Name: _____ Period:_____ Date: _____

Natural Selection Pom-Pom Lab

Pre-lab Questions:

A. Name some examples of traits that vary among dogs, e.g. the size of the prognathous (or muzzle).

*

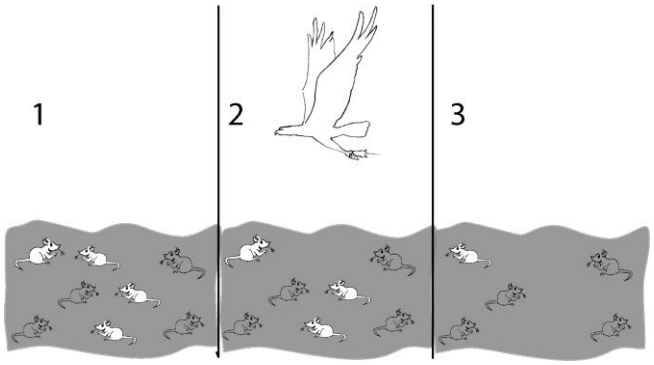
B. Give an example of a trait that has been bred into some breeds of dogs that is **NOT helpful for survival**?

*

C. What would happen if the world somehow suddenly changed, so the only thing that dogs could eat was deer and there was absolutely no way for a dog to eat if it wasn't big or strong enough to catch and kill a deer?

*

D. Next, think about the mice shown below. In the box to the right, describe what is happening in figures 1-3.



*

E. Living things that are well adapted to their environment survive and reproduce. Those that are not well adapted don't survive and reproduce. An **adaptation** is any characteristic that increases **fitness**, which is defined as the ability to survive and reproduce. What are some characteristics of animals or plants that affect their fitness?

*

F. Below are descriptions of four female mice that live in a beach area which is mostly tan sand with scattered plants. According to the definition given for fitness, **which mouse would biologists consider the fittest? Explain why.**

*

	Mouse #1	Mouse #2	Mouse #3	Mouse #4
Color of fur	Brown	Tan	Tan and Brown	Cream
Age at death	2 months	8 months	4 months	2 months
# pups produced by each female	0	11	3	0
Running speed	8 m/min.	6 m/min.	7 m/min.	5 m/min.

G. If a mouse's fur color is generally similar to its mother's color, what color fur would be most common among the pups?

*

H. A more complete definition of fitness is the ability to survive and produce offspring who can also survive and reproduce. Below are descriptions of four male lions. According to this definition of fitness, **which lion would be considered the "fittest"? Explain why.**

*

	George	Dwayne	Spot	Tyrone
Age at death	13 years	16 years	12 years	10 years
# cubs fathered	19	25	20	20
# cubs surviving to adulthood	15	14	14	19
Size	10 feet	8.5 feet	9 feet	9 feet

Directions: *Read the following background information below. Then, continue on to the simulation and questions.*

Suppose that Tyrone had genes that he passed on to his cubs that helped his cubs to resist infections, so they were more likely to survive to adulthood. These genes would be more common in the next generation, since more of the cubs with these genes would survive to reproduce. A characteristic which is influenced by genes and passed from parents to offspring is called **heritable.**

Over many generations heritable adaptive characteristics become more common in a population. This process is called **evolution by natural selection**. Evolution by natural selection takes place over **many, many** generations.

Evolution by natural selection leads to adaptation within a population. The term evolution by natural selection does not refer to individuals changing, only to changes in the frequency of adaptive characteristics in the population as a whole. For example, for the mice that lived in the beach area with tan sand, none of the mice had a change in the color of their fur; however, due to natural selection, tan fur was more common for the pups than for the mother mice.

In summary, a heritable characteristic that helps an animal or plant to have more offspring which survive to reproduce will tend to become more common in a population as a result of evolution by natural selection.

Analysis Questions: *Answer #1 – 18 in complete sentences.*

1. Explain why a characteristic which helps an animal to live longer will generally tend to become more common in the population as a result of evolution by natural selection.

*

2. Not all characteristics which contribute to longer life become more common in the population. Some characteristics contribute to long life, but not more offspring. For example, a female cat which is sterile and cannot have any offspring may live longer because she will not experience the biological stresses of repeated pregnancies. Explain why a characteristic like this which contributes to a long life, but with few or no offspring, would NOT become more common as a result of evolution by natural selection.

*

Natural Selection Simulation

We will now play a **simulation** game to demonstrate how natural selection works.

