Science Inquiry

Science Instructional Lesson Type

Uncommon Schools | Change History.

Do Now & Launch → **Build Evidence** → **Discuss** → **Stamp** → **Apply** → **Assessment**

Lesson Plan Background	
Teacher:	**Lesson:** U7L1 (50 min)
Course: AP Biology	**Unit:** 7
Objectives	
Skills/Content: SWBAT explain the process of natural selection using evidence from antibiotic resistance in bacteria and fur color in rock pocket mice.	**Standard:** EVO-1.C SP-6
Lesson Goals	
Guiding Question: How does natural selection change a population over time? This is the first lesson in Unit 7 – Evolution. In this lesson, students will explain how natural selection changes allele frequencies in a population over time in the context of antibiotic resistance in bacteria and changes in fur color distribution in a population of mice. Students will watch a short video on antibiotic resistance, then answer questions about how natural selection contributes to antibiotic resistance, followed by a discussion. Since students have seen the example of bacterial resistance multiple times, it is likely that they will move through this portion quickly. Then, students will analyze diagrams of two populations of rock pocket mice, collect data on the number of mice of each fur color, and propose reasoning for why the ratio of fur color in the mice population changed over time. In the second discussion, students will compare the evolution in the mouse population to that in the bacterial population. Students often understand the concept of natural selection but struggle to explain it using precise vocabulary. During the discussions, teachers should be sure to hold students to precise language, using the vocabulary list provided when needed.	

Planning

Planning

Vocabulary:

- Natural selection
- Evolution
- Organism
- Population
- Survive
- Reproduce
- Allele
- Phenotype
- Genetic variation
- Fitness
- Selective pressure

Key Understanding/Skill:

- Mutations are a source of genetic variation in populations, which can result in phenotypic variation.
- Environments change and apply selective pressures to populations.
- Some phenotypic variations significantly increase or decrease the fitness of an organism in a particular environment.
- Natural selection refers to the evolutionary mechanism where organisms with more favorable phenotypes are more likely to survive, reproduce, and pass on traits that code for the favorable phenotype to subsequent generations.
- Over time, the genetic makeup of the population changes, which is characterized as evolution.

Setup/Materials

- Each group of 2-3 will need one copy of printed diagrams (preferably in color).
- Video of antibiotic resistance[1] ready to project: https://www.youtube.com/watch?v=znnp-Ivj2ek

Exit Ticket (7 min)

[2]Exemplar

Adult male guppies (*Poecilia reticulata*) exhibit genetically determined spots, while juvenile and adult female guppies lack spots. In a study of selection, male and female guppies from genetically diverse populations were collected from different mountain streams and placed together in an isolated environment containing no predators. The study population was maintained for several generations in the isolated area before being separated into two groups. One group was moved to an artificial pond containing a fish predator, while a second group was moved to an artificial pond containing no predators. The two groups went through several generations in their new environments. At different times during the experiment, the mean number of spots per adult male guppy was determined as shown in the figure below.

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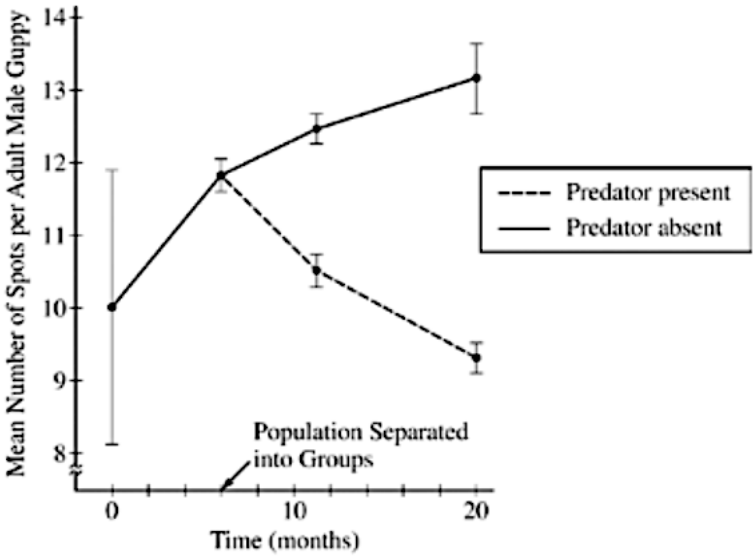

1. Describe the change in number of spots per adult male in the guppy population in the pond with predators compared to the guppy population in the pond without predators.
   The mean number of spots per adult male increased over time in the guppy population in the pond without predators. The mean number of spots per adult male decreased over time in the guppy population in the pond with predators.

2. Propose an explanation for how the number of spots impacts the fitness of a guppy in an environment where a predator is present.
   An increase in the number of spots likely results in lower fitness of a guppy because it is more easily seen by a predator and is therefore less likely to survive and reproduce.

