ANTHR 1-L – BioAnthro Lab Name:_____

NATURAL SELECTION SIMULATION

INTRODUCTION

Natural selection is an important process underlying the theory of evolution as proposed by **Charles Darwin** and **Alfred Russell Wallace**. "Survival of the fittest," as the outcome of ***natural selection*** is sometimes called, is fairly easy to comprehend, especially if we think of the success in breeding dogs or horses or cattle or many kinds of plants to suit OUR purposes. Humans artificially select the traits they want in the population. Natural selection is sometime harder to imagine, although it is a fairly straight-forward concept. What is more difficult is an appreciation for the effects of natural selection within a population over time.

PURPOSE

The purpose of this lab is to demonstrate how natural selection can lead, in only a few generations,

- to changes in sexually reproducing populations
- as well as producing populations "well adapted" for survival in certain habitats.

Using a predator-prey relationship, you and three other students will set up a simple simulation of natural selection.

The prey populations are sophisticated organisms (that look like beans) that vary in size, shape, and color, but are all members of the same species. The habitats they live in (consisting of a piece of cloth) also vary. Thus, some individuals in the population may be better camouflaged than others are.

Each of you will be a large predator living in a specific habitat and hunting and eating the prey. As in real life, each predator varies slightly from all others in terms of a number of traits (and ability). For this simulation, the variation is in the form of feeding structures: tweezers, chopsticks, forks, and spoons.

Using your feeding apparatus, you'll pick up individual prey <u>one at a time</u> (you can go for any color/type of bean that's on the habitat cloth). The individual prey that survives predation will reproduce via random mating and pass their genes to the next generation. Over a number of generations, the composition of the populations (both prey and predator) will change as a result of differential survival and reproduction (that is, natural selection).

DIRECTIONS

1. Work in groups of 4 students per lab table.

2. At each lab table you should assemble the following from the bag at your lab table:
   - ✓ Habitat cloth (to be spread out on table)
   - ✓ Four clear plastic cups – one for each student (your "belly")
   - ✓ One white cup (for mixing up beans)
   - ✓ One red cup (to keep "dead" prey in)
   - ✓ 50 beans of each of the four types/colors (white, red, black, pinto)
     - Each student should pick a bag of beans & begin counting out 50 of that type of bean. Place these in your clear plastic cup & when everyone's done counting, pour all beans into the white cup (this should give you a starting population of 200 beans)
   - ✓ A calculator (your phone calculator is fine)
   - ✓ Four eager and hungry predators (Anthro lab students)

3. Each student (predator) will have a different feeding structure (handed out by instructor). These variations represent genetic differences in the population.

4. Turn to **Data Table #1** (Page 3) and follow the instructions.

5. When all groups are ready, your instructor (playing the role of "Mother Nature") will ask all students to stand and turn their backs to the habitat cloth. You should have your feeding apparatus and your clear plastic cup in your hand. Mother Nature will then scatter the prey on the habitat.

6. When the signal to begin "hunting" is given, **predators will have 30 seconds to feed**. Don't search for particular prey, just grab whatever you can with your feeding apparatus as quickly as you can & drop the prey into your plastic cup ONE AT A TIME (this behavior mimics natural predators that usually eat only one prey at a time). No scraping or pushing of prey into the cup from the table is allowed!

7. Mother Nature will signal when to STOP hunting. After the feeding session ends, count and record how many of each type of prey you have captured. Record your data in **Data Table #2** (Page 3), then share your data with the other predators in your group.

8. Turn to **Data Table #3** (Page 4) and follow the instructions.

9. After completing Data Table #3, all predators should empty the contents of their clear plastic cup into the red cup.

10. Using the data from the OFFSPRING column in Data Table #3, students should select the bag of reserve beans they initially counted and begin counting the number of offspring that will be added into the population. When done counting, add your beans to the white cup.

11. Once all groups are ready, we will repeat steps 5 – 10.

12. At the end of the second generation, the predator groups will be reconstructed for the next generation. Those predator types which captured the least prey & were therefore unsuccessful hunters will be removed from the population. Students who were using the now "extinct" apparatus will be assigned a new one based on the rate of success of the other predator types in the group. This change will represent the offspring of the successful predator types.

13. After the third generation, step 12 will be repeated.

14. After completing four feeding sessions and filling out all data tables, complete the questions for the LAB REPORT.

NOTE: Data tables are to be filled out as you work through the exercise. The tables and Lab Report/Analysis of the data will be turned in together for grading.

DATA TABLE #1 – Relative Success by Predator and Prey Types

INSTRUCTIONS: Taking into consideration the habitat cloth, the size, shape and color of the prey and the variation in the feeding devices, you will be predicting the relative success of the four types of predators in picking up prey ONE AT A TIME and placing it in the cup. You will also predict the relative success of the four types of prey (beans) in surviving each hunting session. In other words, you'll be making some hypotheses (educated guesses) about relative successes.

Enter your predictions in the table as follows:

a. Assign a rank (1 - 4) to each predator based on which feeding device you think will be MOST SUCCESSFUL in capturing prey with #1 being the most successful and #4 being the least successful.
b. Assign a rank (1 – 4) to each prey type based on which bean you think will be MOST LIKELY to survive the hunting sessions with #1 being the most likely to avoid capture and #4 being the bean that you think will be eaten the most.

