

LABORATOR EXERCISE: EVOLUTION - PREDATOR & PREY SIMULATION

Purpose/Objectives:

- To demonstrate the principles of Darwinian Evolution

Background:

The process of natural selection occurs because organisms vary in their genetically determined characteristics or traits. The different genetic traits cause some variants to survive and reproduce better than others. As a result, the genetic structure of a population changes over time, which is a factor in evolution. Although evolution involves the genetic change in a population over time, natural selection is the pressure or driving force behind evolution and occurs through the interaction of the environment and the whole organism. Natural selection does not cause genetic mutations, it only “selects” or pushes for the survival of individuals with certain genotypes.

Darwinian Principles:

1. Variation exists in populations of living organisms.
2. More offspring are born than live AND survive to reproduce.
3. Variation is inherited.
4. The interaction between a population and the environment in which it lives leads to selection of certain variations and removal of other variations.

In this exercise we will simulate how natural selection works. Natural selection and evolution take a long time to occur in natural populations, so we will use artificial organisms or populations. For Part I, the variation is the coloration of the beads, and the environment or habitat is colored cloth. For Part II, the variation is the type of utensil used by the predator and the environment is represented by the container of pasta or beans. As you execute the laboratory, think about the interaction between the variations in the population, the environment, and their differential survival.

Part I – “SURVIVAL OF THE FITTEST PREY”

Materials:

- Fabric (habitat)
- 4 different colored beads in Ziploc baggies
- paper bowls

Procedure:

1. Spread the fabric habitat on the table-top.
2. Count out 20 of each color bead for a total of 80 organisms to start with.
3. Appoint one individual as the organism “distributor”. That individual will place the organisms randomly over the entire habitat, making sure that they are not too close together. The other members of the group should turn their backs (i.e. not watch) while this is happening.
4. The rest of the group members are “predators”. They should take turns picking up the organisms ONE BY ONE until 20 remain. COUNT CAREFULLY and BE ACCURATE and THOROUGH. Predators are to take the first organism they see and keep their eyes on that one organism until it is removed from the habitat. Avoid wandering eyes! For example if you were a bird of prey, you would only be able to see the actual prey you are consuming until you are ready to search for more.

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5. Record the number of survivors of each color on your data sheet.
6. Keep the surviving beads AND assume each survivor produces three offspring and calculate the total number of each color after reproduction. (The total number of each color should equal the survivors multiplied by 4. The total number of organisms is ALWAYS 80. For example, if there is only one pink, then 3 additional pink beads should be added for a total of 4 pink beads).
7. Using the reserve beads, add the offspring to the survivors
8. Repeat Steps 3-6 three additional times, simulating four total generations. Record your data in the Lab Assignment.
9. Replace all colored beads in appropriate Ziplock baggies and return materials to appropriate location.

PART II – EATING UTENSILS AND “SURVIVAL OF THE FITTEST PREDATORS”

Materials

- Sunglasses
- Chopsticks (one set)
- Spoon
- Fork
- Container with an assortment of beans or pasta to serve as “prey”
- Bowl

Procedure

1. Select three people to serve as predators and have each person select one of the available predator modifications (wearing sunglasses over eyes, using chopsticks, using a fork, or using a spoon). The other group members will act as timers and/or prey counters.
2. Give each “predator” 20 seconds to remove as many food items (prey) as possible from the container and place into the bowl. Food pieces must be removed ONE AT A TIME.
3. If the predator is able to get 10 pieces, it will survive. If the predator collects less than 10 pieces, it does not survive. If a predator survives, it gets another chance the next round after each predator has had a turn.
4. Do not replace food between “meals”.
5. Repeat steps 2-3 until only one predator (with the corresponding modification) remains. This predator is the “fittest” because it was able to survive long enough to reproduce.
6. Clean up and answer questions on the assignment. Each person is responsible for turning in their own laboratory assignment. You may talk about the responses with each other, but please write the responses to questions in your own words.

LABORATORY ASSIGNMENT – EVOLUTION

PART I - SURVIVAL OF THE FITTEST PREY

	Colors				TOTAL
# at start					80
# after 1 st predation					20
# after 1 st reproduction					80
# after 2 nd predation					20
# after 2 nd reproduction					80
# after 3 rd predation					20
# after 3 rd reproduction					80
# after 4 th predation					20

Questions:

1. Study your survivor populations (what was left after predation, before reproduction)
 - a. Was one color represented more than others in the first generation of survivors OR was one color much lower than others (after the 1st predation)?
 - b. Were shades of color that were similar (i.e. bright colors or dark colors) also present after the 1st predation? If so which ones?
 - c. What, if any, change occurred between the survivors of the 2nd and 3rd, and again between the 3rd and 4th predation?

2. Is there any color from the original population that is NOT represented in the survivor population (the population left after the 4th predation)?

3. How do you think the colors of the survivors are related to their environment or habitat? Would the results change if you had the same organisms on a different piece of cloth? Look at other tables' cloth and critter colors to aid in forming a hypothesis.

4. What aspect of the simulation represented Darwin's Principle of Evolution #1: "Variation exists in populations."? In other words what trait was different amongst the beads?

5. What aspect of the simulation represented Darwin’s Principle of Evolution #2: “More offspring are born than survive AND reproduce.”?
6. What aspect of the simulation represented Darwin’s Principle of Evolution #3: “Variation is inherited.”?
7. What is/are the driving force(s) behind “natural selection” this simulation? In other words, what aspect(s) of the environment selects FOR certain variation and AGAINST other variations?

PART II – SURVIVAL OF THE FITTEST PREDATOR

Predator Variation	# of prey in 20s	Survival?

8. What aspect of this simulation represented Darwin’s Principle of Evolution #1: “Variation exists in populations.”?
9. What aspect of this simulation represented Darwin’s Principle of Evolution #2: “More offspring are born than survive AND reproduce.”?
10. What aspect of this simulation represented Darwin’s Principle of Evolution #3: “Variation is inherited.”?
Hint: what variation would the surviving predators pass onto the NEXT generation if they reproduced?
11. What is/are the driving force(s) behind “natural selection” in this simulation? In other words, what aspect(s) of the environment selects FOR certain variations and AGAINST other variations?
12. *True or False:* As organisms evolve over millions of years, they are always “getting better”.
13. *True or False:* Random mutations in DNA cause genetic variation.
14. *True or False:* Natural selection involves organisms trying to change and adapt.
15. *True or False:* Evolution is a theory.
16. *True or False:* Scientists regularly debate about HOW evolution took place.
17. *True or False:* All organisms can form fossils.
18. *True or False:* Evolution is neither observable nor testable; therefore, it is not science.
19. *True or False:* Stronger organisms will always be selected for, while weaker organisms will always be selected against.