

Environmental Effects on Phenotype

Learning objective 5.5.A Explain how the environment affects phenotype.

Name: _____ Date: _____ Period: _____

Use the tool **Same Genes, Different Outcome**. Each part uses the tab of the same name. The idea to hold on to: a genotype does not specify a phenotype, it specifies a **response** — which phenotype for which environment. That response is called a **norm of reaction**, and it is a curve, not a number.

Part 1 • One genotype, many phenotypes

Open **Move the environment**. For each system, drag the slider to each end and record what the **first** genotype produces there.

System	Environmental factor	Phenotype at the low end	Phenotype at the high end	Range covered
Hydrangea flower color				
Himalayan rabbit coat color				
Daphnia helmet size				
Crop yield of two varieties				

1. State what determines an organism's phenotype, and define a norm of reaction.

2. Nothing about the DNA changed while you dragged the slider. Explain what this shows about the relationship between a genotype and a phenotype.

Part 2 · Which genotype is better?

Switch to **Which genotype is better?**. For each system, record which genotype is ahead at each end and whether the two lines cross.

System	Ahead at the low end	Ahead at the high end	Do they swap?	Cross at
Hydrangea flower color				
Himalayan rabbit coat color				
Daphnia helmet size				
Crop yield of two varieties				

3. One of these systems does not reverse. Identify it and explain why not, using what you know about the two alleles.

4. For a system that does reverse, explain why the question “which genotype gives the larger phenotype” cannot be answered as asked.

Part 3 · What a difference is evidence for

Switch to **What you can conclude** and select **Crop yield of two varieties**. Set up each arrangement below and record the phenotype difference and what it is evidence for.

Individual 1	Individual 2	Phenotype difference	Evidence for
High-input, environment 1	High-input, environment 9		
High-input, environment 2	Low-input, environment 2		
High-input, environment 1	Low-input, environment 9		
High-input, environment 5.5	Low-input, environment 5.5		

5. Compare your first two rows. Explain why the larger difference is the less informative one.

6. Your last row gives two different genotypes almost the same phenotype. Explain what this shows about inferring a genotype from a phenotype.

Part 4 · Putting it together

These do not need the tool.

7. Explain why a Himalayan rabbit is dark at its ears, nose, feet and tail but pale over its body, given that every cell carries the same alleles.

8. A gardener takes cuttings from one hydrangea and plants them in two beds. One produces pink flowers and the other blue. Explain this result.

9. Two plants of the same species growing in different fields differ in height. Explain why this is not evidence that they differ genetically.

10. Describe how you would design an investigation that could attribute a difference in a trait to genotype rather than to environment.

What the model simplifies

Every norm of reaction here is a straight line, because a straight line is the simplest thing that can cross another one. Real norms of reaction are curved, often flat over part of their range and steep over another, and can be measured only by growing the same genotype in many environments.

Both axes are in arbitrary units. What matters is the shape of each line and whether two of them cross, not the numbers on the axis.

Each system is drawn with two genotypes because two is what you need to show a reversal. Real comparisons involve many genotypes and many environments, and the picture is correspondingly messier.

The environment is treated as one dimension. Real environments vary in temperature, water, nutrients, light, crowding and much else at once, and a genotype can respond to each differently.

The mechanisms named — aluminum availability, a temperature-sensitive enzyme, a predator cue detected during development — are real and well described. The particular numbers are not measurements; they are chosen so the arithmetic can be checked.