Specification for Assessment #10

Supporting a Scientific Theory with Evidence

Competency

Student can provide examples of evidence that support a scientific theory.

Focus of this assessment:

- ☑ Declarative knowledge
- ☐ Procedural knowledge
- ☐ Problem solving

Evidence

Providing examples of evidence that support a particular scientific theory includes being able to explain why a particular observation constitutes supporting evidence for the theory. Because the focus is on the ability to provide and explain supporting evidence, students should already be familiar with the particular theory. Although the competency applies generally to scientific theories, this specification focuses on structural homology and fossil data as evidence for the scientific theory of evolution.

Students are provided examples of observations that may be interpreted to support the scientific theory of evolution and asked to formulate a rationale for how the observations support the theory. Students are also asked to provide related evidence that may be interpreted to support the scientific theory of evolution. A well-developed explanation includes proper use of terminology related to the theory and inclusion of relevant concepts.

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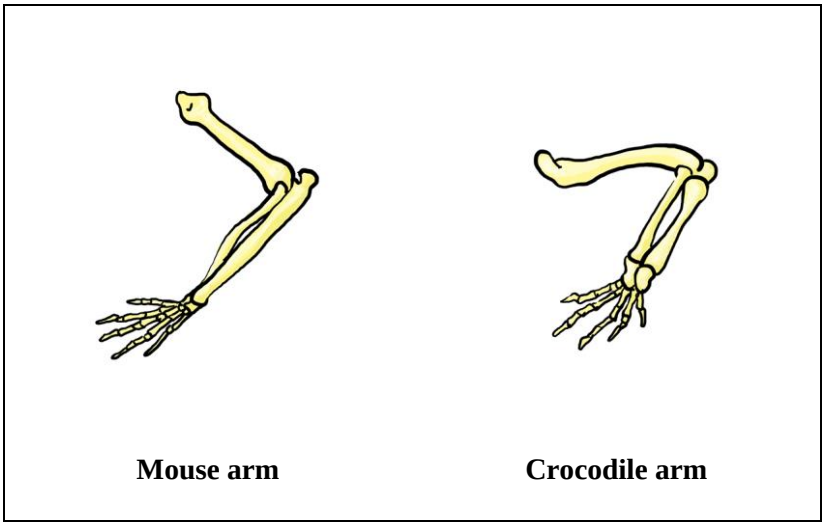
Example Task

Part 1

The arms of a mouse and a crocodile are shown in the figure below. Use the figure to answer the following question.



The scientific theory of evolution claims that **different species are related**. Explain how each animal having five fingers could be used as evidence to support this claim. Provide enough detail so that someone who is unfamiliar with the scientific theory of evolution would understand your explanation. Use appropriate scientific terms in your response.

Example Task (continued)

Choose two animals from the list below. Then, provide five examples of these animals' physical structures that could be used as evidence that they are evolutionarily related.

Horse	Crow	Lizard
Grasshopper	Frog	Goldfish

Which two animals do you choose?

1st animal:
2nd animal:

Below, describe five examples of physical structures that could be used as evidence that the two animals are evolutionarily related:

1st physical structure:

2nd physical structure:

3rd physical structure:

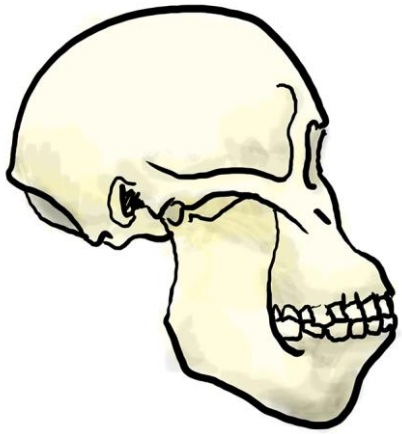
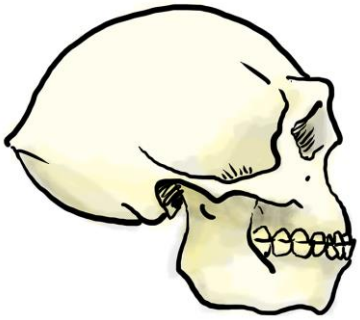
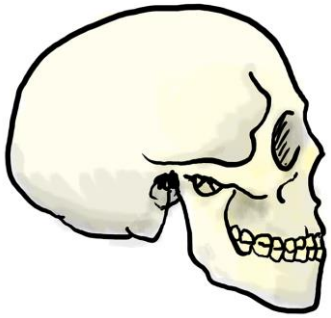
4th physical structure:

5th physical structure:

Example Task (continued)

Part 2

Fossil evidence exists for the three different species shown in the figure below. Use the figure to answer the questions on the following page.

