

PEEBEDU Bed Bug Treatment Lab (NGSS)

Unit 7: Natural Selection and Evolution

Name: _____ Period: _____ Date: _____

Open peebedu.com and navigate to **Bed Bug Treatment Lab**. Click the **How to Play** button to read the introduction. This simulation models a bed bug population in a home where you can apply different pest control treatments and observe how the population changes over time. Pay attention to the population stats panel (Total, Normal, Resistant, Eggs, q Freq), the two graphs (Population Over Time and Allele Frequency), and the five treatment options (DDT Spray, Steam, Vacuum, Wash Sheets, Call Professionals).

Part 1 – Model Evaluation (MAPP Framework)

Scientific models are simplified representations of complex biological phenomena. Use the MAPP framework below to evaluate the Bed Bug Treatment Lab as a scientific model.

M – Mode

What type of model is the Bed Bug Treatment Lab? Describe how this computational simulation represents the evolution of pesticide resistance in an insect population. In your answer, identify at least three specific simulation elements and explain what each one is designed to show about natural selection and allele frequency change.

A – Accuracy

(a) Identify two things this simulation represents **accurately** about the evolution of pesticide resistance. For each, name the specific simulation feature and explain what biological concept it demonstrates.

(b) Identify two things this simulation **oversimplifies or leaves out** about how resistance evolves in real insect populations. Consider what you cannot observe in the simulation that would be important for a complete understanding of resistance evolution.

P – Purpose

What is the learning goal of this simulation? Explain how the Bed Bug Treatment Lab is designed to help you understand how natural selection drives the evolution of pesticide resistance in populations. In your answer, connect at least one specific simulation feature to a real-world consequence of pesticide resistance.

P – Permanency

Could this model change with new scientific evidence? Describe one way that new discoveries about insect resistance mechanisms might change or improve a simulation like the Bed Bug Treatment Lab. Explain why scientific models, including computational simulations, are revised as new evidence becomes available.

Small-Group Discussion

With your group, discuss the following:

- What are the strengths of this simulation as a model for resistance evolution?
- What are its limitations?
- If you could add one feature to improve this simulation, what would it be and why?
- How does the simulation help you connect population-level observations to molecular-level explanations of natural selection?

Part 2 – NGSS Questions

1.

Simulation Task: Reset the simulation so you begin on Day 1 with 100 total bugs (99 Normal, 1 Resistant) and a q frequency of 0.010. Press Play and let the simulation run for 10 days without applying any treatment. Record the Total, Normal, Resistant, and q Freq values on Day 10.

Describe what happens to the proportion of resistant bugs and the q frequency when no treatment is applied. Explain why the resistance trait does not spread through the population under these conditions.

HS-LS4-2

2.

Simulation Task: Reset the simulation. Press Play and apply DDT Spray every time the population begins to recover. Continue until you have applied DDT at least five times. Watch the Population Over Time graph and the q Freq display as you spray.

Explain how repeated DDT application acts as a selection pressure on the bed bug population. In your answer, describe why normal bugs are eliminated while resistant bugs survive and how this changes the makeup of the population over time.

HS-LS4-2

3.

Simulation Task: Reset the simulation. This time, treat the bugs using only Steam and Vacuum (no DDT). Apply these treatments several times over 30 days. Record the final q Freq value and compare it to the q Freq you observed after repeated DDT use in Question 2.

Explain why steam and vacuuming do not cause the resistance trait to become more common in the population. Describe the key difference between treatments that select for resistance and treatments that do not.

HS-LS4-2

4.

Simulation Task: Reset the simulation. Run two separate trials over 30 days each. In Trial 1, use only DDT Spray. In Trial 2, reset and use a combination of DDT Spray, Steam, and Vacuum. Record the final q Freq and total population for each trial.

Compare the outcomes of the two trials. Explain why combining chemical and physical treatments slows the spread of the resistance trait compared to using DDT alone.

HS-LS4-4

5.

Simulation Task: Reset the simulation and apply DDT repeatedly until the q Freq rises above 0.50 and most surviving bugs are resistant. Then stop using DDT and switch to Steam and Vacuum only for the remaining days. Observe what happens to the q Freq after you stop spraying DDT.

Predict what will happen to the frequency of the resistance trait over time once DDT is no longer used. Explain whether you expect the population to return to mostly normal bugs or remain mostly resistant, and why.

HS-LS4-4

6.

Simulation Task: Reset and run two final trials. In Trial A, use only DDT Spray over 30 days. In Trial B, reset and use DDT Spray combined with Steam and Vacuum over 30 days. Observe the Allele Frequency graph for each trial.

In the box below, sketch two labeled graphs showing how the resistance allele frequency (q) changes over 30 days for each trial. Label the x-axis (Days), y-axis (q Frequency), and draw one curve for DDT-only and one curve for the combined approach. Write a one-sentence explanation of why the two curves differ.

Draw your graphs here.

HS-LS4-4

7.

Simulation Task: Review all of your simulation results. Think about how the treatments you chose affected both the bed bug population and the spread of resistance over time.

Pesticide resistance in bed bugs is one example of how human actions can change the traits present in a population. Describe one other real-world example in which human activity has driven a change in a species or ecosystem. Explain a strategy that could reduce this negative impact while still addressing the original human need.

HS-LS4-6