**EFFECTS OF GENETIC DRIFT**

Genetic drift is the random change in gene frequencies of a population from generation to generation. This occurs because some genotypes happen to reproduce more than other genotypes, not because they are “better” but simply by chance. This process causes gene frequencies in a population to drift around over time. Some genes may even “drift out” of a population (i.e., just by chance, some genes may reach a frequency of zero). This can cause populations to lose genetic variation. It is the evolutionary equivalent of a sampling error.

**Simulating Genetic Drift in a Large Population**

* Obtain a bag with a starting population of 100 beans: 50 brown and 50 white.
* Draw 10 beans out of the bag. Record the number of brown beans and the number of white beans and express as a ratio, e.g. 6 brown: 4 white.
* Now replace your bag with 100 beans consisting of the same ratio that you drew, e.g. 60 brown and 40 white beans. This is the second generation.
* Draw 10 beans out of the bag. Record the ratio of brown:white beans.
* Again, replace your bag with 100 beans consisting of the same ratio you just drew. This is the third generation. An example of this process is illustrated below:
* Continue the process through six – seven generations.
* Record your data in the table below.

**Record the population ratios of brown beans:white beans out of 100 beans for each successive generation.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Gen. 1 (Start)** | **Gen. 2** | **Gen. 3** | **Gen. 4** | **Gen. 5** | **Gen. 6** | **Gen. 7** |
| 50:50 |  |  |  |  |  |  |

**Generating Questions**

Work with your team partner to develop (and answer) questions about what you’ve learned about genetic drift in a large population. You may use the following sentence stem examples to help you write your questions:

Why does \_\_\_\_\_ ?

How does \_\_\_\_\_ ?

What would happen if \_\_\_\_\_ ?

**What is the most effective way of showing your results graphically?**

The 10:0 situation illustrates one of the most important effects of genetic drift: it reduces the amount of genetic variation in a population. With less genetic variation, there is less for natural selection to work with. If the brown allele drifts out of the population, and the population ends up in a situation where it would be advantageous to be brown, the population is out of luck. Selection cannot increase the frequency of the brown allele, because it’s not there for selection to act on. **Selection can only act on the variation that already exists in a population; it cannot create variation.**

**Simulating Genetic Drift in a Small Population**

* Obtain a bag with a starting population of 20 beans: 10 brown and 10 white.
* Draw 4 beans out of the bag. Record the ratio of brown:white beans.
* Replace the beans in the bag with 20 beans of the same ratio you drew.
* Continue this process two or three more times. An example of this process is illustrated below.



* Record the data in the table below.

**Record the population ratios of brown beans:white beans out of 20 beans for each successive generation.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Gen. 1 (Start)** | **Gen. 2** | **Gen. 3** | **Gen. 4** |
| 10:10 |  |  |  |

**Generating Questions**

Work with your team partner to develop (and answer) questions about what you’ve learned about genetic drift in a small population. You may use the following sentence stem examples to help you write your questions:

Why does \_\_\_\_\_ ?

How does \_\_\_\_\_ ?

What would happen if \_\_\_\_\_ ?

How does \_\_\_\_\_\_ compare to \_\_\_\_\_\_\_ ?

**What is the most effective way of showing your results graphically?**

The same process operates in small populations. **All populations experience drift, but he smaller the population is, the sooner the drift will have a drastic effect.** This may be a big problem for endangered species that have low population sizes.

This drifting happens in populations of organisms. Due to many random factors, the genes in one generation do not wind up in identical ratios in the next generation, and this is evolution. It is possible for the frequency of genes for brown coloration to increase in a population of, e.g., beetles without the help of natural selection. While this is evolution, it is evolution due to chance, not selection.

**Genetic Drift has Several Important Effects on Evolution**

1. Drift reduces genetic variation in populations, potentially reducing a population’s ability to evolve in response to new selective pressures.
2. Genetic drift acts faster and has more drastic results in smaller populations. This effect is particularly important in rare and endangered species.
3. Genetic drift can contribute to speciation. For example, a small isolated population may diverge from the larger population through genetic drift.

**Simulating Genetic Bottlenecks**

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| --- | --- | --- | --- | --- |
| Genetic drift can cause big losses of genetic variation for small populations. **Population bottlenecks** occur when a population's size is reduced for at least one generation. Because genetic drift acts more quickly to reduce genetic variation in small populations, undergoing a bottleneck can reduce a population's genetic variation substantially, even if the bottleneck doesn't last for many generations. This is illustrated in the diagram below, where, in generation 2, an unusually small draw of 3 beans creates a bottleneck. Generation 4Generation 1Generation 3Generation 2

|  |
| --- |
| = 30= 30= 40=========Draw 10Draw ratio \_\_\_\_:\_\_\_\_:\_\_\_\_Draw 10Draw ratio\_\_\_\_:\_\_\_\_:\_\_\_\_ Restock to 100Restock to 12Draw 3Draw ratio\_\_\_\_:\_\_\_\_:\_\_\_\_Restock to 100 |
|  |

* Obtain a bag with a starting population of 100 beans, with a ratio of 30 brown:30 white:40 yellow.
* Draw 10 beans out of the bag. Record the ratio of brown:white:yellow beans.
* Replace the beans in the bag with 100 beans of the same ratio you just drew. This is the second generation.
* Draw 3 beans out of the bag (this represents the bottleneck). Record the bean color ratio.
* Replace the beans in the bag with 12 beans of the same ratio you just drew. This is the third generation.
* Draw 10 beans out of the bag. Record the ratio.
* Replace the beans in the bag with 100 beans of the same ratio you just drew.
* Record your data in the figure above.

**Generating Questions**Work with your team partner to develop (and answer) questions about what you’ve learned about the bottleneck effect. You may use the following sentence stem examples to help you write your questions:Why does \_\_\_\_\_ ?How does \_\_\_\_\_ ?What would happen if \_\_\_\_\_ ?What if \_\_\_\_\_ ?Reduced genetic variation means that the population may not be able to adapt to new selection pressures, such as climatic change or a shift in available resources, because the genetic variation that selection would act on may have already drifted out of the population.

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| --- | --- |
| http://evolution.berkeley.edu/evolibrary/images/dot_clear.gif | lephant seal  |

**Real-world Example**Northern elephant seals have reduced genetic variation probably because of a population bottleneck humans inflicted on them in the 1890s. Hunting reduced their population size to as few as 20 individuals at the end of the 19th century. Their population has since rebounded to over 30,000 — but their genes still carry the marks of this bottleneck: they have much less genetic variation than a population of southern elephant seals that was not so intensely hunted.**Founder Effect**A founder effect occurs when a new colony is started by a few members of the original population. This small population size means that the colony may have:* reduced genetic variation from the original population.
* a non-random sample of the genes in the original population.

For example, the Afrikaner population of Dutch settlers in South Africa is descended mainly from a few colonists. Today, the Afrikaner population has an unusually high frequency of the gene that causes Huntington's disease, because those original Dutch colonists just happened to carry that gene with unusually high frequency. This effect is easy to recognize in genetic diseases, but of course, the frequencies of all sorts of genes are affected by founder events. |
| *This activity has been adapted from Understanding Evolution. 2012. University of California Museum of Paleontology. 22 August 2008 <*[*http://evolution.berkeley.edu/*](http://evolution.berkeley.edu/)*>.* |