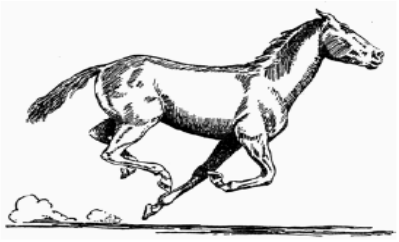
Section 1. Exploring Assessment Items and Formative Assessment Tasks

In this section your team will investigate a number of items and tasks that can be incorporated into formative and/or summative assessments for your students as they progress through this unit. The first twelve items in this section were selected from the released NAEP, TIMSS, & PISA items. These items either involve prerequisite understandings of natural selection and species diversity as outlined in the NGSSS for grades 6-8, or desired student understandings at the high school level. They can be used with students as formative and/or summative assessment items as your team deems appropriate. The released items are followed by a short series of formative assessment tasks that can be employed in your instructional unit on diversity and evolution. Analyze and respond to each item individually before discussing it as a team. For each item, identify the knowledge that is being assessed and answer the following questions:

- How did you respond to the item and how might students respond to it?
- What insights or prerequisite knowledge about species diversity, natural selection, and/or evolution will students need to answer the item satisfactorily?
- What preconceptions or misconceptions about diversity and evolution are addressed by the item?
- What do you think students will find difficult about this item and why do you think this is so?
- At what point in your instructional unit would you implement this assessment item?
- If an item is suitable for use as a formative assessment task, what details, if any, would you modify before submitting it to students?
- Identify possible/probable misconceptions that should be addressed within the assessment. Talking/discussion points for teachers to address misconceptions based on how students answer questions.

The following three items are from the 2006 PISA.

S472: Evolution



Most horses today are streamlined and can run fast.

Scientists have found the fossil skeletons of animals that are similar to horses. They consider them to be the ancestors of the present-day horse. The scientists have also been able to determine the period during which the fossil species were living.

The table below provides information on three of these fossils and on the present-day horse.

ANIMAL NAME:	HYRACOTHERIUM	MESOHIPPUS	MERYCHIPPUS	EQUUS (present-day horse)
Period of existence:	55 to 50 million years ago	39 to 31 million years ago	19 to 11 million years ago	2 million years ago to the present day
Skeleton of the leg (same scale):				

1. EVOLUTION *S472Q01 – 0 1 9*

What information shown **in the table** provides evidence Hyracotherium, Mesohippus, and Merychippus are common ancestors of present-day horses?

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EVOLUTION SCORING 1

Full credit
Code 1: Responses that refer to gradual change (progression) in leg skeleton structure over time.

- The leg skeletons are much the same but have gradually changed.
- The digits/toes fused during the period 55 to 2 million years ago.
- The number of digits has decreased.

No credit
Code 0: Other responses.

- The leg has changed. [Note: Not specific enough.]
- They are called Hippus.
- Genetic mutations have caused the transformations.
[Note: Correct, but does not
answer the question].
- The leg bones are similar.
[Note: Need to mention or imply "gradual change".]

2. EVOLUTION ***S472Q02***

What further research can scientists undertake to find out how horses have evolved over time?
Circle "Yes" or "No" for each of these statements.

Would this research help find out how horses have evolved over time?	**Yes or No?**
Compare the number of horses living at different periods.	Yes / No
Search for skeletons belonging to ancestors of the horse that lived 50 to 40 million years ago.	Yes / No

EVOLUTION SCORING 2
Full credit
Code 1: Both correct: No, Yes, in that order.

No credit
Code 0: Other responses.

3. EVOLUTION *S472Q03*

Which one of the following statements best applies to the scientific theory of evolution?

A. The theory cannot be believed because it is not possible to see species changing.
B. The theory of evolution is possible for animals but cannot be applied to humans.
C. Evolution is a scientific theory that is currently based on extensive evidence.
D. Evolution is a theory that has been proven to be true by scientific experiments.

