Jelly Bean Lab

**Introduction** Natural selection sorts out the useful changes in the gene pool. When this happens, populations evolve. Beneficial new genes quickly spread through a population because members who carry them have a greater reproductive success, or evolutionary fitness, and consequently pass the beneficial genes to more offspring. Conversely, genes that are not as good for an organism are eliminated from the population—sometimes quickly and sometimes more gradually, depending on the severity of the gene—because the individuals who carry them do not survive and reproduce as well as individuals without the bad gene. Over the course of several generations, the gene and most of its carriers are eliminated from the population. Severely detrimental genes may persist at very low levels in a population, however, because they can be reintroduced each generation by mutation.

 Natural selection only allows organisms to adapt to their current environment. Should environmental conditions change, new traits may prevail. Moreover, natural selection does not always favor a single version of a trait. In some cases, multiple versions of the same trait may instill their carriers with equal evolutionary benefit. Nor does natural selection always favor change. If environmental conditions so dictate, natural selection maintains the status quo by eliminating extreme versions of a particular trait from the population.

**Directional selection**

Often, shifts in environmental conditions, such as climate change or the presence of a new disease or predator, can push a population toward one extreme for a trait. In periods of prolonged cold temperatures, for example, natural selection may favor larger animals because they are better able to withstand extreme temperatures. This mode of natural selection, known as directional selection, is evident in cheetahs. About 4 million years ago, cheetahs were more than twice as heavy as modern cheetahs. But quicker and lighter members of the population had greater reproductive success than did larger members of the population. Over time, natural selection favored smaller and smaller cheetahs.

**Stabilizing selection**

Sometimes natural selection acts to preserve the status quo by favoring the intermediate version of a characteristic instead of one of two extremes. An example of this selective force, known as stabilizing selection, was evident in a study of the birth weight of human babies published in the middle of the 20th century. It showed that babies of intermediate weight, about 3.5 kg (8 lb), were more likely to survive. Babies with a heftier birth weight had lower chances for survival because they were more likely to cause complications during the delivery process, and lightweight babies were often born premature or with other health problems. Babies of intermediate birth weight, then, were more likely to survive to reproductive age.

**Disruptive selection**

Occasionally natural selection favors two extremes, causing alleles for intermediate forms of a trait to become less common in the gene pool. The African Mocker swallowtail butterfly has undergone this form of selection, known as disruptive selection. The Mocker swallowtail evades its predators by resembling poisonous butterflies in its ecosystem. Predators have learned to avoid these poisonous butterflies and also to steer away from the look-alike Mocker swallowtails. The Mocker swallowtail has a large range, and in different regions, the Mocker swallowtail looks very different, depending on which species of poisonous butterfly it mimics. In some areas the butterfly displays black markings on a white background; in others the markings float on an orange background. As long as a Mocker swallowtail appears poisonous to predators, it has a greater chance of survival and therefore a higher evolutionary fitness. Mocker swallowtails that do not look poisonous have a much lower evolutionary fitness because predators quickly eat them. Disruptive selection, then, favors the extreme color patterns of white or orange, and nothing in between.

**Pre-lab Questions** 1. Create your own example of the three types of evolution. Show how each type occurs.

2. Decide which of the following groups you could belong to:

a. People who hate black jelly beans (licorice)

b. People who love red jelly beans

c. People who don’t care which type of jelly bean they eat.

3. In your lab notebook, construct a data table that has 7 columns and 5 rows. Label the columns with the following headings: Color, Starting Numbers, Group 1 Finish, Group 2 Finish, Group 3 Finish, Group 4 Finish, and Group 5 Finish. Label the first column with the following names: Red, Orange, Yellow, Green, Blue, and Black.

Procedure:

1. Count the number of each color jelly beans in your bag.
2. Proceed to eat about half of your jelly beans according to the rules!
3. After you have eaten approximately half of the jelly beans, record the number and color of jelly beans that remain.

Results:

* Create a graph showing the start and finish populations for all groups

Analysis Questions:

1. Which groups was the control? Why?
2. Which group represented directional selection? Why?
3. Which group represented stabilizing selection? Why?
4. Which group represented disruptive selection? Why?
5. Suppose you are observing a wild jelly bean population. What traits beside color might you expect to evolve over time as protection from wild humans?