BEAKERBOX
CLEMSON® SCIENCE OUTREACH

ADAPTATION INTRODUCTION

Students think about and discuss why animals have certain traits, then use the fossil record to examine how the structure of a giraffe's neck provides an adaptive function.

SC STATE STANDARD	8-LS4-1 Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operated in the past as they do today. 8-LS4-2 Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer their ancestral relationships.
NEXT GEN STANDARD	MS-LS4-1 Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past. MS-LS4-2 Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.
LEARNING OBJECTIVE(S)	- Students will be able to evaluate fossil records to determine patterns and evaluate evidence. - Students will be able to recognize the impact of the environment on structure and how this relationship affects organism ability to survive and reproduce. - Students will be able to engage in discussion where they can ask questions, defend their interpretations, and work collaboratively. - Students will be able to determine how changes in structure can impact function. - Students will be able to identify cause and effect relationships and provide evidence for these relationships.
ESTIMATED TIME	Two 45 minute class periods

WHAT YOU'LL NEED:

This activity requires a set of adaptation cards. Two sets of laminated cards are provided with the box.

WHAT YOUR STUDENTS SHOULD KNOW BEFORE:

Some general knowledge of adaptation and evolution may be helpful, but not necessary since this activity is designed for students to hypothesize and figure out what effects adaptation and evolution have.

WHAT TO DO BEFORE YOUR CLASS:

Make sure you have adaptation cards, which are available to print in the appendix or are provided as laminated cards in the box.

HOW TO SET UP YOUR CLASS:

Students will work individually, and then discuss their findings in small groups. This may include the grouping of desks if desired.

WHAT YOU NEED TO KNOW FOR YOUR SAFETY:

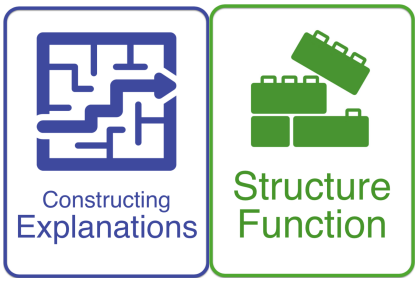
None

This lesson has been designed to follow three dimensional learning, as described in NGSS standards. In this teacher version, we annotate the associated Science and Engineering Practices and Cross-Cutting Concepts using icons (from these NGSS Planning Cards) before the relevant student question and blue and green text, respectively, within the student instructions. Additionally, content and questions that specifically address the Disciplinary Core Idea is represented in orange text. Sample student responses, classroom recommendations, and other hints are in *red italicized text*. See https://scienceweb.clemson.edu/beakerbox/ for additional files such as non-annotated student versions, Spanish versions of student materials, and slides.

ADAPTATION INTRODUCTION

Student activity instructions:

1. Randomly choose one adaptation card from the set of cards.



2. Think about the question on the card. In 3-4 sentences, write down how or why your animal or plant has this feature. Include in your explanation below why you think this structure might help this animal or plant function in its environment.

This activity allows students to begin thinking about adaptations of different organisms and how they benefit from these different traits as they work toward constructing an explanation.

There are 16 unique adaptation cards, so several students may have the same cards.

Some examples of student responses may include coloration, camouflage, spines for protection, size of certain structures, etc.

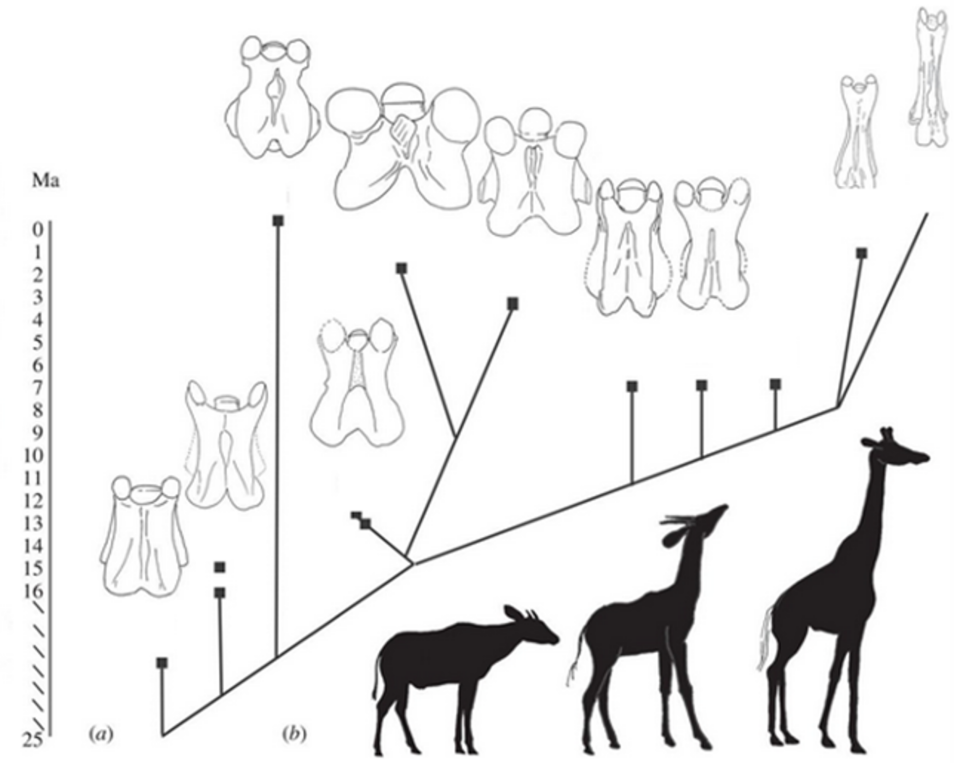
3. Share your thoughts with one or two classmates.
   a. Do you agree or disagree with your classmates' thinking?
   b. What questions do you have about your or your partner's animal's adaptations in general?
   c. What information would help you better evaluate their thinking?

