

Evolution Lab

Essential Knowledge 1.A.1 Natural selection is a major mechanism of evolution.

Challenge Area 1.2 You can evaluate evidence provided by data to qualitatively and/or quantitatively investigate the role of natural selection in evolution.

Building Block A Natural Selection

Goal of tasks

Natural selection is the major driving mechanism of evolution and contributes to the change in the genetic makeup of a population over time. Mutations are a source of genetic variation, which plays a role in natural selection.

For this task you will be evaluated on your ability to

- Determine, both qualitatively and quantitatively, the effects of mutation rate and selection strength on the evolution of a population.
- Explain the relationships between mutation rate, selection strength and natural selection.
- Create graphs from data sets that reflect a change in the genetic makeup of a population over time and apply mathematical and conceptual understandings to investigate the causes and effects of the change.

Tasks summary

In this lab, you will use a computer simulation to track a population of organisms as they evolve. You will take data on the number and varieties of the organisms and graph them to show change over time and determine how two factors, mutation rate and selection strength, affect how populations evolve.

Task 1: Pre-lab questions (Individual)

1. Go to www.biologyinmotion.com and click on the link that says "Evolution Lab."
2. Read the introduction and the contents to learn about the imaginary creatures you will be studying and how to operate the simulator. You may also want to look at the help link.
3. Open the simulator and practice using the controls before you go on to the real simulation. Be sure to "reset" the simulator when you're finished practicing.

5. Show your pre-lab questions to your teacher before proceeding with Task 2.

Check your understanding

- Can you explain the differences between mutation rate and selection strength?
- Can you explain the characteristics of your population?
- How you will use those characteristics to evaluate the effects of changes to the evolution of your population?

Task 2: Evolution lab (Individual)

1. To determine how mutation rate affects the evolution of your population, you will run four trials with varying settings for mutation rate, keeping selection strength at the default value of 0.8. Each trial will consist of 250 cycles. You will collect mean phenotype data for the initial state and for cycles 50, 100, 150, 200 and 250.
2. Go to www.biologyinmotion.com and click on the link that says “Evolution Lab.” Open a second window for the graphing program at www.nces.ed.gov/nceskids/graphing. Select line graph. Under the data tab, fill in the fields that follow:
 - Graph Title: Evolution Simulation–Mutation Rate
 - X Axis Label: Cycles
 - Y Axis Label: Mean Phenotype
 - Source: Copy/paste the URL of the Evolution Lab into the box
 - Data Set: Items, 6; Groups, 4
 - Group Label: For each of the four groups, enter the mutation rate you have selected (the default rate is 0.3).
 - Item Labels: Initial, Cycle 50, Cycle 100, Cycle 150, Cycle 200 and Cycle 250
3. Make sure you have reset the simulation between each trial. Select your desired mutation rate. Record the initial mean phenotype (2) in the appropriate box in the graphing program. In the simulation, click the “Go to Cycle 50” arrow. Record the mean phenotype in the graphing program. Continue until you have recorded the mean phenotype for all cycles in the graphing program.

4. Reset the simulation and select your next mutation rate, recording your data in the graphing program after each cycle. Repeat this process for the remaining two mutation rates you've selected.
5. In the graphing program, use the Preview tab to observe your graph. Use the Print/Save tab to download and save your graph as a PDF file for printing.
6. Repeat steps 1–5, varying the selection strength while keeping the mutation rate setting at the default value of 0.3.

Task 3: Post-lab analysis questions (Individual)

Answer the post-lab analysis questions:

1. Describe how the simulation models natural selection (and evolution).
2. Explain HOW the mutation rate affects the evolution of your populations.
3. Explain HOW the selection strength affects the evolution of your populations.
4. What do you think would happen if the creatures with a shorter reach had an advantage over those with a longer reach? Explain
5. If there is time remaining, return to the simulation and complete the "Further Experiments to Try" exercises located under the Contents drop-down menu.

Check your understanding

Can you

- Use your data to explain how mutation rate and selection strength affects the evolution of your population?

- Evaluate the strengths and weaknesses of how this simulation models natural selection and evolution?