**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Block: \_\_\_\_\_\_**

**Introduction to Natural Selection**

**(December 10, 2012)**

Change in allele frequency over time is one useful definition of evolution (there are others). Evolution by natural selection, as first proposed by Charles Darwin, includes four conditions:

1. **Variation**: there are significant differences between the individuals in populations. Furthermore, it is generally assumed that these variations are random (*i.e*. not purposeful).
2. **Inheritance**: These variations that exist within the population must be inheritable from parents to offspring, that is they can be passed on in genes. Darwin clearly recognized that this was the case, although he did not know about genes or DNA and did not originally propose a genetic method by which this could occur.
3. **Overpopulation**: As a consequence of reading Malthus’s *Essay on the Principle of Population*, Darwin realized that in natural populations, more offspring are born than can possibly live to reproduce.
4. **Differential Survival and Reproduction (natural selection):** Given thethree conditions described above, certain individuals will survive and reproduce more often than others, and such individuals (and their offspring) will therefore become proportionally more common over time. This, in a nutshell, is evolution by natural selection.

How to Play the Game

In this game/simulation, paper dots of different colors represent butterflies. The different colors represent different color variations *within* ***one*** *species of butterfly.* These different color variations are the result of purely random genetic mutations and recombination within this single species. To model the random character of these variations, we will begin with equal numbers of each color dot at the start of the game. It is assumed that the different colors are inherited genetically.

**Step 1: One person should be designated as the first predator. This person should not** be allowed to see what goes on during the following steps, in order that her/his “predation” be unbiased.

**Step 2**: Each group will begin with a different, colored cloth “environment”. One person in each group should count out **four dots** of each color. – This is the starting population for your environment—Generation #1. This same person should then randomly scatter these dots on the cloth environment. Since there are **five colors**, there will be a total of twenty dots on the environment to start with. This is the **carrying capacity** of your environment.

**Step 3**: The predator should now pick up ten dots as quickly as possible, one dot at a time. Also, it is important that the predator ***break eye contact with the ground after each pick****-- be sure to pick the very first dot that you see*! After all, time is energy (you’re flying, remember!), and so you can’t afford to waste either time or energy by being too picky. Set your “eaten” dots aside, so that they won’t accidentally be counted as surviving dots.

**Step 4**: Now collect your surviving dots (butterflies) by gently shaking the cloth out onto the table (it works best to pour the dots out). There should be ten surviving dots.

**Step 5**: Each surviving dot now reproduces. For each surviving dot, add one dot of the same color from your reserve—your dots have now reproduced! This is the second generation; there should now be twenty dots ready to go into your environment again.

Notice that there may not necessarily be the same number of each color any more—natural selection has been at work in your population of individuals! Before you scatter the dots in the environment for the second time, record the frequencies of each color type in the table, below. Notice that each dot is worth five percent.

**Step 6**: Randomly scatter the new generation of twenty dots in your environment and repeat the above steps using a new predator. Continue until you have completed five generation, recording the data in the tables below. This is now your “raw data”.

**Data Collection**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **RAW DATA** | **Number of Butterflies Entering Generation** | | | | | |
| **Color Variants** | **1** | **2** | **3** | **4** | **5** | **6**  **(final)** |
| **Red** | 4 |  |  |  |  |  |
| **Yellow** | 4 |  |  |  |  |  |
| **Blue** | 4 |  |  |  |  |  |
| **Green** | 4 |  |  |  |  |  |
| **White** | 4 |  |  |  |  |  |
| **TOTALS** | 20 | 20 | 20 | 20 | 20 | 20 |

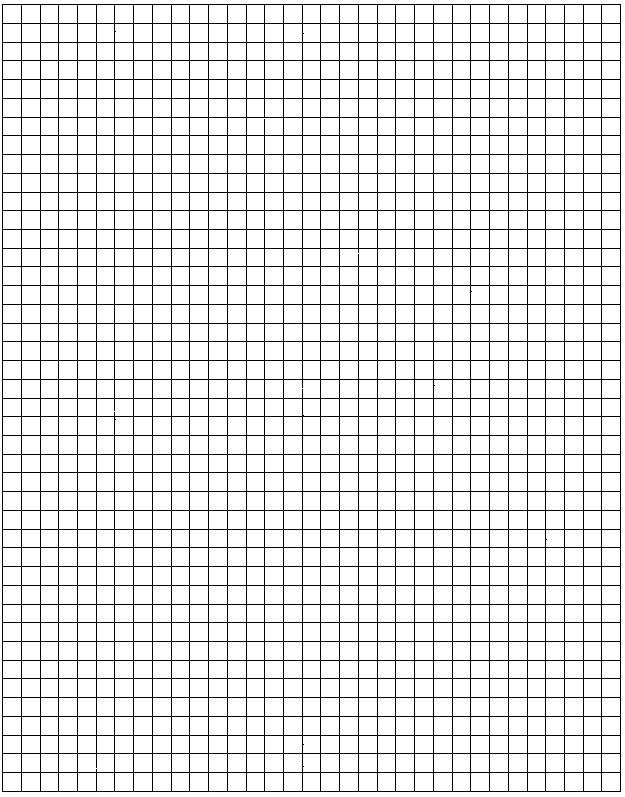
|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Percentages** | **Frequency of Color Variants Entering Generation** | | | | | |
| **Color Variants** | **1** | **2** | **3** | **4** | **5** | **6**  **(final)** |
| **Red** | 20% |  |  |  |  |  |
| **Yellow** | 20% |  |  |  |  |  |
| **Blue** | 20% |  |  |  |  |  |
| **Green** | 20% |  |  |  |  |  |
| **White** | 20% |  |  |  |  |  |
| **TOTALS** | **100%** | 100% | 100% | 100% | 100% | 100% |

**Calculating Percentage:**

**(# of Butterflies/Total) X 100**

**Sample: (4/20) X 100 = 20%**

1. **Graph your calculated frequency (percentages) using a bar graph.**



**Post Activity Summary Questions**

**1**. Describe the environment you used in this simulation (color, design).

**2**. How many “butterflies” of each color did you start with in generation #1? \_\_\_\_\_\_\_

**a**. What was the frequency of each color in generation #1? \_\_\_\_\_\_\_\_\_\_

**3**. Did you end up with the same number of each color entering generation #6? \_\_\_\_\_

**4**. Which color butterfly was the **most** “fit” in your environment? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**a**. What was the frequency of this color butterfly in generation #1? \_\_\_\_\_\_\_

**b**. What was the frequency of this color butterfly in generation #6? \_\_\_\_\_\_\_

**5**. Hypothesize a possible explanation of why this color butterfly was more “fit” in your environment.

**6**. Which color butterfly was the **least** “fit” in your environment? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**a**. What was the frequency of this color butterfly in generation #1? \_\_\_\_\_\_\_

**b**. What was the frequency of this color butterfly in generation #6? \_\_\_\_\_\_\_

**7**. Hypothesize a possible explanation of why this color butterfly was the least “fit” in your environment.