TEACHER PREPARATION GUIDE.

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The Sieve Predator: A Natural Selection Lab

Biology | TEACHER GUIDE

Planning notes for teachers: materials, setup, expected results, and what to watch for.

Not yet classroom-tested. This is a new lab design that has not been tested in a classroom yet. Expected results, times and costs are estimates, not measured values. Run the full lab yourself before you use it with students or grade it, and adjust amounts to match your materials.

Item	Details
Unit and lessons	Unit 4: Evolution and Natural Selection. Lessons: Natural Selection, Selective Pressures and Allele Frequencies
Class time	One to two 50-minute periods
Groups	3 to 4 students (shaker, breeder, recorder, culler)
Cost	About $3 to $5 per group; beans and colanders are reusable for years
Standards	HS-LS4-2, HS-LS4-3, HS-LS4-4. SEP: Developing and Using Models; Using Mathematics and Computational Thinking; Constructing Explanations. CCC: Cause and Effect; Patterns.

Big Idea

Every one of the four HS-LS4-2 factors is a visible rule in the model, and no student chooses who survives. Random mutation (the die) is separate from selection (the colander). The environment change shows that selection depends on conditions, and that lost variation makes a population slow to respond.

Materials for 8 Groups

Item	Amount	Notes
Lentils, split peas, black beans, pinto beans, lima beans	1 lb (450 g) bag of each	Large (baby or Fordhook) lima beans.
Plastic colanders	8	Test first (see below).
Trays or dish tubs	8	Catch fallen beans.
Dice	8	
Supply bins or bowls	40	One per bean type per group, or shared supply stations.

Advance Preparation: Test the Colander

The model only works if the colander catches small beans *some* of the time. Put 20 of each bean in a colander and shake for 3 seconds. Aim for about half of the lentils, a little under half of the split peas, a few black beans, and almost no pinto or lima beans to fall through. If too many fall through, shorten the shake to 2 seconds. If too few, use a colander with bigger holes or a wire cooling rack, and adjust the time. Record the time that works and post it.

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Running the Lab

- Assign roles: shaker, breeder (adds offspring), mutation roller, recorder. Rotate roles at Generation 4 and Generation 7.
- Model one full generation for the class before groups start.
- Groups that finish early can graph mean size against generation for all 10 generations.

Expected Results

These are sample results from a computer run of the same rules, using fall-through chances of 60%, 45%, 15%, 3% and 0% for classes 1 to 5. Real colanders will differ.

Gen	Class 1 lentil	Class 2 split pea	Class 3 black bean	Class 4 pinto	Class 5 lima	Total	Mean size
0 (start)	6	6	6	6	6	30	3.00
1	1	2	10	8	9	30	3.73
2	0	1	11	8	10	30	3.90
3	0	0	8	9	13	30	4.17
4	0	0	9	9	12	30	4.10
5	0	0	9	8	13	30	4.13
6	0	1	10	9	10	30	3.93
7 *	0	2	12	8	8	30	3.73
8	0	1	13	8	8	30	3.77
9	0	2	13	9	6	30	3.63
10	0	3	12	10	5	30	3.57

Mean size rises quickly for 2 to 3 generations and then levels off near 4. After the environment change, it falls slowly, because the small classes are nearly gone. Chance matters: some groups will see a class vanish early from unlucky shakes, which is a good bridge to genetic drift.

What Can Go Wrong

- Colander holes that pass too many classes. Test first.
- Skipped steps, especially the limit to 30. A step checklist at each table helps.
- Groups that "help" beans through. Keep the shake short and the same every time.

Misconceptions to Listen For

- "The beans adapted." Individuals did not change; the population did.
- "Mutations happen because they are needed." The die does not know about the colander.
- "Evolution has a goal." When the predator changed, the "best" size changed too.
- "Rare traits disappear immediately." Small classes often linger for a few generations.

Debrief Questions

- Which rule would you remove to stop evolution in this model? (Without variation or without differential survival, the mean stays near 3.)
- How is the colander like antibiotics and bacteria?

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Differentiation and Extensions

- Support: a step checklist card and a pre-filled Generation 0 row. Sentence frame: "The mean size changed from ___ to ___ because the predator ___."
- Extension: compare with the ZornScience virtual Natural Selection Lab, which can run many more generations.
- Extension: remove the mutation rule and compare how the population responds to the environment change.

Safety and Disposal

- Check for legume allergies before the lab. No eating.
- Beans are reusable. Store them sorted in labeled bags.

Standards

This lab builds toward these NGSS performance expectations:

- **HS-LS4-2:** Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.
- **HS-LS4-3:** Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.
- **HS-LS4-4:** Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

Disciplinary core ideas: LS4.B Natural Selection; LS4.C Adaptation

Science and engineering practices: Developing and Using Models; Using Mathematics and Computational Thinking; Constructing Explanations

Crosscutting concepts: Cause and Effect; Patterns

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