3. Provide reasoning for the change in the mean number of spots per adult male guppy in the population where a predator is present.
   The mean number of spots per adult male guppy decreased over time in an environment where a predator was present. This is because the guppies with a lower number of spots were not as easily seen by the predator, survived, and were able to pass on their alleles that coded for a lower number of spots. Over time, the frequency of guppies with a lower number of spots increased.

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	Start to Class
Do Now & Review **(6 min./6)**	**Do Now (4 minutes):** Students reflect on the article about the evolution of plants on land. **1: Researchers claim that algae in the water obtained genes from bacteria that enabled them to survive on land, such as drought resistance. The expression of these genes allowed plants to survive and proliferate on land.** **2: Scientists compared the DNA sequences of various algae to land plants. Scientists found that the genes for drought survival were present in bacteria that lived in soil, but not in other species of freshwater algae.** **3: Plants capture sunlight and carbon dioxide and release oxygen through the process of photosynthesis. Heterotrophs rely on plants as a food source and source of oxygen for cellular respiration.** **Review:** • Have students T&T for question 3. • Have students T&T: *How did freshwater algae give rise to land plants? What evidence did scientists use to support the explanation?*
	Mini-Stamp: • Some algae obtained genes from bacteria that helped the plants survive in droughts. This is one of the traits that allowed plants to survive and proliferate on land. • Scientists sequenced the DNA of different types of algae to determine which was most closely related to plants.
Daily Drill	N/A
Launch (3 min./9)	**Guiding Question:** How does natural selection change a population over time? **T:** *Today we are beginning Unit 7: Evolution. Evolution is defined as the change in the genetic makeup of a population over time. Until now, we have been largely focused on the transmission and expression of genetic information at an individual level. In this unit, we are going to zoom out and consider how the transmission and expression of genetic information affects populations over time. One of the mechanisms for evolution is natural selection.* **T&T:** *Our focus for the next two days will be on how natural selection changes populations. In ninth-grade biology, you learned about the concept of natural selection. Based on what you know, discuss with your partner – what role did natural selection play in the evolution of land plants?* (Circulate to identify any student misconceptions, do not share out.) *In AP Biology, the error we typically see is not in understanding the concepts, but the ability to explain the concept with precise vocabulary. In page 3 of your handout, there is a vocabulary list with the most essential terms from this unit. Use this as a reference tool—our goal for the next two days is to utilize precise vocabulary to explain how natural selection changes populations in organisms such as viruses, bacteria, and mammals!* (Teacher Note: At some point, either during a floating block or for homework, students could copy this list into their notebooks.) **Bright Line:** *We will start by explaining how natural selection causes a bacterial population to change over time.*

Inquiry (21 min./30)	**Summary:** • Students watch a video of antibiotic resistance and explain the role of natural selection in antibiotic resistance. • Students collect data on the population of rock pocket mice in different environments and explain the role of natural selection on the frequency of fur color over time. **Setup (21 min):**

- 4 min: Students watch antibiotic resistance video.
  - Frame: *We are going to watch a video on how a population of bacteria develops antibiotic resistance. We have already discussed antibiotic resistance before in the context of genetic diversity. T&T – why is genetic diversity important for a bacterial population?*
  - Directions: *Before we watch the video, take 1 minute to read questions 1-4 in your handout. These are your focus questions as you watch the video.*
- 5 min: Students independently answer questions 1-4.
- Transition to discourse Part 1.
- 7 min: Students read provided information on rock pocket mice and fill in data table for #5 in groups.
  - Frame: *We just explained how natural selection affects a population of bacteria, which are microorganisms. Let's observe how natural selection affects a population of a larger organism: rock pocket mice.*
  - Directions: *Each group has four diagrams of two different populations of mice over time. Read the description on top of page 4 in your groups and fill out the table for question 5. Begin.*
- 5 min: Students independently answer questions 6 and 7.
- Transition to discourse Part 2.

Academic Monitoring:

Question #	Monitor For	Common Error	How to Respond
2	C	B or A	Stop the show and have students T&T: *Think back to Unit 6 - how do new traits emerge in a population?*
3, 4	Utilizing the term "survive and reproduce." Stating that population changes over multiple generations.	Students may state that evolution occurs in only one generation, or that bacteria develop the resistance trait in response to the antibiotic. Students may also not mention reproduction/passing on of traits.	Note error and address during discourse.
5	Correctly counting the number of mice in each location.	Students may mix up locations A/B.	After 7 min, project an accurate table so students can check their counts.
7	Explaining the change/lack of change in both populations. Referencing likelihood of predation, survival, and reproduction.	Students may not compare both populations of mice. Students may miss the idea that organisms that survive are more likely to pass on their alleles.	Direct students to reference both populations in their explanation. Note errors and address during discourse.

Exemplar:

1: The purpose of the antibiotics is to kill the bacteria.

