TEACHER'S GUIDE

Catch Me If You Can!

How does coloration affect species survival in different environments?

GRADES 6–8

Life Science

INQUIRY-BASED
SCIENCE

Catch Me If You Can!

Life Science

Grade Level/Content	6–8/Life Science
Lesson Summary	In this lesson, students will discover how variation in a trait can increase some individuals' probability of survival.
Estimated Time	2, 45-minute class periods
Materials (per team)	10 each of five different types of dried beans (such as black, white, pinto, black-eyed peas, pink, kidney), three pie pans (or paper plates), about 1 cup each of three different "environments" (such as white rice, brown rice, wild rice, lentils, sand, gravel, soil, multi-color aquarium pebbles, rainbow candy), stopwatch or clock with seconds, small drinking cups, Investigation Plan, Observation Form, journal
Secondary Resources	UC Berkeley: Understanding Evolution: Natural Selection BBC Bitesize: Natural Selection How Stuff Works: Natural Selection
NGSS Connection	**MS-LS4-4** Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.
Learning Objectives	• Students will collect data on the survival of individuals with different traits in model environments. • Students will provide evidence of why some individuals survive better in a model environment. • Students will describe how survival rates increase the likelihood of passing on favorable traits to future generations within a model environment.

How does coloration affect species survival in different environments?

Organisms tend to be specialized to survive their environment. Sea wasps are successful and effective hunters in ocean environments and among the deadliest of jellyfish species. Their tentacles can stretch up to 3 meters, delivering painful stings that can be fatal. However, if a sea wasp were taken out of its environment and placed in a desert or forest setting, it would become completely helpless and mostly harmless. Similarly, placing a ferocious land predator into an ocean environment would take away many of its advantages.

The differences in traits between sea and land creatures are dramatic, but the same principles apply to less obvious examples. Within a population, individuals with some traits survive and reproduce better than individuals with other traits. With each successive generation, favorable traits for a given environment become more common over time. In this lesson, students will discover how traits like coloration can affect an individual's likelihood of survival.

Investigation is based on the Van Andel Education Institute (VAEI) Instructional Model for Inquiry-Based Science. In all investigations:

Students don't know the "answer" they are supposed to get.

Students play a driving role in determining the process for learning.

Teachers and students construct meaning together by journaling.

Students are working as hard as the teacher.

Part 1

INVESTIGATION SETUP

Obtain 500 ml of at least five different dried beans (e.g. black, white, pinto, kidney, black-eyed peas) and an assortment of model "environment" materials. Materials for model environments can include white rice, brown rice, wild rice, sand, soil, multi-color aquarium gravel, or candy of various colors. Each group will need different environment materials based on their chosen scenarios. Students will need the following:

- 10 each of five different types of dried beans
- Approximately 1 cup each of three different "environment" materials
- Three pie pans or paper plates
- 1 plastic or paper drinking cup
- Stopwatch or clock to count seconds
- Investigation Plan
- Observation Form
- Journal

Part 2

INVESTIGATION FACILITATION

? Question — *Introduce the investigation question.*

How does coloration affect species survival in different environments?

CURIOSITY

Show images of organisms that carefully mimic their environments, such as:

- goldenrod crab spider
- orchid mantis
- stick insects

Encourage students to ask questions about how camouflage arose in these organisms and what advantages these traits give the organisms. Then, introduce the investigation question.

Personal Knowledge — *Students capture what they already know about camouflage, species survival, and natural selection.*

- Have students record their personal knowledge in their journal as lists, statements, or diagrams.

COLLABORATION

In small groups have students brainstorm a list of traits that make each of the organisms introduced with the investigation question successful in its environment.

CRITICAL THINKING

Once the students have compiled their list of traits; have students think about what might happen to each organism if their environment changed in some way. Each group should share their information with the other groups.

🔵 Prediction
Students communicate an expected outcome, based on personal knowledge.

- Introduce the beans to be used as individuals and model environment materials to provide an understanding of how the investigation will be conducted. Have students predict the role of bean coloration in its survival in a selected model environment. Students present the prediction as *I predict _____ because _____.*

Students may write something like, "I predict the black beans will survive better in the wild rice environment because they will blend in and be harder to see."

📋 Investigation Plan
Students review available materials and identify scenarios to investigate.

