

AP BIOLOGY · UNIT 7 · TOPIC 7.3

Artificial Selection

Learning objective 7.3.A Explain how humans can affect diversity within a population.

Name: _____

Date: _____

Period: _____

Use the tool **Choosing the Parents**. Parts 1 and 2 use **One round**, Part 3 uses **Twelve generations**, and Part 4 uses **Back in the wild**. Topics 7.1 and 7.2 let the environment do the choosing. Here a human does it, on purpose, and the point of the topic is how little else changes: the same requirement for heritable variation, the same differential reproduction, the same cost paid in diversity. The population is **4,000** individuals, each with a heritable component and an environmental component to its trait value.

Part 1 · One round of selection

The breeder keeps the top **20%** of the population as parents and breeds only from them. Record what happens for a trait with a heritable component and then for a trait with none, using the two buttons above the graph.

Trait	Mean of population	Mean of chosen parents	Differential S	Mean of offspring	Response R
Heritable					
No heritable component					

1. Define artificial selection.

2. Using your two rows, explain what the selection differential measures and what the response measures. Say clearly which one is under the breeder's control.

Part 2 · Why the offspring fall short

Stay on the heritable trait. The chosen parents averaged **52.02** and their offspring averaged **50.99**, which is better than the population and worse than the parents. Work out the arithmetic before you explain it.

Quantity	Value	How you got it
Response R, observed		
Heritability h^2		
Predicted response $h^2 \times S$		
$R \div S$		

3. Explain why the offspring of the selected parents fall back toward the population mean.

4. In the second row of your Part 1 table the breeder achieved a differential of about 2.0 and a response of about 0.03. Explain what this shows about the requirements for selection of any kind to work.

5. The simulation bred four thousand individuals one at a time and never used the equation $R = h^2S$; the equation was never shown the simulation's result. Explain why the two arriving at the same number is worth more than either on its own.

Part 3 · Twelve generations, and what it costs

Go to **Twelve generations**. Run the program at each of the three intensities and record the endpoints. Note the heritability at the start and at the end of the default program too.

Top fraction kept	Gain in the mean	Heritable variance left	h^2 at generation 12
50%			
20%			
5%			

6. Describe what happens to the gain per generation as the program continues, and explain why.

7. Explain how artificial selection affects genetic diversity within a population.

8. Using your table, explain why a breeder cannot choose to have the faster gain without the greater loss of diversity.

Part 4 · Back in the wild

Go to **Back in the wild**. The same population is now scored on how well it would survive and reproduce in the environment its ancestors came from. Nothing about the breeding program changes; only the question being asked of the population changes.

Generation	Trait mean	Gain for the breeder	Fitness in the wild
0			
2			
4			
8			
12			

9. Explain why a population improved by artificial selection becomes less fit in its natural environment, even though nothing went wrong with the breeding program.

10. Explain why reduced genetic diversity is a problem for a breeding population, and what breeders do about it.

11. Give one way artificial selection differs from natural selection and one way in which the two are identical.

What the model simplifies

The trait is controlled by many loci of small effect and its heritable component is treated as a single number that halves and recombines cleanly between parent and offspring. Real traits have loci of unequal effect, and alleles at linked loci are inherited together rather than independently.

Heritability is set at 0.50 and the environmental variance is held constant throughout. Real heritabilities differ between traits, between populations and between environments, and a change in husbandry changes the heritability of the same trait in the same animals.

Every selected individual contributes equally and mating among the selected parents is random. Real programs use a few outstanding sires far more than the rest, which reduces the effective population size and removes diversity faster than these figures show.

The population is 4,000 individuals with no mutation and no immigration, so heritable variance can only fall. Real populations gain a small amount of new variation by mutation each generation, which is why long-running programs do not stall completely.

Natural fitness is modeled as a single peak at the population's original mean. Real environments impose many demands at once and the peak itself moves, so a domesticated organism's problem in the wild is rarely as simple as one trait sitting in the wrong place.