AP BIOLOGY · UNIT 5 · TOPIC 5.5

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 names the tab it uses, and Part 4 does not use the tool. A genotype does not specify a single phenotype. It specifies a **response**: which phenotype is produced in which environment. This response is the genotype's **norm of reaction**, and it is a curve, not a number.

Part 1 · One genotype, many phenotypes

Open **Move the environment**. For each system, click its button and drag the environment slider to each end. Record what the **first** genotype produces at each end (the Phenotype, first genotype readout). Record the environmental factor named on the slider, and the Range the first one covers readout.

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. (a) Describe what determines the phenotype of an organism.

(b) Describe a norm of reaction.

2. In Part 1, the genotype stayed the same while the environment changed. Explain what the Part 1 table indicates 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 genotypes swap places. In the Cross at column, record the Where they are identical readout.

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. (a) Identify the system in the Part 2 table in which the two genotypes do not swap places.

(b) Explain why the two genotypes in this system do not swap places, based on the enzyme that each allele produces.

4. In the crop system, the two genotypes swap places. Explain why the question "Which genotype gives the larger phenotype?" cannot be answered without specifying the environment.

Part 3 · What a difference is evidence for

Switch to **What you can conclude** and select **Crop yield of two varieties**. For each row, set the genotype and the environment of each individual. Then record the Phenotype difference and What the difference is evidence for readouts.

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. In the Part 3 table, the phenotype difference in the first row is larger than the difference in the second row. Explain why only the second row provides evidence of a genetic difference between the two individuals.

6. In the last row of the Part 3 table, two different genotypes have almost the same phenotype. Explain what this result indicates about inferring a genotype from a phenotype.

Part 4 · Putting it together

These do not need the tool.

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

8. A gardener plants cuttings from one hydrangea plant in two beds. The plants in one bed produce pink flowers, and the plants in the other bed produce blue flowers. Explain why the flowers in the two beds differ in color.

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

10. Describe an investigation that could determine whether a difference in a trait between two varieties of a plant is caused by their genotypes rather than by their environments.

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 and 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.