EVOLUTION SCORING 3

Full credit

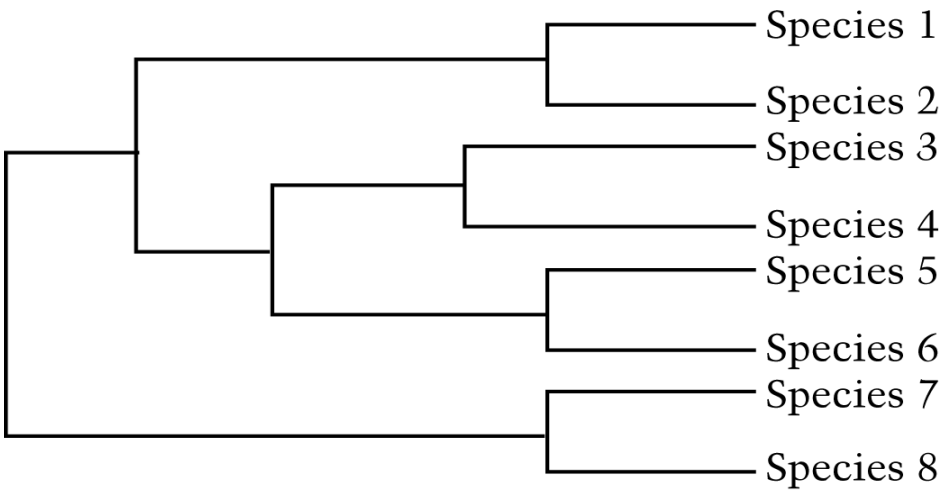
Code 1: C. Evolution is a scientific theory that is currently based on extensive evidence.

No credit

Code 0: Other responses.

The next three items were released from the 2009 NAEP

Scientists are studying the evolutionary history of a group of plants in the United States, and based on the physical evidence collected, they develop an evolutionary tree, as shown below.



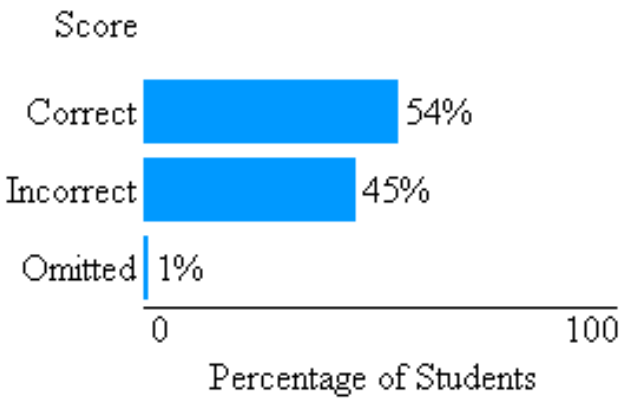
4. What information about the organisms <u>best</u> helps the scientists to determine the evolutionary relationships?

A. DNA sequences
B. Anatomical features

C. Habitat types
D. Reproductive strategies

The correct answer is A.

NAEP national performance results in Science at grade 12: 2009 Identify information used to determine evolutionary relationships



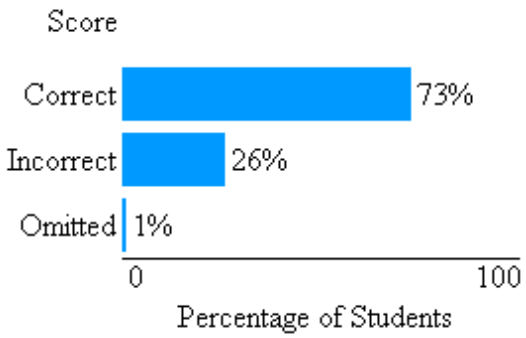
NOTE: These results are for public and nonpublic school students. Percentages may not add to 100 due to rounding. SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2009 Science Assessment.

5. Which statement can be inferred from the evolutionary tree?

A. Species 1 is most closely related to Species 8.
B. Species 2 is most closely related to Species 3.
C. Species 3 is most closely related to Species 6.
D. Species 5 is most closely related to Species 6.

