

# Category IV Notes for Natural Selection Examples

## Representing Ideas Effectively

**Evolution Module, pp. 23s, 23t, 24s, 24t, 25s**

Represents key idea that “Natural selection provides the following mechanism for evolution: Some variation in heritable characteristics exists within every species, some of these characteristics give individuals an advantage over others in surviving and reproducing, and the advantaged offspring, in turn, are more likely than others to survive and reproduce. The proportion of individuals that have advantageous characteristics will increase” (idea c).

## LABORATORY WORKSHEET

Evolution of "Bead Bugs"Materials

Multicolored flowered cloth material

Beads: four different colors (for example, blue, pink, yellow, and gray)

Overhead transparencies for class data

Introduction

You should work in teams of four to five students.

During this laboratory exercise you will observe the evolution of a hypothetical population of "bead bugs." It is necessary for you to simulate the process of evolution by means of natural selection rather than observe it directly because of the time involved (from a few years to millions of years, depending on the organism) for the event to occur naturally.

You have available to you, a species of insect, "bead bugs" (represented by beads) and the environment in which the bug lives (represented by flowered cloth). The following are some relevant facts about "bead bug" biology.

Bead bugs live in flowered meadows and feed on pollen. The only death in a population is due to predation by birds. Each year, birds eat about one half the total population of bugs in a meadow.

Bead bugs reproduce just once a year in June. Reproduction is asexual. Each parent produces one offspring.

You will simulate four generations of bead bugs by repeating 4 times this cycle of predation and reproduction.

Setting Up

1. Variation among individuals is a characteristic of organisms of the same species. Observe the bead bugs in your jar.

What are some of the differences between individual bead bugs?

2. You will be working with a population of bead bugs which lives in a meadow. You will start with 40 bead bugs. Count out 20 blue beads and 20 pink beads and scatter them randomly on the meadow.

What is the biological definition of a population?

Commentary: Evolution of "Bead Bugs"Materials

Multicolored flowered cloth

Beads: four different colors (for example, blue, pink, yellow, and gray)

Overhead transparencies for class data: Data Tables 2 and 3

Advance Preparation

Provide each group of students (4-5 students per group) with one square of the cloth material. Each square of material should be approximately 16" x 16".

Provide each student with a jar or beaker containing the four colors of beads. (Students should be provided with at least 40 beads of each color.) Make overhead transparencies of Data Tables 2 and 3 (page S-28).

The success of this activity depends on the color of the beads and the cloth. Beads should be small enough so they are not easily spotted. One of the original colors (blue in this case) and one mutation (gray in this case) should closely match one of the major colors in the cloth (i.e., be hard to see). The other two colors of beads should be more easily seen against the cloth background.

Rationale

Students will observe that the color composition of the bead bug population changes over time.

Students should be able to recognize the mechanism of color change as differing survival rates and reproductive rates of different colored beads.

Students will observe that mutation causes new colors to appear in the population. Students should be able to recognize that the nature of the environment does not influence the number and/or kind of mutations which occur and that the success of any mutation is dependent on particular environmental conditions.

Suggested Use

It is suggested that instructors take the class as a whole through the first generation in order to make sure students understand the instructions.

It is recommended that instructors hold a postlab discussion in which class data are accumulated on the overhead transparency (the master is at the end of this section) and the questions at the end of the laboratory handouts are discussed.

3. You are now ready to simulate predation on the first generation.

You will act as the bird predators. Think about how birds capture bugs: They fly over an area, spotting and capturing bugs, one at a time. Choose one or two students in your group to act as birds. These students should pick up and remove 20 beads from the meadow, picking the beads that are easiest to see and catch.

4. Count the number of bead bugs of each color that remain in the meadow. Record this number in Data Table 1 (page S-25) under the column "First Generation After Predation." These are the bead bugs which will produce the second generation.

- a. What percent of blue bead bugs survived to reproduce? (Divide the number of blue bead bugs left after predation by 20.)
- b. What percent of pink bead bugs survived to reproduce? (Divide the number of pink bead bugs left after predation by 20.)
- c. How do your percentages compare with the class average?

### Reproduction

It is now June and time for your bead bugs to reproduce. As explained earlier, reproduction in bead bugs is asexual. Each parent gives birth to one offspring. Offspring are the same color as their parent except if a mutation occurs.

To simulate reproduction:

1. Look at the number of each color remaining after predation in the meadow.
2. Add an equal number of beads for each color (for example, if 7 blue beads are left, add 7 more).
3. You should now have 40 beads in the meadow.

### Mutation

Color mutations occasionally occur in bead bugs. Two common color mutations result in blue beads producing yellow offspring and pink beads producing gray offspring. On the average, each mutation occurs once a generation. To simulate this, remove one blue offspring and replace it with one yellow offspring. Remove one pink offspring and replace with one gray offspring.

You are now at the beginning of the second generation. Determine the number of beads of each color in the meadow and record these numbers in the appropriate columns in Data Table 1 under "Second Generation Before Predation."

Answers to Questions

1. Students probably will recognize first the obvious difference of color. With encouragement, students may recognize more subtle differences between individuals, such as differences in size, shape, and weight.
2. It is important that students understand that a population consists of organisms of the *same species* in a given area, also that evolution concerns populations.
4. At this point we suggest that laboratory instructors collect individual data and summarize it on an overhead transparency of Data Table 2 (page S-28).

From this table students should recognize:

1. Not all colors of bead bugs survived at the same rate.
2. The environment determined which colors survived at the highest frequencies.
3. The colors will not be equally represented in the next generation.

It is recommended that students be introduced to the following terms:

Differential Survival: Different colors of beads have different survival rates. This leads to differential reproduction. Different colors as a whole produce different numbers of offspring.

It is recommended that after students finish the exercise, instructors compile class results of the number of bead bugs of each color in the fifth generation and present them on an overhead transparency of Data Table 3 (page S-28). This process is a safeguard against individual groups obtaining atypical results.

It is also recommended that students answer questions with reference to whole-class data.

Repeat 3 more cycles of predation and reproduction, and mutation, filling in your data tables as you go. To help you, a summary of steps follows.

### Summary

1. Scatter 20 blue beads and 20 yellow beads on meadow.
2. Acting as bird predators, remove 20 beads from the meadow.
3. Count the number of each color of beads left in the meadow. Record this number in Data Table.
4. Simulate reproduction.
5. Simulate mutation.
6. Record the number of bead bugs of each color in the meadow in Data Table under the column "Before Predation" for the next generation.
7. Repeat steps 3 through 6 three times.

Data Table 1  
Number of Bead Bugs

	Before Predation				After Predation			
	blue	yellow	pink	gray	blue	yellow	pink	gray
First generation	20	0	20	0				
Second generation								
Third generation								
Fourth generation								
Fifth generation								
Class average								
Fifth generation								