NOTE: This can be done in small groups or as a class. Use these students' questions to create a driving question board.

#1-3 can be repeated for as many adaptation cards as you would like.

Figure 1: Fossil Record of Giraffe

Ma = millions of years ago



(c)

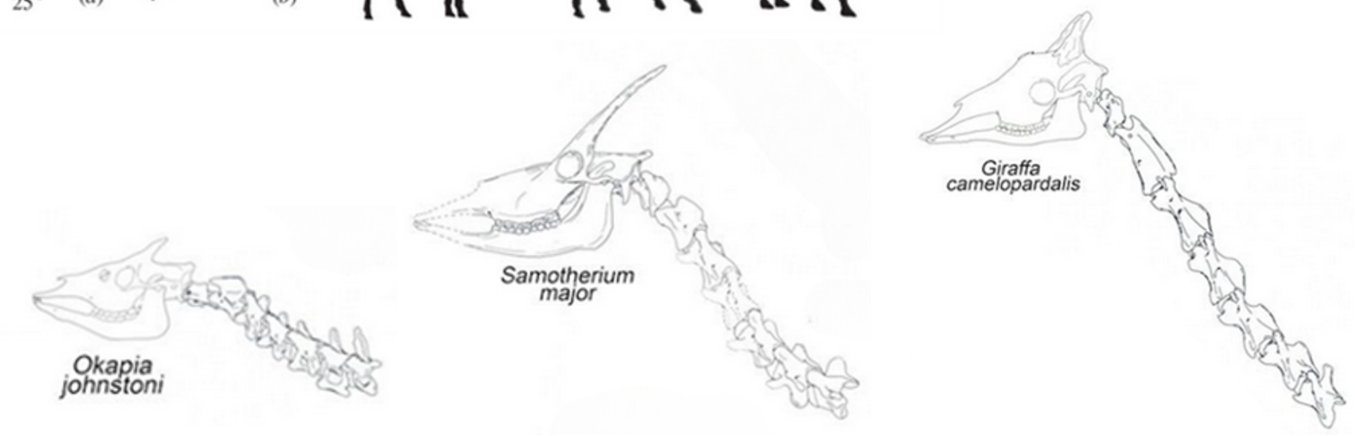
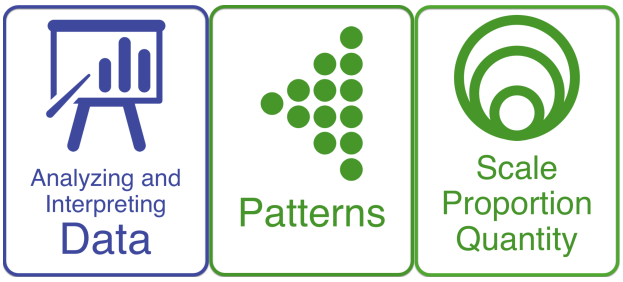


Figure from Danowitz, Vasilyev, Kortlandt, and Solounias. 2015. Fossil evidence and stages of elongation of the *Giraffa camelopardalis* neck. *Royal Society Open Science* 2(10): 150393. doi:10.1098/rsos.150393



4. The above data shows a fossil record of a giraffe. The image shows how their vertebrae (back and neck bones) have changed (adapted) over time. The oldest giraffe ancestor species called *Okapia johnstoni* is shown at the left of part c, and the most recent giraffe species called *Giraffa camelopardalis* is shown on the right of part c.
    a. When you analyze the data in these images, what parts of the giraffes' neck stayed the same and what parts changed? Write your observations in the box provided.
    b. How does the size of vertebrae in the neck relate to the overall proportion of the body? Write your observations in the box provided.