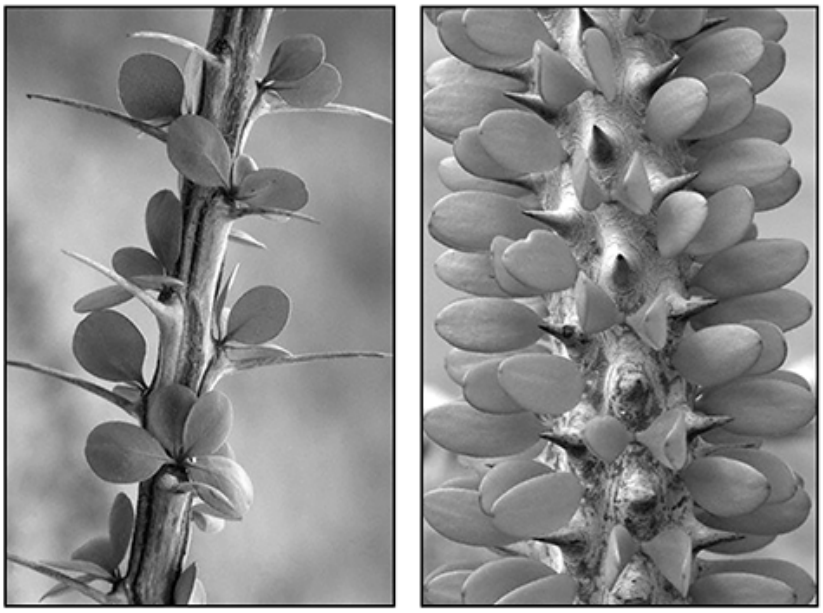
The correct answer is D.

NAEP national performance results in Science at grade 12: 2009. Determine relationships between species based on evolutionary tree



NOTE: These results are for public and nonpublic school students. Percentages may not add to 100 due to rounding. SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2009 Science Assessment.

DIFFERENT PLANT SPECIES WITH SIMILAR LEAF STRUCTURES



Species 8

Species from Madagascar

6. Additional data indicated that Species 8 shares a similar thorny leaf structure with a different plant species found in Madagascar (an African country), as shown below. The scientists hypothesized that different plant species can have similar leaf structures but not be closely related.

Explain how to test the scientists' hypothesis.

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Score & Description

Complete

Student response describes the type of data to be collected and indicates that these data need to be collected from both species and compared.

Partial

Student response describes the type of data to be collected.

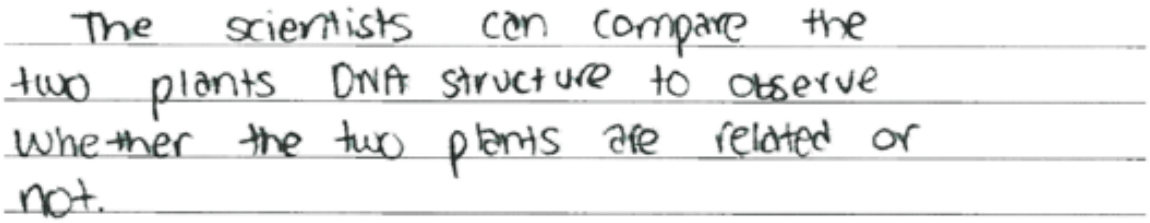
OR

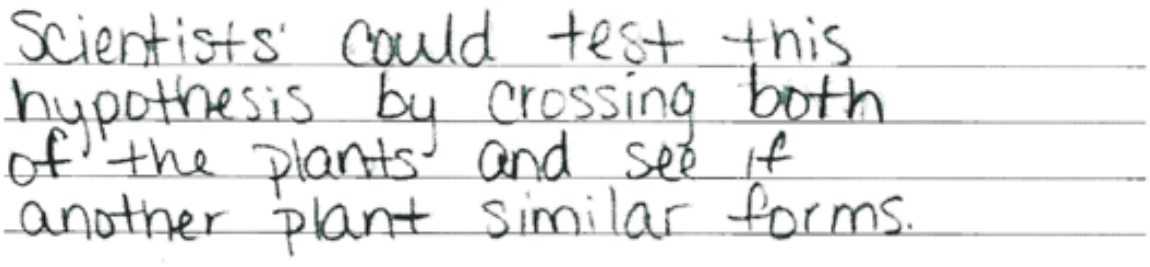
Student response indicates that these data need to be collected from both species and compared.

Unsatisfactory/Incorrect

Sample Responses

The following are two examples of complete responses provided by students for this item.

