1 Engage

Name Date

Look around your school and you quickly notice that not everyone looks the same. There is a wide range in height, hair color, skin tone, and body shape. Most human physical features show up in different variations. Even though we are all the same species, our DNA is different enough to produce many physical differences. Some of these variations may be useful. For example, someone with long legs may be better suited to run long distances. Someone with long fingers may be better suited to play the piano. Of course, those are not the only traits that determine whether someone is a good runner or pianist, but they may give these people an advantage over others.

Variation exists in all species. Animals of the same species are genetically different. These differences may be apparent (e.g., size or strength), or they may be at the cellular level (e.g., ability to combat a disease). This genetic variability is critical for species' survival. If there is a change in the environment, these differences may give some individuals an advantage over others and allow them to pass these traits along to their offspring. Over time, traits that provide an advantage for the organisms are likely to become more pronounced in the population.

PRIOR KNOWLEDGE
Have you ever seen an albino animal? These animals lack any pigment, making them white. Albinism is genetically linked and can be passed down from parent to offspring. We do not see many albino animals in the wild because they usually cannot hide from predators and do not make it to a reproductive age. Albino plants have no chlorophyll, are unable to make food, and live only a short time. Why are there still albino organisms if most do not reproduce?

Did you know that all domestic dogs are the same species? Dog breeds provide an excellent example of genetic variation within a species. These variations came about through artificial selection, rather than natural selection. By crossing individual dogs with desired traits for thousands of years, humans have created dog breeds ranging from Chihuahua to Great Dane. Since they are the same species, dogs of different breeds can mate and produce offspring. Imagine a Great Chihuahua!

What causes genetic variability within a species?

Are there genetic traits that do not play a part in an organism's ability to adapt?

Why is having genetic differences important to the survival of a species?

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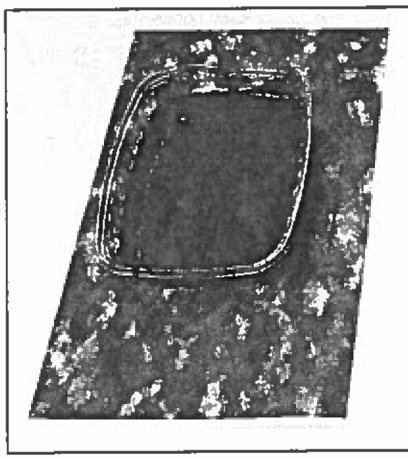
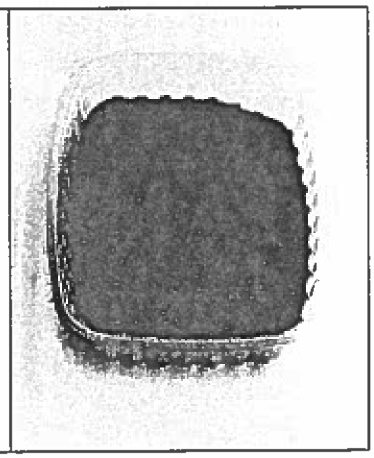
Activity 1: Predator/Prey

In this activity, your group becomes predators. The idea is to capture as many prey (represented by pom-poms) as possible from three different habitats: water, sand, and paper. Time will be limited, and each member will have a different feeding tool to collect as many of the pom-poms as possible and place them in his or her feeding cup.

1. At each workstation, there should be one of three habitats: a tray of water with a blue environment sheet under it, a tray with white sand, or a tray with a yellow environment sheet under it. There should also be three different colors of pom-poms: yellow, blue, and white.

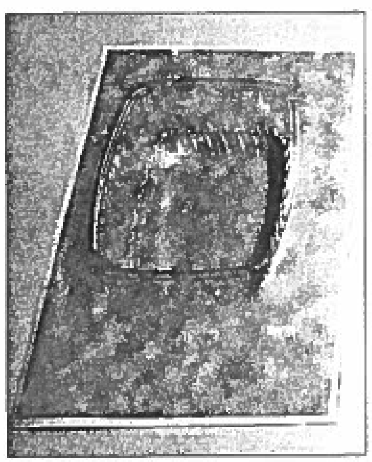


Blue environment



Sand environment

2. First, scatter 50 of each color of pom-pom through each habitat (i.e., 150 pom-poms per habitat). In the sand habitat, mix them with the sand so that some are buried. Make sure all the pom-poms in the water are dunked; some may start to sink. For the yellow paper, make sure all three colors are mixed evenly across the sheet. Record the starting population on Data Sheet 1.