PREDATORS	Ranking	PREY	Ranking
Tweezers		White Bean	
Spoon		Red Bean	
Chopsticks		Black Bean	
Fork		Pinto Bean	

DATA TABLE #2 – Prey Captured by Predators

Legend: T = Tweezers; C = Chopsticks; S = Spoon; F = Fork

INSTRUCTIONS: Record the number of each type of bean you captured in each feeding session. Then, share your data with the other predators in your group & record their data in the table so that you can calculate the TOTAL number of each type of bean captured in each session.

	1st Generation					2nd Generation					3rd Generation					4th Generation				
	T	C	S	F	Total Beans*	T	C	S	F	Total Beans*	T	C	S	F	Total Beans*	T	C	S	F	Total Beans*
White																				
Red																				
Black																				
Pinto																				
Total by Predator																				

*Transfer these totals to Data Table #3 for *each generation* (it will go in the second column - # of Prey Eaten)

DATA TABLE #3 – Prey Population Figures

INSTRUCTIONS:

1. For the # of Prey of Eaten column, record your totals from Data Table #2 (shaded grey column).
2. For the # of Survivors column (shaded light grey), subtract the total number of each type of bean taken in the feeding session from your beginning population figure in the first column and record your answer.
3. For the # of Pairs able to Reproduce column, divide the number of survivors by 2 to determine how many pairs are left to reproduce (it takes two to tango) and record your answer. (*NOTE: If you get a half #, round down. Example: 13.5 would be 13 pairs)*
4. Now, to determine the # of Offspring produced for the next column, multiply the number in the previous column (#of pairs able to reproduce) by 3. This means that EACH PAIR of survivors is producing three offspring per generation. Record your answer.
5. Complete the table by adding the light grey shaded columns (Survivors PLUS Offspring) and record the totals in the last column.
6. **FINAL STEP: Each student will need to count out the number of offspring (from the Offspring column shaded light grey in the Data Table) from the reserve bag of beans and put them in the white cup.**
7. The next feeding session will begin when all groups have completed their tables & counting out the offspring to be added in to the population.

1st Generation

	Beginning Population	# of Prey Eaten (from Table #2)	# of Survivors (Beg. Pop minus # of prey eaten)	# Pairs able to reproduce (Survivors ÷ 2)	# of Offspring (Each pair of survivors x 3)	TOTALS (Survivors plus offspring)
White	50					
Red	50					
Black	50					
Pinto	50					
Total	200					

- After a second round of feeding, follow the same procedures as above for completing the data tables that follow. Remember to transfer the Totals (dark grey column) from the previous generation table to the Beginning Population column of the next generation table.

2nd Generation

	Beginning Population	# of Prey Eaten (from Table #2)	# of Survivors (Beg. Pop minus # of prey eaten)	# Pairs able to reproduce (Survivors ÷ 2)	# of Offspring (Each pair of survivors x 3)	TOTALS (Survivors plus offspring)
White						
Red						
Black						
Pinto						
Total						

3rd Generation

	Beginning Population	# of Prey Eaten (from Table #2)	# of Survivors (Beg. Pop minus # of prey eaten)	# Pairs able to reproduce (Survivors ÷ 2)	# of Offspring (Each pair of survivors x 3)	TOTALS (Survivors plus offspring)
White						
Red						
Black						
Pinto						
Total						

4th Generation

	Beginning Population	# of Prey Eaten (from Table #2)	# of Survivors (Beg. Pop minus # of prey eaten)	# Pairs able to reproduce (Survivors ÷ 2)	# of Offspring (Each pair of survivors x 3)	TOTALS (Survivors plus offspring)
White						
Red						
Black						
Pinto						
Total						

LAB REPORT: The lab report is to be completed INDIVIDUALLY. Review your data tables carefully to answer the following questions.

1. According to your data, which **PREY (bean**) variation was the BEST adapted to the environment? (meaning, it had greater reproductive success than the other prey/beans)._____

Based on your observations, what characteristics do you think contributed to that bean's survival?

2. According to your data, which **PREDATOR (feeding device)** variation was BEST adapted to the environment? (meaning, it was the one that captured the most prey)._____

Based on your observations, what characteristics do you think contributed to that predator's hunting success?

3. According to your data, which **PREY (bean)** variation was the LEAST adapted to the environment? (meaning, it was eaten the most)._____

Based on your observations, what characteristics do you think contributed to it being captured most frequently?

4. Which **PREDATOR (feeding device)** variation was the LEAST adapted to feeding on the prey population? (meaning, it caught the least amount of prey)_____

Based on your observations, what characteristics do you think contributed to this predator's lack of success in catching prey?

5. Identify the selective pressures (environmental conditions) that determined which traits/characteristics were advantageous in the PREY population.

6. Identify the selective pressures (environmental conditions) that may have affected the success of the PREDATORS.

7. Write a statement explaining how natural selection worked in this simulation. Your statement should include the following: identifying the variation in the populations, the selective pressures operating on those populations and how reproductive fitness/success can lead to the evolution of the populations.

NOTE: You must complete this question to receive credit for this lab.