success and was recorded for four groups of birds. Tail feathers were artificially shortened in one group, two groups were used as control groups, and tail feathers were artificially lengthened in the fourth group.

1. Look at the bar representing the group with shortened tail feathers. What is the approximate average for this group?
2. Next, notice that the bars for the two control groups show that these groups both averaged less than what?
3. Now, look at the bar representing lengthened tail feathers. What was the approximate average for this group?
4. Which population showed the greatest reproductive success?