Yellow environment

MATERIALS

Materials per group of four:

- 4 plastic cups
- teaspoon
- fork
- plastic forceps
- 2 wooden sticks
- Data Sheets 1 and 2

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3. Each person in your group should get one of four different feeding tools: fork, spoon, forceps, or pair of applicator sticks. Everyone should also receive a cup to contain the collected pom-poms.
4. Once your teacher says to start, the object is to collect as many pom-poms as possible. You may collect only one pom-pom at a time. Once you collect it, it must be placed in your cup before you can go after another one.
5. Don't be shy about going after the same pom-pom as your teammate. In the wild, animals often chase the same prey, but only one may get it. Once the pom-pom is on a person's feeding tool, it is off limits, and no one else can pursue it.
6. When your teacher calls time, stop all collecting. Replace any captured pom-pom that has not yet made it to your feeding cup. Count out all the pom-poms you've collected, and record this number on Data Sheet 2. Gather the results from the rest of your group and record them. Also count the total number of each color of pom-pom collected by the group for each habitat and record this information on Data Sheet 1.
7. Assume that each pom-pom that survived and is still in the environment had one offspring to create the next generation. To account for this, for each pom-pom remaining add one more pom-pom of the same color to the habitat. Add up the new population total and record it on Data Sheet 1.
8. Repeat steps 4–6.
9. Once you are finished with two generations, set up the habitat for the next group. Make sure there are 50 of each color of pom-pom in the habitat. With your feeding tools and cups, move to a different habitat. Repeat the procedures. Each student should use a different tool at each station. Your group will visit three different habitats (sand, water, and paper) before the end of the activity.

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Data Sheet 1 Prey

Prey		Habitat					
		Water		Sand		Paper	
		Generation 1	Generation 2	Generation 1	Generation 2	Generation 1	Generation 2
White	Initial Population	50		50		50	
	Number Captured						
	Number Remaining						
	Percent of Total Remaining Population						
Blue	Initial Population	50		50		50	
	Number Captured						
	Number Remaining						
	Percent of Total Remaining Population						
Yellow	Initial Population	50		50		50	
	Number Captured						
	Number Remaining						
	Percent of Total Remaining Population						
Total	Initial Population	150		150		150	
	Remaining Population						

② Explore

Name ______________________ Date __________

Data Sheet 2 Predator

Predator	Habitat					
	Water		Sand		Paper	
	Generation 1	Generation 2	Generation 1	Generation 2	Generation 1	Generation 2
SPOON Number Captured						
SPOON Percentage of Total Captured						
FORK Number Captured						
FORK Percentage of Total Captured						
STICKS Number Captured						
STICKS Percentage of Total Captured						
FORCEPS Number Captured						
FORCEPS Percentage of Total Captured						

Total Captured	Water	Sand	Paper
Generation 1			
Generation 2			

3 Explain

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Charles Darwin introduced his theory of evolution in the mid 1800s. His theory stated that species evolve over time, adapting to their environments. One mechanism driving this change is the process of natural selection, the differential success rate in the reproduction of different phenotypes resulting from the interaction of the organisms with their environment. In other words, an organism that is well adapted to its environment has a better chance of reproducing and passing on its genes than does an organism that is poorly suited to that environment. Over time, this difference affects the allelic frequencies of the population, making subsequent generations better adapted to that environment.

GENES AND ALLELES

Every organism possesses a sequence of genes dictating its individual characteristics. The total aggregate of genes in a specific population is known as the gene pool. Each gene may have alternative (dominant and recessive) versions, called alleles. Imagine, for example, a particular species of flower. The color of this flower might be determined by one gene, a gene that possesses two color variations, one allele for purple and one allele for white. The flower receives one allele from each of its parents, and the combination of these alleles determines the color of the flower. If the inherited alleles are identical, or homozygous, then they express that color trait. Two "purple" alleles make a flower purple. Likewise, two "white" alleles make a flower white. When alleles of different types are combined, only the dominant allele is expressed. For instance, if the "purple" allele is dominant and the "white" allele recessive, then the heterozygous flower will be purple. Whether homozygous or heterozygous, the combination of alleles is called the organism's genotype, and the specific trait expressed by the genotype is the organism's phenotype.

