AP BIOLOGY · UNIT 7 · TOPIC 7.1

Introduction to Natural Selection

Learning objective 7.1.A Describe the causes of natural selection, and 7.1.B explain how natural selection affects populations.

Name: Date: Period:

Use the tool **Who Leaves the Most Offspring**. Parts 1 and 2 use **Run it**, Parts 3 and 4 use **Survival or offspring?**, and Part 5 uses **When the environment changes**. This worksheet measures natural selection instead of describing it: the tool gives a population an advantage, runs the generations, and reports what comes out.

Part 1 · Run the model

A new variant starts at **10%** of the population. Click each advantage button in turn, from 5% advantage to 100% advantage, and record the After 50 generations, Generations to reach 95% and Ever fell? readouts.

Advantage per generation	Frequency at generation 50	Generations to reach 95%	Did it ever fall?
5%			
10%			
25%			
50%			
100%			

1. Identify the three conditions that natural selection requires.

2. A 5% advantage means that the variant leaves five more offspring per hundred than the alternative, a difference too small to notice in any one generation. Using the Part 1 table, determine whether a 5% advantage is enough for the variant to spread through the population. Provide reasoning to justify your determination.

Part 2 · What is actually changing

Look at the curve on **Run it** and answer without the tool. These questions are about what the graph does and does not show.

3. On the Run it tab, the frequency of the variant follows an S-shaped curve rather than a straight line. Explain why the frequency rises slowly at first, then quickly, then slowly again.

4. Explain why it is incorrect to say that an individual organism in this population evolved.

5. In the model, individuals compete for limited resources. Explain how competition for limited resources leads to a change in the proportions of phenotypes in a population.

Part 3 · Testing “survival of the fittest”

Switch to **Survival or offspring?** Click each case button in turn, from Case 1 to Case 4. Record the Better survivor and More offspring readouts. Cover the Higher fitness and Takes over readouts, write your prediction, then uncover them and record which variant takes over.

Case	Survives better	More offspring	Your prediction	Actually takes over
Case 1				
Case 2				
Case 3				
Case 4				

6. (a) Describe how evolutionary fitness is measured.

(b) Describe how fitness is calculated in this model.

7. In two of the four cases, the variant that survives better is the variant that disappears. Using one of these cases, explain how a variant that survives better can disappear from a population.

Part 4 · Breaking it on purpose

Stay on Survival or offspring? and open the section The three things selection needs, removed one at a time, below the table of all four cases. Record what happens to the allele frequency when each requirement is taken away.

Requirement removed	What that means in practice	Frequency after 50 generations	Did anything change?
Variation			
Heritability			
Differential reproduction			

8. All three runs with a requirement removed give the same result.
(a) Describe the result of removing any one of the three requirements.

(b) Explain what this result indicates about how the three requirements relate to one another.

9. A population has variation in a trait, and individuals with different phenotypes leave different numbers of offspring. However, the trait is not heritable. Predict the effect on the frequency of the trait over 100 generations. Justify your prediction.

Part 5 · When the environment changes its mind

Go to **When the environment changes**. Click Environment stays put and then Environment fluctuates to compare the two runs. The graph follows the allele for the dark variant. Then record each spell of the fluctuating run from the table Which environment favored which variant.

Generations	Environment	Which variant it favors	Frequency at the end of the spell
0–12			
12–24			
24–36			
36–48			

10. In the fluctuating run, the frequency of the allele rises for twelve generations and then begins to fall, although nothing about the allele has changed. Explain what caused the frequency of the allele to change direction.

11. In the constant environment, the frequency of the allele reaches 100% and stays there. In the fluctuating environment, it never rises above 94%. Explain why a fluctuating environment maintains variation that a constant environment removes.

12. Using the fluctuating run, explain why natural selection does not work toward a goal.

What the model simplifies

The population is treated as haploid, with one allele per individual, so the arithmetic stays visible. Real diploid populations hide recessive alleles in heterozygotes, which changes how quickly selection can remove them. Topic 7.2 takes that up.

The population is treated as infinitely large, so frequencies change exactly as the fitnesses dictate. Real populations are finite and chance plays a part, sometimes a decisive one; Topic 7.4 puts numbers on that.

Fitness is a single number that does not change as the variant becomes common. In real populations fitness is often frequency-dependent: a variant can be advantageous while rare and disadvantageous once it is common, which is another way variation is preserved.

Survival and offspring number are the only two components of fitness here. Real reproductive success also depends on age at first reproduction, mating success, and whether the offspring themselves survive to breed.

The environments are drawn from the peppered moth, a real and well-documented case, but the fitness values are illustrative round numbers chosen so the arithmetic can be followed rather than measurements taken from a particular study.