



### Science Objectives

- Students know how natural selection determines the differential survival of groups of organisms.
- Students know both genetic variation and environmental factors are causes of evolution and diversity of organisms.
- Students know sexual reproduction produces offspring that inherit half their genes from two parents.

### Vocabulary

- |                      |                         |
|----------------------|-------------------------|
| • natural selection  | • evolution             |
| • phenotype          | • genotype              |
| • population         | • generation            |
| • parent             | • offspring             |
| • dominant           | • recessive             |
| • Charles Darwin     | • feature               |
| • selective pressure | • selective advantage   |
| • mutation           | • differential survival |
| • trait              | • environment           |
| • wild-type          |                         |

### About the Lesson

This lesson allows students to model natural selection, providing an opportunity to make predictions about evolution in a population over a short period of time observing some of the mechanisms of evolution.

As a result, students will:

- Understand how natural selection drives evolution.
- Understand how populations change as a result of mutations and selection.
- See how parental genetics influence offspring over generations.

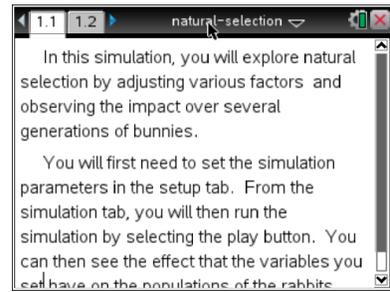


### TI-Nspire™ Navigator™

- Send out the *Natural\_Selection.tns* file.
- Monitor student progress using Class Capture.
- Use Live Presenter to allow students to show how they manipulate variables that effect results and the results they achieve.

### Activity Materials

- Compatible TI Technologies:  TI-Nspire™ CX Handhelds,  TI-Nspire™ Apps for iPad®,  TI-Nspire™ Software



### Tech Tips:

- This activity includes screen captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at <http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials>

### Lesson Files:

#### Student Activity

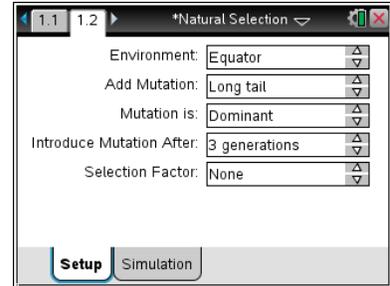
- Natural\_Selection\_Student\_MG.doc
- Natural\_Selection\_Student\_MG.pdf
- Natural\_Selection.tns



### Discussion Points and Possible Answers

#### Part 1: No Selection

Your students will be running a simulation of a rabbit population with no selection with the settings as shown to the right. A mutation will be introduced after three generations, and they will see what the final result when the mutation is dominant and then recessive. Without selection, the growth of one phenotype in the population is only influenced by genetics. A dominant mutation will appear more prominently than when a recessive mutation is introduced, but both can remain in the population.



Your students can explore the different mutations, but it will slow down the simulation if they increase the “Introduce Mutation After” selection.

There is a subtle difference between the pictures of the different phenotypes. These images are included for your reference.



Wild-type



White Fur



Long Teeth



Long Tail

Alternatively, you can export data from a simulation to retrieve the exact numbers of each mutation after a simulation.



**Tech Tip:** To export the data for a simulation, select **menu** and then select **4: Export Data > 1: Export All**.



**Tech Tip:** To export the data for a simulation, select **> Export Data > Export All**. Students may need to back-out to the main Tools Menu to see the desired menu option.

Students could also be encouraged to create a spreadsheet to keep track of the results after each generation. To add a spreadsheet, select **Doc > Insert > Lists & Spreadsheets**, which will add a new tab to the simulation. Data can be added to the spreadsheet.

gen	whitefur	nowf
1	0	2
2	0	6
3	0	18
4	9	40
5		



**Tech Tip:** To add a spreadsheet, select **+** > **Lists and Spreadsheets**. To type in the spreadsheet, select any cell twice. The keyboard will appear. To enter text into a cell, select the **“ABC”** button.

Q1. What is a phenotype?

**Answer:** A phenotype is an observable trait that is influenced by genetics.

The genetic part is important. The color of your hair is a phenotype. How long your hair is not a phenotype because it is not influenced by genetics.

Q2. When you used the long tail or teeth mutation, did any of the rabbits have white fur? Explain why or why not?

**Answer:** No, the rabbits inherit traits from their parents. If there is no “white fur” gene in the population, it cannot be inherited.

Q3. For the Mutation you selected, after 6 generations, how many rabbits show the dominant phenotype? The recessive phenotype? Why do think this is? What do you think will happen with 6 more generations?

**Answer:** Check students’ work. These numbers can be exported from the simulation. The important point is that more rabbits are showing the dominant (mutant) phenotype.

Q4. In this simulation with None as the Selection Factor, what force changes the proportion of each phenotype?