IMPORTANT TERMS

- alleles
- emigration
- evolution
- founder effect
- gene flow
- gene pool
- genetic drift
- genotype
- Hardy-Weinberg principle
- immigration
- mutations
- natural selection
- phenotype
- population bottleneck
- selective mating

3 Explain

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THE HARDY-WEINBERG PRINCIPLE AND NATURAL SELECTION

The Hardy-Weinberg Principle states that a population's allelic frequencies will remain the same for each generation if the following conditions are met:

1. The population is large.
2. There is completely random mating within the population.
3. There is no genetic mutation.
4. There is no immigration or emigration of individuals of the population.
5. There is no natural selection.

When allelic and genotypic frequencies remain constant over time, a population is in genetic equilibrium.

In nature, it is difficult to find a population in equilibrium. Ecosystems tend toward a state of flux due to environmental changes and competition between organisms for finite resources. Organisms must be able to adapt to these changes in order to survive. Darwin postulated that natural selection is the major force to shape the traits of a population (or change the allele frequencies, as we would now say). Four other mechanisms are also known to change a population: mutation, gene flow, genetic drift, and selective mating.

MUTATION

Mutations occur in DNA molecules. They involve deletions, transpositions, or duplications to a portion of DNA. Not all causes for mutations are known, but some major causes are x-rays, ultraviolet rays, radioactive compounds, and a variety of chemical substances. Most mutations occur spontaneously, meaning the chemical or physical forces that caused them are unknown.

GENE FLOW

Gene flow is the movement of alleles into or out of a population, changing the allele frequency. This happens when a breeding population is not completely isolated and there is some interbreeding with individuals of another population. Gene flow often occurs through immigration or emigration.

3 Explain

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GENETIC DRIFT

Genetic drift occurs in small breeding populations. With fewer individuals breeding, there are larger swings in the allele frequency from generation to generation due to chance. Imagine flipping a coin 10 times. Chances are that heads may come up more than tails, or vice versa. Heads may come up 6 times (at 60% frequency), or sometimes even more. If the coin is flipped 100 times or 1000 times, it becomes more likely that heads will come up closer to 50% of the time. This pattern holds true with allele frequency in small breeding populations versus large populations. Genetic drift occurs when a small group becomes separated from the larger group. The allele frequency in the small population may differ significantly from that in the parent population, a situation called the founder effect. Genetic drift also occurs through population bottleneck, in which the population becomes very small for a period of time and then expands. Both the founder effect and bottleneck reduce genetic diversity in the population.

SELECTIVE MATING

Another mechanism that can change the allelic frequency is selective mating. This occurs when a certain trait in a population becomes preferred by one sex or the other and increases the chances for mating in an individual with that trait. For example, some male animals in a population may have a bright red color that attracts more females; consequently, red males have a higher chance to pass on their genes.

3 Explain

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1. As a group, analyze the data collected. Calculate the percentage of the remaining population for each color of pom-pom.

$$\text{percent} = \frac{\text{number remaining of one color}}{\text{total remaining population of all colors}} \times 100$$

2. Together, on either graph paper or plain paper, visually represent the calculated percentages. Include the data from both generations on the same graph. Construct a graph for each habitat.

3. Calculate the percentage of the captured pom-poms collected by each feeding tool for each generation.

$$\text{percent} = \frac{\text{number captured by one feeding tool}}{\text{total number captured by all tools}} \times 100$$

4. As a group, graphically represent the calculated percentages for each feeding tool in each generation in each habitat.

3

Explain

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The Prey Graphs

1. Is there any correlation between the color of the pom-poms and the habitat in regard to the number remaining in each generation? If yes, explain why.

2. Is there a difference between the percentages of each color remaining in generation 1 versus the same color in generation 2?

3. Compare your group's results for the different habitats. Is there a difference in which color of pom-pom was captured most from each habitat? Explain why or why not.

4. If there were a change in the environments, would you expect to see a change in the percentages of each color of pom-pom remaining in the third generation? Explain why.

3 Explain

Name Date

The Predator Graphs

5. Which tools were the most successful in each habitat?

6. Was there a large difference between generation 1 and generation 2 in the percentages of prey captured by each feeding tool? Explain.

7. Compare your group's results for the different habitats in terms of whether any feeding tool performed better in any habitat. Explain your findings.

8. If there were a change in the environments, would you expect to see a change in the percentages of success of each feeding tool in the third generation?