- Have the students follow the Investigation Plan and review all available environment materials as a whole class.
- Divide the students into teams (ideally with three students each). Allow teams to choose and collect their materials.
- Share the following parameters with student teams:
  - Each group will create three different "environments" with materials spread over three pans or plates.
  - Explain that each environment will have a population of 30 dried beans. *(Shown is an image of a brown rice environment with black and pinto beans.)*
  - For each trial, one student will be the time-keeper, one will mix the beans into the environment, and the third will be the "predator." Jobs should be swapped for each trial.
  - Explain that each predator will hold his or her index finger and thumb in a pinching position. The cup will act as their stomach and only one bean may be pinched and moved to the cup at a time.
  - Tell the students that prior to each trial, predators must close their eyes while another student mixes the beans and the environment. The time-keeper then tells the predator when to open their eyes. The predator finds and pinches beans as quickly as possible and transfers them to the cup. This continues for 15 seconds.
  - Encourage predators to pinch the first bean they see, and continue based on the beans that first catch their eye. To make it extra challenging, students may decide to keep their nose pressed against the back of their hand, forming a pinching beak. If they do this, all predators should use the same technique as data will be shared between teams.
- Prior to beginning, have students explain their three planned trials as a check-in with the teacher and to get a sense of the different types of scenarios and data that will be collected.

Sample environment

CRITICAL THINKING

Use the Fair Test checklist to help students think critically about the investigation plan. Help them understand that a good investigation plan must include a test that is repeatable, generates quality data, and minimizes error. The more critically students think about their investigation plan, the more confident they can be in their results.

STUDENT CHOICE

Allow students to identify their three scenarios and collect materials necessary for each trial.

INVESTIGATION PLAN
CATCH ME IF YOU CAN!

Part 1: Group Observations

1. Identify three scenarios to conduct trials to answer the investigation question, "How does coloration affect species survival in different environments?"
2. Check in with your teacher to share your planned scenarios before conducting your trials.
3. Choose bean and environment types that will allow you to answer the question. Record the environment characteristics for three scenarios in Part 1 of your **Observation Form** or similar tables in your journal.
4. For each scenario, one student will be the predator, one will mix the beans into the environment, and one will be the time-keeper. Switch jobs between scenarios.

Predator instructions:
- Hold your finger and thumb in a pinching position. Hold a cup in your other hand to act as your stomach.
- To begin, close your eyes while another student mixes the beans and the environment. The time-keeper tells you when to begin. Open your eyes as quickly as possible pinch the beans **ONE AT A TIME** and transfer them to the cup. You have 15 seconds to pick up and transfer as many beans as you can.
- Pinch the first bean you see, and continue based on the beans that first catch your eye.
- (Optional) To make it extra challenging, keep your nose pressed against the back of your hand, forming a pinching beak. If you utilize this technique, all predators in your group should use the same technique.

Part 2: Matching Scenarios

5. After completing Part 1, your teacher will ask groups to share observations.
6. Identify up to three groups with matching scenarios with the same environment materials. Record data collected from these groups in Part 2 of your **Observation Form** or similar tables in your journal.
7. Continue on with your Data Analysis.

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Investigation Plan

🔍 Observation

Students record the number of "surviving" beans for each trial.

- Have the students record the number of **eaten** individuals of each bean type in Part 1 of the Observation Form or similar tables in their journal.
- Remind students to conduct trials for each environment with different team members acting as time-keeper, mixer, and predator.
- After investigating their chosen scenarios, have student groups share observations with their peers. Encourage students to record data from up to three matching scenarios with the same environment materials conducted by other groups. Students should record this data in Part 2 of their **Observation Form** or similar tables in their journal.

INTEGRITY

Encourage students to follow the investigation plan, and record their observations correctly and ethically.

Observation Form

Part 3

INVESTIGATION ANALYSIS AND DEVELOPMENT OF CLAIM

📊 Data Analysis

Students make sense of their data by organizing it and representing it visually.

- Have students analyze their data. They may wish to use the Data Analysis prompt as a guide.
- Have students **evaluate** their data for trustworthiness.
- Then, have them analyze their data to find patterns and trends.
- They may **organize** the data and/or **represent** it visually to construct meaning. They should be encouraged to use math as appropriate *(calculating the number of surviving individuals, comparing the percentage of surviving individuals, etc.).*
- Have students **interpret** what the identified patterns or trends mean. *Encourage them to compare the numbers of survivors of the same type of bean in different environments, or different types of beans in a single environment.*
- Ensure they have enough data that it can be used as evidence to support a claim.

📖 Secondary Knowledge

Students use secondary sources to understand how natural selection works to increase the number of individuals with certain traits within a population.

- Use these resources (or your own) to develop students' understanding of natural selection.
  - UC Berkeley: Understanding Evolution: Natural Selection
  - BBC Bitesize: Natural Selection
  - How Stuff Works: Natural Selection

Continued

- After reviewing these resources, students should more deeply understand the concept of natural selection. They should recognize that some heritable traits increase in a population over time because they are favored by environmental conditions like the coloration or camouflage of an individual within a population.
- Students use this information in the reasoning portion of their explanation.