	**Species A** Fossil evidence is 3.5 million years old. Braincase volume is 375–500 cm^3.
	**Species B** Fossil evidence is 1.8 million years old. Braincase volume is 850–1100 cm^3.
	**Species C** Fossil evidence is 200,000 years old. Braincase volume is 1330–1400 cm^3.

Example Task (continued)

The scientific theory of evolution claims that **traits can change within populations over time**. Explain how the information in the figure could be used as evidence to support this claim. Provide enough detail so that someone who is unfamiliar with the scientific theory of evolution would understand your explanation. Use appropriate scientific terms in your response.

Describe the evolutionary processes that cause traits to change over time. Use the species' braincase volume as an example. Provide enough detail so that someone who is unfamiliar with the scientific theory of evolution would understand your explanation. Use appropriate scientific terms in your response.

Scoring Plan for the Example Task

Note: Correct answers written in the wrong section of a particular assessment, but intended for the appropriate prompt, will be graded in full. For example, observable evidence can appear under the limiting factor hypothesis prompt.

Part 1: Homology

Common Ancestry	
Student indicates that mice and crocodiles could have evolved from a common ancestor. • For example, "they evolved from the same animal" or "they evolved from a four-legged animal." • The response must contribute new information beyond what is given in the prompt. For example, "they are related" or "they are relatives" is not sufficient to receive credit. • No point is awarded for indicating that one of the presented species is ancestral to the other.	2 pts.
Note: Credit for the following five scoring items may only be earned if the student is awarded the previous item for indicating common ancestry.	
Student provides sufficient detail so that someone who is unfamiliar with the scientific theory of evolution would understand how homologous structures (not homoplasious structures, which are similar in form and function but separately evolved) support the theory of evolution. • For example, the student describes the process by which the mice and crocodiles could each have inherited four legs from a common ancestor.	1 pt.
Homologous Structures	
Student describes a specific similarity between physical structures (e.g., number of fingers, number of legs) of mice and crocodiles. • The similarity the student describes does not have to be visible within the illustration.	1 pt.
Student describes a specific variation or difference between physical structures (e.g., length of ulna, shape of head) of mice and crocodiles. • The variation the student describes does not have to be visible within the illustration.	1 pt.
Terminology	
Student uses the term *common ancestor* or equivalent scientific terminology (e.g., *like ancestor*, *shared ancestor*) to refer to the concept of common ancestry.	1 pt.
Student uses the term *homology* or equivalent scientific terminology (e.g., *homologous structure*, *comparative anatomy*) to refer to the concept of homology.	1 pt.

Scoring Plan for the Example Task (continued)

Examples of Homologous Structures	
For the 1st physical structure, student names a homologous structure shared by the two animals indicated. Responses that would NOT receive credit include • Only describing a shared behavior, such as "each one breathes" or "they both make nests." • Comparing animals' size or coloration. • Stating a shared lack of a specific physical structure. • Describing nonspecific characteristics, such as "things," "organs," "skin," or "muscles," or characteristics common to *all* animals.	1 pt.
As above, for a 2nd physical structure.	1 pt.
As above, for a 3rd physical structure.	1 pt.
As above, for a 4th physical structure.	1 pt.
As above, for a 5th physical structure.	1 pt.