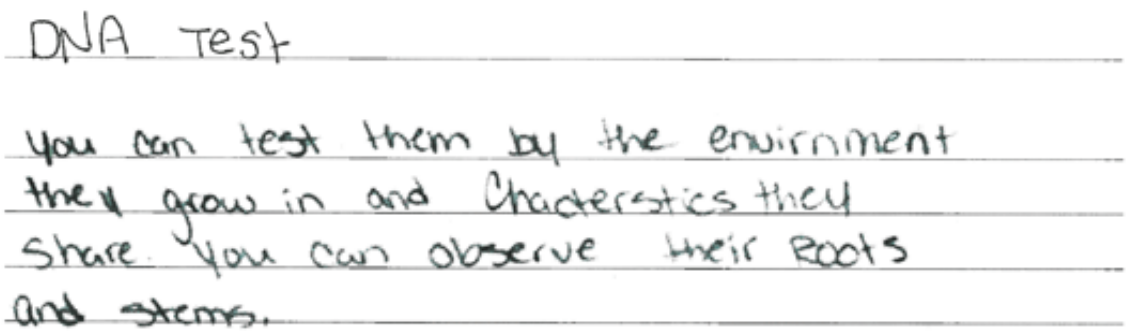




Scorer Comments:

The first response indicates that DNA analysis should be compared between the two species. The second response indicates comparing the traits of both plants to the plants produced from crossbreeding.

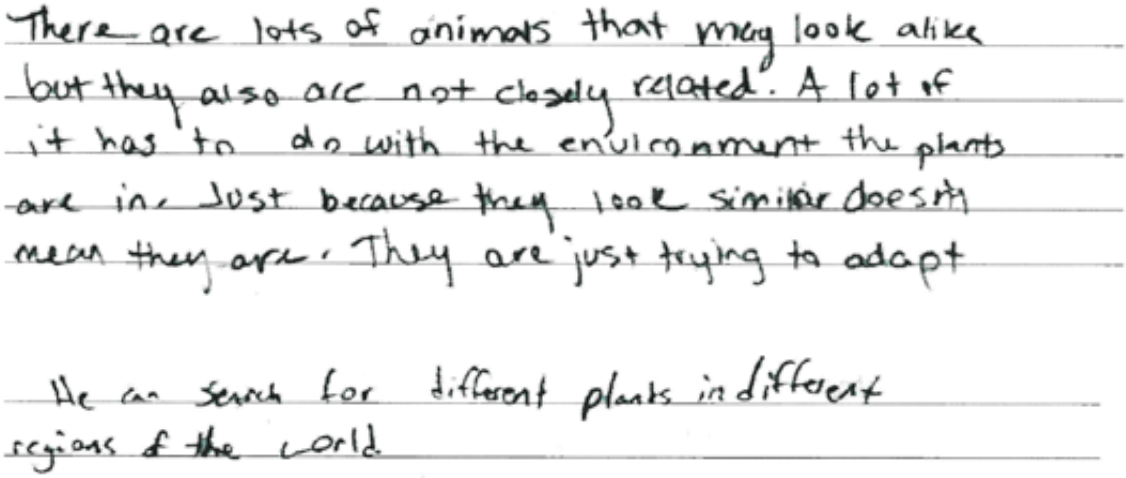
The next two responses are partial responses to this item.



Scorer Comments:

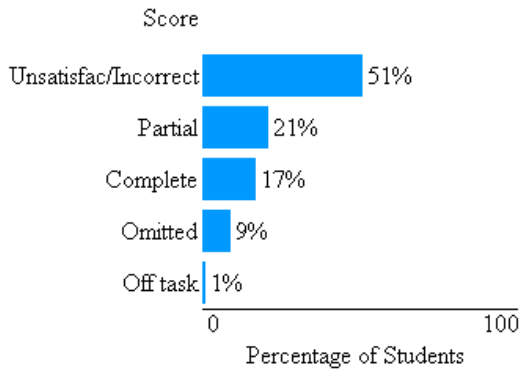
Both responses describe the data that need to be collected, but do not indicate that they should be collected from both species and compared. The first response indicates that DNA analysis should be done, and the second response indicates that root and stem structure should be examined.

The next two samples are unsatisfactory or incorrect responses.