A simulation is a good way to simplify the problem in such a way that we can observe how evolution by natural selection may work in a real population. This simulation involves pom-poms that can reproduce. These pom-poms live out their lives on a Black Forest or Red Grassland habitat in the middle of the classroom. The only concern our pom-pom creatures have is the presence of ravenous hunters (that's you!). All we need is a system that has the necessary conditions for evolution by natural selection.

I. **Variation in characteristics**: For natural selection to occur, different individuals in a population must have different characteristics. In our simulation, pom-poms vary in color; they are black, red, and white. The hunters vary as well; hunters have three distinct types of feeding structures: forks, knives, and spoons.

II. **Differences in fitness**: For natural selection to occur, the different characteristics of different individuals must contribute to differences in fitness (i.e. differences in ability to survive and reproduce). It seems possible that variation in pom-pom color will influence the probability that a pom-pom is snatched up by a hungry hunter. It also seems possible that different feeding types may vary in their success in capturing pom-poms. These differences contribute to survival and therefore success in reproducing.

III. **Heritability of characteristics**: For natural selection to occur, the characteristics that affect fitness must be heritable (i.e. passed by genes from one generation to the next). In our simulation, a pom-pom that is born into the pom-pom population is the same color as its parent and a hunter that is born into the hunter population has the same feeding structure as its parent.

3. Your class will be split into two groups which will carry out the simulation using two different habitats: Black Forest (represented by a rough black material such as faux fur) and Red Grassland (represented by a red fleece material).

   Pom-poms come in three colors: <u>black, red, and white</u>. Your teacher will "plant" an equal number of each color on the Black Forest and on the Red Grassland at the beginning of the simulation. <u>Which color</u> pom-pom do you think will be more likely to survive <u>in each habitat</u>?

   Black Forest: <u>black / red / white</u> *(circle one)* **Red Grassland:** <u>black / red / white</u> *(circle one)*

* Why do you think that?

4. Now it is time to arm the hunters. **There are three different feeding types: <u>forks, knives, and spoons</u>.** Your teacher will distribute the feeding structures so that there are equal numbers of each. You will also be given a cup. This cup will serve as your "stomach;" a pom-pom capture is only successful if you can manage to get the pom-pom into your cup using just your feeding apparatus. <u>Which hunter</u> do you think will do better <u>in each habitat</u>?

   Black Forest: <u>forks / knives / spoons</u> *(circle one)* **Red Grassland:** <u>forks / knives / spoons</u> *(circle one)*

* Why do you think that?

5. Your teacher will go through the steps of the simulation. Please follow the directions carefully and ask when you do not understand! You will run through the simulation two times. Your teacher will post on the board the numbers of pom-poms of each color and hunters of each type at the beginning of the simulation (generation 1) and at the end of each cycle (generations 2 and 3). Using these numbers you will, for each generation of pom-poms in each habitat, calculate the percent that are black, red, or white. Similarly, for each generation of hunters in each habitat, calculate the percent that have spoons, forks, or knives as their feeding implement. Record these numbers in the tables below:

Pom-Pom Chart (prey)

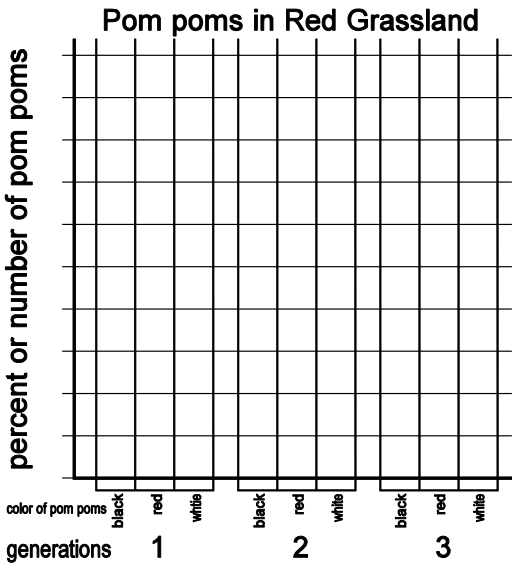
	Red Grassland				Black Forest			
	Pom-poms				Pom-poms			
	Black	Red	White	Total	Black	Red	White	Total
<u>Generation 1</u> Number								
Percent				100%				100%
* <u>Generation 2</u> Number								
Percent				100%				100%
<u>Generation 3</u> Number								
Percent				100%				100%