This question prepares the students to write an explanation in question 5

Some concepts to point out here would be the way giraffes don't have more vertebrae than other animals, they are simply larger in size (they have gotten larger over time). This is what creates their very long necks.

5. Explore one or more of the resources provided by your teacher to answer this question.

See the youtube videos, articles, and images below.

    a. How does the structure of the modern giraffe neck provide advantages or disadvantages to how the animal lives and functions?
    b. How do you think the changes over time in the giraffes' necks have affected a giraffe's ability to survive?

Provide explanations 5a and 5b below. Be sure to include evidence to back up the explanations!

Class discussion is possible here (feeding, battling for reproduction rights, battling predators, etc.)

- *A concept to point out here is Structure before function. The change in structure allowed for greater survival (greater function) and therefore more reproduction of those genes*
- *Class discussion is helpful to hear student thinking and address misconceptions*

RESOURCES FOR QUESTION 5

(1) Youtube videos showing giraffes using their necks for various functions in the wild:

- https://www.youtube.com/watch?v=ZKL87WUPAks
- https://www.youtube.com/watch?v=uIquHbS3wHg

(2) Reading about a scientific study on giraffes, including hypotheses about the evolution of neck length:

New Study on Giraffe Neck Evolution: AMNH. American Museum of Natural History. (2022, June 3). https://www.amnh.org/explore/news-blogs/research-posts/giraffe-neck-evolution

Reading Support option: For students with lower Lexile levels, students can read the lower Lexile level article and then read the upper Lexile level article. The two copies of the article cover the same content but with different vocabulary. Students can identify and circle new terms in the higher Lexile article to support new vocabulary development and reading comprehension.

Lexile Level	1410-1600 (HS+ Level)	1010-1200 (8th Grade-HS level)	810-1000 (5th Grade-7th Grade)
Copy of Article	PDF of Original Article	Adapted Article Copy 1	Adapted Article Copy 2

(3) Images of giraffes using their necks:

OPTIONAL EXTENSION AFTER STUDENTS COMPLETE QUESTION 5:

Students have been exposed to two hypotheses about why giraffes have evolved long necks. Engage students in a class debate where they discuss the merits of each hypothesis. Have students conduct additional research and list evidence under each hypothesis. *Note: This would be a good opportunity to teach students how to determine source credibility.*

Hypothesis 1: Giraffes evolved long necks in response to food pressures.	Hypothesis 2: Giraffes evolved long necks in response to reproductive pressures.

Appendix: Adaptation cards

Why do pufferfish expand in size?

Why do giraffes have long necks?

Why do hummingbirds have long beaks?

Why do cacti have spikes?

Why do dart frogs have bright colors?

Why do only male peacocks have large, colorful feathers?

Why do turtles have a hard shell?

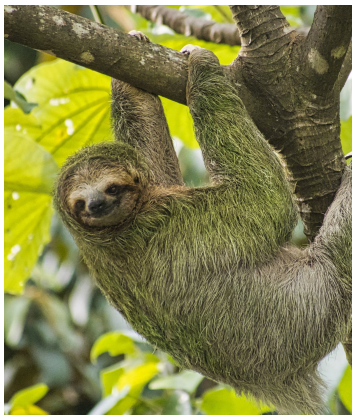
Why do chameleons change colors?

Why do camels have humps?

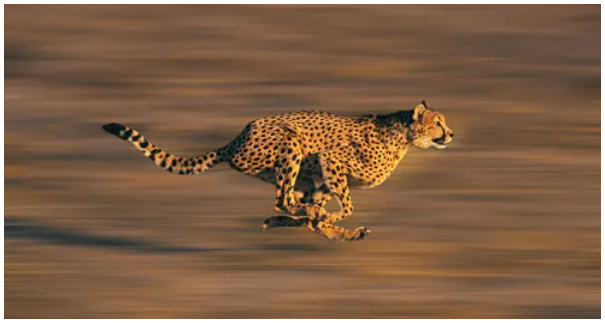
Why are polar bears white?

Why do pelicans have large, deep beaks?

Why do sloths move slowly?



Why do cheetahs run so fast?



Why do zebras have stripes?

Why do squid shoot ink?

Why don't snakes have legs?