CONSTRUCTION OF MEANING

This secondary knowledge provides additional context for scientific terms and concepts necessary to develop a sound explanation. For example, the trait with a higher percentage of survivors will have a greater representation in the next generation. Take the time to facilitate a discussion where each group shares a new piece of information obtained through online research before moving students on to the explanation.

Explanation
Students write a claim and provide evidence and reasoning to support it.

- Have students use what they've discovered to write an explanation that answers their investigation question. Students may wish to use the Explanation prompt as a guide. Have them write their explanation in their journal.

- Have students use what they've discovered from their analyzed data and secondary knowledge research to develop a **Claim** to answer the question: How does coloration affect species survival in different environments?

- Encourage them to include **Evidence** (the analyzed data) to support their claim.

- Finally, have them add **Reasoning** to their claim. Reasoning should include the information obtained from this investigation, as well as science principles researched and shared during the Secondary Knowledge component.

Claim

We claim that species that blend in with their environments will survive better because individuals of these species are harder for predators to see.

Evidence

The evidence that supports our claim is shown by the graph that shows a higher percentage of black beans survived in the wild rice environment than did other bean types. And, a lower percentage of black beans survived in the white rice environment than did other bean types.

Reasoning

Investigation: We tested a similar population of five bean types in three different environments. In each test, the bean that blended in with the environment survived better. We used a different person as the predator and time-keeper each time to help with observer bias. We used the same prey capture technique for all three tests.

Tests on similar environments completed by other teams support our claim.

Science: We learned from readings and class discussion that natural selection can lead to an increase in certain traits within a species population. The traits that are favored are ones that give the individual a survival and/or reproductive advantage in that particular environment. Individuals with advantageous traits survive or reproduce better and pass on these same traits to future generations.

- Once the explanation is written, have students discuss their results using a Present and Defend.

Continued

DISCOURSE

Having students conduct a Present and Defend will develop presentation skills as well as audience participation skills. Teams present a summary of their investigation to the class. The class analyzes the information presented and asks clarifying questions, challenges and/or supports the arguments made, and even presents alternative explanations as appropriate. Research teams defend their explanation with evidence and reasoning. With students conducting the same general investigation, choose 1 or 2 groups to share.

Evaluation
Students reflect on the investigation.

- How confident are you in your results?
- How might you have set up the test differently given unlimited time and materials?
- What question would you like to investigate next?

Part 4
INVESTIGATION ASSESSMENT AND EXTENSION

Application
Students demonstrate understanding of natural selection by applying their learning in multiple contexts.

- Have students apply their learning by answering the question: What are some examples of traits that might be advantageous to predators, rather than prey? *(Students might say: good eyesight, long claws, sharp teeth, fast reflexes, strong limbs, etc.)*
- In this downloadable interactive simulation, students can further explore natural selection by manipulating an environment and examining the effect on the local populations: The Concord Consortium: Natural Selection

CRITICAL THINKING

Images of non-mimicking organisms may be shown to the students. They can be asked what traits may offer them an advantage in the environment in which they are found. *(Examples may be body shape, size, parts that are advantageous for swimming, flying, hunting, staying warm, etc.)*

Assessment

Evaluate student completion of the investigation based on how well they:

- Collect data on the survival of individuals with different traits in model environments.
- Provide evidence of why some individuals survive better in a model environment.
- Describe how survival rates increase the likelihood of passing on favorable traits to future generations within a model environment.

CATCH ME IF YOU CAN!

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Part 2: Matching Scenarios

5. After completing Part 1, your teacher will ask groups to share observations.

6. Identify up to three groups with matching scenarios with the same environment materials. Record data collected from these groups in Part 2 of your **Observation Form** or similar tables in your journal.

7. Continue on with your Data Analysis.

CATCH ME IF YOU CAN!

NAME: _____

DATE: _____

Part 1: Group Observations

Scenario A
Environment Description: _____

Bean Type	# Eaten	Roles	Other Observations

Scenario B
Environment Description: _____

Bean Type	# Eaten	Roles	Other Observations

Scenario C
Environment Description: _____

Bean Type	# Eaten	Roles	Other Observations

NAME: _____

DATE: _____

Part 2: Matching Scenario Data

Match A
Environment Match with **Scenario ....   A   B   C**   (circle one)

Bean Type	# Eaten	Roles	Other Observations

Match B
Environment Match with **Scenario ....   A   B   C**   (circle one)

Bean Type	# Eaten	Roles	Other Observations

Match C
Environment Match with **Scenario ....   A   B   C**   (circle one)

Bean Type	# Eaten	Roles	Other Observations