NATURAL SELECTION SIMULATION
(Bean Lab)

Introduction:

In 1859, Charles Darwin published his most famous and influential work, The Origin of Species. In this book, Darwin presents two main arguments. First, he argues persuasively that biological species are not constant, as had been previously supposed by most scientists, but instead had evolved (or, “transmuted”, in Darwin’s words) through long periods of geological time. Second, Darwin argued that this evolutionary transformation had been brought about by a mechanism he called Natural Selection. Darwin’s evidence for evolution was regarded as compelling by most biologists within a few years after publication, but Darwin’s suggested mechanism, Natural Selection, has been debated by biologists for many decades. Natural Selection was not widely accepted by biologists until the 1930s, many years after Darwin’s famous book was first published. Today, although biologists still debate the importance of alternate mechanisms of evolutionary change, most agree that Natural Selection is the most significant mechanism.

One of the reasons that Natural Selection is not well understood today by non-biologists is that the concept is statistical in nature, and cannot be observed or understood by examining individual organisms. In Darwin’s conception, individual animals and plants do not evolve; rather, populations or species evolve. To illustrate this subtle concept, we will do a simulation of Natural Selection. Although the simulation is fun, since it is, after all, basically a game, the concepts it illustrates are essential for a understanding of how evolution works.

The Simulation

In this exercise, the class will represent a particular species of animal. But, since Natural Selection requires that there be a significant genetic variation between individuals of the same species in a population, we will assume in this simulation that there are several genotypes in the population that each represent differing abilities to obtain resources and produce offspring. Since the students will represent the animals, we will use beans of differing types to represent the resources (say, various species of prey animals). “Capturing” white beans will translate to the successful production of 1 offspring in the next generation. Likewise, solid red or brown beans will represent 2 offspring in the next generation, pinto beans 3 offspring, and black beans 4 offspring. Be careful. These are very potent beans.

Materials Needed:

Bean mix
Spoons, forceps, dissecting needles, straws, spatulas
Cup

Procedure:

1. Divide the class into 4-5 groups of 4-5 students each. Although the class members will represent individuals of the same species, remember that there will be genetic variation in ability to gather resources (beans). So, one group will gather resources using spoons, one groups will use forceps, one group will use dissecting needles, one group will use straws, and one group will use spatulas. Each student will also be given a cup in which to collect the beans.

2 All groups will go outside to the lawn, and the instructor will distribute a mixture of beans on the lawn. Following this, students will gather beans for the lawn as quickly as possible during a 2 minute interval. During this time, the students are not allowed to touch the beans with any part of the body. Only the instruments they have been issued (spoon, forceps, etc.) will be allowed to touch the beans. Also, the cups are not allowed to touch the ground. Students must therefore use only the instruments to put the beans into the cup. At the end of 2 minutes, all students will quit collecting beans and return to the lab.

3. Dividing into their groups (spoons, forceps, etc.) students will pool all the beans that their group has gathered, and count the number of each type (white, pinto, etc.). Then, multiply the number of beans of each type by the number of offspring produced from each bean (1 for white beans, 2 for red/brown beans, 3 for pinto beans, 4 for black beans), and total the number of offspring in the next generation produced by each group. These are the results for the first generation. The instructor will record the total number of offspring produced by each group.

4. It is best if we assume that the entire class "dies" at the end of the first generation, to keep the mathematics simple. (Don't be squeamish—it's only a game!) Class members will then represent their offspring in the next generation by re-allocating the instruments in the correct new proportions. to allocate the number of each genotype (spoons, forceps, etc.) in the next generation, take the total number of offspring produced by each genotype, divide the total number of all offspring produced, and multiply by the total number of students in the class. Again, the instructor will record the number in each group in each generation. For example, if the spoons produce 450 offspring for the next generation, the entire class total offspring produced by all genotypes is 1500, and there are 20 students in the class:

   (450/1500) x 20 = 6 students will represent spoons in the next generation

5. After re-allocating all the instruments, repeat steps 2 & 3 two more times, for a total of 3 generations.

6. At the end of the 3 generations, the instructor, who has been faithfully recording the numbers of each group in each generation, will make these data available to the class.

Name___________________________

Natural Selection Simulation Report Sheet

Table 1. Simulation Data

Generation	Spoons	Forceps	Spatulas	Needles	Straws
0					
1					
2					
3					

Note: *Generation 0 is the initial generation when all the instruments were allocated to the class by the instructor.*

Using these data, construct the following line graph. Plot the data from spoons, forceps, spatulas, needles, and straws as separate lines on the graph.