Scoring Plan for the Example Task (continued)

Part 2: Fossil Evidence

Physical Structure	
Student provides an example of a specific trend in a physical structure changing over time (e.g., limb articulation) of the three fossils presented in the figure. • Credit can still be awarded if the student incorrectly interprets the fossils' ages in reverse chronological order.	2 pts.
Student is awarded the preceding item ***and*** provides sufficient detail so that someone who is unfamiliar with the scientific theory of evolution would understand the explanation. • Student may earn credit by providing a description of a potential cause for the trend (e.g., adaptation to a selective pressure).	1 pt.
Chronology	
Student explains how the ages of the three fossils are consistent with a trait changing within populations over time. • For example, credit is given for indicating a progression through time (e.g., "over the years," "gradually").	2 pts.
Student is awarded the preceding item ***and*** provides sufficient detail so that someone who is unfamiliar with the scientific theory of evolution would understand the explanation. • For example, credit is given for citing specific fossils' ages or number of years between fossils' ages.	1 pt.
Terminology	
Student uses the term *adaptation* or equivalent scientific terminology (e.g., *increased fitness*) to refer to the concept of adaptation.	1 pt.

Scoring Plan for the Example Task (continued)

Note: Credit is awarded if scoring criteria are met by the response to the first prompt in part 2 (e.g., the student discusses the concept of selection in the previous explanation).

Variation	
Student describes the concept of variation (e.g., braincase volume, phenotype, genotype) within populations. • Response must indicate that variation existed within a single population at a particular point in time, not over time. Indicating that one species had different braincase sizes than the other is not sufficient, because this implies variation over time.	2 pts.
Note: Credit for the following two scoring items may only be earned if the student is awarded the previous item for describing the concept of variation.	
Student uses the term *variation* or equivalent scientific terminology (e.g., *phenotypic differences, differences in genotype*) to refer to the concept of variation.	1 pt.
Student provides sufficient detail so that someone who is unfamiliar with the scientific theory of evolution would understand the concept of variation. • For example, student provides an example of variation in a specific trait (e.g., "some members of species A had larger brains and some smaller").	1 pt.
Selection	
Student indicates that selection (e.g., natural, sexual) occurred based on variation in braincase volume. • For example, student provides an example of a selective pressure that may have acted on braincase volume.	2 pts.
Note: Credit for the following two scoring items may only be earned if the student is awarded the previous item for describing the concept of selection.	
Student uses the term *selection* or equivalent scientific terminology (e.g., *differential reproduction*) to refer to the concept of selection.	1 pt.
Student provides sufficient detail so that someone who is unfamiliar with the scientific theory of evolution would understand the concept of selection. • For example, student describes specific differences within a population at a given time and states one of the phenotypes may have had a selective advantage (e.g., "Some members of species A had larger brains and that helped them be smarter.").	1 pt.

Scoring Plan for the Example Task (continued)

Inheritance	
Student indicates that changes in braincase volume could have been inherited by offspring.	2 pts.
Note: Credit for the following two scoring items may only be earned if the student is awarded the previous item for describing the concept of inheritance.	
Student uses the term *inheritance* or equivalent scientific terminology (e.g., *heredity, genetic, genotype*) to refer to the concept of inheritance.	1 pt.
Student provides sufficient detail so that someone who is unfamiliar with the scientific theory of evolution would understand the concept of inheritance. • For example, student states that traits are inherited through genes.	1 pt.

Procedure for Creating Parallel Tasks

Parallel tasks will reference different examples of homologous structures and fossil progressions.

Part 1: Homologous Structures

- Provide a brief statement specifically referencing a similarity between two animals without using the word *homology* or other advanced vocabulary, or stating how the example could be used as evidence in support of the scientific theory of evolution. Be sure the structures you choose are homologous structures, rather than analogous structures. Homologous structures are structures shared by different species due to common ancestry, whereas analogous structures are structures that are similar but have evolved separately. Include references to the specific similarity in the sections above and below the figure.
- The pictures must
    - clearly depict in both animals the physical similarity referenced in the preceding statement.
    - both be illustrations or both be photographs.
    - both represent the entire animal or both represent the homologous structure exhibited by the animals.
- List six animals. The six animals must
    - each be one with which the student is reasonably expected to be familiar.
    - each be listed by their common or colloquial name (i.e., use "squirrel" instead of "*Sciurus carolinensis*").
    - not be ones used elsewhere in the assessment.
    - represent each of the following six categories (in any order): mammal, bird, insect, fish, reptile, and amphibian.