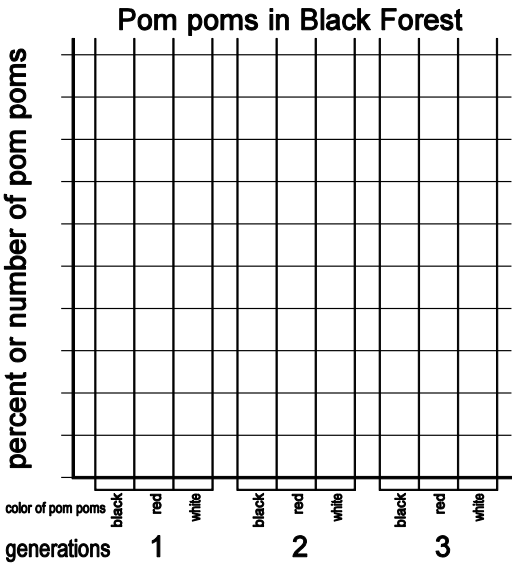
Hunters Chart (predators)

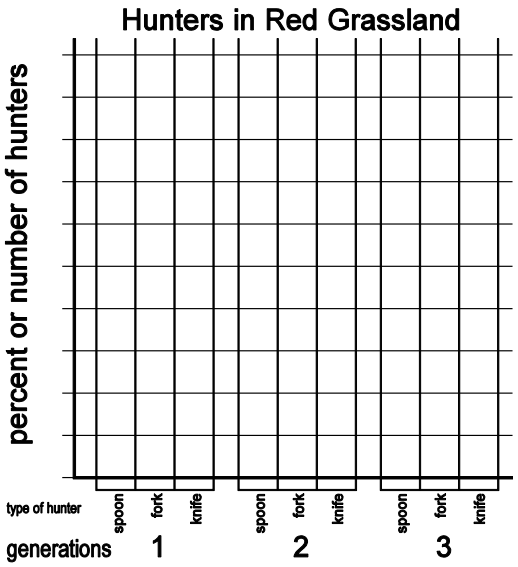
	Red Grassland				Black Forest			
	Hunters				Hunters			
	Spoon	Fork	Knife	Total	Spoon	Fork	Knife	Total
<u>Generation 1</u> Number								
Percent				100%				100%
* <u>Generation 2</u> Number								
Percent				100%				100%
<u>Generation 3</u> Number								
Percent				100%				100%

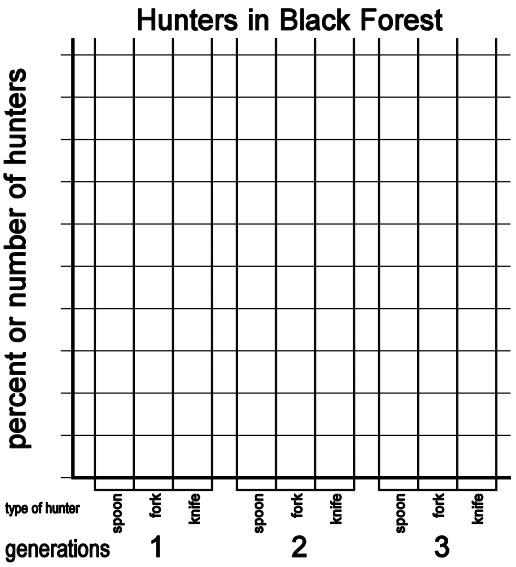
6. Use the data to complete the following 4 bar graphs. Show the changes in the **percent** of pom-poms of each color and hunters of each type over the three generations in each habitat. Use the actual colors for the pom-pom graphs.

*









7. Did evolution by natural selection occur in each pom-pom population? In other words, did one pom-pom color become more common over time while the other colors became less common? What traits contributed to the survival of pom-poms that survived to reproduce?

Black Forest:

*

Red Grassland:

Remember that the pom-pom populations were the same on the Black Forest and Red Grassland at the beginning. Explain why the trends differ in these two different habitats and the two populations of pom-poms end up so differently.

*

8. For each population of hunters, did one feeding type become more common while other feeding types became less common? What traits contributed to the survival of hunters that survived to reproduce?

Black Forest:

*

Red Grassland:

Explain the differences in the trends in the feeding type of the hunters in the two habitats.

9. Did <u>any individual pom-poms</u> change color or adapt? If not, then why did the colors of the pom-poms in the final population differ from the colors of the pom-poms in the original populations?

*

10. If we ran the simulation for 50 more generations, what would you predict about the colors of the pom-poms and the hunter types in each habitat?