**Answer:** Without selection, genetics is the only thing that drives changes in the population.

Even discussing basic genetics can bring up some confusion about vocabulary. The **phenotype** is the visible, observable trait. The **genotype** is the heritable information, or the genetics. Since each person receives two complete sets of their genes (one from mom, one from dad), it is possible to have a mixed genotype, such as one dominant and one recessive copy of the gene, that will result in the dominant phenotype. A **dominant** trait simply masks the effect of a **recessive** trait. Freckles are a good example of a dominant gene—if you have one dominant copy, you show freckles. Students often confuse “dominant” for common. Counter examples of this are Down’s Syndrome, Huntington’s disease and some forms of deafness. If your students struggle with this, suggest they run a simulation where the dominant mutation is not advantageous (i.e., long tail with wolves) and assess which is the most common after several generations.



Q5. Do you predict more or less rabbits will show the recessive mutation than no mutation after 6 generations?

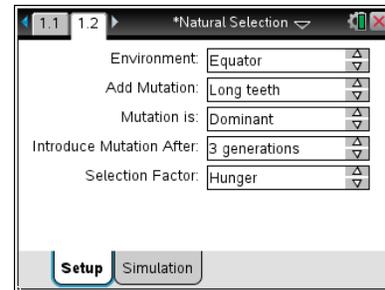
**Answer:** Without selection, most rabbits will show the wild-type trait, not the recessive mutation.

Q6. Was your prediction in Q5 correct? If not, why do you think you were incorrect?

**Answer:** Check students' answers.

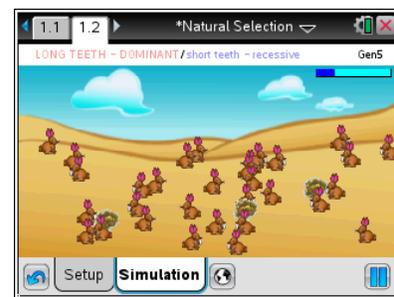
**Part 2: Selection by Hunger**

Students will repeat the simulation with Hunger as the selection factor. In this case, the simulation indicates that there is a new, and difficult to eat food available for the rabbits. Rabbits with long teeth have an advantage for eating the food. Unlike the other mutations, when long teeth are present, this mutation will expand in the population. Rabbits that can't eat this new food are more likely to die than those with long teeth, and cannot pass their genes to their offspring. This is a great example of a kind of selection by the environment, rather than an interspecies selection. As the climate changes, only species that can adapt to their new environment will survive.



Q7. How does the phenotype of parents influence the offspring? Do you see rabbits with a phenotype that you have not selected?

**Answer:** All organisms get all their genetic material from their parents, so you will only see the phenotype that you have selected.



Q8. What trait gives a selective advantage against hunger? Explain why you think so.

**Answer:** Long teeth give rabbits the ability to eat the new bush in their environment.

Unlike long teeth, the other mutations don't provide any advantage in this environment. A selective advantage can be anything that influences an individual's ability to survive long enough to pass along its genes to the next generation.

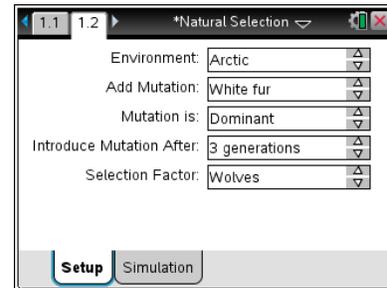


Q9. How does a phenotype provide a selective advantage?

**Answer:** An advantageous phenotype allows the individual to survive better in its environment, and pass on its genes to future generations.

### Part 3: Selection by Wolves

In this part, students will be testing how predation by wolves acts as a form of natural selection. In this case, white fur can influence the selection. It makes white rabbits more visible in the equatorial climate, and less visible in the arctic environment. Testing two variables at once might confuse some students, so encourage them to focus on one factor at a time.



**Tech Tip:** After selecting the Simulation tab, students can select the globe icon  to change the environment between the Equator and the Arctic.

Q10. Record the values of the variables you are testing with a Selection Factor of Wolves in a log book on the Nspire.

**Answer:** Check students' answers.



### TI-Nspire Navigator Opportunities

Use Class Capture to ensure students have covered all the variables.

Q11. Given these settings, which phenotype do you predict will be most common after 9 generations?

**Answer:** Students might predict that the coat color that makes them least visible to predators will give a selective advantage. They also might predict that other mutations give no selective advantage in this condition. In this case, they should be clear what that would look like.

Students will test this predication, and can amend this prediction in future simulations.

Q12. When wolves are performing natural selection, which phenotype gives the selective advantage? That is, what do the rabbits that are most likely to survive look like?

**Answer:** White rabbits survive best in the arctic, brown rabbits survive best at the equator.



Q13. How does the choice of environment influence natural selection? Do you get the same results in the Arctic and at the Equator?

**Answer:** The results are opposite at the Arctic and Equator. The environment affects which color is the best camouflage. As the environment changes, populations must adapt with them.



### TI-Nspire Navigator Opportunities

Allow students to volunteer to be the Live Presenter and demonstrate how to adjust the parameters of the simulation. Use Quick Poll to check for understanding during the course of the activity or to ask some of the questions in the student activity sheet.

### Wrap Up

When students are finished with the activity, collect students' worksheets.

### Assessment

- Formative assessment will consist of questions embedded in the student worksheet. Analyze questions in the student worksheet with the students
- Summative assessment will consist of questions/problems on the chapter test.