Part 2: Fossil Progressions

- List three species
    - for which fossil evidence exists.
    - in chronological order.
    - that represent a trend in a physical structure.
- Include a picture of each species. The pictures must
    - each represent an entire organism or each represent a homologous structure exhibited by each of the three species.
    - each be illustrations or each be photographs.
- For each species, indicate
    - its name.
    - the approximate age of its fossil evidence.
    - a measurement or brief description of the differences in a homologous structure exhibited by each of the three species.

Scoring Plan for Parallel Tasks

Note: Correct answers written in the wrong section of a particular assessment, but intended for the appropriate prompt, will be graded in full. For example, observable evidence can appear under the limiting factor hypothesis prompt.

Scoring plan used for the example task	Generic scoring criteria for all parallel tasks

Part 1: Homologous Structures

Common Ancestry		
Student indicates that mice and crocodiles could have evolved from a common ancestor. • For example, "they evolved from the same animal" or "they evolved from a four-legged animal." • The response must contribute new information beyond what is given in the prompt. For example, "they are related" or "they are relatives" is not sufficient to receive credit. • No point is awarded for indicating that one of the presented species is ancestral to the other.	Student indicates that the two animals could have evolved from a common ancestor. • For example, "they evolved from the same animal." • The response must contribute new information beyond what is given in the prompt. For example, "they are related" or "they are relatives" is not sufficient to receive credit. • No point is awarded for indicating that one of the presented species is ancestral to the other.	2 pts.
Note: Credit for the following five scoring items may only be earned if the student is awarded the previous item for indicating common ancestry.		
Student provides sufficient detail so that someone who is unfamiliar with the scientific theory of evolution would understand how homologous structures (not homoplasious structures, which are similar in form and function but separately evolved) support the theory of evolution. • For example, the student describes the process by which the mice and crocodiles could each have inherited four legs from a common ancestor.	Student provides sufficient detail so that someone who is unfamiliar with the scientific theory of evolution would understand how homologous structures (not homoplasious structures, which are similar in form and function but separately evolved) support the theory of evolution. • For example, the student describes the process by which the two animals could each have inherited a trait from a common ancestor.	1 pt.
Homologous Structures		
Student describes a specific similarity between physical structures (e.g., number of fingers, number of legs) of mice and crocodiles. • The similarity the student describes does not have to be visible within the illustration.	Student describes a specific similarity between physical structures of the two animals. • The similarity the student describes does not have to be visible within the illustration.	1 pt.

Scoring Plan for Parallel Tasks (continued)

Student describes a specific variation or difference between physical structures (e.g., length of ulna, shape of head) of mice and crocodiles. • The variation the student describes does not have to be visible within the illustration.	Student describes a specific variation or difference between physical structures of the two animals. • The variation the student describes does not have to be visible within the illustration.	1 pt.
Terminology		
Same as generic.	Student uses the term *common ancestor* or equivalent scientific terminology (e.g., *like ancestor*, *shared ancestor*) to refer to the concept of common ancestry.	1 pt.
Same as generic.	Student uses the term *homology* or equivalent scientific terminology (e.g., *homologous structure*, *comparative anatomy*) to refer to the concept of homology.	1 pt.
Examples of Homologous Structures		
Same as generic.	For the 1st physical structure, student names a homologous structure shared by the two animals indicated. Responses that would NOT receive credit include • Only describing a shared behavior, such as "each one breathes" or "they both make nests." • Comparing animals' size or coloration. • Stating a shared lack of a specific physical structure. • Describing nonspecific characteristics, such as "things," "organs," "skin," or "muscles," or characteristics common to *all* animals.	1 pt.
Same as generic.	As above, for a 2nd physical structure.	1 pt.
Same as generic.	As above, for a 3rd physical structure.	1 pt.
Same as generic.	As above, for a 4th physical structure.	1 pt.
Same as generic.	As above, for a 5th physical structure.	1 pt.

