



Sticky Adaptations

A Lesson on Natural Selection

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Lesson #14

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Note: The activities that follow are DRAFT activities and have not yet been peer reviewed for content accuracy or pedagogy. The lesson plans and opinions in this report are those of the authors and do not necessarily reflect the opinions of any of the supporting institutions or the editors.

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References

National Research Council (NRC). (1996). *National Science Education Standards*. Washington, DC: National Academy Press.

Alignment and references to state science education standards as of 2010 are cited by the authors.

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PURPOSE	The purpose of this lesson is to explore the conditions in which natural selection occurs. Students will identify adaptations during a web info search involving animal adaptations. Having students create an experiment to test the effects of environmental change and the survival rate of organisms with different adaptations will help students understand how variations within a population is a vital component of Darwin's Theory of Natural Selection. Students will demonstrate an understanding of adaptations by participating in a simulation of bird habitats and bird beaks. Students will then produce a concept map showing how natural selection of bird beaks occurs in different habitats with different food sources.
OBJECTIVES	Upon completion of this activity, students will be able to: <ul style="list-style-type: none">• describe the conditions under which natural selection occurs.• students will identify adaptations and predict the function of a variety of adaptations.• students will analyze the use adaptations and make connections between the adaptation and the survival of the organism.• design an experiment to test how changing an organism's environment can lead to natural selection.• using information gathered about natural selections students will create a concept map.
GRADE LEVEL	This lab was created for high school (9 th -12 th grade) students, but can be adapted for middle school students.
PRIOR KNOWLEDGE	Students should understand the definition of evolution. Students should also be exposed to ideas that shaped Darwin's thinking (e.g., James Hutton, Charles Lyell, geological change, Jean-Baptiste Lamarck, Thomas Malthus) and artificial selection.
TIME REQUIRED	Six to seven 50-minute class periods.
INCLUDING ALL STUDENTS	<ul style="list-style-type: none">• Visual: students will observe pictures of various adaptations of different animals during a web info search. Students will create a poster, of an experiment they develop, showing the results of their experiment. Finally students will produce concept map.• Auditory: students will participate in many classroom discussions during the candy dish selection, stick bug survival activity and bird bill activity. Students will present information discovered from internet research and listen to other students during a pair and share session.• Tactile: students will participate in an experiment to test how changing an organism's habitat may affect the organism's population.
QUESTIONS TO ASK ALONG THE WAY	<ul style="list-style-type: none">• What is variation? What variations do you see in the organisms found in this classroom? What causes these variations?• What is an adaptation?• How do adaptations help an organism survive?• What is fitness?• What conditions are necessary for natural selection to occur?