Scorer Comments:

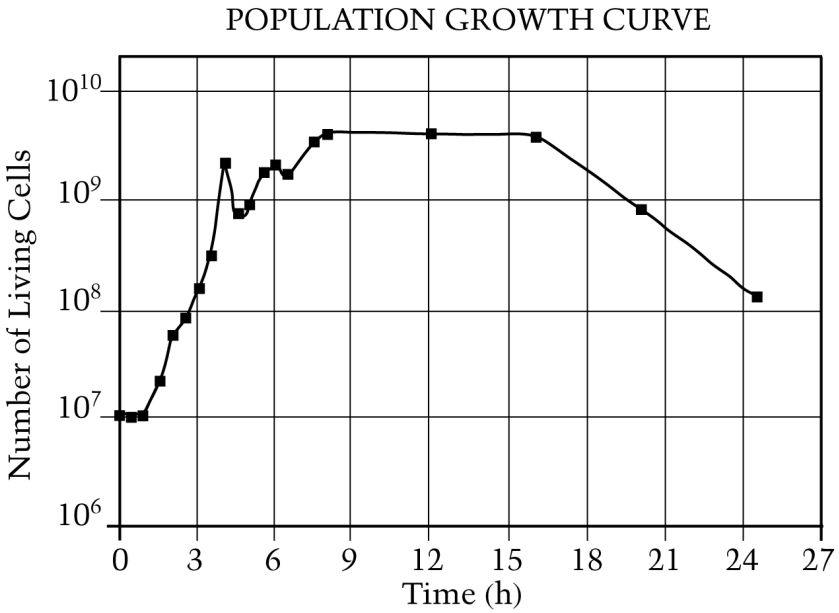
Both responses are incorrect because they do not address either part of the correct explanation. NAEP national performance results in Science at grade 12: 2009. Design experiment to test hypothesis about relatedness of species



NOTE: These results are for public and nonpublic school students. Percentages may not add to 100 due to rounding. Off task applies to responses that do not address the question presented, are illegible, or cannot otherwise be scored. SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2009 Science Assessment.

7. A scientist studied the growth rate of a species of bacterium. The scientist introduced some of the bacteria into a flask of nutrient-rich solution and monitored the growth of the bacterial population by measuring the number of living cells in the solution.

The graph below shows the growth of the bacterial population over time in hours (h).



The scientist wanted to determine the effect of an antibiotic on the growth of the bacterium. To a second flask of nutrient-rich solution with the bacterial cells, he added the antibiotic, and monitored the growth of the bacterial population.

The data showed that most of the bacteria in the solution died, but some survived. The scientist concluded that some of the bacteria were resistant to the antibiotic.

Explain why some of the bacteria were resistant to the antibiotic, based on the theory of evolution.

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Score & Description

Complete

Student response correctly explains that some of the bacteria resistant to the antibiotic had a genetic mutation. The resistant bacteria divided passing the genetic mutation to the next generation.

Partial

Student response indicates that some of the bacteria resistant to the antibiotic had a genetic mutation.
OR
Student response indicates that the resistant bacteria divided, passing the genetic mutation to the next generation.

Unsatisfactory/Incorrect

Student response is inadequate or incorrect.

Complete - Student Response

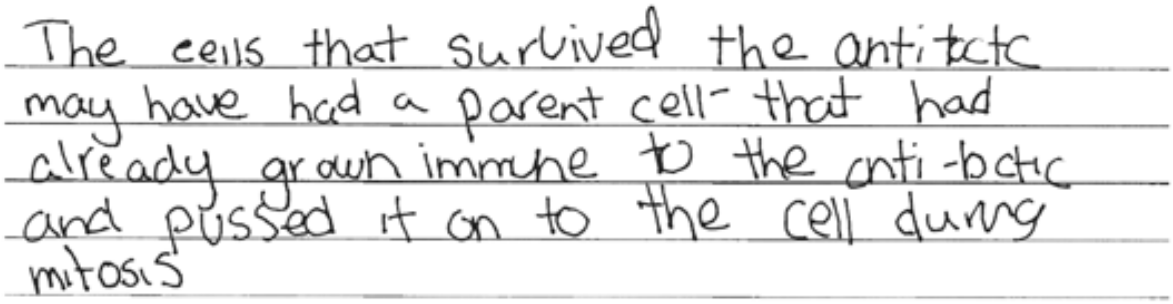
benefic molatons in Same of the bacteria allowed then to Survive and propsete. This, their offspring inherited the survival trait of their parents and were abt to continue to grow while others died Off.

some bacteria were resistant because of mutations which happened within their DNA, which made them able to withstand the anti biotic, those bacteria then passed the new genes to their ofspring

Scorer Comments: Both responses indicate that resistant bacteria are a result of genetic mutations, which are passed to their offspring.