Scoring Plan for Parallel Tasks (continued)

Part 2: Fossil Evidence

Physical structure		
Student provides an example of a specific trend in a physical structure changing over time (e.g., limb articulation) of the three fossils presented in the figure. • Credit can still be awarded if the student incorrectly interprets the fossils' ages in reverse chronological order.	Student provides an example of a specific trend in a physical structure changing over time of the three fossils presented in the figure. • Credit can still be awarded if the student incorrectly interprets the fossils' ages in reverse chronological order.	2 pts.
Same as generic.	Student is awarded the preceding item ***and*** provides sufficient detail so that someone who is unfamiliar with the scientific theory of evolution would understand the explanation. • Student may earn credit by providing a description of a potential cause for the trend (e.g., adaptation to a selective pressure).	1 pt.
Chronology		
Same as generic.	Student explains how the ages of the three fossils are consistent with a trait changing within populations over time. • For example, credit is given for indicating a progression through time (e.g., "over the years," "gradually").	2 pts.
Same as generic.	Student is awarded the preceding item ***and*** provides sufficient detail so that someone who is unfamiliar with the scientific theory of evolution would understand the explanation. • For example, credit is given for citing specific fossils' ages or number of years between fossils' ages.	1 pt.
Terminology		
Same as generic.	Student uses the term *adaptation* or equivalent scientific terminology (e.g., *increased fitness*) to refer to the concept of adaptation.	1 pt.

Scoring Plan for Parallel Tasks (continued)

Note: Credit is awarded if scoring criteria are met by the response to the first prompt in part 2 (e.g., the student discusses the concept of selection in the previous explanation).

Variation		
Student describes the concept of variation (e.g., braincase volume, phenotype, genotype) within populations. • Response must indicate that variation existed within a single population at a particular point in time, not over time. Indicating that one species had physical structures different from the other is not sufficient, because this implies variation over time.	Student describes the concept of variation (e.g., phenotype, genotype) within populations. • Response must indicate that variation existed within a single population at a particular point in time, not over time. Indicating that one species had physical structures different from the other is not sufficient, because this implies variation over time.	2 pts.
Note: Credit for the following two scoring items may only be earned if the student is awarded the previous item for describing the concept of variation.		
Same as generic.	Student uses the term *variation* or equivalent scientific terminology (e.g., *phenotypic differences, differences in genotype*) to refer to the concept of variation.	1 pt.
Student provides sufficient detail so that someone who is unfamiliar with the scientific theory of evolution would understand the concept of variation. • For example, student provides an example of variation in a specific trait (e.g., "Some members of species A had larger brains and some smaller.").	Student provides sufficient detail so that someone who is unfamiliar with the scientific theory of evolution would understand the concept of variation. • For example, student provides an example of variation in a specific trait.	1 pt.
Selection		
Student indicates that selection (e.g., natural, sexual) occurred based on variation in braincase volume. • For example, student provides an example of a selective pressure that may have acted on braincase volume.	Student indicates that selection (e.g., natural, sexual) occurred based on variation in a specific trait.	2 pts.
Note: Credit for the following two scoring items may only be earned if the student is awarded the previous item for describing the concept of selection.		
Same as generic.	Student uses the term *selection* or equivalent scientific terminology (e.g., *differential reproduction*) to refer to the concept of selection.	1 pt.

Scoring Plan for Parallel Tasks (continued)

Student provides sufficient detail so that someone who is unfamiliar with the scientific theory of evolution would understand the concept of selection. • For example, student describes specific differences within a population at a given time and states one of the phenotypes may have had a selective advantage (e.g., "Some members of species A had larger brains and that helped them be smarter.").	Student provides sufficient detail so that someone who is unfamiliar with the scientific theory of evolution would understand the concept of selection. • For example, student describes specific differences within a population at a given time and states one of the phenotypes may have had a selective advantage.	1 pt.
Inheritance		
Student indicates that changes in braincase volume could have been inherited by offspring.	Student indicates that changes in a specific trait could have been inherited by offspring.	2 pts.
Note: Credit for the following two scoring items may only be earned if the student is awarded the previous item for describing the concept of selection.		
Same as generic.	Student uses the term *inheritance* or equivalent scientific terminology (e.g., *heredity*, *genetic*, *genotype*) to refer to the concept of inheritance.	1 pt.
Same as generic.	Student provides sufficient detail so that someone who is unfamiliar with the scientific theory of evolution would understand the concept of inheritance. • For example, student states that traits are inherited through genes.	1 pt.