2: C

3: Bacteria that exhibit the trait for antibiotic resistance survive when an antibiotic is administered and reproduce, passing on the trait to antibiotic resistance. Over multiple generations, the proportion of bacteria with the antibiotic resistance trait increase.

4: Some individuals in the bacterial population had a mutation that caused them to express antibiotic resistance. These individuals survived when an antibiotic was administered and reproduced, passing on the allele for the trait of antibiotic resistance. Over multiple generations, a greater proportion of individuals in the bacterial population exhibited the trait for antibiotic resistance.

5:

		Time →			
		1 (Oldest)	2	3	4 (Most Recent)
Location A	Number of Light-Colored Mice	**11**	**10**	**10**	**11**
	Number of Dark-Colored Mice	**1**	**2**	**2**	**1**
Location B	Number of Light-Colored Mice	**10**	**9**	**6**	**2**
	Number of Dark-Colored Mice	**2**	**3**	**6**	**10**

6: The trait for dark fur color likely emerged as a result of a mutation in the mouse DNA.

7: In a light-colored environment (Location A), the number of light-colored mice was in greater proportion to the dark colored mice at all four points in time. This is because the light-colored phenotype allowed the individual mice to avoid being seen by predators. Therefore, mice with the light-colored phenotype were more likely to survive and reproduce, passing on the allele for light-colored fur to the next generation.

When location B changed from a light-colored to a dark-colored environment, the proportion of dark-colored mice increased over time. This is because individuals with the light-colored phenotype were easily spotted and eaten by predators and were therefore unable to survive and reproduce to pass on the trait for light-colored fur. Over time, the number of individuals with light-colored fur in the population decreased.

Discuss (10 min./40)

Discourse Overview (Part 1):
- Students explain how the process of natural selection increases the frequency of antibiotic-resistant bacteria.

Show-Call Student Work or Relevant Diagram:
- N/A

Overarching Question:
- T&T: *How does natural selection change the bacterial population over time?*
- As students are discussing, teacher should circulate and note students that accurately respond to the evidence and reasoning questions below.
- Call of 3-4 students to initiate discussion. Use prompts below if needed to add nuance to student understanding.
- Utilize the stretch prompts once students are able to articulate the key understanding.

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	Knowledge Questions that require students to state content: • *What was the selective pressure?* • *Which phenotypes contributed to the organism's fitness, given the selective pressure?* **Explain Questions that require students to synthesize an explanation:** ○ *How did the antibiotic resistance trait emerge in the population?* ○ *Why did the frequency of the antibiotic resistance allele increase over time?* ○ *What would be different in the population if it had not been exposed to methicillin?* ○ *How is the methicillin resistance allele passed from generation to generation?* ○ *Stretch: What would be different in the population if all individuals were genetically identical?* **Discourse Overview (Part 2):** • Students explain how the process of natural selection impacts the frequency of certain fur color alleles in different environments. **Show-Call Student Work or Relevant Diagram:** • Data table with counts of mice of each fur color. **Overarching Question:** • T&T: *How does natural selection change the mouse over time?* • As students are discussing, teacher should circulate and note students that accurately respond to the evidence and reasoning questions below. • Call of 3-4 students to initiate discussion. Use prompts below if needed to add nuance to student understanding. **Knowledge Questions that require students to state content:** • *What was the selective pressure?* • *Which phenotypes contributed to the organism's fitness, given the selective pressure?* **Explain Questions that require students to synthesize an explanation:** ○ *How did the dark fur color trait emerge in the population?* ○ *How was the frequency of the dark fur/light fur allele affected by the selective pressure?* ○ *How did environmental conditions contribute to the selective pressure?* ○ *Stretch: Which population likely took more time to evolve: bacteria or mice? Why?*
Stamp the Under-standing (3 min./43)	**Stamp:** How does natural selection change a population over time? • Mutations are a source of genetic variation in populations, which can result in phenotypic variation. • Environments change and apply selective pressures to populations. • Some phenotypic variations significantly increase or decrease the fitness of an organism in a particular environment. • Natural selection refers to the evolutionary mechanism where organisms with more favorable phenotypes are more likely to survive, reproduce, and pass on alleles that code for the favorable phenotype to subsequent generations. • Over time, the genetic makeup of the population changes, which is characterized as evolution.
Apply	N/A
Reference	Teachers are encouraged to read Teach Like a Champion: 49 Techniques that Put Students on the Path to College by Doug Lemov, an Uncommon Schools publication, to better understand the methods of teaching employed in this lesson.

[1] "What causes antibiotic resistance?" by Kevin Wu, from Ted-Ed. Uncommon Schools does not own the copyright in "Antibiotic Resistance Video" and claims no copyright on this material. The material is being used exclusively for non-profit educational purposes under fair use principles in U.S. Copyright law. The user should make the judgement about whether this material may be used under fair use/fair dealing permissions in the user's country.

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