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[**Student Exploration: Microevolution**](https://www.explorelearning.com/index.cfm?method=cResource.dspDetail&ResourceID=521)

**Directions: Follow the instructions to go through the simulation. Respond to the questions and prompts in the orange boxes.**

**Vocabulary:** allele, cystic fibrosis, deleterious, dominant allele, fitness, genotype, heterozygote superiority, heterozygous, homozygous, incompletely dominant, malaria, predator, recessive allele, sickle cell anemia

**Prior Knowledge Questions** (Do these BEFORE using the Gizmo.)

Many people from warm regions carry an **allele** that provides resistance to **malaria**. Two copies of this allele,

however, causes a deadly blood disorder called **sickle cell anemia**.

1. Suppose two parents are healthy carriers of the sickle-cell allele. The **genotype** of each parent is *AS* (*A* is the normal allele, and *S* is the sickle-cell allele).

| How likely is it for a child of these parents to have sickle cell anemia (*SS*)? | 1/4 |
| --- | --- |

1. Do you think the allele for sickle cell anemia would be common in regions where malaria did not exist?

| No |
| --- |

| Explain why or why not. | If malaria does not exist, resistance to malaria wouldn’t exist as well. |
| --- | --- |



**Gizmo Warm-up**

If natural selection does not favor one trait over another, the frequencies of various alleles in a population will tend to be stable over long periods of time. But what happens when one allele confers an advantage or disadvantage to an individual? These scenarios and others can be explored with the *Microevolution* Gizmo.

1. The feather color of the parrots in the Gizmo is controlled by two alleles, *D* and *d*. The *D* allele is **incompletely dominant** over *d*. What is the feather color of each parrot genotype?

| *DD* | Dark green | *Dd* | Light green | *dd* | Yellow (Lime) |
| --- | --- | --- | --- | --- | --- |

1. The **fitness** of parrots is determined by how well they blend into the background trees. Set the **Fitness of *DD*** slider to 100% and the other fitness sliders to 60%.

| The birds with which genotype blend into the background now? | Dark green (DD) |
| --- | --- |

1. Click **Begin**, and then click **Predator**.

| Which parrots were killed by **predators**? Why? | Dd and dd were killed as they stood out |
| --- | --- |

| **Activity A:**  **Deleterious dominant alleles** | Get the Gizmo ready:   * Click **Reset**. * Set the ***DD*** and ***dd*** sliders to 34%. | 521SE2 |
| --- | --- | --- |

**Introduction:** A **deleterious** allele is one that significantly lowers the fitness of an individual. If the deleterious allele is a **dominant allele** (*D*), then both **homozygous** *DD* and **heterozygous** *Dd* individuals will be at a disadvantage.

**Question: How will allele frequencies change if a dominant allele is deleterious?**

1. Observe: To model the effects of a deleterious dominant allele, set the **Fitness of *DD*** and **Fitness of *Dd*** sliders to 60%. Set the **Fitness of *dd*** to 100%.

Based on the color of the trees, which parrots will be easiest for predators to spot and kill?

| DD would be the easiest, next being Dd |
| --- |

1. Predict: How do you expect the proportions of *D* and *d* alleles to change in five generations?

| D would decrease in population and d will increase |
| --- |

1. Record: Click **Begin** and **Predator**. Record the results of hawk predation in the table below.

|  | ***DD*** | ***Dd*** | ***dd*** | **Totals** |
| --- | --- | --- | --- | --- |
| **Starting population** | 170 | 160 | 170 | 500 |
| **Killed by hawks** | 61 | 75 | 0 | 136 |
| **Ending population** | 109 | 85 | 170 | 364 |

1. Calculate: To calculate the percentage of survivors for each genotype, divide the **Ending population** by the **Starting population**. Multiply each result by 100 to convert to a percentage, and record the percentages below.

| *DD* | 64.1% | *Dd* | 53.1% | *dd* | 100% |
| --- | --- | --- | --- | --- | --- |

1. Analyze: How do the percentages of survivors relate to the fitness of each parrot genotype?

| Survival rate of all three variations show that they are close to the fitness percentage set. |
| --- |

1. Gather data: Click **Breed**, and then click **Hatch**. Click **Continue**, and then click **Predator**. Repeat this sequence to play the simulation for five generations. Select the TABLE tab and record the genotype populations over time in the spaces below.

| **Generation** | ***DD*** | ***Dd*** | ***dd*** |
| --- | --- | --- | --- |
| 0 | 170 | 160 | 170 |
| 1 | 85 | 238 | 177 |
| 2 | 56 | 228 | 216 |
| 3 | 36 | 208 | 256 |
| 4 | 23 | 143 | 334 |
| 5 | 14 | 110 | 376 |

1. Analyze: What patterns do you see in your data?

| DD and Dd are decreasing when dd is increasing |
| --- |

1. Interpret: Select the ALLELE GRAPH tab.

| What does this graph show? | D alleles are decreasing and d are increasing |
| --- | --- |

1. Interpret: Select the GENOTYPE GRAPH tab.

| What does this graph show? | DD and Dd are decreasing when dd is increasing |
| --- | --- |

1. Think and discuss: Why do you think deleterious dominant alleles are not very common?

| I think it’s because there wouldn’t be an environment where the fitness is high for just one allele |
| --- |

| **Activity B:**  **Deleterious recessive alleles** | Get the Gizmo ready:   * Click **Reset**. * If necessary, set ***DD*** and ***dd*** to 34%. | 521SE3 |
| --- | --- | --- |

**Introduction: Cystic fibrosis** is a genetic disease caused by a **recessive allele**. Individuals with one copy of this allele are healthy, but having two copies of the allele causes the production of abnormally thick mucus in the lungs and pancreas. This leads to breathing difficulty, frequent infections, and usually a shortened life span.