<p>NATIONAL SCIENCE EDUCATION STANDARDS</p>	<p><i>Grades 9-12</i> <u>K-12 Unifying</u> Evidence, models, and explanation Evolution and equilibrium Form and function <u>Science as Inquiry</u> Abilities necessary to do scientific inquiry Understandings about scientific inquiry <u>Life Science</u> Biological evolution Interdependence of organisms Behavior of organisms <u>Science in Personal and Social Perspectives</u> Population Growth <u>History and Nature of Science</u> Nature of scientific knowledge</p>			
<p>SOUTH DAKOTA STATE SCIENCE EDUCATION STANDARDS</p>	<p><u><i>Nature of Science</i></u> 9-12.N.1.1 Students are able to evaluate a scientific discovery and determine and describe how societal, cultural, and personal beliefs influence scientific investigations and interpretations. 9-12.N.1.2 Students are able to describe the role of observation and evidence in the development and modification of hypotheses, theories, and laws. 9-12.N.2.1 Students are able to apply science process skills to design and conduct student investigations. <u><i>Life Science</i></u> 9-12.L.1.3 Students are able to identify structures and functions relationships within major taxa. 9-12.L.2.2 Students are able to describe how genetic recombination, mutations, and natural selection lead to adaptations, evolution, extinction, or the emergence of new species.</p>			
<p>MATERIALS</p>	<table border="0"> <tr> <td style="vertical-align: top; padding-right: 20px;"> <p><i>Candy Bowl Selection</i></p> <ul style="list-style-type: none"> • candy: chocolate candies or fruit flavored hard candy (2 pieces per student), black licorice, sour, or other non-popular flavored of candy (3 pieces per student) • 1 candy bowl to place all the candy • box • 50 green plastic toothpicks </td> <td style="vertical-align: top; padding-right: 20px;"> <p><i>Skill Instruction</i></p> <p>All materials are found in the Stick Bug Survival Kit which can be purchased from Flinn Scientific, Inc.</p> <ul style="list-style-type: none"> • 50 red plastic toothpicks • yellow plastic toothpicks • 50 tan flat wooden toothpicks • 4 pairs of forceps </td> <td style="vertical-align: top;"> <p><i>Inquiry Activity</i></p> <p>Per group, suggested size of 3-4 students per group</p> <ul style="list-style-type: none"> • materials form Lab Skill Instruction • red, green, yellow, tan felt, fabric, or construction paper, • multicolored rounded wooden toothpicks (which can be dyed several different colors using food coloring or commercial dye) • large poster paper, markers, colored pencils </td> </tr> </table>	<p><i>Candy Bowl Selection</i></p> <ul style="list-style-type: none"> • candy: chocolate candies or fruit flavored hard candy (2 pieces per student), black licorice, sour, or other non-popular flavored of candy (3 pieces per student) • 1 candy bowl to place all the candy • box • 50 green plastic toothpicks 	<p><i>Skill Instruction</i></p> <p>All materials are found in the Stick Bug Survival Kit which can be purchased from Flinn Scientific, Inc.</p> <ul style="list-style-type: none"> • 50 red plastic toothpicks • yellow plastic toothpicks • 50 tan flat wooden toothpicks • 4 pairs of forceps 	<p><i>Inquiry Activity</i></p> <p>Per group, suggested size of 3-4 students per group</p> <ul style="list-style-type: none"> • materials form Lab Skill Instruction • red, green, yellow, tan felt, fabric, or construction paper, • multicolored rounded wooden toothpicks (which can be dyed several different colors using food coloring or commercial dye) • large poster paper, markers, colored pencils
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SAFETY If students are going to eat the candy passed out during the engagement activity, special precautions should be considered (perhaps carry out the engagement activity in the cafeteria.) Candy with peanuts may also cause problems for students who have peanut allergies.

- PREPARATION AND PROCEDURE**
- I. Capturing the student's interest: Candy Bowl Selection**
Adapted from the Candy Dish Selection activity authored by Carol Tang on the University of California Museum of Paleontology website.
- A. Pass a mixture of candy around the class. Have each student select one piece of candy. After each student has selected a piece of candy show the students the left-over candy. Ask students the following question:
 1. What are characteristics of the candy you selected? Why did you select the piece of candy you choose?
 - B. Show students the remaining candy. Ask students
 1. Which candy was most popular? Which candy was least popular?
 2. If you were a candy how would you like to taste?
 - C. Reproduce the candy by placing one piece of the same candy for each piece of that candy remaining in the bowl. If 10 black licorice candies remain add 10 new pieces of black licorice to the bowl. Pass the dish again and have the students select one more piece of candy. Ask students the following questions.
 1. What will eventually happen to the candy dish?
 2. How will this change the candy population?
 - D. Continue passing the candy dish until all the desirable candy is gone. At this point many students will begin to pass the bowl without taking a piece of candy. Ask the students the following questions.
 1. What happened to the candy population in the dish?
 2. Which candy has successfully survived? What characteristic is responsible for this?
 3. Could this have an effect on the predator population? If so, how?
 4. Can you think of a characteristic that helps an eagle survive? How about a mouse?
- II. Web Info Search: Animal Adaptations (one class period)**
In order to better make connections between adaptations and the survival of the organism students should complete the Animal Adaptation Web Info Search. After completion, students will pair and share answers.
- III. Guided Skill Instruction**
- A. This step is to help the students gain skill in data collection. Along with gaining skill in data collection the students will also create a control for their future experiment. Divide students into groups of four and hand out materials. Assign each group member a color of toothpick to hunt.
 - B. When all groups are ready, instruct the students to start hunting. After 30 seconds instruct to stop hunting and tally their results. The number captured should be recorded into the data table provided in the student handout. Before performing the next hunting session have members in the same group switch color of toothpick they will hunt. It is very important that the members of each group switch colors after each hunting session. This eliminates obtaining invalid results due to some students naturally being better hunters than other students.