Black Forest:

*

Red Grassland:

11. What do you think would happen to the hunter and pom-pom populations if the black forest experienced a decade long drought and became red grassland? First, make your prediction of what would happen if the population of pom-poms in the black forest at the beginning included red, white and black pom-poms.

Pom-pom population:

*

Hunter population:

12. Next, suppose that natural selection over many generations had resulted in only black pom-poms surviving in the black forest, and then a prolonged drought resulted in this habitat turning into a red grassland. Would natural selection for pom-pom color occur?

*

Based on this example, explain why evolution by natural selection **cannot occur if there is no variation** in a characteristic.

*

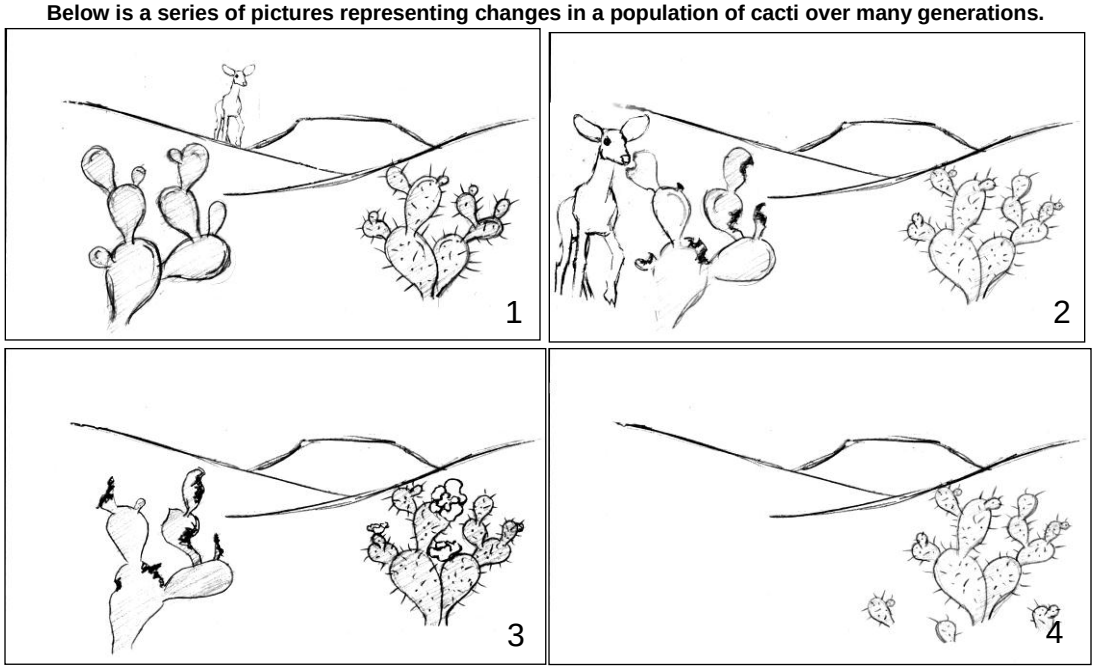
13. Explain why evolution by natural selection **cannot occur if the variation in a characteristic does not contribute to differences in fitness**. Suppose, for example, that all the hunters in the simulation were blindfolded and could only find pom-poms by touch. Would you expect evolution by natural selection in the color of the pom-poms?

*

14. Explain why evolution by natural selection **cannot occur if the variation in a characteristic is not heritable**. Suppose, for example, a tree limb fell on a young lion and broke his leg, and the leg never healed normally. Obviously, this would affect the lion's ability to survive and reproduce. However, if this lion did manage to have cubs, the offspring would each have four normal legs. Explain why natural selection does not operate on characteristics like this which affect fitness but are not heritable.

*

Below is a series of pictures representing changes in a population of cacti over many generations.



15. In picture 3, the right cactus has flowers, but the cactus that has been eaten by the deer is too damaged to make flowers. Picture 4 shows the situation several months later. What has happened, and what is the beneficial adaptation? Explain this scenario in terms of natural selection.

*

16. If we came back and looked at this environment years later, how would the cactus population probably be different? (*Think about the bar graphs you made.*)

*

17. What do you think most people mean by "survival of the fittest"? Based on what you now know about natural selection, **explain what it really means.**

*

18. What characteristics of humans do you think helped them survive and reproduce during the hundreds of thousands of years when they were hunter-gatherers? (*HINT → What traits do we have that distinguish us from other primates?*)

*