Partial - Student Response

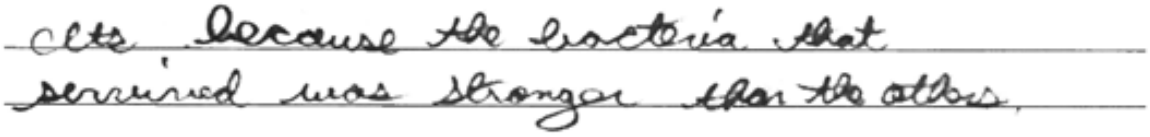
In the process of evolution, some members of a species may develop mutations that variate from the rest of the group. In some cases, this mutation makes these members more able, or "fatter," to survive. Thus, survival of the fittest determines who lives and who dies.

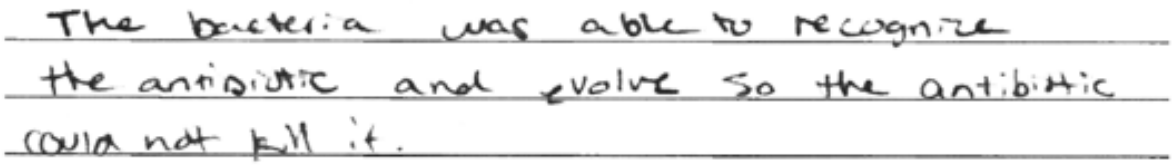


Scorer Comments:

The first response indicates that resistant bacteria are a result of genetic mutations. The second response indicates that the antibiotic resistance is passed from parent to offspring.

Unsatisfactory/Incorrect - Student Response

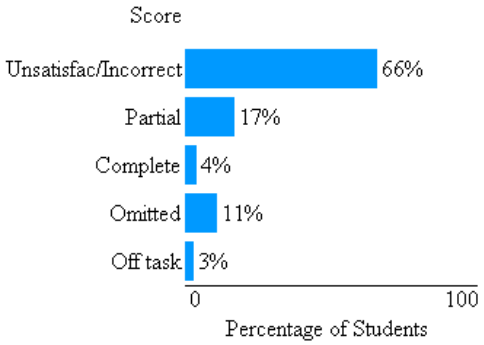




Scorer Comments:

Neither response indicates that resistant bacteria are a result of genetic mutations, which are passed to their offspring. The first response incorrectly indicates that strength determines survival. The second response incorrectly indicates that bacteria change in response to the antibiotic.

NAEP national performance results in Science at grade 12: 2009. Relate evidence to natural selection



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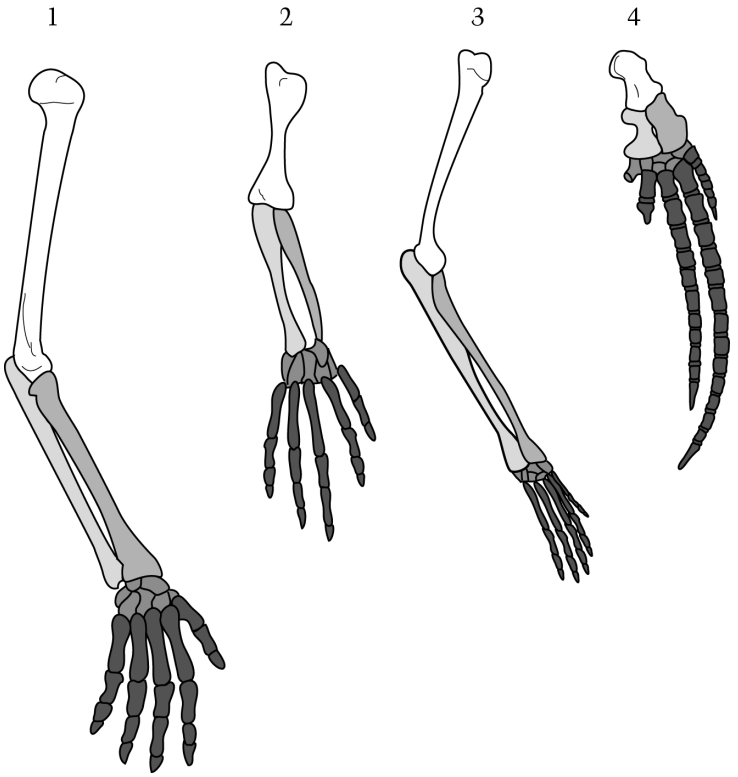
Questions 8-9 refer to the following diagram of forelimbs of different animals.