**PREPARATION
AND
PROCEDURE**

- C. After four hunting sessions have students total their results. Ask students to place their totals on a table you have drawn on the board. Ask the students the following questions.
1. Is there any one color of stick bug that was more susceptible to hunting than the others? Why or why not?
 2. Many female stick bugs lay hundreds of egg at a time. All of these eggs could not possible survive due to a lack of resources. Why is it an advantage to lay so many eggs when they will not all survive?
 3. With so many eggs hatching there is a high amount of competition why is this a vital part of evolution?

IV. Stick Bug Survival (Inquiry Activity)

- A. Once students have finished the guided skill instruction, ask students to brainstorm ideas on how to answer this question. What changes could be made to the habitat of the stick that may result in changes in the stick bug population. Ask students to predict how these changes would affect the stick bug population. Examples of variables that students may change could be:
- change in color of habitat background
 - provide camouflage for stick bugs by using colored rounded wooden toothpicks (round toothpicks bought at a store and then dyed) or rice
 - size of habitat
- B. At the end of the brainstorming session students will decide on their question and develop a hypothesis. Some example questions include:
- How would placing a green background in the stick bug habitat change the stick bug population?
 - Would providing coverage in the form of red rounded wooden toothpicks help hide the red plastic stick bugs?
 - Would increasing the size of the habitat have an effect on the stick bug population?
- C. Next, students will design an experiment that will answer their question. Students should identify the independent variable, dependent variable, any constants, and their control in their experimental design.
- D. Upon teacher approval students may perform their experiment.
- E. Each group will then create a poster of their results to present to the class.

V. Stick Bug Web Info Search

Students can now research other adaptations and characteristics of stick bugs that aid in its survival. Each student should find four adaptations other than camouflage. Once students are finished they will participate in another pair and share session.

VI. Create a concept map using the following terms: (1 class period)

Struggle to survive, Theory, Inherited Variation, Darwin, Overpopulation, Successful Reproduction. Students will create their concept map using sticky notes and butcher paper first, then draw it on their paper.

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- WHERE TO GO FROM HERE**
- Have students write a paragraph using the stick bug experiment to explain the components of Darwin's Theory of Evolution.
 - Have students research other adaptations of different organisms.
- SUGGESTIONS FOR ASSESSMENT**
- Answers to Web Info Search: Students should start to explore the idea of adaptations. Students should begin to identify that adaptations are helpful to the organism's survival.
 - Experimental Design: rubric provided in student section.
 - Answers to Stick Bug Research: after reading through the website students should be able to identify different adaptations and explain how those adaptations help survival of stick bugs.
 - Concept map: rubric provided in student section.
- REFERENCES AND RESOURCES**
1. *Animal Adaptations*
http://www.uen.org/utahlink/activities/view_activity.cgi?activity_id=4750
A website produced by the Utah Education network that supplies information on animal adaptations. Accessed on 12/27/10.
 2. *Biology Corner*
http://www.biologycorner.com/worksheets/beaks_feet.html
A website sponsored by a biology teacher provides teachers with lessons, activities, labs and worksheets. Accessed on 12/27/10.
 3. Llewlynn, Douglas. (2005). *Teaching High School Science through Inquiry*. Thousand Oaks, CA: NSTA Press, Corwin Press.
 4. *San Diego Zoo*
<http://www.sandiegozoo.org/zoo/index.php>
A website produced by the San Diego Zoo. Website contains many educational links informing the public about organisms found in this zoo. Accessed on 12/27/10.
 5. *University of California Museum of Paleontology Lessons*
http://www.ucmp.berkeley.edu/education/lessons/candy_dish.html
A paleontology website that offers resources and lessons for K-12 teachers, including the Candy Dish Selection activity authored by Carol Tang. Accessed on 12/27/10.

ANIMAL ADAPTATIONS

Web Info Search: What are examples of animal adaptations and how do they relate to the survival of an organism?

Directions: Visit the “Animal Adaptations” website http://www.uen.org/utahlink/activities/view_activity.cgi?activity_id=4750 to find the answers to the following questions about animal adaptations.

1. What is the mission of the Utah Education Network?
2. Why did they create the website?
3. How credible (accurate) do you think the information is?
4. What does an animal’s habitat provide an animal?
5. What is a physical adaptation? List three examples.
6. Visit the “Lion” section. Research and answer the 6 questions below.
 - What is the purpose of the mane on a male lion?
 - Why are the eyes of a lion set in the front of its head rather than on the sides?
 - A lion has heavily muscled forelimbs and shoulders. Why?
 - Why do they have forepaws equipped with long, retractile claws?
 - Why do they have a rough tongue?
 - Why do they have loose belly skin?
5. Explore the rest of the website. Answer 7 questions about 7 different animals.