**Question: How will allele frequencies change if a recessive allele is deleterious?**

1. Observe: To model the effects of a deleterious recessive allele, set the **Fitness of *DD*** and **Fitness of *Dd*** to 100%. Set the **Fitness of *dd*** to 60%.

Based on the colors of the trees, which parrots will be easiest for predators to spot and kill?

| dd parrots |
| --- |

1. Predict: How do you expect the proportions of *D* and *d* alleles to change in five generations?

| D increase d decrease |
| --- |

1. Gather data: Click **Begin**. Play through the simulation for five generations. Select the TABLE tab and record the genotype populations over time in the spaces below.

| **Generation** | ***DD*** | ***Dd*** | ***dd*** |
| --- | --- | --- | --- |
| 0 | 170 | 160 | 170 |
| 1 | 177 | 237 | 86 |
| 2 | 212 | 226 | 62 |
| 3 | 233 | 211 | 56 |
| 4 | 233 | 218 | 49 |
| 5 | 265 | 197 | 38 |

1. Analyze: What patterns do you see in your data?

| D are constantly increasing, d are decreasing |
| --- |

1. Interpret: Select the ALLELE GRAPH tab. What does this graph show?

| increase in D, decrease in d |
| --- |

1. Interpret: Select the GENOTYPE GRAPH tab. What does this graph show?

| DD and Dd are increasing and dd are decreasing |
| --- |

1. Compare: Compare the rate at which the deleterious *d* allele disappears in this activity to the rate at which the deleterious *D* allele disappeared in activity A.

| 1. Which disappears more rapidly from a population, a deleterious dominant allele or a deleterious recessive allele? | recessive allele disappears more quickly |
| --- | --- |
| 1. Why do you think this is so? | there are only one way to show recessive trait |

1. Apply: Deleterious recessive alleles, such as the allele that causes cystic fibrosis, can persist in a population indefinitely. Why aren’t these rare alleles eliminated completely?

| As Dd alleles can still produce dd. |
| --- |

1. Think and discuss: Why are most genetic diseases caused by recessive alleles? If possible, discuss your answer with your classmates and teacher.

| As they are rarest |
| --- |

| **Activity C:**  **Heterozygote superiority** | Get the Gizmo ready:   * Click **Reset**. * If necessary, set ***DD*** and ***dd*** to 34%. | 521SE4 |
| --- | --- | --- |

**Introduction:** In the case of **heterozygote superiority**, individuals who are heterozygous for a particular trait are more fit than either of the homozygous varieties. For example, individuals with one copy of the sickle cell allele are resistant to malaria but do not have sickle cell anemia.

**Question: How will allele frequencies change if heterozygous individuals have the greatest fitness?**

1. Observe: To model heterozygote superiority, set the **Fitness of *DD*** and the **Fitness of *dd*** to 60%. Set the **Fitness of *Dd*** to 100%.

Based on the color of the trees, which parrots will be easiest for predators to spot and kill?

| DD and Dd |
| --- |

1. Predict: How do you expect the proportions of *DD*, *Dd*, and *dd* genotypes to change over the course of five generations?

| Decrease in DD and dd, increase in Dd |
| --- |

1. Gather data: Click **Begin**. Play through the simulation for five generations. Select the TABLE tab and record the genotype populations over time in the spaces below.

| **Generation** | ***DD*** | ***Dd*** | ***dd*** |
| --- | --- | --- | --- |
| 0 | 170 | 160 | 170 |
| 1 | 126 | 265 | 109 |
| 2 | 118 | 261 | 121 |
| 3 | 129 | 245 | 126 |
| 4 | 126 | 256 | 118 |
| 5 | 118 | 269 | 113 |

1. Analyze: What patterns do you see in your data?

| DD and dd seem to be decreasing and Dd is increasing |
| --- |

1. Interpret: Select the ALLELE GRAPH tab. What does this graph show?

| They are about the same |
| --- |

1. Interpret: Select the GENOTYPE GRAPH tab. What does this graph show?

| DD and dd seem to be decreasing and Dd is increasing |
| --- |

1. Calculate: Suppose that the *dd* genotype represents a debilitating disease such as sickle cell anemia. In this population, what percentage of the offspring has sickle cell anemia?

| About 20% |
| --- |

1. Think and discuss: Malaria is transmitted through mosquito bites. Symptoms include high fever, joint pain, and violent shivering. It can be deadly, especially in children or the elderly.
   * 1. Why do you think the sickle cell allele is still common in tropical regions?

| Because the allele for resisting malaria exists |
| --- |

* + 1. How might the occurrence of sickle cell anemia change if anti-malaria drugs and preventative measures (such as the use of mosquito netting) become more widespread in tropical regions?

| The number of sickle cell anemia cases will decrease over generations |
| --- |