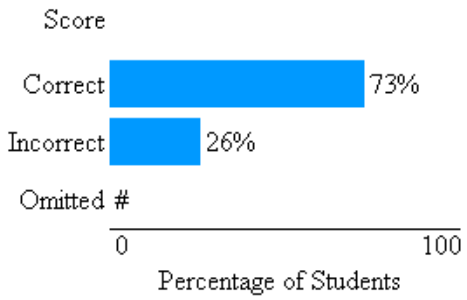


8. Based on the anatomical structure of the forelimbs, which animal most likely evolved to live only in an aquatic (water) environment?

The correct answer is D.

NAEP national performance results in Science at grade 12: 2009

Relate anatomical structure to habitat



Rounds to zero.

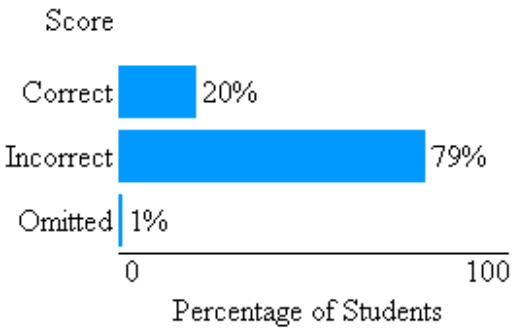
NOTE: These results are for public and nonpublic school students. Percentages may not add to 100 due to rounding. SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2009 Science Assessment.

9. Which statement best helps to explain how these different structures could arise from a common precursor?

A. Mutations in the genes regulating limb development led to gradual changes in structure, which provided a selective advantage to the organisms.
B. A single mutation in the genes regulating limb development resulted in a change in structure, which led to the modified limbs in offspring.
C. Changes in the environment caused mutations in the genes regulating limb development, which provided a means to thrive under the new conditions.
D. Limbs changed in response to the changing needs of the organisms, which led to the modified limbs in offspring.

The correct answer is A.

NAEP national performance results in Science at grade 12: 2009. Explain variations in development of anatomical features



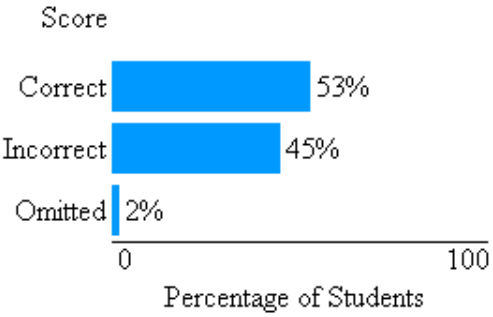
NOTE: These results are for public and nonpublic school students. Percentages may not add to 100 due to rounding. SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2009 Science Assessment.

10. Which of the following is <u>most</u> consistent with the modern theory of evolution?

A. Parents pass their physical traits to their offspring; those offspring with traits that help them survive in the environment are able to reproduce.
B. Parents change their physical traits in order to survive in the environment, then those parental traits are passed to their offspring.
C. Life on this planet came from another planet far out in space.
D. Living organisms have not changed for hundreds of millions of years.

The correct answer is A.

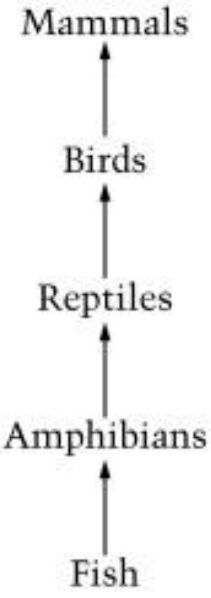
NAEP national performance results in Science at grade 8: 2000. Theory of evolution



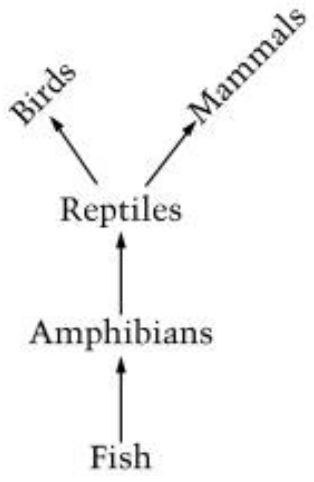
NOTE: These results are for public and nonpublic school students. Percentages may not add to 100 due to rounding. SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2000 Science Assessment.