Animal	Question	Answer

STICK BUG SURVIVAL

Today you will be predators!! Predators of a delicious insect known as stick bugs. These stick bugs come in four genetically controlled colors – red, green, yellow and tan. Obtain a habitat from your teacher. Your habitat is a box with yellow, red, green, and tan stick bugs and a set of forceps for each member of your group. Assign each member a color of stick bug to hunt. When instructed to do so use your forceps to go hunting. Continue hunting stick bugs until you are instructed to stop hunting. Count your hunting results and record in the table below. Reassign stick bug colors to new group members before starting a new hunting session. Repeat hunting sessions. After 4 hunting sessions each member should have hunted each color of stick bug.

Hunting Session	# of Red Stick Bugs Captured	# of Green Stick Bugs Captured	# of Yellow Stick Bugs Captured	# of Tan Stick Bugs Captured
1				
2				
3				
4				

Brainstorm! What changes could be made to the stick bugs habitat? How would these changes affect the stick bug population? Will these changes help or harm the stick bugs?

After brainstorming your job will be to complete the following

- Ask a question.
- Form a hypothesis.
- Devise an experiment to test your group's hypothesis.
- Collect and analyze data.
- Form a conclusion.

Question	
Hypothesis	
Experiment	
Data	
Conclusion	

Experimental Design and Poster Rubric

Criteria (number of points given in parentheses)	Possible Points	Earned Points	Comments
Question: The question is clear and understandable to a new reader (2), can be investigated using safe and available materials (1), will generate new learning for the investigator (2).	5 points		
Hypothesis: The hypothesis is properly stated as a prediction of what might happen(1), include a brief explanation for why the prediction is made the way it is (2), and describes the expected relationship between variables involved(2).	5 points		
Experiment: The independent and dependent variable is clearly stated. (4), includes all necessary constants (2), includes a clear and thorough description of the procedure to be followed (5), The procedure is designed to gather sufficient amount of data to support or not support the hypothesis (2). Repeated trials are described (2).	15 points		
Data: Data is presented in the form of a neat table and organized in a useful manner (3). Table uses proper labels for the independent and dependent variables (2). Repeated trials are recorded (2)Mean is appropriately calculated.(3)	10 points		
Conclusions: The conclusion attempts to explain WHY the results happened as they did. (2), compares findings to the hypothesis by stating whether data supported or did not support the hypothesis(2), states limitations and possible future investigations (1)	5 points		
Poster/Presentation: All group members participated in presentation (2). Poster displayed a detailed summary of experimental design(4) and findings were clearly presented (4)	10 points		
Total	50 points		

STICK BUG INFORMATION

The San Diego Zoo website has several purposes. Besides advertizing the zoo and its events it also has many educational links to educate the public about the life forms that call this zoo home. Go the following website: <http://www.sandiegozoo.org/zoo/index.php>. This is the homepage of the San Diego Zoo. Click on the “Animals & Plants” tab found on the top of the screen. Under the Animals Category, click on the insect link, then click on the stick insect link to find information about stick bugs. Use this website to answer the following questions.

1. Why are stick bugs known as the masters of disguise?
2. How many different stick bug species are currently known?
3. How do stick bugs reproduce? How does this fact ensure reproduction and survival of the species?
4. Read through the rest of the page and you will find several adaptations that help the stick bug survive. List and describe 4 of these helpful adaptations processed by stick bugs.
5. Why is the conservation status of stick bugs considered “vulnerable”?
6. What are possible adaptations that would be useful to overcome these vulnerabilities?

CONCEPT MAP

Create a concept map including the following words or phrases: theory, inherited variation, Darwin, overpopulation, fitness, natural selection, successful reproduction.

Concept Map Rubric

Criteria (number of points given in parentheses)	Possible Points	Earned Points	Comments
Concept: Concept map shows an understanding of natural selection (2), and uses appropriate terminology (2). Linking words demonstrates understanding on natural selection (1).	5 points		
Organization: Concept map was well organized with a logical format (2). It identifies all main concepts and shows an understanding of relationships between them (3).	5 points		
Participation: Group worked extremely well together (2). All ideas were complemented and respected (3).	5 points		
Total	15 points		