11. According to evolutionary theory, which of the following evolutionary trees best describes the relationship between groups of vertebrates?

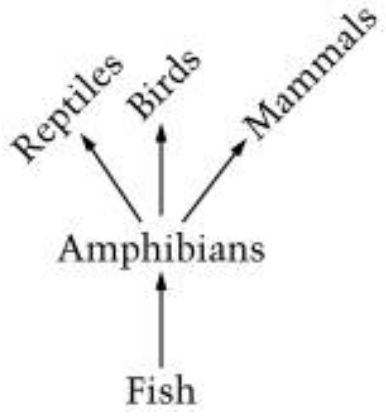
A.



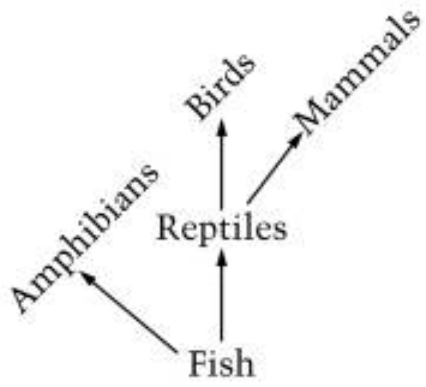
B.



C.

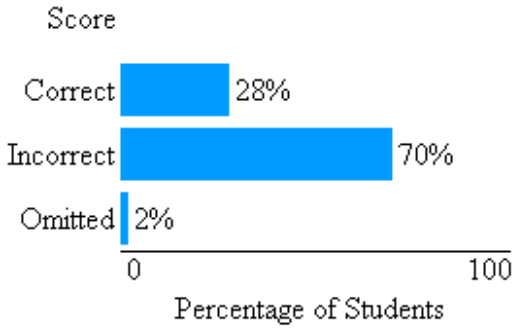


D.



The correct answer is B.

NAEP national performance results in Science at grade 12: 2000. Evolutionary trees



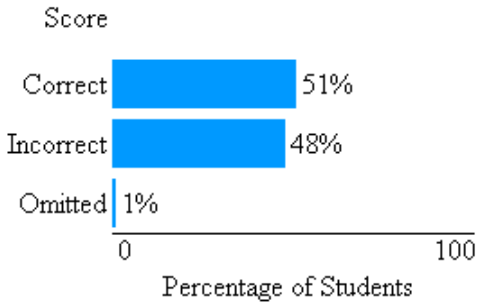
NOTE: These results are for public and nonpublic school students. Percentages may not add to 100 due to rounding. SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2000 Science Assessment.

12. Which of the following is NOT a part of Darwin's theory of evolution by natural selection?

A. Individuals in a population vary in many ways.
B. Some individuals possess features that enable them to survive better than individuals lacking those features.
C. More offspring are produced than can generally survive.
D. Changes in an individual's genetic material are usually harmful.

The correct answer is D.

NAEP national performance results in Science at grade 12: 2000. Darwin's theory of evolution



NOTE: These results are for public and nonpublic school students. Percentages may not add to 100 due to rounding. SOURCE: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2000 Science Assessment.

Formative Assessment Tasks

Access the "Visualizing life on Earth: data interpretation in evolution" **web page at** http://evolution.berkeley.edu/evolibrary/article/0_0_0/ldg_01

After working through each of the activities individually, discuss your responses to the following questions:

Lesson Study Discussion Questions

1. How did you reply to the task?
2. How might your students reply to the task?
3. What understandings, misunderstandings, and/or misconceptions about evolution might this task reveal?
4. How can your team ensure in your planning that students are afforded opportunities to interact deeply with the concepts about which they have misconceptions, so that they can move toward more scientific understandings?
5. Do you think your students would find this task challenging?
6. Which of these tasks would you adapt as formative assessments for your students?